THE DEVELOPMENT OF *LACHENALIA* CULTIVARS

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LIST OF ABBREVIATIONS

2*n*	- Somatic chromosome number
AHC	- Agglomerative hierarchical clustering
ARC	- Agricultural Research Council
cm	- centimeter
D	- Many abnormal seeds
DAPI	- 4',6-diamidino-2-phynylindole
DNA	- Deoxyribonucleic Acid
ED	- Few abnormal seeds
EN	- Few normal seeds
FISH	- fluorescent in situ hybridization
GS	- No seed set
Gy	- Gray
ITS	- Internal Transcribed Spacer
n	- Gametic Chromosome Number
N	- many normal seeds
OrMV	- *Ornithogalum* Mosaic virus
PCA	- Principle Component Analysis
RAPD	- Random Amplified Polymorphic DNA
rDNA	- ribosomal DNA
SANBI	- South African National Biodiversity Institute
SC	- Self compatible
SI	- Self incompatible
trnF	- Transfer RNA gene for Phenylalanine
trnL	- Transfer RNA gene for Leucine
USA	- United States of America
USDA-ARS	- United States Department of Agriculture – Agricultural Research Service
VOPI	- Vegetable and Ornamental Plant Institute
x	- basic chromosome number
XLSTAT	- Excel Statistical program

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CHAPTER 1

INTRODUCTION TO *LACHENALIA* CULTIVAR DEVELOPMENT

Flowers have become a part of everyday life for many people and this fact supports the growing international ornamental industry. Flowers are used to beautify, to celebrate major life events, to display art and to express emotion and have formed part of different cultures for many thousands of years. The importance of flowers is illustrated by their mention in mythology, ancient history, art and literature over many centuries. The more recent movement towards the green environment has opened even more doors for the flower industry to grow.

The floriculture or ornamental industry is worth more than US$ 30 billion in import and exports alone (Boshoff, 2010) with a production value world-wide that rose to an estimated US$60 billion in 2003 (Van Uffelen & De Groot, 2005). The industry is dynamic and closely links to fashion and life style, thus explaining the interest in novel products as well as the constantly changing demands and requirements for these new products. The industry is also hugely competitive and the ability to innovate and adapt to market changes is essential for growth.

The establishment of new market interest along with the retention of current market interest is needed for continuous growth. New products have been one of the ways to address this vibrant market sector. New products can include new cultivars/ selections of existing floriculture crops, but also the development of completely new/novel crops for marketing and distribution. The regular release of new cultivars of existing crops like roses and lilies forms part of the innovation in the market to maintain the market share of these flower crops. There is, however, an international saturation with traditional plants and flowers which in turn stimulates the interest in novelties or new crops (Benschop *et al.,* 2010). Southern Africa is one of the centres of diversity for floriculture crops. Species from this region can and has played an important role in the diversification of new plant species in the international market.

Breeders in other parts of the world have used South African plant species extensively. These species were improved through hybridization, development and commercialization. Five plant species (*Gerbera, Freesia, Zantedeschia, Gladiolus* and *Ornithogalum*) native to South Africa generated a turn-over revenue of more than €218 million on Dutch auctions in 2009 (Anon, 2010a). This illustrates the importance of South African plant species in the international trade. Yet most of these plant species were developed elsewhere and are being produced and sold on international auctions without many benefits flowing back to South Africa.

The question on how this situation can be changed, thus rightfully needs to be asked. There are various actions that can address this question, but the local development of indigenous plants through breeding and selection is probably the most important for sustainable development of new crops. The development of new cultivars and the local production and export of this material can furthermore support the flow of benefits back to South Africa. These benefits can include amongst others the generation of foreign revenue from export, the creation of job opportunities from the production of material and the local establishment of expertise.

Breeding and selection is, however, an expensive exercise requiring expertise and commitment over an extended period of time. On a continent where the absence of food security is a real threat to the existence of many people, research, however, rightly tends to be focused on food crops. Floriculture crops as a result thus do not receive priority when research funds are made available and the local Industry turnover is too small to carry large breeding programs (Reinten *et al*., 2011).

One of the few exceptions is the floriculture crop, *Lachenalia*, developed at the Agricultural Research Council (ARC) by South African researchers. The first cultivars were already released in 1980 with several (20+) following on this release during the late eighties (Kleynhans *et al.,* 2009b). The release of new cultivars since then, slowed down dramatically. This was, first of all because of a lack of cultivation information needed to produce a sustainable supply of material for marketing. A multi-disciplinary approach was thus followed focusing on the development of production systems to solve this issue. The development of new cultivars is, however, still an essential need to ensure continued market interest and market growth.

In the breeding of new cultivars, the breeder, however, needs to satisfy the major requirements for the development of new flower bulb cultivars. These requirements links to various aspects covering the complete value chain from the breeding through the various production and marketing steps to the consumer needs. Although all these requirements have to be taken into account from the inception of a breeding program, the progress of the breeding itself is reliant on the availability of basic information (Kleynhans, 2009). This basic information is necessary to establishment good breeding strategies and includes knowledge on the germplasm available for breeding and knowledge on the compatibility and cross-ability of material (Krens & Van Tuyl, 2011).

The aim of this thesis is thus to establish the different aspects and requirements needed for the development of new *Lachenalia* cultivars and to use the basic genetic information generated through research to develop specific breeding strategies for the development of new *Lachenalia* cultivars.

The thesis is organized as a number of publications addressing the different aspects important in the development of new *Lachenalia* cultivars. The scientific publications were published over a period from 2006 to 2012 and include, amongst others, an invited crop specific chapter in a floriculture plant breeding monograph.

Each of these publications needed to stand on its own in peer reviewed journals and there is thus some information that overlaps from chapter to chapter to facilitate the validity of each publication. Additional data or information from on-going research has been included in each publication to place it in perspective with regard to the aim of the thesis. This includes data (no detail shown) not directly linked to breeding, but essential for the whole-product approach necessary for successful development.

Publications are also not in chronological order, but rather relates to the natural flow of information. The titles of some of the publications were changed for the purpose of the thesis, but published titles and complete reference to publications are indicated as footnotes and the first page of each publication are attached in Appendix A.

The thesis is structured as follow:

Chapter 2: Requirements for the development and breeding of new flower bulb crops. This chapter includes an overview of the floriculture industry with a specific focus on flower bulbs and lists the requirements for the development of new cultivars. The chapter concludes with the importance of basic genetic information in this development. Publication reference: Kleynhans, R. & Spies, J.J. (2011) Requirements for the development and breeding of new flower bulb crops. *Philosophical Transactions in Genetics* 1: 80–101.

Chapter 3: Overview of the development of *Lachenalia* as flowering pot plant crop. Chapter three gives a broad overview of research and development on the genus *Lachenalia*, also including the history of the development of the genus. Publication reference of this invited contribution: Kleynhans, R. (2006) *Lachenalia*, spp. In N.O Anderson (ed) *Flower Breeding & Genetics: Issues, Challenges, and Opportunities for the 21st Century*, pp. 491–516. Springer.

Chapter 4: Cytogenetic and phylogenetic review of the genus *Lachenalia.* This chapter discusses the basic genetic information available on the genus. This information is essential for further progress and the development of effective breeding strategies for the development of new cultivars. Publication reference of invited review paper: Kleynhans R., Spies P. & Spies J.J. (2012). Cytogenetic and phylogenetic review of the genus *Lachenalia*. In *Floriculture and Ornamental Biotechnology* 6 (Special Issue 1) pp. 98–115. Eds. Van Tuyl J.M. & Arens P.

Chapter 5: Development of new Lachenalia cultivars using conventional and mutation breeding techniques. This chapter contains an *Acta Horticulturae* publication titled "Potential new lines in the Hyacinthaceae" discussing the conventional and mutation breeding techniques utilized in the development of new lines. Publication reference: Kleynhans, R. (2011) Potential new lines in the Hyacinthaceae. *Acta Horticulturae.* (ISHS) 886: 139–145.

Chapter 6: Cross-ability in the genus *Lachenalia*. Chapter six includes information on the cross-ability between species linking this information to the genetic and cytogenetic information available. Publication reference: Kleynhans, R., Spies, J.J. and Spies, P. (2009) Cross-ability in the genus *Lachenalia*. *Acta Horticulturae*. (ISHS) 813: 385–392.

These publications will be followed by a final chapter (chapter 7) linking additional information on the genetics and cross-ability and all relevant published results to the development of strategies for the breeding of new *Lachenalia* cultivars. The thesis will be concluded by the normal summaries in Chapter 8 and References in Chapter 9.

The number of *Lachenalia* species increased from 120 to 133 in 2012 with the publication of a new monograph on the genus *Lachenalia* by Graham Duncan. The same publication also includes various name changes, as well as the description of 11 new taxa. For the purpose of this thesis species names in the published publications were changed where possible. Species changes are also mentioned in table 1.1 to facilitate the link to new species names for future reference.

Table 1.1: List of *Lachenalia* species with relevant name changes as published in Duncan, 2012

Old species name	**New species name**
Lachenalia aloides var (Piketberg)	*L. callista*
Lachenalia aloides var. *aurea*	*L. flava*
Lachenalia aloides var. *quadricolor*	*L. quadricolor*
Lachenalia aloides var. *vanzyliae*	*L. vanzyliae*
Lachenalia bulbifera	*L. bifolia*
Lachenalia elegans var. *flava*	*L. karoopoortensis*
Lachenalia elegans var. *membranacea*	*L. membranacea*
Lachenalia elegans var. *suaveolens*	*L. suaveolens*
Lachenalia gillettii	*L. pallida*
Lachenalia juncifolia var. *campanulata*	*L. magentea*
Lachenalia mediana var. *mediana*	*L. mediana subsp. mediana*
Lachenalia mediana var. *rogersii*	*L. mediana subsp. rogersii*
Lachenalia pustulata	*L. pallida*
Lachenalia rubida	*L. punctata*
Lachenalia orchioides var. *orchioides*	*L. orchioides* subsp. *orchioides*
Lachenalia orchioides var. *glaucina*	*L. orchioides* subsp. *glaucina*
Lachenalia unicolor	*L. pallida*
Lachenalia violacea var. *violacea*	*L. violacea*
Lachenalia violacea var. *glauca*	*L. glauca*
Polyxena corymbosa (including *P. brevifolia*)	*L. corymbosa*
Polyxena ensifolia	*L. ensifolia* subsp. *ensifolia*
Polyxena maughanii	*L. ensifolia* subsp. *maughanii*
Polyxena paucifolia	*L. paucifolia*

To address the aim of this thesis the following questions needs to be answered:

- What are the requirements for the development of new floriculture crops?
- Is *Lachenalia* a suitable crop to address these requirements?
- What is the extent of the germplasm variation available in the genus?
- What are the cross-ability and compatibility issues in the genus?
- Can new cultivars be developed?
- What are the required breeding strategies for future development of new cultivars?

CHAPTER 2

REQUIREMENTS FOR THE DEVELOPMENT OF NEW FLOWER BULB CROPS

ABSTRACT

South Africa has an indigenous floriculture plant heritage that is unique in many ways and consists of approximately 10% of the world's plant species. The potential to develop some of these into commercial products exist. The crop *Lachenalia* is an example of a crop native to South Africa that was not developed abroad as is the case with many other indigenous flowers like *Freesia, Gerbera* and *Gladiolus*. In order to address development of new crops successfully, the specific requirements of the floriculture industry in terms of production, the global trade and consumer preferences have to be taken into account. The floriculture industry is a multi-billion dollar trade and flower bulbs as a section within the wider floriculture market is worth an estimated US$ 1 billion. South Africa captures less than one percent of the global market. The South African market can, however, be expanded by addressing the major requirements for growth and export as well as the development of new niche crops of which new flower bulbs is one example. During the development of new crops the overall requirements need to be taken into account even when the selection of the genus to be developed is made. Successful development requires a multi-disciplinary approach on many research areas, followed by an equal expanded approach for commercialization. In contrast to the large commercial bulbous crops like tulips, basic information on new crops is often very limited. Genetic information in terms of genetic variation, cytology and cross-ability is one of the areas where basic information must be generated. Without this basic information the chain of development in terms of breeding, selection, propagation, cultivation, commercialization and marketing is at risk. Continued innovation requires basic information on many different research areas. Although the generation of genetic information might be perceived to be non-essential by the end-users in the floriculture value chain, it forms an integral starting point for the innovations that realize as new cultivars and products commercialized on global floriculture markets.

Kleynhans, R. & Spies J.J. (2011) Requirements for the development and breeding of new flower bulb crops. *Philosophical Transactions in Genetics* 1: 80–101

PREFACE

This chapter was adapted from a peer reviewed publication in "*Philosophical Transactions in Genetics*" and contains background information on the floriculture industry with a specific focus on the role of flower bulbs in this industry. The chapter describes the wider market and commercial requirements for the development of new cultivars. During the development of new cultivars it is essential to consider the requirements of the end market to ensure that new lines can be commercialized successfully. This chapter, however, also includes the needs and requirements for basic research. These requirements for basic research serve as motivation for the variety of research chapters in the rest of the thesis. Without this information the development of new cultivars to satisfy the market demands is also not possible.

As first author, I was responsible for this publication in its totality. For the purpose of the thesis, the chapter ends with a clear statement of the research question and how the chapter addresses the development of new cultivars.

2.1 INTRODUCTION

Flowers have been a part of civilization and culture since the beginning of man. Numerous cultures have incorporated flowers into their everyday lives, to celebrate major life events, to express emotions and beauty and display art. Today flowers forms an integral part of daily living and the movement towards the green environment opens doors for the ornamental industry to grow. In developed countries plants are seen as part of a lifestyle and can even form part of the image of certain companies. The floriculture industry has thus developed into a global industry worth more than $100 billion at retail value (Sandler, 2011).

The industry is a dynamic, constantly changing and competitive trade. It is closely linked to fashion and life style explaining the ever-changing demands and requirements for new products. Any developmental and research work has to take these requirements into consideration from conception to be able to succeed. The failure to innovate and adapt to the constant market changes can have devastating results for growers and breeders of new material.

Flower-bulbs are a section within the wider floriculture market, estimated to be worth more than US$1 billion (Kamenetski & Miller, 2010). This section experienced a growth of more than 15% during 2003-2007 in comparison to the previous five year periods (Boshoff,

Kleynhans, R. & Spies J.J. (2011) Requirements for the development and breeding of new flower bulb crops. *Philosophical Transactions in Genetics* 1: 80–101

2010). Flower bulbs or in broad terms also called ornamental geophytes are a large group of plants, containing tens of families, hundreds of genera, possibly thousands of species and numerous cultivars (Rees, 1992). Although the ornamental geophytes contain various underground structures, including true bulbs, corms and rootstocks, these are all generally referred to as 'flower bulbs'. This group of plants are utilized in various marketing sectors of the floriculture industry, including outdoor usage in home gardens, parks, arboreta, commercial landscapes, roadsides, cut flowers, resorts, golf courses and containers as well as for forcing as cut flowers, potted flowering plants, growing (sprout) plants, home forcing, house plants and interiorscapes (De Hertogh & Lenard, 1993). Forcing is a term used for the treatment of flower bulbs to induce flowering during specific time periods. Of this large diverse group of species, from more than 800 genera, only seven genera (*Tulipa* L.*, Lilium* L.*, Narcissus* L.*, Gladiolus* L.*, Hyacinthus* L.*, Crocus* L. and *Iris* L.) previously dominated the industry (Kamenetsky & Miller, 2010). *Tulipa* and *Lilium* are still the two most important genera, but *Freesia* Klatt*, Hippeastrum* Herb.*, Alstroemeria* L. and *Zantedeschia* Spreng. have surpassed crops like *Gladiolus* and *Hyacinthus* in terms of sales volume for cut flowers (Anon, 2010b). Other prominent genera are *Ornithogalum* L., *Allium* L. and *Muscari* Mill. Many bulbous genera are utilized in the market, but limited information is available on the minor or specialty bulbs. In contrast, detailed research, development and experience, are available for those of major commercial significance. Experience and research results on crops like tulips and narcissus have been gained over several decades, contributing to the commercial success of these crops.

The ever changing and growth demands of the floriculture market can be addressed through, amongst others, the development of new crops. New crops can include new genera or new cultivars and uses of existing crops. For the purpose of this publication new crops will be seen as a new genus developed into a commercial crop. The development of new crops in general has several challenges, but the specific nature of the floriculture industry complicates development even more. South Africa has an extremely rich biodiversity and our floriculture plant heritage consists of approximately 10% of the world's plant species including over 2700 flower bulb species (Du Plessis & Duncan, 1989, Niederwieser *et al.,* 2002). Breeders in other parts of the world have utilized South African plant species extensively. These species were improved through hybridization, development and commercialization. Five plant species (*Gerbera* L.*, Freesia, Zantedeschia, Gladiolus* and *Ornithogalum*) native to South Africa generated a turn-over revenue of more than €218 million on Dutch auctions in 2009 (Anon, 2010a). *Freesia* also accounts for one of the top ten cut flowers on these auctions. None of these crops have, however, been developed in

South Africa and are also not grown extensively in South Africa either (Benshop *et al.,* 2010). Other South African species that can be explored for further development exists (Niederwieser *et al.*, 2002), but development has to link to floriculture trends and requirements. To understand this better an overview of the floriculture market and its trends and requirements are presented.

To aid successful future development an investigation into the global environment, a list of developmental, commercial and market requirements as well as research goals for new crop development should be compiled. A multi-disciplinary approach to address development is thus needed. In this chapter an overview of the floriculture market and the requirements for growth in this market will be discussed with specific reference to South Africa. The role of flower bulbs in each of these aspects will be indicated and lastly the importance of the generation of the basic information in terms of breeding and genetics, required for successful development will be illustrated.

2.2 THE GLOBAL FLORICULTURE INDUSTRY

Floriculture industries exist in almost every country of the world, but available figures of trade and production is often not accurate (Younis, 2009). According to Boshoff (2010) the world exports in floriculture products exceeded US$16 billion and the global imports exceeded US$17 billion in 2008. The production value world-wide rose to an estimated US$60 billion in 2003 (Van Uffelen & De Groot, 2005). Germany, USA and Japan are among the three largest ornamental plant markets world-wide when all aspects of ornamentals including landscaping and garden use are included (Anon, 2010b). Ornamental production statistics for the EU alone amounted to €19.8 billion in 2011 (Anon, 2013) and the global flower retail value was estimated at a $100 billion (Sandler, 2011).

Import and export markets: Not with-standing this multi-million dollar trade, the bulk of imports and exports are traded by only a few role players. Eighty present of the world imports are handled through Germany, the United Kingdom, the USA, Netherlands, France, Italy, Belgium and Japan. In turn more than 75% of all exports are via the Netherlands, Colombia, Denmark, Italy and Belgium. The Netherlands still has the largest market share and plays a leading role in the world floriculture industry. The country acts as the largest redistribution market trading more than 50% of all exports (Boshoff, 2010). The driving force behind this success is directly related to the crucial role of the auctions and the well-developed infrastructure in the country. It is further supported by extensive research and development services supplied to growers and the excellent air and land transport links with the most important producing and consuming countries (Kargbo *et al*., 2010). Import markets are growing in countries like Russia, Poland and Hungary, whereas countries like Spain, the UK and Ireland shows growth in the marketing segment. Export is increasing from countries like Kenya, China, Ecuador and India (Boshoff, 2010).

Various categories for import and export markets: The floriculture market consists of various categories of which the fresh cut flower sector is the largest both in terms of export and import. Other sectors include dormant bulbs, flowering bulbs, live/potted plants, treated cut flowers, fresh foliage and treated foliage. Categories, like fresh summer flowers and foliage for bouquets, flowering bulbs/pot plants and treated cut flowers and foliage have experienced noticeable growth in both import and export over the period 2003-2007 (Table 2.1). These categories can be summarized as ornamental plants used for home decoration and lifestyle and the growth can be attributed to the general drive towards a green environment.

Table 2.1: World flower export growth per category over five year periods in percentage (Boshoff, 2010).

Category	2000-2004	2001-2005	2002-2006	2003-2007
Dormant bulbs	9	7	11	10
Flowering bulbs	27	24	23	20
Live plants	15	12	10	8
Fresh cut flowers	9	10	10	10
Treated cut flowers	1	1	7	16
Fresh foliage	7	8	8	13
Treated foliage	6	9	12	15

The general growth trend of the market was negatively influenced by the world-wide recession and the effect of this should be displayed in 2009/10 market information. This information is, however, not so readily available. Floriculture products are often seen as luxury items that suffer severely when the buying power of the consumer is limited. A fall of 15% in the export quantity from Kenya in 2009, partly because of the recession, serves as an example of this (Kargbo *et al*., 2010).

Market outlets: Consumers are continuously exploring new and different kinds of outlets like for example supermarkets for buying their flower bulbs. This leads to a growing trend where supply chains are formed to ensure constant high value supply of material. Supermarkets, warehouses and garden centres are thus moving away from the auctions and more and more working with preferred direct suppliers (Van Uffelen & De Groot, 2005). On the other hand supermarkets as a growing supplier, has realized the importance of quality for fresh produce and are buying from specific specialists that can supply constant, high quality produce throughout the season. These supermarket suppliers thus form larger co-operative chains working closer and closer to growers. Consumers are usually focusing on long lasting and reliable plants and flowers, but have also started to include a variety of colours and flower forms in their preferences. These preferences sustain the interest in novelty crops and the development of new products in the market.

International flower bulb trade: The role of flower bulbs within the wider floriculture market follows the same trends. Besides being the largest re-distribution market for floriculture import and export, the Netherlands is also the largest producer of flower bulbs in the world (Benchop *et al.,* 2010, Kamenetsky & Miller, 2010). At the end of the 20th century the Netherlands controlled 92% of the world flower bulb trade. Dutch companies will probably maintain their world-wide position in the bulb industry, specifically because of the industry history, expertise, capability and financial structures that facilitate investment in new ventures (Kamenetsky & Miller, 2010). This advantage came from a history of industry co-operation in three key areas. These areas included research, promotion and pre-clearance inspection to ensure rapid release at entry ports and thereby minimizing the risk of damage to the bulbs during shipping (Kamenetsky & Miller, 2010). Most of the production in the Netherlands consists of traditional crops like tulips, lilies, hyacinths, narcissus, gladiolus, crocus and Iris (Benschop *et al.,* 2010). There are, however, many opportunities for niche players to emerge. The increased competition in the flower bulb markets has increased the demand for high quality bulbs and bulb flowers and yet the market still needs to increase the consumption and use of flower bulbs.

The USA and the EU are currently the leading export markets for flower bulbs. The Netherlands focuses largely on the forcing of some of the traditional crops as cut flowers, whereas the USA in turn focuses more on forcing as pot plants (Benschop *et al*., 2010, Kamenetsky & Miller, 2010).

International production of ornamentals: On the production side the term ornamentals also include additional categories like garden plants, nursery stock, annuals and perennials. Most ornamentals are produced in Europe (44% of world production in the

EU) (Anon, 2013), focusing on cut flowers, potted plants, bulbs, annuals, perennials, some nursery stock and garden plants. In North and South America ornamental production mainly consists of flowers and cuttings. Both Africa and Asia are growing production areas, but figures are difficult to obtain. Oceania, Australia and New Zealand are smaller producers focusing mainly on cut flowers (Van Uffelen & De Groot, 2005).

International flower bulb production: Flower bulb production areas have expanded from the mostly Northern Hemisphere production to include production in various Southern Hemisphere countries. Southern Hemisphere countries have the advantage that they can expand the narrow window of production and flowering that flower bulbs often exhibit. Although storage to facilitate year round production is possible for many bulb species, experience have shown that better quality is often obtained if Southern Hemisphere production is utilized for the supply of material during certain seasons (Kamenetsky & Miller, 2010). Globalization and increased competition in the flower bulb market thus led to the establishment of new flower bulb production centres like Latin America, Africa and Asia. It is anticipated that these will most probably increase with certain countries addressing specific niche market segments and that the north-south axis will be important in this regard. Increased export from Africa to Europe and from South America to North America is expected (Benschop *et al.,* 2010). The quality of material produced will continue to play an integral role in distribution and will contribute towards competitive advantages from specific production areas.

2.3 THE SOUTH AFRICAN FLORICULTURE INDUSTRY

Export and import markets: South Africa, despite the country's rich floriculture diversity, only contributes a fraction (less than 1%) to the world market. Cut flowers comprise the largest part (44%) of this export market followed by plant material (26%) and foliage (21%) (Table 2.2). Just over 8.6% of the market comprises of bulbs, both dormant and in flower (Boshoff, 2010). These floriculture products are mainly exported to Europe (EU core) (68%), other African countries (7.4%) and North America (6.9%) (Table 2.3). The floriculture export revenue for South Africa amounted to more than R524 million in 2008 (Boshoff, 2010).

Table 2.2: SA export Rand value per category (Boshoff, 2010).

Category	HS Code[1]	2006	2007	2008
Bulbs	0601	40,420,220	40,128,922	45,128,570
Plants	0602	90,310,672	106,759,303	137,971,606
Cut flowers	0603	150,068,270	179,022,576	232,355,317
Foliage	0604	77,263,665	89,099,691	108,613,368
Total		357,982,609	415,010,492	524,069,261

[1]There are 4 major categories in the local flower trade consisting of a) bulbs and tubers including dormant bulbs and both growing and flowering bulbs (HS 0601); b) ornamental plants including young plant material like un-rooted cuttings and slips, flowering plants like azaleas and roses, finished indoor/outdoor rooted/flowering plants like cuttings, young plants, palms, outdoor perennial plants, indoor flowering plants/pot plants and indoor foliage plants (HS 0602); c) a wide range of greenhouse and open field cut flowers, including protea species and veld flowers in fresh and dried/preserved form (HS 0603) and d) foliage including fresh and dried/preserved foliage (HS 0604).

Table 2.3: Value per area of destination as percentage of total export rand value (Boshoff, 2010).

Area	2006	2007	2008
Africa	7.9	7.2	7.4
Asia & Australasia	4.5	4.3	5.6
Eastern Europe	1.2	0.8	1.2
EU core	64.1	68.0	68.2
Other West. Europe	3.3	3.2	2.4
Scandinavia	3.9	4.0	4.0
Middle East	4.1	3.9	3.8
North America	10.7	7.8	6.9

Export marketing in South Africa is mainly dominated by export agents, linked to overseas import houses. These agents are mostly located at the international airports in Cape Town and Johannesburg, because most of the flower products are exported by air. They also have access to cold room facilities at the airports. Traditionally the largest bulk of material was exported to the Dutch flower auctions but there is a growing trend to consolidate to obtain volume and market directly to overseas distribution houses and supermarket chains (Boshoff, 2010).

Imports mainly consist of plant material (66%), followed by bulbs (22%), cut flowers (11%) and foliage (1%). Plant material comprises the largest import, because cultivars are mainly bred abroad and material is only available from there. Cut flower and foliage imports are used as top-up during winter months when local production is not available (Boshoff, 2010).

Market outlets: The local marketing is dominated by the Multiflora auction structure located in Johannesburg (similar to the Dutch flower auctions). Local pricing is therefore purely determined on a daily demand and supply basis. Multiflora handles approximately 70% of the local market and is owned by the producers. It also consists of Flora Direct who handles bulk orders between farmers and supermarkets outside the auction system. The Multiflora auction had a total value of almost R318 million for 2008 (Boshoff, 2010). These sales volumes consisted of mainly roses (±30%), Chrysanthemum (15%), Lilies (10%) and carnations (6%) all of which are mainly produced in greenhouses. The rest consists of summer flowers and proteas, which are mainly shade net or field produced and sales to supermarkets. The extent of the latter sales is not available, because the supermarkets do not publish their sales figures.

Supermarkets like Pick 'n Pay and Woolworths have followed international trends by selling value-added products such as mixed bouquets. There is also a trend that supermarket chains increasingly purchase large volumes of flowers directly from growers and thus bypassing the auction altogether (QC fresh, 2005).

Local production of ornamentals: Local producers are mainly located in the northern, southern and eastern parts of the country and dominantly within one hour's drive from the main metropolitan markets and international airports. With the exception of a few big growers, the bulk of the producers are of Small to Medium Enterprise (SME) type with a trend toward consolidation into larger units.

Farmers and suppliers in the industry are mainly organized into three producers organizations namely the South African Flower Growers Association (mainly the northern producers), the South African Protea growers Association (mainly consisting of the southern growers and the Kwazulu Natal flower growers organization (mainly the eastern growers). All three the producer organizations are in turn members of the South African Flower Export Council (SAFEC), responsible for the promotion of the local and export industry development. SAFEC is in turn a member of the National Department of Trade and

Industry's export council organization (TISA). TISA is tasked with the development of the export activities of all South African industries (Boshoff, 2010).

Local flower bulb production: Flower bulb production in South Africa is dominated by the company, Hadeco. Their sales estimates in 2003 included 100 million bulbs and 40 million flower stems (QC-fresh, 2005). Hadeco ensures optimal production in South Africa by growing bulbs on seven farms situated at various altitudes and including a range of soil types and climates from subtropical to cool temperate regions. Flower bulb production in general is very labour intensive and can therefore make an important contribution to employment creation in South Africa. Contract bulb production was popular by growers in the early 2000`s where the growers entered directly into contracts with European agents for commercial bulb production. This is still done but the practice is, however, not economic viable when the local currency is strong. Despite the fact that many indigenous South African bulb genera are products on the international market the production of these in South Africa is fairly limited.

2.4 REQUIREMENTS FOR DEVELOPMENT AND GROWTH IN THE FLORICULTURE INDUSTRY

According to Wijnands (2005) the growing and marketing of cut flowers in the floriculture sector depend on several key success factors both on the production and marketing side. Most of these factors are, however, relevant in general to floriculture production and not only to cut flower production.

2.4.1 Production requirements

Physical conditions: With regard to production the first important factor is good physical conditions, including high light intensity, abundant water, clean soil and a suitable climate (Wijnands, 2005). With the diverse climatic conditions and different habitats in South Africa, these requirements are available. Specific crops, however, need to be linked to correct environments to ensure quality production. Indigenous crops are often adapted to local conditions and can as such only benefit from local production.

Plant material: Secondly appropriate seed and planting material needs to be available. The availability of disease free propagation material is essential for any flower producer. Without high quality starting material, production cannot continue according to quality standards. Most flower bulbs are multiplied vegetatively, necessitating a quality source of mother material to prevent the spread of virus diseases. Acquisition of high quality material that is in line with the newest market trends is seen as one of the challenges facing the South African industry (Matthee *et al.*, 2005). The importance of constantly renewing the production material from a reliable disease tested source thus has to be addressed.

Capital investment: The specific nature of floriculture production often requires large capital investments. Depending on the crop this could include glasshouses, shade net structures, irrigation equipment, stores, cold store facilities, grading facilities and working areas. This infrastructure is usually expensive, but essential for quality production. The investment capital to establish sophisticated infrastructure are not always available in South Africa, limiting the type of crops that can be grown especially by small to medium enterprise producers. The economic viability of establishing such infrastructure should also be weighed against the financial gain that can be obtained from such investments.

Productive and skilled labour force: Floriculture production is also labour intensive requiring specific skills in terms of daily monitoring and maintenance to ensure quality production. The transfer of these skills to labourers can be an advantage for skills development in South Africa. Unfortunately it also puts South Africa at a disadvantage in relationship to other African competitors, who employs labour at much cheaper rates.

Organization and management skills: Production is management intensive and requires specific knowledge and information to be able to supply sufficient numbers of high quality plants/flowers during specific time periods. This information is usually not freely available and often transferred from family member to family member in family businesses. Especially in the South African context, information on production under South African conditions, are limited and often kept secret by specific growers (Matthee *et al.*, 2005). New entrants to this market thus need to be mentored carefully, even more so if the complex market and consumer requirements are taken into account.

Pesticide and chemical availability: The availability of the correct chemicals to ensure quality production is essential. With strict international measures for the use of chemicals it is also important to ensure that the correct measures are taken to prevent rejection of material during export. This presents problems for the floriculture industry in South Africa because most pesticides and chemicals are not registered on floriculture crops and the size of the industry does not warrant sufficient financial gain for chemical companies to do so.

Energy and infrastructure: The relevant infrastructure and the required energy to heat or cool this infrastructure is a pre-requisite for quality production.

Quality: Finally quality consciousness all along the production and post-harvest chain is absolutely essential for success (Wijnands, 2005). The floriculture market is extremely competitive and the only way to achieve success and premium prices is through ensured quality. This quality consciousness starts with the acquisition of seed or mother material and need to be addressed during every step of the production process. Lack of quality management will most certainly result in failure and non-profitable production. Quality assurance through independent testing can assist in building trust within the production chain (Van Uffelen & De Groot, 2005).

2.4.2 Marketing requirements

Domestic markets in many countries including South Africa is small and global markets need to be accessed for local production growth. To target the export markets the following requirements are added on top of those for production:

Logistic and supply chain infrastructure: Adequate logistic structure for exporting as well as adequate supply chain infrastructure is necessary (Wijnands, 2005). Logistics include shipping by road, sea or air under specific temperature and humidity requirements. The relevant infrastructure for storage has to be available at the production site, throughout the transport chain, at airports and end users. Without this, quality produce cannot be delivered to end users and the market will not be available. South Africa has the necessary logistic links, but the industry needs to commit to increase exports as many growers do not export on a regular basis (Matthee *et al.*, 2005).

Market intelligence: Knowledge of the destination export markets especially in terms of consumers' preferences (also linked to existing trends) and knowledge on the strengths and weaknesses of competitors assist producers to be responsive to the requirements of the destination markets (Wijnands, 2005). The best quality products supplied at the wrong time or not addressing the consumer demand will lead to failure. This market information is thus essential to successfully target export markets. Production should be linked to this and producers from Southern Hemisphere countries can for example benefit if they can supply during a specific window where demand is high, but supply from the local export country is low. Knowledge on suitable distribution channels can also assist in growing the market demand. In the Netherlands for example garden centers and florists are the most important distribution channel for pot plants. In this regard, consumers are looking for new interesting products, of high quality, with a long shelf life (Magnus 2010). Taking the changing nature and demands of the end-consumer into account is also essential for the continued success of businesses in the ornamental industry (Dudek & Behe, 2012). In this fierce competing market the consumer is looking for information, especially when relatively new products are marketed. Knowledge on competitors and providing information that can give a growers' product an advantage above other products can assist to grow sales (Magnus, 2010).

Marketing concepts: Consumers furthermore buy product concepts and not so much a plant with leaves and flowers (Van Uffelen & De Groot, 2005). Concepts such as a flower in a specific pot for Valentine's speak to consumers and with added value can get better prices. To get consumers to consistently buy the same product concept they want quality assurances. Flowers are most often bought as a gift and especially for pot plants it is important that a complete product is made available (Magnus, 2010). The marketer should also be aware of the changes in consumer demands. An important tool to increase market awareness is to tell consumers how plants should be treated and why it is important to buy then or what benefits they will get from them. The provision of information also on social media directly addresses the new generation and can assist in increasing sales (Dudek & Behe, 2012). Consumers also like to hear the story behind the plants and providing information about local development or community involvement and beneficiation is one of the marketing concepts that can successfully be utilized to grow sales (Dudek & Behe, 2012).

International trade standards: Lastly producers must comply with international trade standards as well as meet specific quality standards including compliance to specific codes of conduct (Wijnands, 2005). These codes of conduct addresses quality, but also the consumers concern about the environment and ethical aspects. Codes of conduct will become even more important in future. Non-appliance to eco-label standards was seen as one of the reasons why South Africa has not reached the floriculture production potential as described in the Kaizer study of 2000 (Wijnands *et al*., 2005). Consumers are becoming more educated and preference will be given to products that were produced under circumstances that do not influence the environment negatively, as well us under fair labour practices.

Van Uffelen & De Groot (2005) concluded that consumption and trade patterns in the floriculture industry will follow the following future trends:

- The demand will rise linked to higher income in targeted countries.
- High volume products (the more traditional crops) will remain in the traditional markets, because low product cost are essential.
- There is, however, niche markets for high quality products all over the world. When a product is special, price is not so much of an issue, but constant innovation is required to keep the market interest.
- When supplying these niche markets the supply chain concept of quality from "seed to vase" preferably on a year-round basis should be followed.
- To address niche markets successfully all the actors in the international chain should co-operate.

2.5 DEVELOPMENT POTENTIAL FOR THE SOUTH AFRICAN FLORICULTURE INDUSTRY

A study by Kaizer (2000) indicated that, although South Africa only has a small market share of the world's floriculture market, it has the potential to increase. A growth in the South African export market can significantly increase revenue from the floriculture industry and create additional job opportunities. In order to realize growth a number of key factors, however, need to be addressed. These factors link to generic critical success factors for floriculture development as well as addressing specific challenges related to South African conditions and identifying priorities for development.

Matthee *et al.* (2005) mirrors some of these requirements when recommending the way forward for the South African industry. According to the authors, South Africa needs to increase its export market by integrating further into the global market through increasing both the volumes and values of their exports. Furthermore they need to participate in international programs by moving into more competitive global chains (i.e. export more directly). The competitiveness of the industry can also be improved through the provision of financial and managerial assistance to the numerous domestic floriculture suppliers.

Boshoff (2010) confirms these requirements by concluding that products must be linked to specific market segments. These segments include mature, growing and developing markets each with their specific product requirements. This can only be done successfully if market information is available and will require pooling, networking and clustering within the industry. Compliance to best practice and quality controlled production systems is essential and this includes total quality management training and mentoring.

South Africa thus faces specific challenges to facilitate growth in the floriculture industry. One of the areas that need to be addressed is research and development of indigenous plant material. The availability of new crops can address specific niche markets, as it is difficult for South Africa to compete with other African countries like Kenya due to cost factors including labour cost (Matthee *et al*., 2005). Innovation in terms of new crops, products and production processes is seen as an important way of increasing the countries competitiveness (Kaizer study, 2000; Matthee *et al.*, 2005). Research and development in itself, however, has its own requirements and challenges and especially for new crop development requires a multi-disciplinary approach for success (Kleynhans *et al.,* 2002).

2.6 RESEARCH REQUIREMENTS FOR THE DEVELOPMENT OF NEW FLOWER BULB CROPS

In a ten year study on the development of new floral crops, Lawson & Roh (1995) found that successful commercialization of new floral crops is a combination of the availability of superior plant material to the trade, production technology and a marketing strategy. They found that if any of these three factors are not properly developed and fully implemented, the chance of success is greatly diminished. These three factors summarizes the production and marketing requirements as explained in detail above but also includes research requirements as superior plant material can be developed through the breeding of new crops.

Rees (1992) identified three areas for development in flower bulb crops:

1) The improvement of cultivars of existing crops.
2) A new horticultural use for an existing and well known species.
3) Research on a little known species to develop a new commercial crop.

Development of new crops is described as the most interesting, but also the most difficult of the three options (Rees, 1992; Niederwieser *et al*., 2002). The earliest forms of development in flower bulbs also concentrated on the third option and entailed simple selection from varieties or ecotypes for desirable appearance (size of flower, shape, stem length, foliage colour and marking) (Rees, 1992). These selections were made either from the wild or subsequent to collection from the native habitat and introduction to other areas. This was later followed by deliberate crossing of plants with desirable characteristics to achieve specific goals and today includes sophisticated techniques like genetic manipulation.

Breeding and selection can, however, not function in isolation when new crop development is considered. Many other aspects like production, plant protection, physiology and commercial marketing are just as important and form an integral part of the research for new crop development (Erwin, 2009; Karlovic, 2009; Reid & Cevallos, 2009; Schoellhorn, 2009). The commercial availability and demand in the market is the final proof of successful new crop development. Successful breeding thus does not end with the availability of a superior hybrid, but goes all the way including commercial production and marketing (Kleynhans *et al.*, 2002). Throughout the development process a holistic product approach should thus be followed. Niederwieser *et al*. (2002) summarized the requirements for new flower bulb development as follow: Sustainable funding, expertise in production of flower bulbs, involvement of a multi-disciplinary team, early links with commercial agents, knowledge of market demands and trends, sufficient germplasm material, production research, access to basic research, correct product identification and early identification of crop related problems.

Being aware of the market requirements from the conception of new crop development is essential (Schoellhorn, 2009). The different markets involved in flower bulb development are basically linked to the usage of flower bulbs. In the horticulture sector, ornamental geophytes are utilized as: i) landscape plants, ii) commercial interiorscape plants, iii) container grown plants for the home, patio or balcony, iv) outdoor cut flowers, v) forced cut flowers, vi) forced potted plants, and vii) growing (sprout) flowering plants (De Hertogh *et al.*, 1992). This can be combined into two major usage sectors: Outdoor usage and forcing (De Hertogh & Le Nard, 1993). Outdoor usage includes: Home gardens, parks, arboreta, commercial landscapes, roadsides, cut flowers, resorts, golf courses and containers, whilst the forcing sector includes: cut flowers, potted flowering plants, growing (sprout) plants, home forcing, house plants and interiorscapes (De Hertogh & Le Nard, 1993).

The breeder or developer of the new crop thus has to keep all of these factors in mind when developing new products. The breeder has to be aware of any changes and consult with colleagues in various areas of expertise to address the different requirements successfully. For new crops, where little information is available this requires and extensive research input, before products can be delivered.

2.6.1 Breeding and selection of new flower bulb crops

As part of the holistic approach for new crop development, breeding and selection plays an important role. The basic aim of the breeder in the development of new bulb crops is to produce improved plants (Rees, 1992) and thus addressing the superior plant material required by the producer and the market. The kind of improvement is, however, very wide. Like most agricultural crops there are common goals for breeding, including easy propagation, adaptation to a wide range of growing conditions and possession of significant levels of resistance to the major diseases and insects affecting the species. However, flower bulb breeding has some unique and specific goals. The major breeding objective is to obtain plants exhibiting excellent horticultural characteristics, e.g. the leaves, the flowers and the general shape of the plants have to be attractive. This criterion of ‘attractive’ is, however, difficult to measure and quantify and it may even differ from country to country (Le Nard & De Hertogh, 1993). The breeder has the advantage that novelty per se has value in the ornamental sector and that new forms are appreciated and sought, but the breeder needs to address each flower bulb usage sector with specific aims. Cut flowers for instance require long stems to succeed in the market, whilst pot plants should preferable by small and compact.

The breeding objectives thus vary depending on the type of market that is addressed. In landscape and garden use easy adaptation to climatic and soil conditions is very important, but for cut flower production, the physiological characteristics would be more important, because these flowers are often produced out of season and thus under environmental condition that are different from those encountered in the native habitat (Le Nard & De Hertogh, 1993).

Krens & Van Tuyl (2011) summarized the role of the breeder in new crop development as follows: i) Knowing the germplasm available; ii) Knowing the compatibility and crossing ability of the material; iii) Performing crosses; iv) Selecting the best candidates; v) Testing for the stability of the phenotype and for propagation potential; vi) Finalizing the cultivar, applying for breeders rights and bringing it to the market.

When faced with new crop development, where very little basic information is available, researchers are required to start with their germplasm and go 'back to basics' before attempting more advanced breeding techniques (Kleynhans, 2009). With large commercial crops it is easier to address breeding problems with modern biotechnological techniques, because the financial back-up and genetic background information is available, but for new crops this is not the case (Benschop *et al*., 2010, Sandler, 2011). 'Back to basics' for new crop development, thus, include the establishment of basic information in several fields, with the future prospect of utilizing this information for advanced breeding.

Germplasm availability and characterization: The breeder first of all needs to collect germplasm to utilize and then investigate the variability in this germplasm to generate knowledge for further utilization. South Africa has an advantage in that it is exceptionally rich in flower bulb biodiversity. Many new potential crops can be developed from this diversity, but it requires a substantial financial input in terms of research.

Value needs to be added to the germplasm by characterizing the accessions according to the various requirements for development. Here at the start of the breeding program, the breeder should already ensure that the requirements of the international market are met. Germplasm should thus be characterized in various areas including the genetic and phenotypic diversity, pest and disease susceptibility/resistance, various production aspects and applicable target market.

Crossing ability and breeding strategies: Knowing the compatibility and crossing ability amongst species in the germplasm greatly assist the breeder to develop crossing strategies for the combination of suitable characteristics. The availability of basic genetic information in terms of cytogenetic and phylogenetic variation contributes positively to the development of such strategies.

Selection criteria: The selection of the best candidates often requires additional research inputs where new crops are concerned. To be able to select the lines with the best propagation and production potential the best method of propagation and cultivation often first need to be developed before it can be applied. Similarly knowledge on the major pest and diseased affecting new crops are not available and these need to be identified and assessed before the breeder can try to address these problems through breeding. It is thus clear that a multidisciplinary team is essential for final successful development.

2.6.2 Challenges linked to flower bulb breeding

The first major challenge when breeding flower bulbs is the existence of incompatibilities that prevent successful crosses or result in sterile hybrids (Le Nard & De Hertogh, 1993). Techniques to overcome incompatibility thus need to be developed to ensure continued breeding progress. The second challenge is linked to the long period between sowing and obtaining a flowering plant. In some genera like tulips this juvenile period can be as long as seven years constituting a serious impediment to the rapid improvement of such genera (Le Nard & De Hertogh, 1993).

Many genera also have a slow multiplication rate resulting in a long period necessary for the release of new cultivars. Furthermore a large percentage of bulbs are used under environmental conditions that differ from those under which they are bred. Efficient screening methods must thus be developed. This is often difficult and requires multi-site and multi-year trials in order to get sufficient information. This experimentation is expensive and requires a sufficient quantity of bulbs.

Information on the transmission and/or heritability of major characteristics is non-existent when new crops are utilized for development. It is thus difficult or impossible to anticipate the usefulness of the progeny from a specific crossing combination. This necessitates the production of numerous crosses in order to increase the probability of obtaining a good genetic arrangement. Inevitably this leads to a high number of seedlings and in genera with long juvenile periods it leads to serious logistical constraints for the maintenance of all the plant material (Le Nard & De Hertogh, 1993).

When breeding new crops the absence of basic information also constitute further problems. Information on pollen storage to overcome non-synchronous flowering needs to be generated. Techniques to screen for selection criteria are absent and techniques for accelerated propagation need to be developed.

Most flower bulbs are vegetatively propagated resulting in serious constraints that effect the management of a breeding program (Le Nard & De Hertogh, 1993). The advantage of this propagation on the other hand is the immediate utilization of an interesting genotype. Practical constraints present firstly links to managerial problems. Most bulbs need to be planted, lifted, cleaned, graded and stored under well controlled environmental conditions. These time-consuming procedures must be carried out yearly and often require specialized equipment. Secondly careful plant protection is also necessary during breeding. If a bulb is contaminated by a virus, all the progeny will also be contaminated. If at all possible, it is difficult and extremely expensive to rid material of viruses. The management of systems to ensure the maintenance of disease free material from early on is thus essential (Le Nard & De Hertogh, 1993). Lastly and probably the major factor linked to vegetative propagation is the existence of strong genotype-environment interactions. Knowledge of the effects of the environmental factors is thus necessary to permit a precise definition of the selection criteria and to determine the best conditions for genotype screening (Le Nard & De Hertogh, 1993).

2.6.3 Genetic requirements for *Lachenalia* development

Breeding of *Lachenalia* for the development of a new flower bulb crop started in South Africa during 1965 (Kleynhans, 2006). Since then many crosses were made, cultivars have been selected (Kleynhans, 2011) and five of these are currently sold on the international market. Extensive morphological (Duncan, 1988), cytological and genetic (Kleynhans *et al.*, 2009b, 2012) variation is present in the genus. This resulted in the existence of both internal and external crossing barriers (Lubbinge, 1980; Kleynhans & Hancke, 2002; Kleynhans, 2006). In order to address these crossing barriers and progress in terms of the development of new hybrids for the market it became essential to investigate the genetic diversity and cross-ability in the genus in more detail.

Various lessons were learned during the first developmental stages of *Lachenalia* as new crop and the importance of addressing the requirements for new crop development was evident. In order to grow this initiative, continuous research inputs are required along with establishing the correct commercialization and marketing links. Continued successful progress in the market is reliant on a regular supply of new and interesting types. Going back to the genetic diversity of the genus and linking this to the cross-ability is thus essential for future success of this genus. Although experience have shown that the failure to address some of the market and commercial requirements have delayed success in the market, no future progress will be possible without the basic genetic information needed for successful breeding strategies.

2.7 CONCLUSION

When attempting to address the development of new crops for the floriculture market it becomes essential to obtain an overview of the floriculture industry and the requirements for development within this industry to ensure that final success is possible. The world floriculture industry is still growing, but trends in the market for both the general flower market and more specific flower bulb market have been changing over the past decade.

Within this changing environment South Africa needs to adapt to grow its own industry, especially in the light of the rich heritage in terms of floriculture diversity in the country. In this regard South Africa will need to forge more global links and ensure that production for export conforms to international quality standards. There are specific opportunities to address niche market segments, but for that specific quality products is needed. There is an opportunity for the development of such products from the genetic diversity in the country, but the development of new crops requires huge, multidisciplinary research inputs.

On many of the indigenous floriculture crops the information on the genetic diversity and requirements for breeding needs to be developed. Addressing these basic research information requirements is just the first step in a long chain of development, commercialization and marketing. Without the basic genetic information continued progress in breeding is, however, not possible. The lack of new innovation to sustain the complex chain, will inevitably lead to failure in the market.

Basic genetic research might thus be perceived to be non-essential by the end-users in the floriculture value chain, but it forms an integral starting point for the innovations that realize as new cultivars and products commercialized on floriculture markets.

2.8 STATEMENT OF RESEARCH QUESTIONS ADDRESSING THE DEVELOPMENT OF NEW *LACHENALIA* CULTIVARS

Research question: What are the requirements for the development of new floriculture crops?

Based on this floriculture industry background information the following conclusions can be drawn:

- South Africa has the potential genetic material to address new crop development
- There is an interest for novel crops in the international floriculture market and South Africa can address this through the utilization of its genetic resources

- During the development of new cultivars, breeders need to address all requirements (breeding, production, commercialization and marketing), thus following a whole product approach including a multi-disciplinary research team for research and development
- When novel crops like *Lachenalia* are developed, there is a strong need for basic research information in order to successfully develop new cultivars

CHAPTER 3

OVERVIEW OF THE DEVELOPMENT OF LACHENALIA AS FLOWERING POT PLANT CROP

ABSTRACT

Lachenalia species are geophytic endemics of South Africa and Namibia. This chapter includes a short overview of the taxonomic and breeding history of the genus. Diversity present in the genus is discussed in terms of morphology, distribution, propagation and genetics. The large diversity and until recently absence of a key for the identification of species emphasizes the importance of investigating the diversity within species and establishing species boundaries. Crossing mechanisms and available information on the reproductive biology of *Lachenalia* are mentioned. The influence of production methods on the selection criteria and selection procedures is discussed. Information on the extent of reproductive barriers in the genus is included. Present and future breeding strategies and research needed to overcome these barriers are discussed. The chapter concludes with future perspectives for research and breeding in the genus.

PREFACE

This chapter was adapted from an invited peer reviewed book chapter in the book *Flower Breeding and Genetics: Issues, Challenges and Opportunities for the 21st Century* edited by Neil O. Anderson. This book was the first comprehensive literature source on flower breeding and genetics and includes various chapters from international experts. As sole author of the chapter (*Lachenalia*, spp.), I was responsible for this chapter in its totality, consisting of all the relevant literature on *Lachenalia* available at the time. The chapter includes background information on *Lachenalia* as new flower bulb crop and has been adapted where necessary on production, historical and commercialization issues to include new literature and experiences generated since publication. Additional literature generated on breeding and genetics of the genus are covered in subsequent chapters of this thesis and not included here to avoid duplication.

The title of the published chapter was changed to address the purpose of the thesis. The chapter again ends with the research questions and conclusions in relation to the development of new *Lachenalia* hybrids.

Kleynhans, R. (2006). *Lachenalia*, spp. In *Flower Breeding & Genetics: Issues, Challenges, and Opportunities for the 21st Century*, pp. 491–516 Edited by Anderson, N.O. Springer

3.1 INTRODUCTION

The genus *Lachenalia* Jacq. f. ex Murray consists of small bulbous geophytes endemic to South Africa and Namibia. This winter-growing genus previously belonged to the family Hyacinthaceae (Manning *et al.*, 2004; Duncan & Edwards, 2006 & 2007), but was reclassified to the family Asparagaceae Juss. in 2009 (Angiosperm Phylogeny Group, 2009) and consists of more than 130 species and sub-species (Duncan, 2012).

Although *Lachenalia* has a long history commercial products from the genus are relatively new to the international flower market. The Roodeplaat Vegetable and Ornamental Plant Institute of the Agricultural Research Council (ARC-Roodeplaat VOPI) developed commercial potted plants from the genus in South Africa (Niederwieser *et al.,* 1998). The breeding history and slow commercialization discussed are thus related to specific circumstances and South African conditions. Without state funds, invested during the early years of the development, this program would never have been successful.

The large diversity present in the genus was one of the main reasons for selecting it for development. Various phenotypic characters (Duncan, 1988 & 2012) as well as an unusual variation in chromosome numbers (Kleynhans & Spies, 1999, Spies *et al.*, 2002, 2008, 2009) describe this diversity. Preliminary studies on the molecular systematics of the genus also revealed high molecular diversity (Kleynhans & Spies, 2000, Spies *et al*., 2002).

Since the start of work on the genus in 1965 in South Africa, hundreds of crosses have been made and several reports published (Lubbinge, 1980, Malan *et al*., 1983, Lubbinge *et al*., 1983a, 1983b, 1983c & 1983d, Ferreira & Hancke, 1985, Hancke & Coertze, 1988, Coertze *et al*., 1992, Kleynhans & Hancke, 2002). Several species and intra-species varieties of *L. aloides* (L.f.) Engl. have long been available in small numbers, but the developed cultivars offer a superior product to the consumer. Several cultivars have been registered with Plant Breeders Rights and currently five cultivars are marketed internationally. This successful commercialization would not have been possible without the development of the required production research.

The multiplication phase takes place in South Africa under license to ARC-Roodeplaat VOPI. Dry bulbs are exported to commercial forcers abroad where bulbs are then forced, potted and marketed. Bulbs also make good garden and patio subjects. The bright coloured cultivars will provide a rewarding show of flowers for two to four weeks depending on the temperature and climatic conditions. The colour variation available and the

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good keeping quality are two of the advantages that this new flower bulb crop presents to the consumer.

This chapter includes a short overview of the taxonomic and breeding history of the genus. Diversity present in the genus is discussed in terms of morphology, distribution, propagation and genetics. The large diversity and the (until 2012) absence of a key for the identification of species emphasises the importance of investigating the diversity within species and establishing species boundaries.

Crossing mechanisms and available information on the reproductive biology of *Lachenalia* are mentioned. The influence of production methods on the selection criteria and selection procedures is discussed. Information on the extent of reproductive barriers in the genus is included. Present and future breeding strategies and research needed to overcome these barriers are discussed. The chapter concludes with future perspectives for research and breeding in the genus.

3.2 HISTORY

3.2.1 Taxonomy

The taxonomic history of *Lachenalia* extends over a period of more than three centuries. The earliest record of the genus is a painting of *L. hirta* (Thunb.) considered to be a painting used by Simon van der Stel of the Dutch East India Company to illustrate his diary of the expedition undertaken to Namaqualand during 1685/86. During the period from 1686 to 1784 several reports were made of plants now classified as *Lachenalia*. The first published report on the genus *Lachenalia* appeared in “Linnaeus Systema Vegetabilium” Ed. 14 in 1784. The correct citation for the genus is *Lachenalia* Jacq. f. ex Murray (Duncan, 1988). Jacquin named the genus after a Swiss Professor, Werner de Lachenal.

In 1896-1897 Baker published his monograph on the genus in “Flora Capensis” Vol. VI (Baker 1897; citing forty-two species. Since the publication of Baker’s monograph, Winsome F. Barker and Graham Duncan undertook most of the taxonomic work on *Lachenalia*. Barker published forty-seven species and eleven new varieties for the genus (Barker, 1933a & b, 1966, 1969, 1972, 1978, 1979, 1980, 1983, 1984, 1987, 1989).

In 1988, Graham Duncan of the Kirstenbosch Botanical Gardens published “The Lachenalia handbook” (Duncan, 1988). This handbook contains introductory notes on history, identification and cultivation, with descriptions of 88 species and colour illustrations.

Graham Duncan has continued the work of Winsome Barker and is still in the process of describing new species (Duncan, 1993, 1996, 1997, 1998a, 1999 a, b, c & d, 2001a & b, 2002 a & b, 2003 a, b & c, 2005 a & b, Duncan *et al.,* 2005, Duncan & Edwards, 2006 & 2007).

In 2012 Duncan published a new monograph on the genus including 133 species and sub-species. This publication is the first systematic complete monograph of the genus and includes a key for identification supported by detailed botanical descriptions and photographs (Duncan, 2012). A detailed historical description is also included in this book.

3.2.2 Breeding and commercialization

Rev. John Nelson raised the first authenticated hybrid of *Lachenalia* in or about 1878 (Moore, 1905, Crosby, 1978). This was a cross between *L. aurea* and *L. tricolor luteola.* As these were until 2012 both varieties of *L. aloides* this was thus an intra-species cross. Other hybrids reported earlier proofed to be self-pollinations. The first inter-species cross (a cross between *L. flava* Andrews and *L. reflexa* Thunb.) was also made by Rev. Nelson (Moore, 1905). Since then several hybrids have been mentioned in literature (Moore, 1905, Crosby, 1978 for review), but none of these became commercial products probably because the so-called hybrids were selfings of pure species. Other combinations were published but never referred to again (Crosby, 1978). Crosby (1978) therefore concluded that the majority of early claims of inter-specific hybridization in *Lachenalia* could not be substantiated. The only reliably authenticated inter-specific hybrids (made on more than one occasion) seem to be crosses between *L. aloides* and *L. reflexa.* Crosby (1978) and Lubbinge (1980) were the first to report on a number of different inter-specific crosses in later years.

Despite all these claims of hybrids, *Lachenalia* has commercially remained relatively unknown with only limited numbers of claimed hybrids and species being commercially available until recently (De Hertog & Le Nard, 1993). The first improved hybrids developed in South Africa became commercially available during 1997/98. Progress in the breeding program was slow due to several problems, of which some are unique to the South African environment (Kleynhans & Hancke, 2002, Niederwieser *et al*., 2002). One unique problem was the political isolation of the country up until the early 1990's. Isolation prevented researchers from networking with colleagues abroad.

Progress made since 1965 with the breeding program in South Africa were divided into five phases by Niederwieser *et al*. (1998) and Kleynhans *et al*. (2002). Currently a sixth phase can be added to cover the development since 2004.

During Phase I which extended over a seven-year period from 1965-1972 the program consisted of a small gene bank. Basic procedures for breeding and gene bank maintenance were determined and the first inter-species crosses were made. Selections based on phenotype were made. Material was supplied to several South African growers for evaluation. This phase was concluded with the South African flower growers association's recommendation that hybrids had a commercial potential.

Phase II from 1973-1982 is regarded as the actual start of the breeding program. During this period a large number of crosses were made and superior hybrids were produced. Initial characterization and evaluation work was done. The first problems arose when growers emphasized the susceptibility of *Lachenalia* to the *Ornithogalum* mosaic virus (OrMV). The virus problem was addressed by the initiation of tissue culture propagation (Klesser & Nel, 1976, Nel, 1983, Van Rensburg & Vcelar, 1989, Niederwieser & Van Staden, 1990a & b, Niederwieser & Vcelar, 1990, Coertze *et al*., 1992) for the supply of disease-free stock material to growers. This phase was concluded by the application for Plant Breeders Rights for 5 cultivars.

The approach during the first three phases of the project was that the bulb growers in S. Africa and The Netherlands had enough expertise to develop suitable cultivation practices. This, however, proved to be a fatal mistake that delayed the commercialization of *Lachenalia* for several years. The extent of this mistake became apparent during Phase III (1983-1992).

During Phase III local growers experienced problems because propagation material was not available in sufficient quantities and there was no cultivation and virus control information or information available. Furthermore they did not have the expertise or resources to conduct in-house cultivation trials (Niederwieser *et al*., 1998, Kleynhans *et al*., 2002). These problems were emphasized when the first trials were conducted in Holland. The Dutch applied techniques used for the production of well-known winter bulbs such as hyacinth on *Lachenalia* with detrimental results. Conditions in the Northern Hemisphere, which differs greatly from those in SA, also had a large effect on the growth habit of the plants (Niederwieser *et al*., 1998, Kleynhans *et al*., 2002). This emphasized the need for a whole new set of production protocols to commercialize the product. Early attempts at commercialization were thus unsuccessful due to the absence of cultivation information. Despite the lack of cultivation information, the availability of sustainable state funding during these earlier phases was indispensable for the development of superior hybrids (Niederwieser *et al*., 1998, Kleynhans *et al*., 2002).

Nineteen ninety-two is seen as the watershed year for the *Lachenalia* program. The finding that for successful commercialization of a new crop all the relevant information including production protocols must be available, led to a whole product approach. This meant that ARC-Roodeplaat VOPI had to take a strong lead in not only the commercialization of the product but most importantly the development of the required technology for production and the continuous supply of disease free propagation material (Niederwieser *et al*., 1998, Kleynhans *et al*., 2002). The decision to implement this approach led to the start of a multi-disciplinary research program with a large committed team.

During Phase IV, which extended from 1993-1996 the breeding program was revitalized. An average of 250 crosses per year were made and a hybrid evaluation system including all the relevant selection criteria (desired phenotype, multiplication and pot plant characteristics) were established, implemented and improved. Several propagation methods were tested and the basic cultivation requirements were determined. There was a tremendous improvement in pot plant forcing methods. A plant improvement scheme was established which included an *in vivo* and *in vitro* production unit at ARC-Roodeplaat VOPI. Regular working group meetings were held with local growers to exchange the acquired information and technology (Niederwieser *et al*., 1998, Kleynhans *et al*., 2002).

Several actions were also taken to commercialize *Lachenalia* during this phase: Royalty administration and distribution agents were appointed; plant breeder's rights were obtained to protect ten varieties internationally; a trade name "Cape Hyacinth" was registered for the lachenalias; and a commercial pot plant grower (forcer) was identified in the Netherlands (Niederwieser *et al.,* 1998, Kleynhans *et al.,* 2002).

A smaller research program and the development of a production system for *Lachenalia* characterized Phase V, 1997-2004. A market study conducted by Fides in 1993 estimated the potential market for *Lachenalia* in Europe at 20 million bulbs per annum. Initial trials in the USA (by USDA-ARS Maryland [Roh *et al*., 1995]) were completed and other markets have yet to be targeted. The potential for successful commercialization thus existed, but the problem of producing large numbers of flowering bulbs needed to be overcome. The solution to this bottleneck to commercialization lay in the mass production of bulbs by commercial growers (Niederwieser *et al*., 1998, Kleynhans *et al*., 2002).

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Here again ARC-Roodeplaat VOPI was prompted to take a strong lead in facilitating the commercial production of *Lachenalia* bulbs. During 1997 and 1998 there was only one commercial grower with exclusive rights to produce *Lachenalia* bulbs. However, when the number of bulbs produced did not grow as predicted, ARC-Roodeplaat VOPI had to identify additional commercial growers (Niederwieser *et al*., 1998, Kleynhans *et al*., 2002).

In order to convince these commercial growers to become involved in the production of *Lachenalia,* researchers needed detailed information in terms of production schedules, infrastructure and financial requirements. Accordingly ARC-Roodeplaat VOPI spent a considerable amount of time during 1998 and 1999 developing production systems that could address the market demand and the commercial grower's requirements (Kleynhans *et al*., 2002).

This led to the development of a production system consisting of propagators, who receives propagation bulbs and multiplies planting stock, producers, who produces commercial sized bulbs and forcers, who plants potted plants for marketing. Propagators and producers are located in South Africa while the forcers are in the areas (mostly abroad) where the potted plants are marketed. The development of this system is not unique. Production systems like these also exist for other flower bulb crops (De Hertog & Le Nard, 1993).

The development of this production system is, however, seen as one of the most important steps toward successful commercialization. In 2000, commercial growers produced one million marketable bulbs and in 2001 an estimated 3 million using this system. Large scale production of bulbs for sales is thus possible. Due to the small numbers of bulbs sold and the resulting small royalty income, the research during this period was limited to certain aspects of crop production and the evaluation of hybrids (Kleynhans *et al*., 2002).

Currently a sixth stage best linked to pot plant production and marketing strategies can be added to this development. With the production technology available for the production of large numbers of bulbs material were exported for potted plant production in target countries (mostly Europe). Pot plant growers experienced challenges with the production of quality potted plants under Northern Hemisphere conditions. Specific onsite research is needed by forcers to ensure that their potted plant production practices are optimal for the specific conditions of growth. Challenges with uneven flowering of bulbs planted in the same pot and scheduling of early and late flowering cultivars to have a variety of flower colours available at the same time were some of the research aspects that had to be addressed during the sixth phase.

Marketing, especially the extent of marketing required to promote new crops, is an aspect in the commercialization of *Lachenalia* that has not received sufficient attention. In a ten year study on the development of new floral crops, Lawson and Roh (1995) found that successful commercialisation of new floral crops is a combination of the availability of superior plant material to the trade, production technology and a marketing strategy. They found that if any of these three factors are not properly developed and fully implemented, the chance of success is greatly diminished. The importance of a proper marketing strategy was also stressed by Johannes Matthee (2005). This importance was experienced as a critical success factor in the commercialization of new crops by the ARC during attempts to commercialize *Lachenalia*. The number of bulbs sold in the market dropped substantially after 2002 and feedback received implied that this drop was partly due to the absence of market information, For the successful continued commercialization and market growth of *Lachenalia* pot plants it became imperative that a marketing and commercialization strategy should be developed and implemented. Marketing aspects are currently being addressed and the development and regular release of new cultivars forms an essential part of keeping the interest of the end market and growing sales

In a world where funding is becoming limited, the development and commercialization of a new crop like *Lachenalia* will require suitable funding and a concerted effort of all parties involved. This includes researchers, commercial producers and marketers. The importance of a whole product approach, where all relevant information is available to producers as early as possible, cannot be stressed enough.

3.3 DIVERSITY

3.3.1 Morphology

The genus *Lachenalia* is unusually diverse in phenotype. There are a number of “complex” species consisting of many forms, which grade into one another (Duncan, 1988). These are difficult to separate into distinct varieties or species. The newly published *Lachenalia* monograph and identification key (Duncan, 2012) has contributed to merging some of these complex species into one or on the other hand separating some species into various species or sub-species.

The morphological diversity among species starts with the tunicate bulbs that can be minute (5-9mm diameter) for *L. patula* Jacq. compared to the large fleshy bulbs of *L. bifolia* (Burm.f.) W.F. Barker ex G.D. Duncan (up to 35mm diameter) (Duncan, 1988). The number of leaves produced may vary from one to numerous, although two leaves are the most common. The leaves themselves may vary from robust and broad (certain forms of *L. bifolia*) to short and cylindrical (succulent leaves of *L. patula*). The foliage is usually produced in an upright or spreading position, but in certain species, like *L. nervosa* Ker Gawll, they lie flat on the ground (Knight, 1987, Duncan, 1988).

Simple or stellate hairs occur on the leaves of several species. These hairs may be on the upper or lower surface of the leaf or may be restricted to leaf margins. Some species also show undulate leaf margins. Spotting and banding on *Lachenalia* leaves is a conspicuous feature of many species. The colour (green, brown, magenta) and density of spots varies and although usually on the upper surface, sporadic spots may also occur on the undersides of leaves (Knight, 1987, Duncan, 1988).

A wide variety of banding-patterns on the leaf-bases occur in many species while some species (*L. pallida* Aiton) bear pustules on their leaves. These pustules range in size from fairly large irregularly scattered ones to small, dense ones. In the majority of species leaves and flowers are present simultaneously, but in certain species (*L. muirii* W.F. Barker) leaves appear after the flowers (Knight, 1987, Duncan, 1988).

Three different types of inflorescence are encountered in the genus.

1. A spike: the flowers are sessile and attached directly to the rachis;
2. The sub-spicate inflorescence: the flowers are attached to the rachis by very short pedicels and
3. The raceme: The flowers are attached by long pedicels.

Flowers range in shape from long and tubular to small and campanulate, while the position of the flowers on the rachis varies from pendulous to erect (Knight, 1987, Duncan, 1988). The perianth is zygomorphic and the inner segments usually protrude. The stamens vary in position from included to well exerted. Flower colour varies from white, green, blue and purple to red, pink, yellow and brown. Some species are pleasantly scented. Lastly the black usually shiny seeds vary considerably in size from 0.7 mm diameter to 2 mm diameter (Duncan, 1988).

3.3.2 Distribution and habitat

The genus is mainly found in southern Africa where it is widely distributed from the south-western region of Namibia, southward throughout the Northern, Western and Eastern Cape provinces of South Africa to as far inland as the south-western Free State Province (Duncan, 1998b). With one exception [*L. pearsonii* (Glover) W. F. Barker] the genus is exclusively winter growing, with a pronounced dormant period during summer months. Even species occurring in predominantly summer- or intermediate rainfall areas follow the typical winter rainfall growth cycle (Duncan, 1998b).

Due to its wide distribution, the genus is encountered in a very wide range of habitats such as semi-desert conditions in deep sand, rocky outcrops in humus rich soil, mineral rich, barren stony flats, limestone outcrops, seasonally inundated flats and marshes and high rainfall montane conditions (Duncan, 1992, Duncan, 1998b). As can be expected those species which are widely distributed are, morphologically, widely variable. However, even within species with relatively small distribution ranges, a remarkable degree of variation exists (Duncan, 1998).

3.3.3 Propagation

Lachenalia species can be propagated through seeds, offsets, bulbils, stolons, supernumerary bulblets, leaf cuttings or tissue culture propagation (Duncan, 1988, Roodbol & Niederwieser, 1998, Niederwieser & Ndou, 2002). Some species produces an abundance of seed after self-pollination. Others however, produce no seeds or a limited number of seed (Kleynhans & Hancke, 2002).

The best time to sow *Lachenalia* seed is in autumn (March for the Southern Hemisphere) (Knight, 1987, Duncan, 1988). Seeds can be sown onto several mixtures (Knight, 1987, Duncan, 1988) as long as they are thinly covered and kept moist. Seeds will germinate over a period of two to six weeks. Optimum temperature for germination is 10-20^{o}C (Detail results not shown). Hybrid seeds are treated the same as species seed. An added advantage of seed production is the elimination of OrMV infections. The virus is not seed transmissible. Other methods of multiplication do not eliminate the virus.

Offsets are side-bulbs which develop out of the mother-bulb, from which they eventually break away (Duncan, 1988). Not all species reproduce readily by this method. Offsets are generally too slow for commercial production. Certain species produce small bulblets at or above ground level on the leaf surface, which are commonly known as bulbils (Duncan, 1988). Some species (*L. namaquensis* Schltr. Ex W.F. Barker) reproduce by means of stolons. Supernumerary bulblets (adventitious buds formed from axial meristem) were reported by Roodbol and Niederwieser (1998). These methods are species-specific. Depending on the inheritance of the method hybrids can be propagated to a greater or lesser extent using propagation methods of the parent plants. The inheritance of a production method, thus influences the specific production scheduling of different cultivars.

Leaf cuttings have also been described as method of propagation (Cook, 1931, Duncan, 1988, Perrignon, 1992). Most species can be successfully multiplied by means of leaf cuttings (Niederwieser & Ndou, 2002). Leaves are severed above ground level and planted vertically in a well-drained rooting medium and kept moist. Bulblets and roots start to form on the basis of severed leaves after about one month (Ndou *et al*., 2002). These bulblets can be harvested at the end of the growing season and stored until the next planting season. Commercial production of cultivars is done via leaf cuttings (Kleynhans *et al*., 2002, Niederwieser & Ndou, 2002).

Propagation through tissue culture is also possible and well established for *Lachenalia* (Klesser & Nel, 1976, Nel, 1983, Niederwieser & Vcelar, 1990, Louw, 1995, Niederwieser & Ndou, 2002). In both leaf cutting and tissue culture propagation the genotype, tissue age, physiological stage of donor plants and medium components influence the success of multiplication (Van Rensburg & Vcelar, 1989, Niederwieser & Van Staden, 1990a & 1990b, Niederwieser & Vcelar, 1990, Perrignon, 1992, Niederwieser *et al*., 1992, Ndou *et al*., 2002, Niederwieser & Ndou, 2002).

3.3.4 Genetics (see chapter 4 for updated detail)

The genus exhibits a remarkable variability with regard to chromosome number. Numbers ranging from 2n = 10 to 2n = 56 have been reported in literature (Moffett, 1936, De Wet, 1957, Riley, 1962, Mogford, 1978, Ornduff & Watters, 1978, Nordenstam, 1982, Crosby, 1986, Hancke & Liebenberg, 1990, Johnson & Brandham, 1997, Hancke &

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Liebenberg, 1998, Kleynhans & Spies, 1999, Spies *et al*., 2000 & 2002, Van Rooyen *et al*., 2002). The basic chromosome numbers of x = 7 or 8 are the most frequent but x = 5, 9, 10, 11, 12, 13 and 15 have also been reported (Ornduff & Watters, 1978, Johnson & Brandham, 1997, Hancke *et al*., 2001).

The origin of and relationship among these different basic chromosome numbers are still unclear. Johnson and Brandham (1997) investigated karyotypes and found that all the basic numbers x = 7-13 and 15, produced structural diploids. The authors stated that it was, however possible that diploids with $2n = 2x = 30$ (x = 15) could actually be allotetraploids derived from taxa with x = 7 and x = 8 following hybridization and doubling of the chromosome number. They also state that plants of *L. mutabilis* Sweet with x = 5 ($2n$ = 10) are derived from plants with $2n$ = 14 via Robertsonian fusions. Spies *et al* (2002) differed from the former authors in their explanation of the chromosome number variation in *L. mutabilis*. They found a basic chromosome number x = 6 for this species, but dismissed the explanation of Johnson and Brandham (1997) due to the absence of any long chromosomes (as a result of a Robertsonian fusion). They suggested the existence of an aneuploid series in this species.

Polyploidy is fairly common in the genus. Although some species have few to no polyploid specimens (Johnson & Brandham, 1997, Spies *et al*., 2000, Spies *et al*., 2002), others include many polyploid specimens (Johnson & Brandham, 1997, Kleynhans & Spies, 1999, Spies *et al*., 2002). A polyploid complex ranging from tetraploid, hexaploid, heptaploid to octoploid was identified in *L. bifolia* (Kleynhans & Spies, 2002). Another species in which a polyploid complex seems to be present is *L. elegans* W.F. Barker (Johnson & Brandham, 1997). Polyploidy seems to be more common in species with x = 7 as basic chromosome number (Spies *et al*., 2002).

Meiotic information on *Lachenalia* was limited (Moffett, 1936) up until the 1990's, when published reports increased (Hancke & Liebenberg, 1990, Hancke & Liebenberg, 1998, Hancke *et al*., 2001, Du Preez *et al*., 2002). Hancke and Liebenberg (1990) described the presence of B-chromosomes in both mitotic and meiotic material. Much of the variation in chromosome numbers described by earlier workers could probably be ascribed to the wrong identification of the B-chromosomes. Incorrect species identification could also have contributed to inaccurate reports on chromosome number (Crosby, 1986).

B-chromosomes in *Lachenalia* have no specific staining pattern. They may stain slightly lighter or darker or similar to other chromosomes in the chromosome complement. The B-chromosomes are similar in size to the smallest chromosomes of the complement (Hancke & Liebenberg, 1990). The staining patterns and similar size makes it difficult to identify B-chromosomes.

The meiotic behaviour of hybrids gives an indication of the relationship between the parental species and can indicate the possible origin of the different basic chromosome numbers. Investigations into the meiotic behaviour of hybrids (Hancke & Liebenberg, 1998) showed that *L. aloides, L. orchioides* (L.) Ait.*, L. reflexa* and *L. viridiflora* W.F. Barker were closely related. These species all have an *x* = 7 chromosome complement. However, the relatedness of *L. mutabilis* (also *x* = 7) to these species is unclear from the results and needs further investigation (Hancke & Liebenberg, 1998).

A study on chromosome pairing in three dibasic inter-specific hybrids revealed a high incidence of bivalents (Hancke *et al*., 2001), which indicates that the parent species are closer related than initially expected. The same study also revealed a degree of homoeology between two chromosomes of the *x* = 7 karyotype and three chromosomes of the x = 8 karyotype. This indicated that the *x* = 7 plants differed from the *x* = 8 plants by at least two exchanges of chromosome material and the loss of one centromere from the *x* = 8 karyotype. The results thus imply that the change in the basic chromosome number of *Lachenalia* involves a reduction in chromosome number. The process of change was, however, not straight forward since the *x* = 8 karyotype has no acrocentric chromosomes. The change was thus not just the result of simple centric fusion as suggested by Johnson and Brandam (1997).

Initial studies on meiosis in hybrids between species of the *x* = 8 complement (*L. carnosa* Bak.*, L. splendida* Diels.*, L. pallida, L. namaquensis* and *L. framesii* W.F. Barker) again revealed a high level of relatedness (Du Preez *et al*., 2002). Chiasma frequencies that were very similar to those of the parental species were found.

Genetic variation in 21 accessions of the polyploid complex of the species *L. bifolia* revealed genetic distance values ranging from 0.11 to 1.08 (Kleynhans & Spies, 2000). A

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dendogram constructed from the RAPD banding profiles clustered certain accessions together. These clusters were supported by the geographical locality and chromosome data of accessions. Accessions with the same chromosome number, but from different geographical localities did not group together (Kleynhans & Spies, 2000). Accessions within the species *L. bifolia* having the same chromosome number are thus not necessarily closely related. Further investigations are needed to clarify these relationships.

Studies on the species delimitation of *L. hirta* and *L. unifolia* Jacq. revealed that the genetic variation between the two species, as revealed by DNA amplification fingerprinting was only marginally higher than the variation within any of these species. Consequently it was suggested that these species probably represent two subspecies of the same species rather than two separate species (Van Rooyen *et al*., 2002). These and other genetic studies (Spies *et al.,* 2002) stress the fact that the variation in the genus needs further investigation.

3.3.5 Sub-generic delimitation (see chapter 4 for updated detail)

In the first attempt for sub-generic delimitation Baker (1897) described five subgenera, i.e. *Eulachenalia*, *Coelanthus, Orchiops, Chloriza* and *Brachyschypha.* These subgenera were based on morphological differences. Crosby (1986) reclassified the genus, using five groups, each based on a typical species, i.e. *L. aloides, L. orchioides, L. pusilla, L. unicolor* (now part of *L. pallida*) and *L. unifolia* groups. Crosby added chromosome numbers and cross-ability within groups to the morphology and used these three criteria for his groupings. Duncan (1988) used the ratio between the lengths of the perianth and stigma, as well as the inflorescence form as criteria and divided the genus into 10 subgroups. None of the methods above were exhaustive. Many new taxonomic aids, of which molecular methods are only one can be used to assist in the delimitation of species.

In a preliminary study, chromosome numbers and sequencing of the *trn*L-F region was used to determine the phylogenetic relationship between 19 *Lachenalia* species (Spies *et al*., 2002). The aim of the study was to determine which of the above mentioned sub-generic classifications corresponded best to the phylogenetic relationships within this group. The results indicated that none of the sub-generic groupings conform to the natural phylogeny as found in the preliminary study. The system proposed by Crosby is, however, the most natural one (Spies *et al*., 2002).

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From the results of this study as well as studies on meiosis and morphology mentioned above it is clear that a full revision of the genus is urgently needed. Various additional taxonomic aids (anatomy, cytogenetics, molecular systematic, etc.) should be implemented in combination. Such a method may culminate in the best natural classification possible for *Lachenalia.* In view of a considerable amount of within species diversity it might be difficult to obtain a complete survey of all possible variation in the genus. However, a system including multiple taxonomic aids will contribute to a better understanding of the diversity in the genus.

3.4 BREEDING

The international floriculture market continuously requires new products (De Hertog & Le Nard, 1993). *Lachenalia's* wonderful variety makes it suitable for breeding to satisfy this demand. The spectacular diversity gives rise to a multitude of possible combinations for the breeder to create, but also presents several problems and challenges.

The *Lachenalia* breeding program is still relatively young as compared to those on other large bulbous crops. Breeding methodology is basic and has not required advanced techniques. Naturally occurring genetic diversity presented the breeders with enough variation to produce new products. However, this situation is changing fast so that advanced breeding techniques to overcome crossing barriers will become an important part of future breeding strategies.

Despite numerous claims of inter-specific hybrids produced during the late eighteen hundreds and early nineteen hundreds, very few of the named cultivars survived to the late nineteen hundreds (Crosby, 1978). This lack of commercial success is understandable in light of ARC-Roodeplaat VOPI's problem to commercialize *Lachenalia* (3.2.2). It was only after intensive cultivation research and the establishment of a scheme for the supply of disease free material, that large enough numbers of plants could be raised, making it amenable to commercialization.

3.4.1 Crossing mechanisms and reproductive biology

Crosses are made by hand pollinating after emasculation of flowers (Lubbinge, 1980). *Lachenalia* has a three-year breeding cycle from seed to flower (Kleynhans & Hancke, 2002). Flowers may be obtained in the second year from some hybrids, but these

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flowers are generally of poor quality (few florets and small inflorescences) which makes evaluation difficult. Once a hybrid has been selected propagation is done vegetatively.

A study of the ontogeny of the stamen and the organography of the stigma and style of *L. punctata* Jacq. revealed that the stigma of this species was dry with papillae (Detail results not shown). Other species will have to be investigated to see whether this is generally true for the genus. The style of *L. punctata* is of the open type and has three stylar canals (Detail results not shown).

Lachenalia flowers are protandrous Moore 1905, (Detail results not shown). Initial studies indicated that anthers dehisce one day after the flower has opened but that the pistil is receptive only 4 days later (Detail results not shown). This is, however only true of a few species. In some species the anthers might dehisce before the flowers open fully. Anthers of *L. mutabilis* for instance will dehisce before the flower is opened completely, while anthers of certain *L. bifolia* accessions dehisce after the flower has been open for one to three days (Detail results not shown). The correct time of emasculation thus has to be determined for each species. Even ecotypes within a species might differ with regard to time of dehiscence (Detail results not shown).

Emasculation takes place one or two days before dehiscence. Anthers are collected in gelatin capsules and left in a desiccator overnight to dehisce. Capsules are then closed and stored in tightly sealed glass bottles. Storage of pollen is important because of the diverse flowering times (April-November) among the species (Duncan, 1988). Although reports on pollen storage at room temperature in a desiccator for two years without loss of viability have been made (Lubbinge, 1980), other results have indicated differently. The best storage is at -4^{o}C or in liquid nitrogen (detail results not shown). Providing that pollen was kept dry, it retained 80% of its germination ability when stored for up to two years in a refrigerator (Detail results not shown). Similar figures were obtained with storage in liquid nitrogen. Longer periods have not been tested for liquid nitrogen. Pollen stored at room temperature lost viability rapidly after one month. In tests on the pollen of *L. mutabilis* and *L. pallida,* pollen viability decreased to below 50% after only five days in the desiccator at 25^{o}C (Detail results not shown). Pollen germination tests were done by the hanging drop technique with 10% sucrose and 0.01% boric acid (Hancke & Liebenberg, 1998).

Stigmas are receptive from one to seven days after anthesis (defined as anther dehiscence for this discussion). In trials done on six species *(L. aloides, L. mutabilis, L. bifolia, L. punctata, L. liliflora* Jacq. and *L. pallida)* the optimum period of receptiveness varied greatly (Figure 3.1). In all species stigmas were receptive one to two days after anthesis, although the percentage of receptive stigmas (% from number pollinated) in most cases were low. For *L. punctata* and *L. bifolia* the optimum time for pollination was anytime from three to more than seven days after anthesis. For *L. aloides* times varied from two to six days. For *L. mutabilis* one to three days, for *L. liliflora* two to four days and for *L. pallida* two to three days were found to be optimal (Figure 3.1). The time of receptiveness of the stigma and the style length appeared to be correlated. *L. bifolia, L. punctata* and *L. aloides* all have long flowers and styles, whilst the flowers of *L. liliflora, L. pallida* and *L. mutabilis* are shorter. According to these results the best time for pollination was three to five days after emasculation (Detail results not shown). Large flowered species can be pollinated even later.

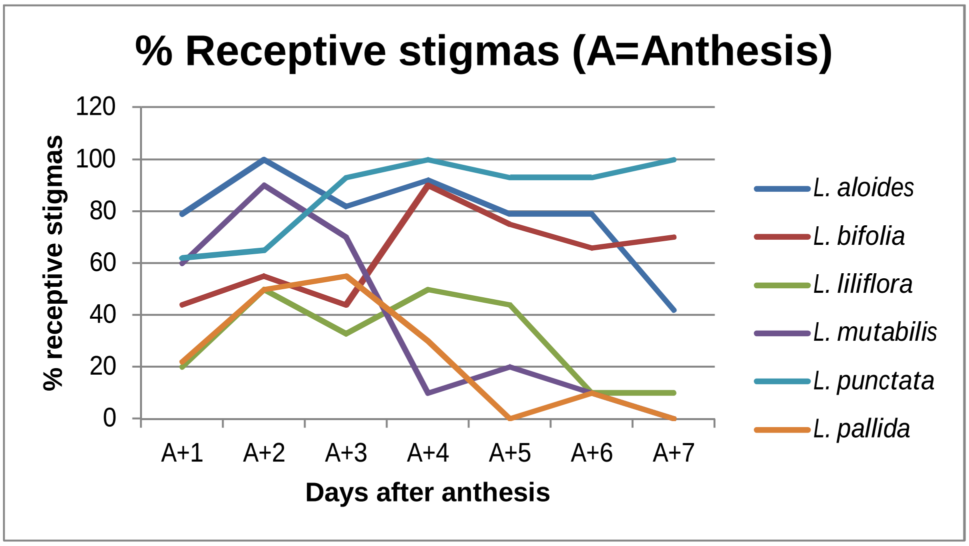

Figure 3.1: Percentage of receptive stigmas after self-pollination 1-7 days (respectively) after anthesis in 6 *Lachenalia* species.

Seeds are ready for collection approximately two months after pollination. Seed capsules turn brown and are harvested before they split open.

3.4.2 Selection procedures and commercial production

The complete selection procedure for *Lachenalia* encompasses a 13-15 year period from making a cross to the commercial availability of a new cultivar. Initial selections take place in the third year (three-year breeding cycle) after making a cross. This first phase in the selection procedure of hybrids is a phenotypic selection based on specific characteristics. These characteristics include the ratio between inflorescence and leaves (60:40 to 50:50), flower colour, density of inflorescence, longevity and sturdiness of the peduncle. Characters like scent and attractive leaf spots are noted. These add value to the product, but are not essential selection criteria.

After initial phenotypic selection (year 3), material has to be multiplied (year 4-5) to have enough bulbs to evaluate the propagation rate of the hybrid in terms of commercial production methods. In the five to seven years of production evaluation the requirements of the commercial growers are evaluated. The first step (year 6-7) involves evaluation for the propagator who mainly does commercial propagation of cultivars through leaf cuttings. Leaf-section position and physiological stage (best before flowering) of the donor plant influences the leaf cutting performance of cultivars (Perrignon, 1992, Ndou *et al*., 2002, Niederwieser & Ndou, 2002). Cultivars may differ in their reaction towards these aspects. New hybrids are evaluated taking these differences into account and information is released to growers. Growers are then able to do commercial scheduling by utilizing the production figures obtained during evaluation.

The second step (year 7-8) in the evaluation addresses the requirements of the producer who receives planting stock (small bulbs) from the propagator and produces commercial sized bulbs. Only bulbs larger than 6 cm. in circumference are suitable for pot plant production and are thus of commercial size. Bulblets harvested from leaf cuttings may vary from less than 2 to 4 cm. in circumference. The rate at which bulblets grow to a commercial size is dependent on cultivar, the size of bulblets produced by leaf cuttings, the level of fertilizer (Roodbol & Niederwieser, 2002, Roodbol *et al*., 2002, , Engelbrecht *et al.,* 2007 & 2008) used and the specific micro-climate under which production is done (Du Toit *et al*., 2001a, 2001b & 2002). The evaluation of these aspects in order to supply production figures is thus extremely important to the commercial grower.

The last step (year 8-9) in the evaluation process involves the requirements of the forcer who receives commercial sized bulbs from the producer. The forcer buys dry bulbs from the producer after harvest and forces these bulbs to produce flowering pot plants at specific times. Forcing includes certain temperature regimes during storage to obtain flower initiation (20-25^{o}C) and year round flowering (low temperatures followed by initiation temperatures), as well as specific planting temperatures to ensure good quality and short

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glasshouse periods (Louw, 1992, Louw, 1993, Roh *et al*., 1995 & 1998, Du Toit *et al.*, 2003 & 2004, Kodaira & Fukai, 2005, Roh, 2005, Kleynhans *et al.*, 2009a). Cultivars again differ with regard to glasshouse period, keeping quality and growth habit (Kleynhans *et al*., 2009a. The microclimate in the pot plant production area (mostly outside South Africa) also has a large influence on the quality of pot plants produced (Unpublished results). Each grower will have to fine-tune his production plan accordingly. The forcer can adapt his specific conditions during production following the indications on the performance of hybrids during the pot plant evaluation.

Cultivar 'Ronina' or its close relative 'Namakwa' is used as crop ideotype throughout the evaluation to compare new hybrids to existing production protocols and scheduling over years. Specific climatic changes occurring in different production seasons can influence the production statistics. These cultivars were selected because they have often been used in cultivation research (Slabbert & Niederwieser, 1999, Du Toit *et al*., 2001a, & 2001b, Ndou *et al*., 2002, Roodbol & Niederwieser, 2002, Roodbol *et al*., 2002, Engelbrecht *et al.,* 2007 & 2008, Kleynhans *et al.,* 2009a).

After successfully passing all evaluation stages (9-11 years), Plant Breeders Rights can be registered for new hybrids. Commercial growers require another four years after release for the multiplication of substantial numbers for commercialization.

3.4.3 Gene bank

A representative and well-characterized gene bank is important for any breeding program. The *Lachenalia* breeding program was thus initiated with the acquisition of several species and species ecotypes through collection trips to the natural distribution areas (Lubbinge, 1980, Niederwieser *et al*., 1998). The acquisition of species is still an important aim in the program. Currently the gene bank at ARC-Roodeplaat VOPI comprises more than 460 ecotypes from 55 species (not all species represented in the ARC genebank).

Initial gene bank accessions were characterized according to colour, shape, size and number of flowers, scent, markings on the leaves and number of leaves (Lubbinge, 1980). Later characteristics such as the ratios between inflorescence and leaf lengths and inflorescence and peduncle length; discoloration of flowers; keeping quality; time of flowering; multiplication method and production potential; chromosome numbers; pollen fertility; self-seed set potential and disease status were found to be important for breeding.

Characterizing gene bank accessions in a genus as diverse as *Lachenalia* are essential for proper planning of crossing strategies. Characteristics recorded and evaluated must be updated on a regular basis to keep up with the newest breeding aims and market requirements.

3.4.4 Reproductive barriers and breeding strategies

Initial results obtained from studies of reproductive biology and inter-species hybrids indicate external and internal isolation barriers to inter-specific crosses (Lubbinge, 1980, Kleynhans *et al*., 2009b, Unpublished results as generated during this study). The external barriers can easily be overcome by growing the plants in controlled conditions and the successful storage of pollen for a 12-month period (Unpublished results as generated during this study). The internal barriers have not been studied in detail.

Internal isolation barriers are encountered either before or after fertilization. Sixty five present of all inter-species crosses made at ARC-Roodeplaat VOPI did not succeed, either because no seeds (pre-fertilization) or non-viable seeds (post-fertilization) were formed (Table 3.1). The death of seedlings accounts for an additional 3%. The reason for the death of these seedlings can not necessarily be ascribed to hybrid breakdown. Seedlings are susceptible to all kinds of rotting diseases and with the absence of specific data on these crosses conclusions cannot be drawn. The extent and exact processes causing these failures needs further investigation.

Lubbinge (1980) described mechanical isolation as the first pre-fertilization barrier. Large flowered species of *Lachenalia* have flowers of over 25mm long whilst in smaller flowered species the flower length can be even less than 10mm. Pollen from small flowered species is thus not adapted to traverse the long distance from the stigma to the ovary of large flowered species (Stebbins, 1950). Reciprocal combinations, utilizing the small flowered species as maternal plants have been successful in overcoming this barrier (Lubbinge, 1980, Table 3.1), but does not guarantee success (Table 3.1).

Studies on pollen tube growth have indicated that self-incompatibility vary from species to species. It can be either just below the stigma (*L. mutabilis)*, or in or at the bottom of the style (*L. aloides)* as well as in the ovule (*L. pallida)* with abnormal penetrations (Detail results not shown). In *L. aloides* pollen germinated on the stigma after self-pollination but, limited growth of pollen tubes were observed in the style. Most pollen tubes stopped just below the stigma or grew less than halfway down the style. Few pollen tubes entered the ovary. Only single penetrations of ovules could be observed. Thickened and branching pollen tube tips (Figure 3.2a) were often observed in the style of this species. Incompatibility in one accession of *L. mutabilis* occurred just underneath the stigma where most pollen tubes stopped their growth. Pollen tubes again had thickened tips. A second accession of *L. mutabilis,* however, displayed little incompatibility in the style and penetrations were observed. Incompatibility in *L. pallida* on the other hand seemed to be situated in the ovule. Numerous abnormal penetrations occurred (Figure 3.2b) (Detail results not shown). These abnormalities imply a gametophytic incompatibility system. The extent to which these barriers are carried over to inter-specific crosses are being investigated.

Table 3.1: Success of interspecific crosses attempted at ARC-Roodeplaat VOPI between large and small flowered *Lachenalia* species, classified according to crossing result.

Interspecific cross type (style length)	**Tot. no. per type**	**Successful crosses**	**Unsuccessful no seed set [a]**	**Unsuccessful abnormal seeds [b]**	**Unsuccessful seedling death [c]**
Short X Short (10-15mm)	150	57	40	49	4
Short X Long (10-15mm X +20mm)	284	75	75	125	9
Long X Short (+20mm X 10-15mm)	121	9	92[d]	15	5
Long X Long (+20mm x +20mm)	169	93	24	50	2
Total no. of crosses	724	234 (32%)	231 (32%)	239 (33%)	20 (3%)

a=Mechanical isolation

b=Pre-fertilization barriers present

c=Post-fertilization barriers present

d=Possible hybrid breakdown

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Lubbinge (1980) also mentioned polyploidy as one of the reasons for the failure of inter-species crosses. The author speculated that relatively large, thick pollen tubes produced by some polyploid species (Stebbins, 1950) have difficulty in penetrating the smaller styles of diploids. Recent results did not support these conclusions (Table 3.2). Most inter-specific crosses (68%) where polyploid *L. bifolia* plants were used as pollen parent were unsuccessful because of the production of abnormal or non-viable seeds. The barrier is thus at the post fertilization stage and should rather be ascribed to reduced hybrid viability, most probably caused by disharmony either between the parental sets of chromosomes or between the developing embryo and endosperm. There were also no obvious differences between polyploid and diploid accessions of the same species (Kleynhans & Spies, 1999) with regard to flower size, leaf size etc. as is often found in other polyploid plants. In *L. bifolia* large flowered and small flowered tetraploid accessions were found (Kleynhans & Spies, 1999). Hexaploid accessions also showed large and small flowered ecotypes.

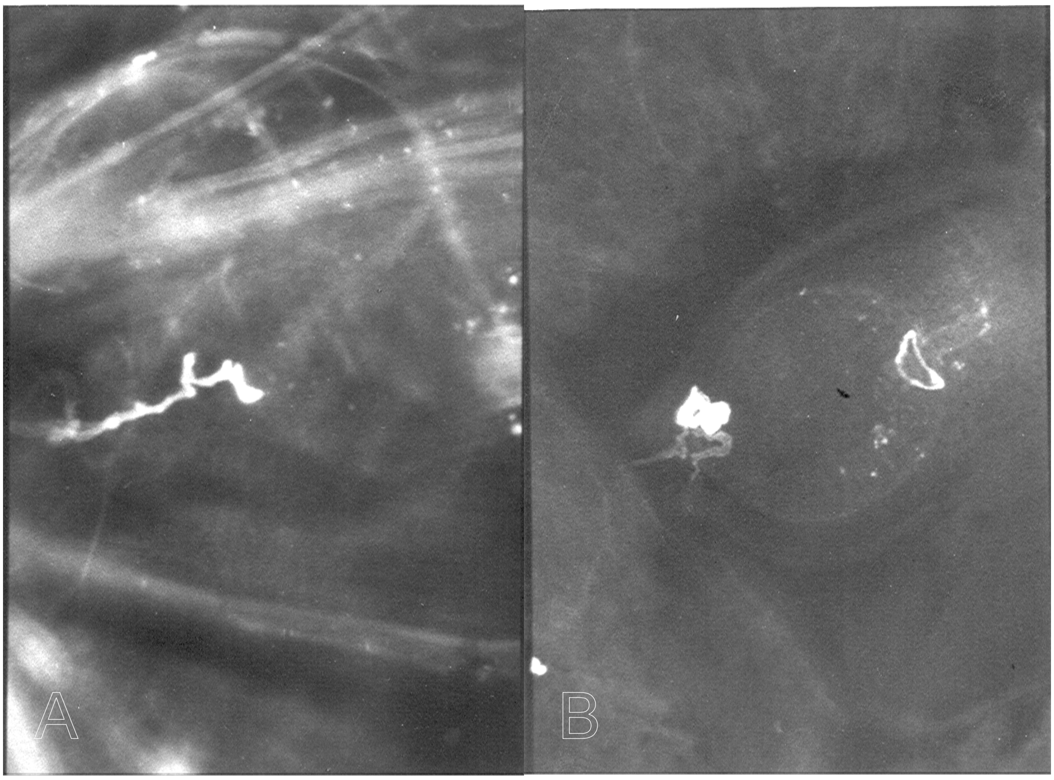

Figure 3.2: Pollen tube growth in *Lachenalia*: (A) Branching and thickened tubes in the style of *L. aloides* after self-pollination (B) Abnormal penetrations in the ovule of *L. pallida* after self-pollination, magnification x400.

Post fertilization barriers are important problems that require investigation. Thirty-three percent of all inter-specific crosses attempted did not succeed because of the production of non-viable seed (Table 3.2). When the large diversity in the cytotaxonomy of the genus is taken into account, this is not surprising. Accordingly, the utilization of embryo or ovule culture to successfully produce hybrids is becoming a priority in the breeding program.

Embryo clearing was done from 5 to 13 days after pollination to determine the developmental stages of the embryos. Only pro-embryos were visible after 13 days (Detail results not shown). The correct time for ovule culture has not yet been established, but the initial results indicated that a period of more than 13 days after pollination was needed before ovules could be collected for successful culture.

Table 3.2: Results of inter-specific crosses between diploid *Lachenalia* species and polyploid accessions of *L. bifolia* used as pollen parent.

	Ploidy of *L. bifolia* as pollen parent			
Result of cross	$2n = 2x = 28$ (tetraploid)	$2n = 2x = 42$ (hexaploid)	$2n = 2x = 56$ (octoploid)	Total %
No. of successful crosses	0 (0%)	4 (8%)	2 (4%)	12
No. of crosses without seed set	3 (6%)	6 (13%)	1 (2%)	21
No. of crosses with abnormal seeds	1 (2%)	23 (48%)	8 (17%)	67

Another aspect mentioned by Lubbinge (1980), was the variance of results obtained when plants of the same species from different ecotypes were crossed in varying combinations. The variance was most probably due to hybrid breakdown. These results and the large variation that can occur within one species (Duncan, 1988, Kleynhans & Spies, 1999, Kleynhans & Spies, 2000) stressed the importance of having more than one ecotype of a species. Utilizing different ecotypes in the same inter-species cross might give totally different results (Lubbinge, 1980, Kleynhans *et al*., 2002). Variation in ecotypes can also be exploited by making intra-species crosses first and then combining different intra-species hybrids instead of the pure species ecotypes (Table 3.3). These bridging crosses can enhance the success of the specific species combination.

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Table 3.3: Differences obtained after using intra-species hybrids of *L. punctata* instead of pure ecotypes of *L. punctata* in crosses with *L. bifolia*

Female parent (ecotype)	**Male parent (ecotype)**	**Result – no of seeds obtained**
L. bifolia (A)[*]	*L. punctata (I)*	No seed set and <10 non-viable seeds
L. bifolia (A)	*L. punctata (J)*	No seed set and <10 non-viable seeds
L. bifolia (B)	*L. punctata (I)*	<10 viable and <10 non-viable seeds
L. bifolia (C)	*L. punctata (K)*	<10 viable seeds
L. bifolia (C)	*L. punctata (L)*	No seed set
L. bifolia (D)	*L. punctata (I)*	No seed set
L. bifolia (E)	*L. punctata (K)*	<10 viable seeds
L. bifolia (F)	*L. punctata (L)*	>50 viable and less than 10 non-viable seeds
L. bifolia (F)	*L. punctata (K)*	>50 viable and less than 10 non-viable seeds
L. bifolia (G)	*L. punctata* inter-species *(IxK)*[#]	>50 viable and less than 10 non-viable seeds
L. bifolia (G)	*L. punctata* inter-species *(IxM)*	>50 viable and less than 10 non-viable seeds
L. bifolia (H)	*L. punctata* inter-species *(LxJ)*	>50 viable and less than 10 non-viable seeds
L. bifolia (H)	*L. punctata* inter-species *(IxL)*	>50 viable and less than 10 non-viable seeds
L. bifolia (H)	*L. punctata* inter-species *(IxK)*	>50 viable and less than 10 non-viable seeds
L. bifolia (H)	*L. punctata* inter-species *(IxM)*	>50 viable and less than 10 non-viable seeds

* Letter indicating different ecotypes of the same species.

Letters indicating ecotypes used as parents for the hybrid crosses

Reduced hybrid fertility is another post-fertilization barrier that occurs especially when species with different basic chromosome numbers are combined (Hancke *et al*., 2001). This barrier can again be overcome with bridging crosses. Crosses between different species within the different basic chromosome groups are first made before the dibasic hybrids are produced. The presence of these barriers and strategies to overcome them stresses the importance of basic studies especially in terms of chromosome numbers, genetic relationships and reproductive studies to develop advanced breeding techniques.

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Besides overcoming reproductive barriers certain breeding strategies are followed to obtain specific goals. Current breeding strategies have two main focus areas. First the development of similar but better adapted hybrids and secondly, and most importantly, the development of new hybrids. Characteristics for better-adapted hybrids include higher production rates and increased longevity. New hybrids are required to be different from any current hybrid. This can be achieved by including new colours in the cultivar range or by making new combinations of colour and flower form.

The aim, to replace or to breed new hybrids, directly influences the breeding strategy as well as the selection criteria used. If the aim is to replace an existing cultivar with a better-adapted hybrid, the selection criteria will become more stringent. Replacement hybrids will be evaluated directly against the old cultivar and will have to outperform the existing hybrid with regard to the required aspects in order to replace the existing one. The cultivar 'Romelia' presents an example of problems experienced during commercialization and marketing that can be improved through breeding. This yellow flowering cultivar tends to produce small bulbs during commercial production. This is probably due to the abundant production of supernumerary bulblets, a highly heritable trait inherited from *L. aloides*. The energy spent in the development of bulblets is not available to the mother bulb to increase in size resulting in the production of low numbers of marketable bulbs.

Producing new cultivars mainly focuses on new colour variation in the current range of cultivars or the production of a new range of cultivars. The current range of cultivars (Figure 3.3) consists of large flowered hybrids with yellow, red, lilac, apricot, and lemon-green inflorescences. Different colour variations of white, purple, blue, green, orange and pink are still available in the gene bank and can be utilized to expand this range. In addition to different colours there is a large potential in the species for developing a range of smaller flowered cultivars. These hybrids will probably have to be marketed separately because they are smaller and more compact than the existing ones. There is a number of small flowered species (See Figure 3.3 for example) that is very floriferous and thus ideal for the development of such a range of cultivars.

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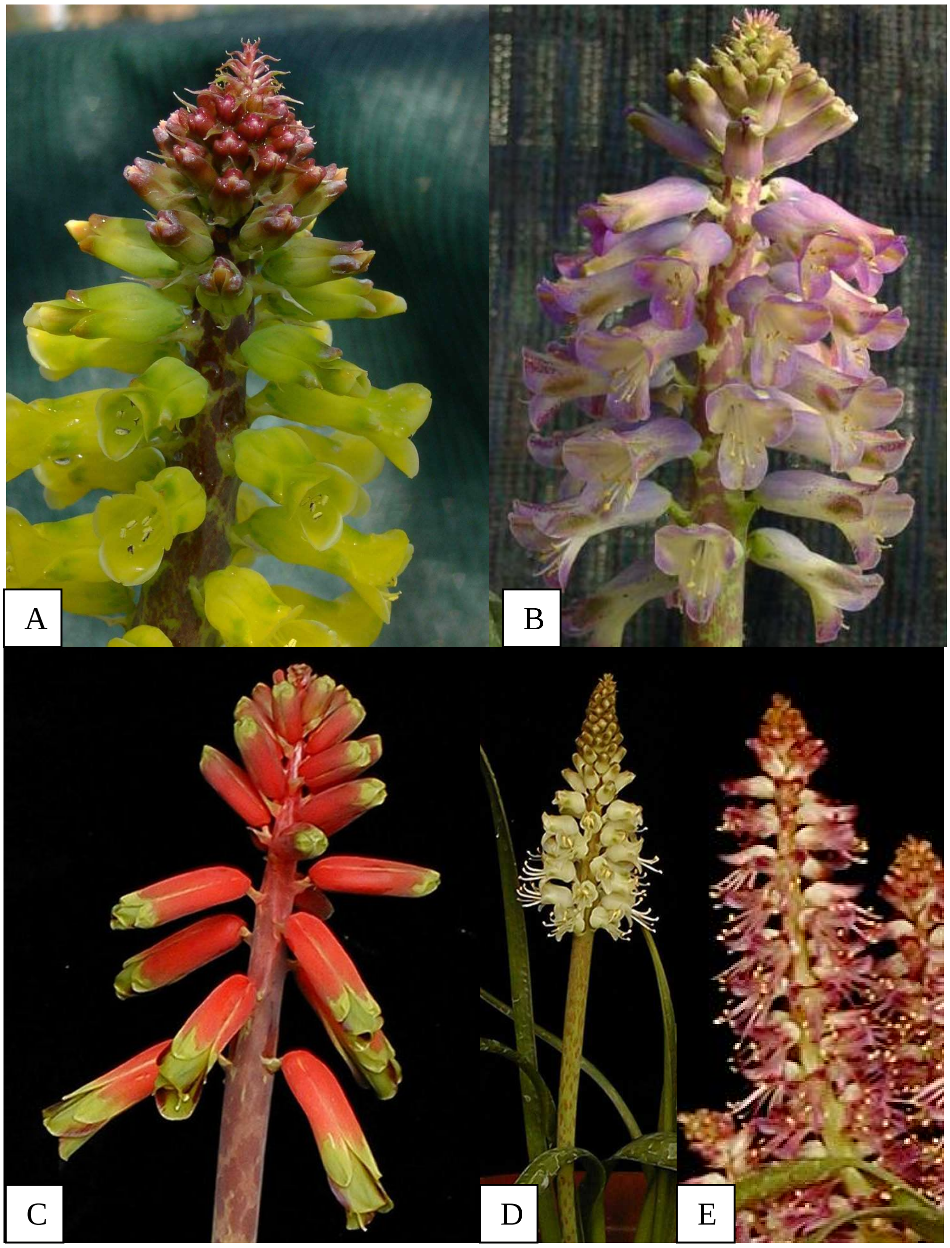

Figure 3.3: Three commercial cultivars and two smaller flowered species of *Lachenalia* (A) *Lachenalia* cultivar Romaud, (B) *Lachenalia* cultivar Rupert, (C) *Lachenalia* cultivar Rosabeth, (D) *Lachenalia bachmanii* Baker*, (E*) *Lachenalia splendida.*

3.5 FURTURE PERSPECTIVES

Investigation of the diversity in the genus received a lot of attention since the publication of the book chapter. Studies on morphological diversity (Duncan, 2005a) and molecular systematics (see chapter 4) were undertaken to enhance the understanding of total diversity. The availability of species boundaries will assist in the correct identification of species. Knowledge on relatedness between and among species will supply the breeders with the basic information to exploit the diversity.

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Future perspectives for *Lachenalia* breeding will have to concentrate on advanced breeding techniques for the successful development of new cultivars. However, utilization of advanced techniques will require some basic research. Developing techniques for successful embryo-rescue after inter-species crosses is a high priority. Determining the extent of pre-fertilization barriers will assist breeders in using the correct techniques to overcome these barriers. Mutation technology presents another strategy of developing new cultivars that can be utilized in *Lachenalia*. This should also receive attention in the near future.

With the increase in commercial production, several disease-related problems have arisen. Virus-related problems have been and will be of great importance in *Lachenalia* production. Successful production will always be directly linked to the presence of a plant improvement scheme. Besides Ornithogalum Mosaic Virus, tobacco necrosis virus (Unpublished results) and Freesia sneak virus (Vaira *et al.,* 2007) has also been identified in *Lachenalia*. Other virus diseases may occur in the future. Fungi such as *Fusarium, Pythium* and *Penicillium* can cause havoc in the production, if not treated correctly. Results from commercial producers indicate that some cultivars are more susceptible to these problems than others. These problems can thus be overcome by breeding for more resistant cultivars in the future. *Embellisia hyacinthii* was also documented to occur in *Lachenalia* (Unpublished results). Although mostly a secondary fungus it is destructive on *Lachenalia* if not controlled. This fungus can cause losses of up to 50% of the production of commercial sized bulbs in certain *Lachenalia* cultivars. The extent of these and new problems will determine the specific research needed to correct the problems through resistance breeding and specific production practices.

In conclusion the development of cultivars from a new genus can never stand on its own. A successful breeding program does not end with the production of a superior hybrid but needs a concerted effort from all involved. Supply of required technology for successful production, involvement in actual commercialization and establishment of a successful marketing channel must all be taken into account.

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3.6 STATEMENT OF RESEARCH QUESTIONS ADDRESSING THE DEVELOPMENT OF NEW *LACHENALIA* CULTIVARS

Research question: Is *Lachenalia* a suitable crop to address the requirements for the development of new floriculture crops?

Based on this review of the breeding and developmental research on the genus following conclusions can be drawn:

- *Lachenalia* has the required diversity to facilitate the development of new hybrids
- Developed hybrids have entered the commercial market and are being sold internationally indicating market acceptance
- Bulbs can successfully be produced in sufficient quantities and of good quality to fulfil the requirement of superior plant material
- Bulbs of the genus can successfully be stored and forced to flower during different periods to address the requirements in the market
- A hybrid evaluation system has been developed for the selection of suitable new lines

However, there are also essential research questions that need to be addressed to continue on the existing initiatives:

- What is the extent of the genetic diversity in the genus?
- How does this diversity link to the cross-ability of different species?
- Can answers on the genetic diversity and phylogeny of the genus assist in the development of breeding strategies?
- What are the extent and the nature of the internal crossing barriers?

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CHAPTER 4

CYTOGENETIC AND PHYLOGENETIC REVIEW OF THE GENUS *LACHENALIA*

ABSTRACT

The genus *Lachenalia* (family Asparagaceae), endemic to southern Africa, is a horticultural diverse genus, with many species featuring in the red data list of southern Africa. The extensive morphological variation within some species complicates species delimitation and has led to taxonomic confusion. The genus is utilised in a breeding programme where cytogenetic and phylogenetic information is important for the development of breeding strategies. Chromosome numbers of 92 species have been recorded in literature, with $2n$ = 10 to 56 and n = 5 to 28. B-chromosomes have been described in some species. Basic chromosome numbers include x = 5, 6, 7, 8, 9, (probably 10), 11, (probably 12), 13, 14 and (probably 15). Polyploidy was reported in 21 taxa (24%), and is most common in the x = 7 group. Molecular cytogenetic studies using 5S rDNA, 18S rDNA probes and DAPI staining, as well as molecular systematic studies using *trnL-F* and *ITS1-2* were used to assess the phylogeny of the genus. All these studies indicated that species with the same basic chromosome number are closely related. The one deviation is that it appears as if there are two separate groups within the x = 7 group. The cytogenetic and molecular studies are further supported by breeding studies, where improved results are generally obtained from crosses within a phylogenetic group or between closely related groups. This review of the literature reveals how different studies obtain similar results regarding the phylogenetic relationships within the genus and how these results can be utilized to improve breeding strategies. It also accentuates that further multidisciplinary studies are needed to solve the evolutionary history of the complex genus *Lachenalia*.

PREFACE

This chapter was published as an invited review publication in a special edition of *Floriculture and Ornamental Biotechnology* focusing on flower bulbs. As first author I received an invitation from the guest editors to contribute to the special edition and initiated the literature review on the cytogenetics and phylogenetics of the genus *Lachenalia*. My direct contribution to the chapter includes the introduction, all cytogenetic studies, cross-

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ability and all aspects linking the cytogenetic data and cross-ability to the phylogenetics. As first author I also structured and combined contributions from co-authors to produce a logical flow of information. The chapter is adapted to include information published during 2011/2012, but the implications of this information in terms of the cross-ability and the effect on breeding will be included in Chapter 7. Additional chromosome numbers of accessions used in the cross-ability study as well as detail information on the species used will also be included in Chapter 7.

4.1 INTRODUCTION

The genus *Lachenalia* Jacq. *f*. ex Murray, previously a member of the family Hyacinthaceae (Manning *et al*., 2004; Duncan & Edwards, 2006 & 2007), but since 2009 reclassified under the family Asparagaceae Juss. (APG III group, 2009), is endemic to southern Africa. The genus now also includes the former genus *Polyxena* (Manning *et al*., 2004). *Lachenalia* is a horticultural diverse genus, with a distribution range extending from the south-western coast of Namibia, southward throughout the Northern, Western and Eastern Cape provinces of South Africa (Duncan, 1992). One species extends as far inland as the south western part of the Free State Province (Duncan, 1996). Of the 133 species and subspecies described, 10% are endangered, 17% are vulnerable, 2% are considered to be near threatened, 6% are critically rare, 9% are rare and 2% are declining (SANBI, 2009).

The genus is geophytic, deciduous and is usually winter growing. The centre of diversity is in the Worcester grid (3319) in the Western Cape Province of South Africa, with species diversity decreasing toward the eastern and northern parts of its range (Duncan, 2005a). Although *Lachenalia* species like *L. bifolia* and *L. obscura* Schltr. ex G.D. Duncan are widely distributed, a substantial number of species (e.g. *L. moniliformis* W.F. Barker, *L. mathewsii* W.F. Barker) have a restricted distribution, contributing to the vulnerability of these species (Duncan, 1998b).

Lachenalia occurs in a wide range of habitats, ranging from arid to high rainfall areas. *Lachenalia punctata* for example always grows in deep, pure sand often very close to the sea, whilst a species like *L. campanulata* Baker on the other hand is found in heavy soil at altitudes exceeding 2000 metres (Duncan, 1988). Between these two extremes, there is a multitude of other habitats, including humus-rich soil on granite, mineral rich soil, barren stony flats, limestone outcrops and seasonally inundated, heavy clays (Duncan, 1988).

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The morphological diversity within the genus is well known (Figure 4.1). Variation occur in several morphological characters, such as plant size, leaf number and posture, flower-size, -colour and -orientation and flowering period (Figure 4.2). The extensive morphological variation within some species complicates species delimitation and has led to considerable taxonomic confusion (Duncan, 1992). Several attempts have thus been made to establish some sub-generic classification within this complex genus, starting with the work by Baker (1897), who divided the genus into five sub-genera based on morphology. The first cytogenetic work by Moffett (1936), however, already indicated that true relationships cut across the groups of Baker and this has been confirmed by various studies (Crosby, 1986, Spies, 2004, Hamatani *et al*., 2009, amongst others).

Figure 4.1: Morphological variation in *Lachenalia* in the greenhouse

Due to the extensive morphological diversity in colour and appearance, collectors have recognized the horticultural potential of the genus for centuries (Duncan, 1988, Du Plessis & Duncan, 1989; Kleynhans, 2009, Kleynhans, 2011, Reiten *et al*., 2011). The huge phenotypic variation was also the most important reason for the initiation of a breeding programme at the Agricultural Research Council in South Africa. This led to the production

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of various hybrids and the introduction of new products to the international pot plant market (Figure. 4.3) (Kleynhans, 2006).

The variability of the genus in terms of morphology and cytogenetics, however, lead to specific challenges for the breeding of new cultivars. Both incompatibility and other isolation barriers exists (Kleynhans & Hancke, 2002). A large number of inter-species crosses are unsuccessful (Kleynhans *et al*., 2009b) and future breeding progress is dependent on information about the genetic variation in the genus. Results generated from cytogenetic and phylogenetic research has value for the breeding programme (Kleynhans *et al*., 2009b) and can furthermore assist in the classification and delimitation of species (Crosby, 1986, Spies *et al*., 2002).

Figure 4.2: Morphological variation in different *Lachenalia* species. (A) *L.*

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aloides; (B) *L. carnosa*; (C) *L. splendida*; (D) *L. bifolia*; (E) *L. longibracteata* E. Phillips; (F) *L. glauca* (W.F. Barker) G.D. Duncan; (G) *L. contaminata* Aiton; (H) *L. pusilla* Jacq.

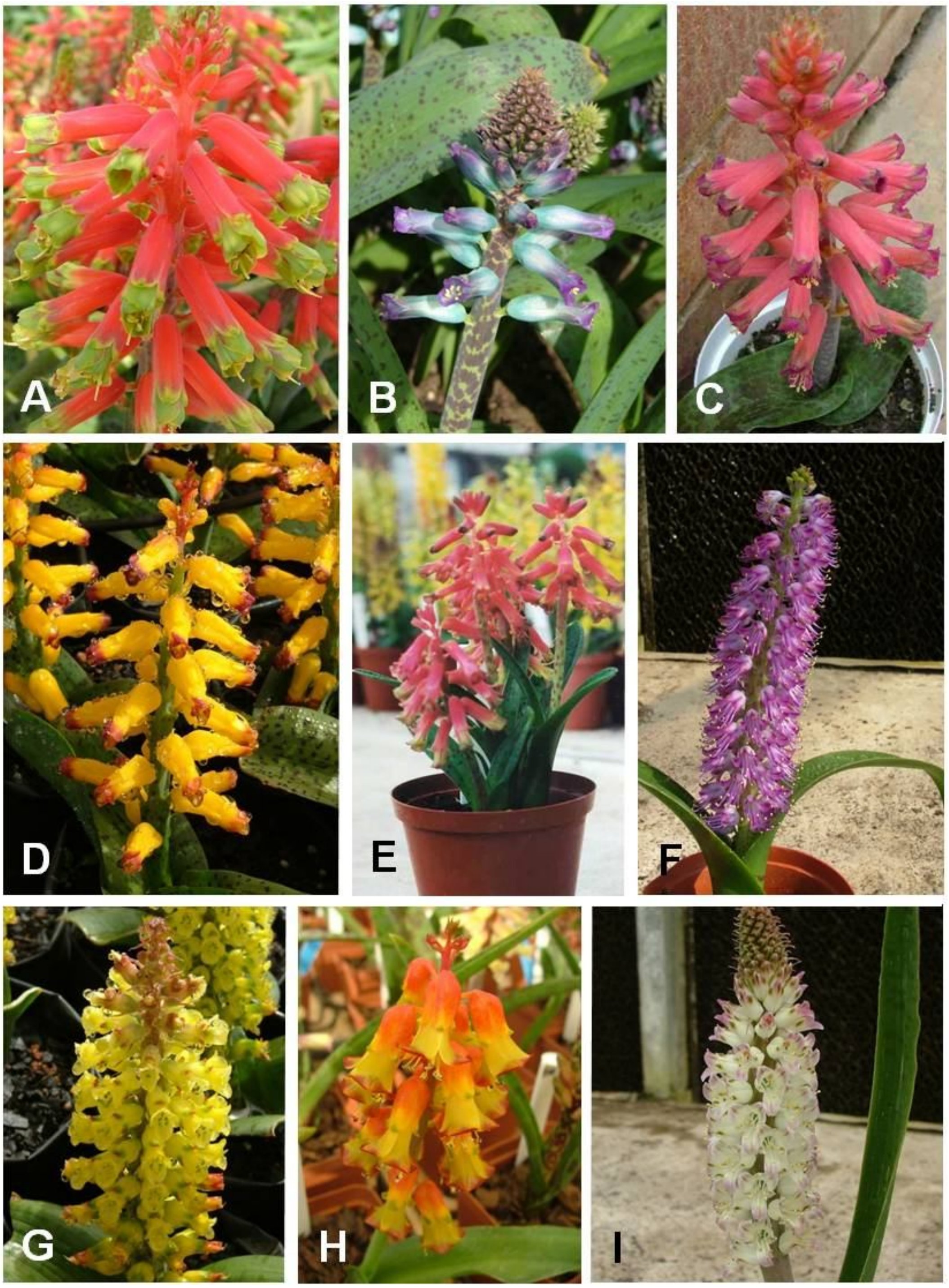

Figure 4.3: Different *Lachenalia* cultivars developed at ARC - Roodeplaat VOPI. (A) 'Rosabeth'; (B) 'Aqua Lady'; (C) 'Cherise'; (D) 'Namakwa'; (E) *L. bifolia* x *L. punctata*; (F) *L. pallida* x *L. splendida*; (G) 'Romaud'; (H) 'Rainbow Bells'; (I) *L. bachmannii* x *L. carnosa*.

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This paper reviews the current information available on cytogenetics and phylogeny for the genus *Lachenalia* and correlates this information to breeding results on cross-ability with the aim to draw some conclusions on relationships among the different species within the genus.

4.2 CYTOGENETIC STUDIES

4.2.1 Chromosome counts

Lachenalia is unusually variable in chromosome number with the presence of different basic chromosome numbers (Moffett, 1936, Crosby, 1986, Johnson & Brandham, 1997), polyploidy (Kleynhans & Spies, 1999) and B-chromosomes (Hancke & Liebenberg, 1990, Johnson & Brandham, 1997). The first cytogenetic studies on the genus came from Moffett (1936). Chromosome numbers steadily increased over many years with information coming from various authors (Table 4.1). Currently the chromosome numbers of 92 species have been recorded in literature. Somatic chromosome numbers vary from 10 to 56 and gametic numbers from 5 to 28.

The cytogenetics is further complicated by varying chromosome number reports for a number of species (Table 4.1). Deviating chromosome counts can first of all be explained by suspected wrong identification of species. In the species *L. orchioides* (L.) Aiton the variation could most probably be ascribed to accessions being wrongly identified. Crosby (1986) reported that he received both *L. fistulosa* Baker and *L. pallida* under the name of *L. orchioides*. Schlechter also identified an accession of *L. pallida* as *L. orchioides* (Barker, 1983). *Lachenalia pallida* have chromosome numbers of 2*n* = 16 which could explain some of the variation reported for *L. orchioides*. *Lachenalia contaminata* similarly has both 2*n* = 14 and 2*n* = 16 reported in literature (Table 4.1). Gouws (1965) was the first to report both these numbers. The author, however, described these two numbers in one specific bulb of *L. contaminata* exhibiting cells with both 2*n* = 14 and 2*n* = 16. In this case the 2*n* = 16 could be B-chromosomes that was not identified. Most other chromosome counts of this species, except two by Spies *et al*. (2008, 2009), are 2*n* = 16. In this species the variation is not a case of mistaken identity and further investigation is needed to explain the variation.

The small size of the chromosomes (Hancke & Liebenberg, 1990, Spies *et al*., 2000) in the genus can furthermore contribute to miscounts and possible miss-identification of B-chromosomes. The presence of B-chromosomes in *Lachenalia* was described by Hancke & Liebenberg (1990). According to the authors, B-chromosomes in *Lachenalia* do not have a

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specific staining pattern and are similar in size to the smallest chromosome in the normal complement. This behaviour makes them difficult to identify and therefore could explain some erroneous counts, reported in literature. B-chromosomes in *Lachenalia* do not occur in all cells of a specific individual and also not in all plants of a specific accession (Hancke & Liebenberg, 1990). It is thus important to investigate the chromosome number of several individuals from a specific population to have accurate chromosome counts and correctly identify the presence of B-chromosomes. Counting insufficient number of cells can similarly lead to miscounts due to chromosome damage occurring during slide preparation.

B-chromosomes have been reported in eight species, namely *L. aloides*, *L. anguinea* Sweet, *L. bifolia*, *L. carnosa*, *L. contaminata*, *L. obscura*, *L. reflexa* and *L. splendida* (Crosby, 1986, Hancke & Liebenberg, 1990, Johnson & Brandham, 1997, Kleynhans & Spies, 1999, Spies *et al*., 2009). Hamatani *et al*. (1998) also reported an expected B-chromosome in a $2n = 23$ accession of *L. zeyheri* Baker. Another example where possible B-chromosomes have not been identified, can be found in *L. barkeriana* U. Müller-Doblies *et al*. where both $2n = 14$ and $2n = 16$ was reported (Table 4.1). The $2n = 16$ was, however, only found in one cell (Müller-Doblies *et al*., 1987) of an otherwise $2n = 14$ accession and could most possibly be ascribed to extra chromosomes.

Table 4.1: List of *Lachenalia* species with the somatic- and gametic chromosome numbers reported in literature. Number in brackets (#) indicates number of accessions for which the specific somatic or meiotic number was reported. All numbers were reported in the table under the current accepted botanical name. Aneuploidy and other abnormalities or specific detail around polyploidy are indicated with superscripts.

Species	**Somatic no.** (#)	**Gametic no.** (#)	**Reference**
L. alba W.F. Barker ex G. D. Duncan	18 (1), 20 (3), 20/40 (1)		Johnson & Brandham, 1997
L. algoensis Schönland	14 (5)		Crosby, 1986; Hamatani *et al*,. 2007; Spies *et al.,* 2008, 2009; Hamatani, 2011
		7 (1)	Ornduff & Watters, 1978
	21 (1)		Hancke, 1991
L. aloides (L.f.) Engl.	14 (22)+0-1B		Moffett, 1936; Therman, 1956; De Wet, 1957; Mogford, 1978; Crosby, 1986; Hancke & Liebenberg, 1990; Hancke, 1991; Johnson & Brandham, 1997; Hamatani *et al.,* 1998, 2007 &2009; Spies *et al.,* 2009
		7 (4)	Hancke & Liebenberg, 1998; Moffett, 1936
	15 (2)[b]		Crosby, 1986; Hamatani, 2011
	21 (2)[c]		Moffett, 1936; Crosby, 1986

[b] Aneuploid (Crosby); Hamatani reported on L. aloides 'Pearsoni" an intra-species hybrid
[c] Autotriploid

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Species	Somatic no. (#)	Gametic no. (#)	Reference
	28 (2)		Crosby, 1986; Hancke & Liebenberg, 1990
		14 (1)	Ornduff & Watters, 1978
L. ameliae W.F. Barker	18 (2)		Johnson & Brandham, 1997
L. anguinea Sweet	30 (1)+2B		Johnson & Brandham,1997
L. arbuthnothiae W.F. Barker	14 (6)		Crosby, 1986; Johnson & Brandham, 1997; Hamatani *et al.,* 1998; Spies *et al.,* 2008 & 2009
		7 (1)	Spies *et al.,* 2009
	15 (1)		Hamatani, 2011
L. attenuata W.F. Barker ex G.D. Duncan	14 (1)		Spies *et al.,* 2009
L. bachmannii Baker	16 (5)		De Wet, 1957; Crosby, 1986; Johnson & Brandham, 1997; Hamatani *et al.,* 2004
L. barkeriana U. Müller-Doblies *et al.*	14 (3)		Müller-Doblies *et al.,* 1987
	16 (2)		Nordenstam, 1982; Müller-Doblies *et al.,* 1987
L. bifolia (Burm. f.) W.F. Barker ex G.D. Duncan	14 (1)		Crosby, 1986
	28 (7)		Kleynhans & Spies, 1999; Spies *et al.,* 2009
		14 (1)	Ornduff & Watters, 1978
	42 (15)+0-1B[d]		Moffett, 1936; Crosby, 1986; Johnson & Brandham, 1997; Hamatani *et al.,* 1998; Kleynhans & Spies, 1999 [c]; Spies *et al.,* 2008
	49 (1)		Kleynhans & Spies, 1999
	56 (5)		Crosby, 1986; Johnson & Brandham, 1997; Kleynhans & Spies, 1999
L. bolusii W.F. Barker	18 (1)		Spies *et al.,* 2009
L. bowkeri Baker	16 (1)		Dold & Philipson, 1998
L. capensis W.F. Barker	16 (2)		Hamatani *et al.,* 1998; Hamatani, 2011
	28 (2)		Johnson & Brandham, 1997; Spies *et al.,* 2008
L. carnosa Baker	16 (26)		Crosby, 1986; Johnson & Brandham, 1997; Hamatani *et al.,* 1998; Du Preez *et al.,* 2002; Spies *et al.,* 2008; Hamatani *et al.,* 2009; Spies *et al.,* 2009
		8 (1)+0-2B	Spies *et al.,* 2009
L. cernua G.D. Duncan	28 (1)		Spies *et al*., 2008
L. comptonii W.F. Barker	20 (5)		Crosby, 1986; Johnson & Brandham, 1997; Spies *et al.,* 2009
		10 (1)	Spies, 2004
	c26 (1)		Crosby, 1986
L. concordiana Schltr. Ex W.F. Barker	14 (1)		Spies *et al.,* 2008
L. congesta W.F. Barker	26, 28 (1)		Johnson & Brandham, 1997
	28 (1)		Hamatani, *et al.* 2010
L. contaminata Aiton	14 (3)		Gouws, 1965; Spies *et al.,* 2008 & 2009
	16 (11)+1B		De Wet, 1957; Gouws, 1965; Crosby, 1986; Hancke, 1991; Johnson & Brandham, 1997; Hamatani *et al.,* 2004
		8 (2)	Ornduff & Watters, 1978
	32 (1)		Johnson & Brandham, 1997
L. convallarioides Baker	30 (1)		Johnson & Brandham ,1997
L. doleritica G.D. Duncan	18 (2)		Spies *et al.,* 2008 & 2009
L. duncanii W.F. Barker	18 (1)		Spies *et al.,* 2008
L. elegans W.F. Barker	14 (4)		Johnson & Brandham, 1997; Spies *et al.,* 2009
	28 (8)		Moffett, 1936; Johnson & Brandham, 1997; Spies *et al.,* 2009
		14 (9)	Ornduff & Watters, 1978; Spies *et al.,* 2009
	42 (3)		Johnson & Brandham, 1997; Spies *et al*., 2009
		21 (2)	Spies *et al.,* 2009
	56 (1)		De Wet, 1957
		28 (2)	Ornduff & Watters, 1978
L. ensifolia (Thunb.) J.C. Manning and Goldblatt	24 (3)		Johnson & Brandham, 1997
	26 (2)		Johnson & Brandham, 1997; Hamatani *et al.,* 2007
L. fistulosa Baker	14 (8)		Johnson & Brandham, 1997; Spies *et al.,* 2002; Hamatani *et al.,* 2004; Spies *et al*., 2009
		7 (2)	Ornduff and Watters, 1978
	28 (1)		Spies *et al.,* 2008
L. flava Andrews	14 (5)		De Wet, 1957; Johnson & Brandham, 1997; Hamatani *et al.,* 2004,

[d] Segmental alloploid

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Species	Somatic no. (#)	Gametic no. (#)	Reference
			& 2009; Spies *et al.,* 2009
L. framesii W.F. Barker	16 (3)		Du Preez *et al.,* 2002; Spies *et al.,* 2008
L. giessii W.F. Barker	32 (1)		Spies *et al.,* 2008
L. glauca (W.F. Barker) G.D. Duncan		7 (1)	Spies *et al.,* 2009
L. haarlemensis Fourc.	18 (2)		Johnson & Brandham, 1997
L. hirta (Thunb.) Thunb.		9 (1)	Ornduff & Watters, 1978
	22 (6)		Johnson & Brandham, 1997; Van Rooyen *et al.,* 2002; Hamatani *et al.,* 2004; Spies *et al.,* 2009
		11 (2)	Ornduff and Watters, 1978
	24 (3)		De Wet, 1957; Hancke, 1991; Johnson & Brandham, 1997
L. inconspicua G.D. Duncan	18 (1)		Spies *et al.,* 2008
L. isopetala Jacq.	30 (2)		Johnson & Brandham, 1997
	40 (1)		Spies *et al.,* 2008
L. juncifolia Baker	22 (9)		Johnson & Brandham, 1997; Hamatani *et al.,* 2007; Spies *et al.,* 2008 & 2009; Hamatami *et al*., 2010
		11 (1)	Ornduff and Watters, 1978
L. karooica W.F. Barker ex G.D. Duncan	16 (1)		Duncan, 1996
L. karoopoortensis G.D. Duncan	42 (1)		Johnson & Brandham, 1997
L. klinghardtiana Dinter	14 (2)		Spies *et al.,* 2008
L. kliprandensis W.F. Barker	16 (1)		Johnson & Brandham, 1997
L. lactosa G.D. Duncan	14 (1)		Spies *et al.,* 2008
L. latimerae W.F. Barker	14 (1)		Spies *et al*., 2008
	18 (2)		Hamatani *et al.,* 2007 & 2010; Hamatani, 2011
L. leomontana W.F. Barker	14 (1)		Spies *et al.,* 2008
L. liliflora Jacq.	16 (7)		Moffett, 1936; De Wet, 1957; Hancke, 1991; Johnson & Brandham, 1997; Hamatani *et al.,* 1998 & 2009; Spies *et al.,* 2009
		8 (1)	Moffett, 1936
L. longibracteata Phillips	14 (7)		Crosby, 1986; Hamatani *et al.,* 2007; Spies *et al.,* 2008; Hamatani *et al.,* 2009; Hamatani, 2011
		7 (2)	Ornduff & Watters, 1978
L. longituba (A.M. van der Merwe) J.C. Manning and Goldblatt	28 (3)		Hamatani *et al.,* 2007 & 2010; Hamatani, 2011
L. macgregoriorum W.F. Barker	22 (1)		Spies *et al.,* 2008
L. margaretae W.F. Barker	14 (1)		Spies *et al.,* 2008
L. marginata W.F. Barker	14 (1)		Spies *et al.,* 2008
	28 (3)		Johnson & Brandham, 1997
	29 (1)		Johnson & Brandham,1997
L. marginata subsp. *neglegta* Schltr. Ex G.D. Duncan	10 (1)		Duncan, 1996
L. marlothii W.F. Barker ex G.D. Duncan	14 (1)		Spies *et al.,* 2008
L. martinae W.F. Barker	26 (1)		Spies *et al.,* 2008
L. mathewsii W.F. Barker	14 (4)		Johnson & Brandham, 1997; Hamatani *et al.,* 1998; Spies *et al.,* 2002, 2008 & 2009
L. maximiliani Schltr. Ex W.F. Barker	16 (1)		Spies *et al.,* 2009
L. mediana Jacq.	14 (1)		Johnson & Brandham, 1997
	18 (2)	9 (2)	Spies *et al.,* 2009
	26 (2)		Crosby, 1986; Spies *et al.,* 2008
		13 (1)	Spies *et al.,* 2009
L. membranacea (W.F. Barker) G.D. Duncan	14 (1)		Moffett, 1936
	28 (1)		Crosby, 1986
L. minima W.F. Barker	18 (1)		Spies *et al.,* 2008
L. moniliformis W.F. Barker	22 (1)		Spies *et al.,* 2008
L. muirii W.F. Barker	14 (3)		Johnson & Brandham, 1997; Hamatani *et al.,* 2007 & 2009

Species	Somatic no. (#)	Gametic no. (#)	Reference
L. mutabilis Sweet	10 (6)		Johnson & Brandham, 1997
		5 (2)	Ornduff & Watters, 1978
	12 (6)		Spies *et al.,* 2000 & 2009
		6 (2)	Spies *et al.,* 2002 & 2009
	14 (20)		De Wet, 1957; Crosby, 1986; Hancke & Liebenberg, 1990; Johnson & Brandham, 1997; Hamatani *et al.,* 1998; Spies *et al.,* 2000 & 2009
		7 (5)	Hancke & Liebenberg, 1998; Spies *et al.,* 2002 & 2009
	24 (1)		Spies *et al.,* 2000
	56 (1)		De Wet, 1957
L. namaquensis Schltr. Ex W.F. Barker	16 (11)		Crosby, 1986; Johnson & Brandham, 1997; Du Preez *et al.,* 2002; Hamatani *et al*., 2007; Spies *et al.,* 2008; Hamatani *et al.,* 2009; Spies *et al.,* 2009
		8 (2)	Spies *et al.,* 2009
L. namibiensis W.F. Barker	22 (2)		Spies *et al.,* 2008
L. neilii W.F. Barker ex G.D. Duncan	18 (1)		Spies *et al.,* 2008
L. nervosa Ker Gawll	16 (2)		Moffett, 1936; Spies *et al.,* 2008
		8 (1)	Moffett, 1936
	24 (2)		Johnson & Brandham, 1997; Hamatani *et al.,* 2007
L. obscura Schltr. Ex G.D. Duncan	18 (2)+1B,		Johnson & Brandham, 1997
	36 (2)		Spies *et al.,* 2008
L. orchioides (L.) Aiton	14 (20)		Crosby, 1986; Hamatani *et al.,* 2007; Spies *et al.,* 2008 & 2009
		7 (19)	Moffett, 1936; Ornduff & Watters, 1978; Spies *et al.,* 2009
	16 (5)		Moffett, 1936; De Wet, 1957; Hancke, 1991
		8 (1)	Moffett, 1936
	17 (1)[e]		Moffett, 1936
	18 (1)		Riley, 1962
	28 (13)		Moffett, 1936; De Wet, 1957; Crosby, 1986; Johnson & Brandham, 1997; Hamatani *et al.,* 2007; Spies *et al.,* 2008; Hamatami *et al.*, 2010
		14 (2)	Moffett, 1936; Ornduff & Watters, 1978
	24 (1)		Hancke & Liebenberg, 1990
	29 (1)		Johnson & Brandham, 1997
L. orthopetala Jacq.	16 (5)		Crosby, 1986; Johnson & Brandham, 1997; Spies *et al.,* 2008 & 2009
L. pallida Aiton	16 (72)		Moffett, 1936; De Wet, 1957; Crosby, 1986; Johnson & Brandham, 1997; Hamatani *et al.,* 1998; Spies *et al.,* 2000; Hancke *et al.*, 2001; Du Preez *et al.,* 2002; Hamatani *et al.,* 2004; Spies *et al.,* 2008; Hamatani *et al.,* 2009; Spies *et al*., 2009
		8 (9)	Moffett, 1936; Ornduff & Watters, 1978, Hancke *et al.*, 2001
	32 (2) [f]		Crosby, 1986; Spies *et al.,* 2000
L. patula Jacq.	16 (1)		Johnson & Brandham, 1997
L. paucifolia (W.F. Barker) J.C. Manning and Goldblatt	26 (3)		Johnson & Brandham, 1997; Hamatani *et al.,* 2007 & 2010
L. peersii Marloth ex W.F. Barker	14 (3)		Johnson & Brandham, 1997; Hamatani *et al.,* 2004; Spies *et al.,* 2009
L. physocaulos W.F. Barker	14 (1)		Spies *et al.,* 2008
L. polyphylla Baker	22 (1)		Spies *et al.,* 2008
L. punctata Jacq.	14 (6)		Moffett, 1936; Crosby, 1986; Hamatani *et al.,* 1998 & 2009; Spies *et al.,* 2009
		7 (1)	Moffett, 1936
	28 (1)		Crosby, 1986
L. purpureo-caerulea Jacq.	16 (3)		Moffett, 1936; Johnson & Brandham, 1997; Spies *et al.,* 2009
		8 (2)	Moffett, 1936; Ornduff and Watters, 1978
	15 (1)		Hamatani, 2011
L. pusilla Jacq.	14 (8)		Crosby, 1986; Müller-Doblies *et al.,* 1987; Johnson & Brandham, 1997; Hamatani *et al.,* 1998, 2007 & 2009

[e] Aneuploid

[f] One cell in a specific specimen

Species	Somatic no. (#)	Gametic no. (#)	Reference
	16 (1)[g]		Nordenstam, 1982
	18 (1)		Spies *et al.,* 2009
	28 (1)		Hancke, 1991
L. reflexa Thunb.	14 (5)+0-2B		Crosby, 1986; Hancke & Liebenberg, 1990; Johnson & Brandham, 1997; Hamatani *et al.,* 1998; Spies *et al.,* 2009
		7 (1)	Hancke & Liebenberg, 1998
	16 (1)		De Wet, 1957
L. rosea Andrews	14 (6)		Moffett, 1936; Crosby, 1986; Hancke, 1991; Johnson & Brandham, 1997; Hamatani *et al.,* 2007; Spies *et al.,* 2008
	21 (1)		Crosby, 1986
	28 (2)		Spies *et al.,* 2009
L. sauveolens (W.F. Barker) G.D. Duncan	14 (1)		Johnson & Brandham, 1997
	28 (1)		Spies *et al.,* 2009
L. splendida Diels.	16 (8)+2B		Crosby, 1986; Johnson & Brandham, 1997; Hamatani *et al.,* 1998; Du Preez *et al.,* 2002; Hamatani *et al.,* 2009; Spies *et al.,* 2009
		8 (2)	Spies *et al.,* 2009
	18 (1)[h]		Crosby, 1986
L. stayneri W.F. Barker	24 (1)		Johnson & Brandham, 1997
L. thomasiae W.F. Barker ex G. D. Duncan	14 (2)		Spies *et al.,* 2008; Hamatani, 2011
L. trichophylla Baker	14 (2)		Johnson & Brandham, 1997
		7 (1)	Ornduff & Watters, 1978
L. undulata Masson ex Bak.	20 (1)		Johnson & Brandham, 1997
L. unifolia Jacq.	16 (1)		Hancke, 1991
	21 (1)		De Wet, 1957
	22 (24)		Moffett, 1936; De Wet, 1957; Crosby, 1986; Johnson & Brandham, 1997; Van Rooyen *et al.,* 2002; Spies *et al.,* 2009
		11 (16)	Moffett, 1936; Ornduff & Watters, 1978; Spies *et al.,* 2009
	24 (2)		De Wet, 1957; Hamatani *et al.,* 2004
	26 (2)		Moffett, 1936; De Wet, 1957
	44 (1)		Johnson & Brandham, 1997
L. valeriae G.D. Duncan	16 (1)		Spies *et al.,* 2008
L. vanzyliae (W.F. Barker) G.D. Duncan & T.J. Edwards	28 (5)		Crosby, 1986; Hancke, 1991; Spies *et al.*, 2009, Hamatani *et al.*, 2010; Hamatani, 2011
L. variegata W.F. Barker	14 (3)		Spies *et al.,* 2008; Hamatani *et al.,* 2009; Hamatani, 2011
	12 (1)		Hamatani *et al.,* 2004
	28 (1)		Spies *et al.,* 2002
L. ventricosa Schltr. ex W.F. Barker	14 (1)		Spies *et al.,* 2008
L. verticillata W.F. Barker	16 (1)		Crosby, 1986
L. violacea Jacq	14 (13)		Hancke, 1991; Johnson & Brandham, 1997; Hamatani *et al.,* 1998
		7 (2)	Ornduff & Watters, 1978; Spies *et al.,* 2009
	15 (1)		Johnson & Brandham, 1997
	16 (1)		Crosby, 1986
L. viridiflora W.F. Barker	14 (7)		Nordenstam, 1982; Crosby, 1986; Hancke & Liebenberg, 1990; Hancke, 1991; Johnson & Brandham, 1997; Spies *et al.,* 2002; Hamatani *et al.,* 2007 & 2009
		7 (1)	Hancke and Liebenberg, 1998
L. youngii Baker	16 (1)		Spies *et al.,* 2008
L. zebrina W.F. Barker	30 (2)		Johnson & Brandham, 1997; Spies *et al.,* 2008
L. zeyheri Baker	22 (2)		Johnson & Brandham, 1997; Spies *et al.,* 2002
	23 (2)[i]		Hamatani *et al.,* 1998 & 2010; Hamatani, 2011

[g] Specific accessions later identified as *L. barkeriana*

[h] Possibly B-chromosomes

[i] Suspected B-chromosome

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4.2.2 Chromosome morphology

The chromosome morphology of *Lachenalia* has been described in various reports (Moffett, 1936, De Wet, 1957, Hamatani *et al*., 1998, Hancke & Liebenberg 1998, Hancke *et al*., 2001, Hamatani *et al*., 2004, Hamatani *et al*., 2007, Hamatani *et al*., 2009, Hamatani *et al*., 2010). Both Moffett (1936) and Hamatani *et al*. (1998, 2004 & 2007) attempted to group the species of the genus based on chromosome length and basic chromosome number. The groupings by Moffett (1936) and Hamatani *et al*. (1998) agreed, except for the division of the first group of Moffett into two separate groups by Hamatani *et al*. (1998). Further studies by Hamatani *et al*. (2004 & 2007) added four groups based on chromosome numbers and varying numbers of larger chromosomes within specific basic chromosome numbers.

Ideograms presented by De Wet (1957) do not agree with karyograms by Moffett (1936) or Hamatani *et al*. (1998, 2004 & 2007). Neither does it agree with ideograms presented by Hancke *et al*. (1998 & 2001) and Hamatani *et al*. (2009). The ideogram for *L. aloides* presented by Hancke *et al*. (2001) agrees with Mofett's division, but differs from the karyograms of Hamatani *et al*. (1998, 2004, 2007) in having six longer chromosomes and not only two long chromosomes. Ideograms for *L. aloides* and *L. splendida* constructed by Hamatani *et al*. (2009) again correlate with that of Hancke *et al*. (2001).

Spies *et al*. (2000) reported that accessions of *L. mutabilis* contained 4 to 8 very short chromosomes. According to the authors the number of short chromosomes can vary between different localities and even between specimens collected at the same locality. Hamatani *et al*. (2007) furthermore reported on varying karyotypes within the same species for a number of *Lachenalia* species. This reported variation and conflicting results thus indicate that karyomorphological data alone cannot be utilized successfully to construct phylogenetic relationships in the genus *Lachenalia*. Similar conclusions were reached by Hamatani *et al*. (2008), resulting in a movement towards molecular methods to determine phylogenetic relationships in the genus.

4.2.3 Basic chromosome numbers and polyploidy

Moffett (1936) identified four different basic chromosome numbers (x = 7, 8, 11 and 13) and polyploids, including 3x, 4x and 6x, in the x = 7 group. De Wet (1957) added a basic chromosome number of x = 12 and reported on an accessions with 2n = 56, a possible 8x.

Ornduff & Watters (1978) added $x = 6$, in an unidentified species as well as $x = 5$ and $x = 9$. Johnson & Brandham (1997) added $x = 10$ and 15.

For the purpose of this review, the 92 species in Table 4.1 was grouped according to their basic chromosome numbers. Basic chromosome numbers of $x = 5$, 10, and 15 were also included as existing basic numbers for the genus and not as polyploid forms of basic group $x = 5$. Basic chromosome number of $x = 14$ was added based on the study by Hamatani *et al.* (2010 & 2012) indicating that *L. longituba* and *L. congesta* have bimodal karyotypes with 28 chromosomes. Of the 92 species five species (*L. mediana*, *L. latimerae*, *L. isopetala*, *L. nervosa* and *L. capensis*) could not be placed into a specific basic chromosome number due to varying reports in literature indicating different basic chromosome numbers within these species. It is possible that *L. mediana* has two different basic chromosome numbers and that $x = 9$ are present in *L. mediana* subsp. *mediana* and $x = 13$ are found in *L. mediana* subsp. *rogersii* (Baker) G.D. Duncan (Spies *et al*., 2008 & 2009). More studies are, however, required to accurately place these six species. Other species with varying chromosome number reports were placed into specific groups according to the most commonly reported chromosome number (Table 4.1). These include:

- basic group $x = 8$ (*L. contaminata* 14 out of 17 reports indicate $2n = 16$);
- basic group $x = 7$ (*L. barkeriana* 3 out of four accessions had $2n = 14$, *L. marginata* 4 out 5 reports indicate either $2n = 14$ or tetraploids of $x = 7$, *L. orchioides* – majority of reports indicate $x = 7$ and $2n = 16$ most probably from wrongly identified species, *L. pusilla* as 8 out of 9 reports indicate $2n = 14$, *L. reflexa* as 5 out of 6 reports indicate $2n = 14$ and the $2n = 16$ could most probably be ascribed to the presence of B-chromosomes, *L. variegata* as 3 out 4 reports indicate basic $x = 7$ and *L. violaceae* as 15 out of 17 reports indicate basic $x = 7$. *L. cernua* was also included here for lack of information on the nature of the karyotype of this species. *L. karoopoortensis* with a single report of 2n=42 was also included here. *L. karoopoortensis* was previously seen as a variety of *L. elegans. L. elegans* as well as *L. membranacea* (previously *L. elegans* var. *membranacea)* display ploidy based on $x = 7$ and *L. karoopoortensis* was thus seen as a hexaploid of basic $x = 7$);
- basic group $x = 10$ (*L. alba* as 4 out of 5 had $2n = 20$ and Johnson and Brandham (1997) concluded that $2n = 20$ forms a diploid based on $x = 10$ rather than a tetraploid based on $x = 5$);
- basic group $x = 11$ (*L. hirta* as 8 out of the 12 reports had $2n = 22$ and *L. unifolia* as 27 out of 32 reports indicated $2n = 22$ as somatic chromosome number);

- basic group x = 12 (*L. ensifolia* as 3 out of 5 reports indicate 2n = 24 but this species can also be a possible x = 13 and *L. stayneri* because it formed a structural diploid based on x = 12 rather than a tetraploid based on x = 6 (Johnson and Brandham 1997);
- Basic group x = 14 (both *L. congesta* and *L. longituba* were moved to this group based on the bimodal nature of the karyotype as reported by Hamatani *et al.* (2010, 2012);
- three different basic chromosome numbers have been recorded for *L. mutabilis*. This is the only species in basic group x = 5, as well as basic group x = 6. The majority of reports however comes from basic group x = 7 (24 out of 38).

Of the 87 taxa that could be grouped, basic x = 7 (45%) and basic x = 8 (22%) were the most common, followed by basic x = 9 (10%) and x = 11 (9%). Basic x = 10 (3%), x = 12 (2%), x = 13 (2%), x = 14 (2%) and x = 15 (3%) are only present in a small number of taxa (Table 4.1, Figure 4.4). Basic x = 5 (1%) and x = 6 (1%) were only present in *L. mutabilis.* Johnson and Brandham (1997) stated that x = 5 reported for *L. mutabilis* were derived from plants with 2n = 14 via Robertsonian fusions. Based on their observations of no constant number of long and short chromosomes in *L. mutabilis*, Spies *et al*. (2000) disagreed with Johnson and Brandham's (1997) conclusion that the x = 5 *L. mutabilis* studied by them resulted from Robertsonian fusions. Spies *et al*. (2000) could not find any long chromosomes as a result of Robertsonian fusions linked to specific specimens or a specific basic number supporting the hypothesis of Johnson & Brandham (1997). Spies *et al*. (2000) thus concluded that the variation in *L. mutabilis* is more likely to be the result of an aneuploid series. More studies are needed to determine the actual mode of chromosome evolution in the species *L. mutabilis*. Dysploid series also occurs in other genera such as *Prospero*: x = 4, 5, 6, 7; *Bernardia*: x = 8, 9; *Hyacinthella*: x = 9, 10, 11, 12 and *Stellarioides*: x = 2, 3, 4, 5, 6, 7, 8 and 9. Like in *Lachenalia* these aneuploid/dysploid series is difficult to interpret (Pfosser & Speta 1999). Combining the chromosome counts with molecular and morphological data might aid in the interpretation of the chromosomal evolution in the genus.

The presence of polyploidy was reported in 21 *Lachenalia* taxa (24%), excluding *L. capensis* where basic chromosome numbers could not be determined from published results and including *L. cernua*, where it is not clear whether the basic number is x = 7 or x = 14 (Table 4.1). Polyploidy are most common in the basic x = 7 group, with 15 of the 39 species (38%) containing polyploid specimens and a few species exhibiting a range of ploidy levels from triploid to octoploid (Figure 4.4, Table 4.1). Polyploidy were also reported in basic group *x* = 6, 8, 9, 10 and 11, but here only tetraploids were observed. Tetraploids (present in 23% of the 87 grouped taxa) are the most common followed by octoploids (3%) triploids (3%), hexaploids (3%) and heptaploids (1%).

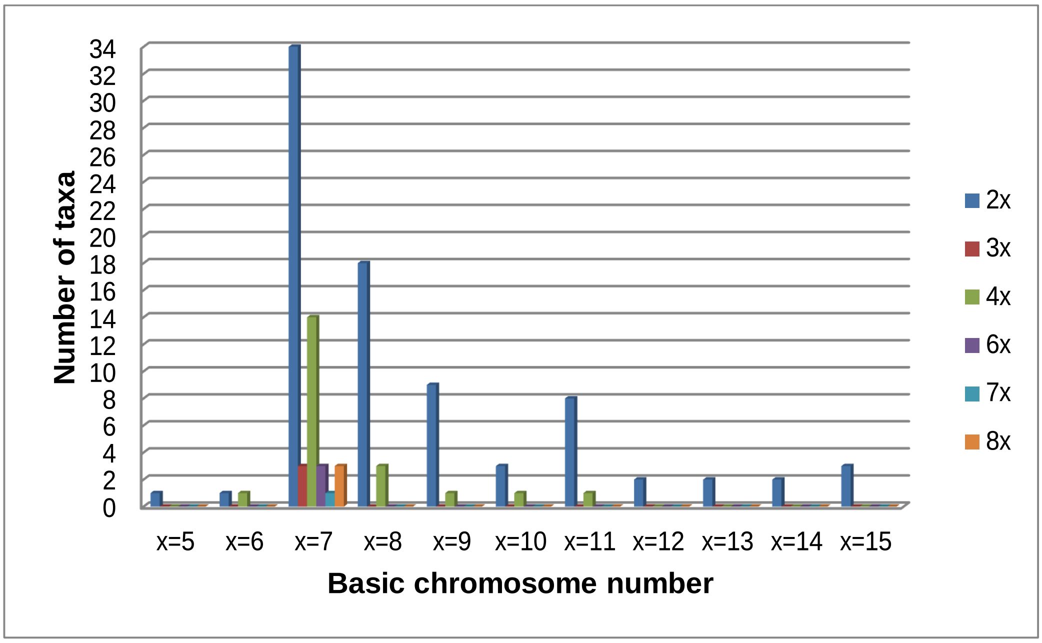

Figure 4.4: Basic chromosome numbers in the genus *Lachenalia* indicating the number of taxa for each basic number and the ploidy levels reported for these basic numbers.

Lachenalia bifolia is the species with the largest number of reported polyploid accessions including 4*x*, 6*x*, 7*x* and 8*x* accessions (Table 4.1). The heptaploid accession of *L. bifolia* originated from seed and it is thus possible that the seed could have originated from an intra-species cross between a 6*x* and an 8*x* individual (Kleynhans & Spies 1999). Specific ploidy levels in *L. bifolia* were better correlated to geographic distribution than morphology (Kleynhans & Spies 1999).

The only other species with ploidy levels above tetraploid are *L. elegans, L. karoopoortensis* and one report of 8*x* in *L. mutabilis* (Table 4.1). The two triploid accessions in *L. aloides* and *L. rosea* could have resulted from intra-species crosses between diploid and tetraploid individuals in these species followed by vegetative propagation or through an unreduced gamete followed by vegetative propagation as suggested by Moffett (1936).

4.2.4 Meiotic studies

Reports on meiotic studies within the genus are less frequent. Moffett (1936) again presented the first report on meiosis. The author found mostly normal meiosis for 2*n* = 14, 16 and 22 species. The only differences were reported where ploidy was present. Hancke & Liebenberg (1998) reported on the meiosis of several 2*n* = 14 species and hybrids. Species studied displayed normal meiosis with 7 bivalents. Four of the six hybrids studied also displayed normal meiosis with 7 bivalents indicting a close relationship between the species *L. aloides*, *L. orchioides*, *L. viridiflora* and *L. reflex*a. Two hybrids (both between *L. aloides* and *L. mutabilis*) displayed a low percentage of trivalents and quadrivalents. Hancke & Liebenberg (1998) presented evidence of structural chromosomal changes involving three chromosomes of which the acrocentric pair of chromosomes was involved in at least one interchange. This chromosome pair also seemed to be prominent in other abnormalities observed during meiosis (Hancke & Liebenberg, 1998).

Hancke *et al*. (2001) studied the chromosome associations of one interspecific dibasic hybrid between *L. splendida* and *L. aloides* and two interspecific dibasic hybrids between *L. pallida* and *L. aloides*. Results showed that *L. aloides* is more closely related to both *L. splendida* and *L. pallida* than expected with genome affinity indexes of 0.9 and above. The results of the pairing configurations observed in these hybrids revealed homoeology between two chromosomes of the *x* = 7 karyotype and three chromosomes of the *x* = 8 karyotype. This could indicate that the *x* = 7 plants differ from the *x* = 8 plants by at least two exchanges of chromosome material and involves also the loss of one centromere from the *x* = 8 karyotype. Hancke *et al*. (2001) thus suggested that the change in basic chromosome number of *Lachenalia* involves a reduction in number.

Du Preez *et al*. (2002) reported on normal meiosis with 8 bivalents for the following species, as well as the hybrids between *L. carnosa* and *L. splendida*, *L. splendida* and *L. carnosa*, *L. pallida* and *L. carnosa* and *L. carnosa* and *L. framesii*. This study indicated that these species are closely related. Hamatani *et al*. (2009) confirmed this relationship.

4.3 PHYLOGENETIC STUDIES

Only a few molecular studies have been done on *Lachenalia* and most of these studies concentrated on the phylogenetic position of the genus. The extensive variation in the genus, and even within a species, as indicated by RAPD studies (Kleynhans & Spies 2000), complicates both the phylogeny and taxonomy. In cultivation, a number of species are easily crossed and reproduce by means of offshoots and bulb formation. The existence of possible natural hybrid species thus further complicates the phylogenetics of the genus.

4.3.1 The phylogenetic position of *Lachenalia*

The genus *Lachenalia* was included in several studies to determine the phylogenetic position and classification of the different species, the first being the inclusion of the genus in the family Liliaceae. *Lachenalia* was reclassified in the family Hyacinthaceae (Perry, 1985) up to 2009, where after the family Hyacinthaceae was dissolved into other families. *Lachenalia* now belongs to the family Asparagaceae (APG III group, 2009).

To find the relative position of *Lachenalia* in the Asparagaceae, Pfosser & Speta (1999) used sequences of the *trnL-F* chloroplast region. From these results the authors were able to group *Lachenalia* in the tribe Massonieae (which consists of all the South African genera investigated, such as *Drimiopsis*, *Ledebouria* and *Polyxena*). This study also presented the first evidence suggesting a close relationship between *Lachenalia* and *Polyxena*, with a bootstrap support of 100%. This was in contrast to that of Müller-Doblies & Müller-Doblies (1997), which placed *Lachenalia* in the subtribe Lachenaliinae and *Polyxena* into Massoniinae. Pfosser & Speta (1999) suggested further studies, since only a few representative species were included in their analysis.

A later study (Pfosser *et al*., 2003) included not only more *Lachenalia* species, but also an additional chloroplast region (*atpB*), as well as data on seed morphology. *Polyxena, Lachenalia* and the genus *Periboea* formed a monophyletic clade with a bootstrap support of 100%. This study thus also supported the inclusion of *Polyxena* in the genus *Lachenalia.* Within the monophyletic clade some species of *Lachenalia* and *Polyxena* had low bootstrap support values (66% and 62%, respectively) and it was suggested that the specific delimitation may not be optimal for these clades. Another explanation was that the species are more recently derived, resulting in an insufficient number of base substitutions to resolve the taxa. The authors suggested that seed size and weight is higher in the basal genera such as *Eucomis*, *Merwilla* and *Ledebouria*, with *Veltheimia bracteata* having seeds of 0.056 g and with a length of 6.1 mm. The smallest seeds were found in the genus *Lachenalia* (*L. angelica* W.F. Barker: 0.0003 g; 0.9 mm long). Analysis on the seed size and weight supports the hypothesis of the authors that *Lachenalia* is a recently derived genus. The seed form and structure of the micropylar swelling of the seed coat in *Lachenalia* suggested that this genus was the most advanced in their study.

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The inclusion of *Polyxena* in the genus *Lachenalia* was raised again in three separate studies (Manning *et al*., 2004; Spies, 2004; Hamatani *et al*., 2008) using *rbcL*, *trnL-F* and *ITS1-2* sequencing data respectively. In all these studies, *Lachenalia* and *Polyxena* formed a well-supported monophyletic group. The two genera were characterised from other genera in the family by their biseriate stamens with the two series inserted at different heights. The two genera can be distinguished from each other by the relative fusion of the perianth (Manning *et al*., 2002). Manning *et al*. (2004) thus included *Polyxena* within *Lachenalia* based on the paraphyletic nature of the two genera.

4.3.2 Phylogeny within the genus

Morphological studies have focused on the entire genus, and many species have, over time, been included and excluded and shifted around from one genus to another. The first of these was when the genus was split into several genera (Salisbury, 1866). Later on the species in the genus were sub-divided into smaller groups by Baker (1897), Crosby (1986) and Duncan (1988, 2002b). These groupings, except for that of Crosby (1986) were based on different morphological characteristics, and did not correspond with each other.

Duncan *et al*. (2005) used morphological data of all the species in the genus to construct a cladogram. The author included 73 characters which comprised of 57 qualitative and 16 quantitative characters. This study concluded that *Polyxena* is paraphyletic with *Lachenalia* and forms the basal clade. Many of the *Lachenalia* species formed polytomies or unrelated groups, but there were some synapomorphies or taxa sharing some traits.

Spies (2004) produced a cladogram based on chloroplast *trnL*-F sequencing data from 129 taxa, including four *Massonia* taxa as out-group. Hamatani *et al.* (2008) investigated nuclear *ITS1*-2 sequencing data of 56 taxa, including two *Massonia* and one *Ornithogalum* as out-group. Both authors identified specific clades within the genus *Lachenalia.* The topologies of the cladograms produced by these authors largely correspond.

4.4 CROSS-ABILITY IN *LACHENALIA*

Rev. John Nelson raised the first authenticated *Lachenalia* hybrid in 1878 (Moore, 1905). Since then a number of claims of interspecific hybridization were published (Crosby, 1978, for review of early work). None of these early hybrids became available commercially. In 1965 the genus was identified as an indigenous genus with potential for development in

South Africa. A breeding programme for the development of flowering pot plants was started at the Roodeplaat Vegetable and Ornamental Plant Institute of the Agricultural Research Council and the first hybrids became available commercially in 1997/1998 (Kleynhans, 2006).

The extensive morphological and cytological variation in the genus *Lachenalia* resulted in the existence of both internal and external crossing barriers (Lubbinge, 1980, Kleynhans & Hancke, 2002, Kleynhans, 2006). External crossing barriers like geographical separation and varying flowering periods can be overcome through the cultivation of species in controlled environments and the successful storage of pollen for a 12 month period (Kleynhans 2006). Internal crossing barriers include both post- and pre-fertilization barriers. Mechanical isolation (Lubbinge, 1980) is one of the first internal pre-fertilization barriers. Flower length in *Lachenalia* species can vary from 5 to 30 mm (Duncan, 2005a). Pollen from small flowered species is thus not adapted to traverse the long distance from the stigma to the ovary of large flowered species (Stebbins. 1950). The utilization of reciprocal crosses has been successful in overcoming this barrier (Lubbinge, 1980, Kleynhans, 2006). Other pre- and post-fertilization barriers have not been studied in detail, but the extent of these barriers become clear when the success rate of inter-species crosses are taken into account.

For each crossing combination at least 10 flowers, within two different inflorescences were pollinated to ensure that wrong conclusions were not drawn, due to specific physiological or developmental problems in the inflorescence or floret. Kleynhans *et al.* (2009b) reported that only 33% of the inter-species crosses (1498) made over a 30 year period were successful. With additional crosses (382) made since 2005, this percentage dropped to only 18% (Table 4.2). Of the 82% that did not succeed, 50% was related to the absence of seed, indicating the presence of possible pre-fertilization barriers. A further 31% of the combinations produced abnormal or non-viable seed that could be ascribed to post-fertilization barriers. Lastly 1% of the crossing combinations did not succeed due to seedling death shortly after germination. The reason for the death of these seedlings can not necessarily be ascribed to hybrid breakdown, as seedlings can also be affected by diseases.

The genetic variability within the genus as described above has a direct influence on the cross-ability. With the additional data presented in this review the comparison between cross-ability and the cytogenetic and molecular data will be discussed in the next section.

4.5 COMPARISON BETWEEN CROSS-ABILITY, CYTOGENETIC AND MOLECULAR DATA

The complexity in the genus, in terms of morphology, cytogenetic and genetic variation complicates the determination of the relationship within and between different species. There are questions on the existence and origin of the different basic chromosome numbers, as well as the mode of speciation. Does the different basic chromosome numbers correlate with the phylogeny of the genus? Can the phylogenetic information assist in the taxonomic grouping of some difficult species and, furthermore, can phylogenetic information shed some light on the existence of possible natural hybrids? How does the phylogeny correlate with the cross-ability between species and finally what conclusions can be drawn when the different data sets are compared.

Table 4.2 Number of inter-species crosses made among different *Lachenalia* species over a 35 year period and the results obtained from these crossing combinations. Crosses that did not succeed were linked to three different aspects namely no seed set, abnormal seeds or seedling death. Results are linked to the basic chromosome complement of the species.

Basic chromosome number of parents	No. of successful crosses	No of unsuccessful crosses		
		No. of crosses with no seed set	No. of crosses with abnormal seed	No. of crosses with seedling death
7x7	169 (27%)	274 (44%)	169 (27%)	10 (2%)
8x8	72 (46%)	44 (28%)	40 (45%)	1 (1%)
11x11	2 (67%)		1 (33%)	
7x8	20 (6%)	251 (79%)	44 (14%)	3 (1%)
8x7	59 (18%)	111 (34%)	155 (47%)	6 (2%)
7x10		17 (100%)		
10x7	1 (5%)	5 (25%)	13 (65%)	1 (5%)
7x11	1 (2%)	54 (86%)	8 (13%)	
11x7	4 (6)	23 (33%)	39 (57%)	3 (4%)
9x8			1 (100%)	
8x10		1 (33%)	2 (67%)	
10x8	2 (33%)	1 (17%)	2 (33%)	1 (17%)
8x11	1 (3%)	23 (79%)	5 (17%)	
11x8	1 (3%)	15 (39%)	22 (58%)	
11x10		1 (100%)		
15x7		2 (67%)	1 (33%)	
Unknown basic numbers in one or both of the parents	4 (2%)	117 (59%)	78 (39%)	
Total	336 (18%)	939 (50%)	580 (31%)	25 (1%)

4.5.1 Basic chromosome numbers and cladograms

A comparison between the groupings from Crosby (1986) (based on chromosome numbers), Spies (2004) (chloroplast *trnL-F*), Duncan (2005) (morphology) and Hamatani *et al.* (2008) (nuclear *ITS1-2*) revealed that, with the exception of a few species, there is a good

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correlation between the basic chromosome numbers and the monophyletic groups identified in the different studies. When chromosome numbers were superimposed on the cladogram of Duncan *et al*. (2005) most of the x = 7 and x = 8 species fall into exclusive monophyletic groups for each chromosome number. There are only two exceptions where x = 7 species (*L. congesta* and *L. mathewsii*) grouped with x = 8. Species with x = 11 were closely related, even though they did not form a monophyletic group. The rest of the chromosome numbers form a polytomy. Although monophyletic groups linked to basic chromosome numbers were obtained the morphological cladogram is poorly resolved for many of the species.

The study using *trnL-F* chloroplast DNA sequences (Spies, 2004) of 129 taxa distinguished several well defined groups. The first group consisted of seven species with a basic number of 11. Species with x = 7 and 8 formed a monophyletic clade (the *Lachenalia* 1 group), suggesting a close relationship between these two basic numbers. Within this monophyletic clade, x = 8 formed a monophyletic sub-clade excluding only one species with a basic chromosome number of x = 8, *L. verticillata*, and including *L. pusilla* (x = 7), which was basal to this group. All species having a basic chromosome number of x = 7, were distributed in different sister sub-clades, of which the two largest x = 7 sub-clades includes 25 and 10 taxa respectively. The second large group in the cladogram (the *Lachenalia* 2 group), consisted of 48 poorly resolved taxa having chromosome numbers of x = 6, 7, 8, 9, 10 and 13. This group has no consistent pattern regarding chromosome numbers. These results led the author to conclude that hybridization might have played a role in speciation and that the genus might represent a hybrid swarm.

In the cladogram based on *ITS1-2* sequencing data (Hamatani *et al.,* 2008), a monophyletic group for x = 8 (supported with a bootstrap value of 83.3) as well as for x = 7 forming a polytomy was obtained. Two species, *L. muirii* and *L. pusilla* both with a basic number of 7, grouped with the x = 8 clade, but formed the base for the rest of the x = 8 species. The *ITS1-2* region seemed to have more variation in the x = 8 taxa than in the x = 7 taxa, since the clade for x = 8 was better resolved. A similar observation was made by Spies (2004) with the *trnL-F* sequences.

The good correlation between basic chromosome numbers and phylogenetic groupings could in the future be used to confirm basic numbers for species. A single count of 2n = 32 was reported for *L. giessii* but based upon a close phylogenetic grouping with x = 11 (Spies 2004), it seems that this species could also be regarded as x = 11 (2n = 33) rather than x = 8 (2n = 32). In this review it was included as a tetraploid of x = 8 for the purpose of calculations, but this species should be investigated further. Similarly *L. capensis* groups with the *x* = 7 group (Spies 2004) thus supporting the chromosome counts of Johnson and Brandham (1997) and Spies *et al.* (2008) and suggesting that *L. capensis* could be a basic *x* = 7 rather than a basic *x* = 8 as reported by Hamatani *et al*. (1998). Further investigations and correct identification of species are, however, essential to solve the inconsistent reports in chromosome numbers in some species.

4.5.2 Basic chromosome number and cross-ability

Kleynhans *et al.* (2009b) presented data showing that the success rate of crossing combinations increased when crosses were made between species containing the same basic chromosome number. The information from additional crosses made in the last five years were added to this data and the number of successful crosses between species with the same basic chromosome number was, substantially higher than between species from different basic chromosome numbers (Table 4.2). The success rate of crossing combinations dropped to below 20% when species with different basic chromosome numbers were crossed. The only exception to this is the combination of basic *x* = 10 crossed with basic *x* = 8 (Table 4.2). The two successful crosses resulted from a *L. alba* x *L. pallida* combination (specific results not shown).

The increased success rate reported between species with the same basic chromosome number were a confirmation of a report by Crosby (1986) who also indicated that species cross more readily within certain basic chromosome number groupings. Based on differences in the cross-ability and morphology the latter author also split the basic *x* = 7 group of species into two different groups. The existence of different groupings within the basic *x* = 7 was confirmed by Spies (2004) as discussed above. Meiotic data presented by Hancke & Liebenberg (1998), as discussed above, also indicated differences between especially the species *L. mutabilis* and *L. aloides* as illustrated by structural chromosome changes. Kleynhans *et al.* (2009) used the three basic clades as well as the phylogenetic groupings within the basic *x* = 7 group as reported by Spies (2004) and presented data that showed improved cross-ability when crosses were made between individual species within the same phylogenetic groupings. The cross-ability was at least 10 to 20% higher when crossing combinations were attempted within the groups, than between groups. The cross-ability data thus supported phylogenetic groupings as identified by Spies (2004).

The close relationship illustrated in the phylogenetic trees, between species with basic *x* = 8 was also confirmed by the cross-ability data with a success rate of 46% (Table

4.2). The only success rate higher than this was that between species with basic *x* = 11. This data, however, only included 3 crossing combinations in comparison to the 157 combinations within the basic *x* = 8 group and would most probably decline with the inclusion of additional crossing combinations. The relationship among species with *x* = 8 was further illustrated by Du Preez *et al.* (2002). In this meiotic study several hybrids between different species with *x* = 8 were investigated and all hybrids produced 8 bivalents. Hybrids resulting from these crosses are also fertile and was successfully utilized in further crossing combinations (results not shown).

4.5.3 Evolution and relatedness of different basic chromosome numbers

The largest number of species in *Lachenalia* are found within the basic *x* = 7 and 8 groups. Molecular data from *ITS1-2* (Hamatani *et al*., 2009) and *trnL-F* (Spies, 2004) sequences indicated a strong relationship between these two basic chromosome number groups and that these groups might have evolved from a common ancestor. Cross-ability data confirmed a relationship between these two basic chromosome number groups with higher success rates (18% for *x* = 8 crossed with *x* = 7), than most of the other between group success rates (Table 4.2). The existence of genome affinity indices of 0.9 in three interspecific dibasic hybrids (Hancke *et al.,* 2001), as discussed above, also confirmed this relationship.

Karyomorphological data presented by Hamatani *et al*. (2009) using FISH and DAPI staining to determine the chromosomal evolution of the *x* = 7 and *x* = 8 groups confirmed the results found from both the phylogeny and the cross-ability. The results of this study between a group of *x* = 7 (consisting of *L. muirii*, *L. aloides* var. *aloides*, *L. flava*, *L. longibracteata*, *L. variegata*, *L. viridiflora*, *L. mutabilis*, *L. punctata*, and *L. pusilla*) and *x* = 8 (consisting of *L. carnosa*, *L. liliflora*, *L. namaquensis*, *L. splendida* and *L. pallida*) led to the conclusion, that there was little morphological chromosome variation within the *x* = 8 group and that this group was derived from an ancestral species followed by on-going speciation.

The *x* = 7 group showed much more variation, with four karyotype patterns indicating several morphological alterations of chromosomes within this group. This was in contrast with the *ITS1-2* region data that seemed to have more variation in the *x* = 8 taxa than in the *x* = 7 taxa, since the clade for *x* = 8 was better resolved than the polytomic *x* = 7 clade (Hamatani *et al*., 2009).

Hamatani *et al.* (2008, 2009) suggested several theories for the evolution of the *x* = 7 and 8 groups. Both groups might have evolved from a common ancestor (as indicated in sequencing data) or they could be the product of mutation or putative hybridization between species in the same geographical distribution area. Reduction in chromosome number either by losing a chromosome or by translocation might have contributed to speciation in these two groups. Hancke *et al.* (2001) speculated that *x* = 7 evolved from *x* = 8 through a reduction in chromosome number based on the homoeology between two chromosomes in the *x* = 7 and three chromosomes in the *x* = 8 species studied.

Five of the nine species in the *x* = 7 group (*L. aloides* var. *aloides*, *L. flava*, *L. longibracteata*, *L. variegata*, *L. viridiflora*) had very similar chromosome morphology (Hamatani *et al.,* 2009) and seemed to be closely related. The close relationship between *L. aloides* and *L. viridiflora* can be confirmed from crossing data with a success rate of between 25 and 100% depending on the reciprocal direction (data not shown) and the production of fertile F_1 hybrids with seven bivalents in meiotic analysis (Hancke & Liebenberg, 1998).

According to (Hamatani *et al*., 2009) the chromosome morphology of *L. mutabilis* and *L. punctata* were very similar, but differed from the above group, and the authors concluded that these species probably originated from a single ancestral species. For the purpose of this review a selection of *ITS1-2* sequences representing only those species used in the FISH study (Hamatani *et al*., 2009) were obtained from Genbank and a phylogram was constructed (Figure 4.5). The tree was drawn to scale, with branch lengths in the same units as those of the evolutionary distances used to infer the phylogenetic tree. The ITS phylogram yielded similar monophyletic groupings than the *ITS1-2* cladogram (Hamatani *et al*., 2009) and included both *L. mutabilis* and *L. punctata* within the *x* = 7 clade. Both these species have a similar branch length that was much longer than the other species in the clade, which supported the similarity in chromosome morphology. This relationship cannot be confirmed from crossing data (success rate of only 10%), neither by the data presented by Spies (2004) or Hamatani *et al.* (2008).

The remaining two species in the *x* = 7 group that were investigated (Hamatani *et al*., 2009), *L. muirii* and *L. pusilla*, shared chromosomal characteristics with species in both the *x* = 7 and 8 groups. The relationship to both *x* = 7 and 8 of *L. muirii* and *L. pusilla* was confirmed by Hamatani *et al.* (2008). Hamatani *et al*. (2009) suggested that *L. pusilla* might be intermediate between the *x* = 7 and *x* = 8 group. None of the crosses made with *L. pusilla* as either parent were successful, neither with *x* = 7 nor with *x* = 8 species. The cross-ability data available can thus not shed any light on the position of *L. pusilla.*

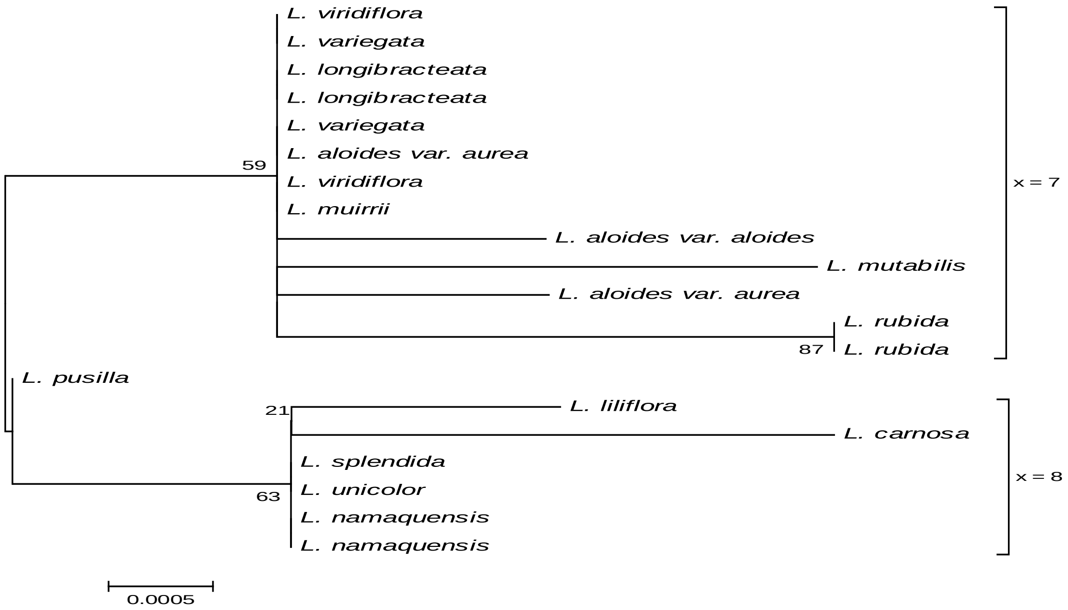

Figure 4.5: Evolutionary relationships of 17 taxa based on the *ITS1-2* region. The phylogram was constructed using the Maximum Likelihood option of MEGA 5 (Tamura *et al*. 2011) to compare the evolutionary development of the *x* = 7 and 8 groups. The correct current citation for *L. aloides* var*. aurea* is *L. flava,* for *L. rubida* is *L. punctata,* and for *L. unicolor* is *L. pallida*.

There seem to be an evolutionary relationship between some of the other basic chromosome number groups and even with other genera. For better insight in the evolution of the rest of the chromosome numbers, sequences from Spies (2004) were selected to represent a broad spectrum of chromosome numbers in the genus. Sequences were selected based on the cladogram produced by Spies (2004), but all sequences forming a polytomy were excluded, and a new cladogram (Figure 4.6) was constructed.

Although many of the clades are not well supported, the new *trnL-F* cladogram (Figure 4.6) supports the suggestion that the genus evolved from a common ancestor. The basic numbers *x* = 7 and 8 evolved from a common predecessor, even though many of the clades are not well supported, thus confirming the data presented above. The higher basic numbers (*x* = 9, 10, 11 and 13) form a poorly supported monophyletic clade (bootstrap value 57). It seems as if the higher numbers evolved independently from the lower numbers in at

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least two separate events. The basic numbers *x* = 9 and 10 forms a polytomy in the higher clade and seems to be the bridge from the lower to the higher numbers or *vice versa* (Figure 4.6). Because none of the *x* = 9 or 10 taxa are well resolved, this group might be a recent group. The low level of variation in these two basic numbers indicates that evolution was recent and these numbers have not evolved into two definite clades.

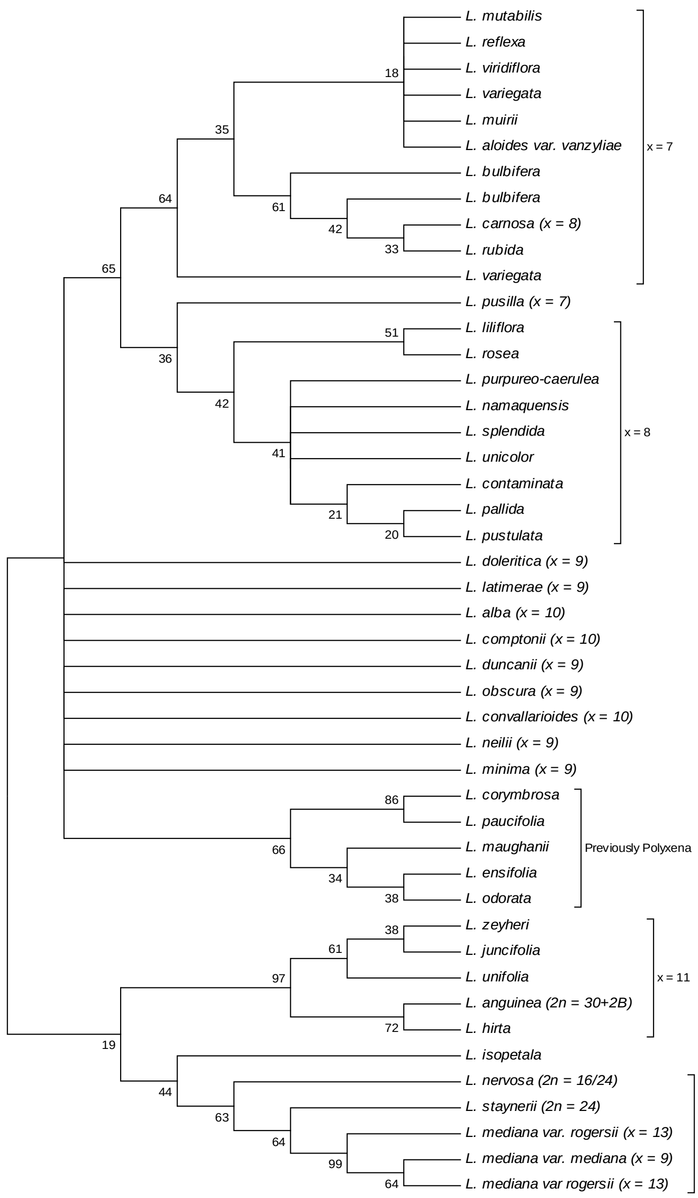

Figure 4.6: Evolutionary relationships of 43 taxa based on the *trnL-F* region (Spies 2004), inferred using the Maximum Likelihood option of MEGA 5 (Tamura *et al*. 2011)**.** The correct current citation for *L. aloides* var*. vanzyliae* is *L. vanzyliae,* for *L. bulbifera* is *L. bifolia,* for *L. rubida* is *L. punctata,* for *L. unicolor* is *L. pallida,* and for *L. pustulata* is *L. pallida*) referred to ensure consistency of species names.

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A median-joining network (Bandelt *et al*., 1999) was constructed from the *ITS* data (Hamatani *et al.,* 2008) (Figure 4.7) as well as from 43 *trnL-F* sequences (Spies, 2004) (Figure 4.8). The *trnL-F* network suggests that *x* = 11 and *x* = 8 have evolved independently from a common ancestor, and that *x* = 9 and 10 could have evolved from any one of these two numbers. The ITS network (Figure 4.7) could not confirm or discard this, due to the lack of ***x*** = 10 species and the inclusion of only a single ***x* =** 9 species. Both the networks support a close relationship between the ***x*** = 7 and 8 groups. The cross-ability success rate of 33% between basic *x* = 10 and basic *x* = 8 (Table 4.2) could be a confirmation of the possible bridge between *x* = 7 and 8 and the higher numbers. The ITS network also supported the relationship between *L. mutabilis* and *L. punctata* (Figure 4.5) and the *trnL-F* network positioned *L. pusilla* in an ancestral position to *x* = 7 and 8 thus supporting the molecular cytogenetic data.

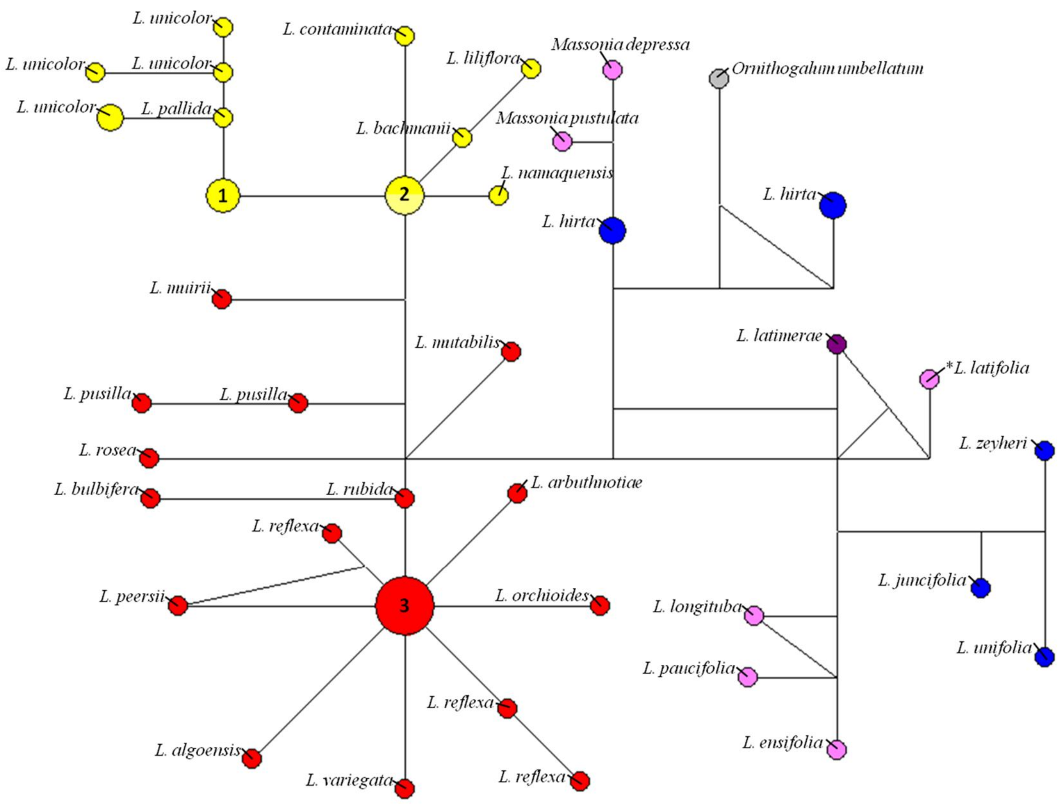

Figure: 4.7 Network of *Lachenalia* species based on *ITS* data using NETWORK 4.6.1.0 (Fluxus Technology, 2012). The correct current citation of *L. latifolia* (indicated with *) is *L. nervosa,* for *L. unicolor* is *L. pallida,* for *L. bulbifera* is *L. bifolia* and for *L. rubida* is *L. punctata*. Colour codes: Red, *x* = 7; Yellow, *x* = 8; Blue, *x* = 11; Purple, 2n = 24/26/28; Grey, *x* = unknown. Node 1, *L. pallida* and *L. purpureo-caerulea*; Node 2, *L. carnosa* and *L. splendida*; Node 3, *L. aloides* var. *aloides*, *L. aloides*

'Pearsonii', *L. aloides* var. *luteola*, *L. vanzyliae*, *L. quadricolor*, *L. flava*, *L. viridiflora*, *L. orchioides* subsp. *orchioide*s and *L. longibracteata*.

Dysploidy (through the fusion of acrocentric chromosomes at the centromere to form larger metacentric to sub-metacentric chromosomes) has been shown to be important in the chromosomal evolution of other plant families, e.g. the *Commelinaceae* (Jones, 1976). If dysploidy is the mode of speciation in *Lachenalia* a study on the chromosome morphology of species with higher basic chromosome numbers compared to lower basic chromosome numbers could assist in confirming the hypotheses. A study of *L. latimerae* (x = 9 according to Hamatani *et al.* 2007) indicated that this species has three large chromosomes, of which two are very similar, with the third one having a satellite (Hamatani *et al*., 2007). The chromosome morphology thus, supports the theory of dysploidy, but it must be further investigated with chromosome banding techniques. A second hypothesis is the possibility that *L. latimerae* could have resulted from a hybridization event (Hamatani *et al.,* 2007) between x = 7 and x = 11, resulting in a gametic number of n = 18. If this theory is correct for other x = 9 species, one would expect at least some of the x = 9 species to group with either x = 7 or x = 11 in the chloroplast cladogram. All the x = 9 species fall between the x = 7/8 groups and the higher numbers, but because the *trnL-F* cladogram (Figure 4.6) is not supported with high bootstrap values, neither the dysploid theory nor the hybridization theory could be proven. The *trnL-F* median-joining network (Figure 4.8) is inconclusive in this matter, since the evolutionary direction for x = 9 can be from either x = 11 or x = 7/8 or both (thus hybridization).

The group x = 11 is very well supported with a bootstrap value of 94 in the *trnL-F* cladogram (Figure 4.6), suggesting a strong relationship within this group. The close relationship within this group is also supported by the morphological cladogram constructed by Duncan (2005a), even though these species do not form a monophyletic group. The evolution of x = 11 is not clear, but from the cladograms obtained in the different studies i.e. morphological (Duncan *et al*., 2005), *ITS* (Hamatani *et al*., 2008) and *trnL-F* (Spies, 2004), x = 11 (and x = 13) is basal to the lower numbers and it seems that species with x = 11/13 is the intermediate between the out-group species (which have higher numbers) and the lower numbers in the genus. The network drawn from the *ITS* sequences provides evidence of the link between the higher basic numbers in *Lachenalia* and out-group species used in this study. The out-group for the *ITS* network (Figure 4.7) is *Massonia* and *Ornithogalum umbellatum*. The latter species has a high degree of cytogenetical variation (Czapik, 1968) with numbers of 2n = 18-30 and B-chromosomes reported. Hamatani *et al*. (2008) obtained the *ITS* sequences for *L. hirta* (*x* = 11) by cloning the maternal and paternal genomes. One genome was cloned in some specimens and seem to have evolved from *Massonia*, while the other genome have evolved from *Ornithogalum* this may be the reason why different specimens form two different nodes in the network.

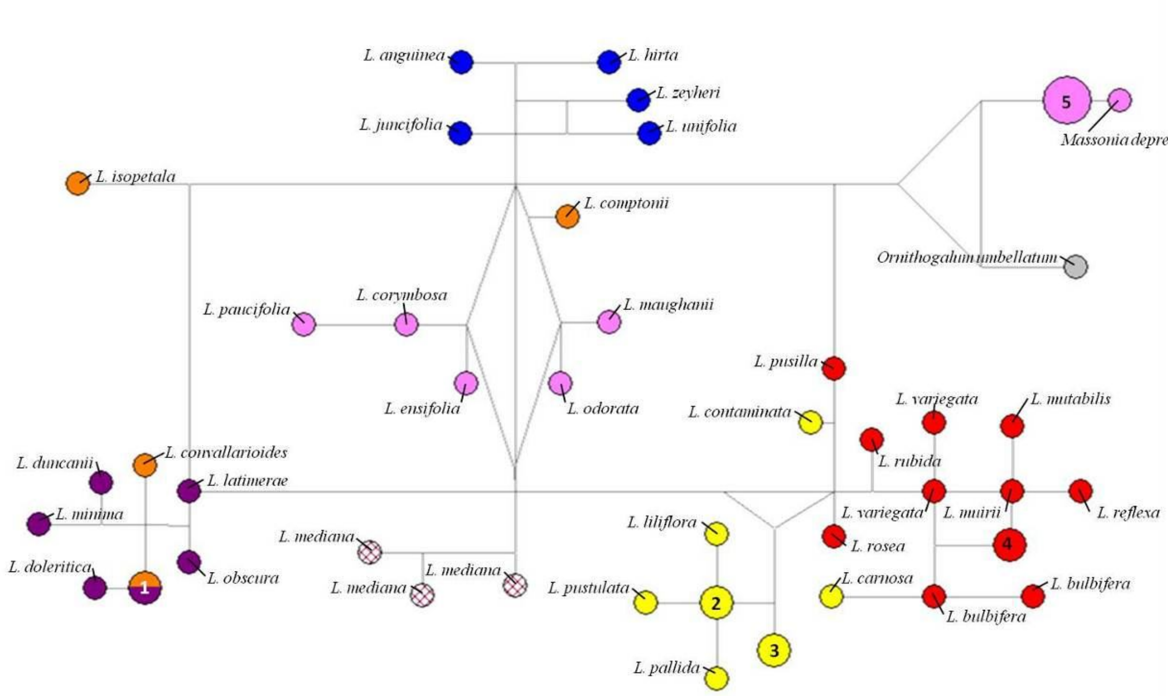

Figure 4.8: Network of *Lachenalia* species based on *trnL-F* data using NETWORK 4.6.1.0 (Fluxus Technology, 2012)**.** Colour codes: Red, *x* = 7; Yellow, *x* = 8; Blue, *x* = 11; Light purple, 2n = 24/26/28; Dark purple, x = 9; Orange, x = 10; Diagonal crosses, x = 9 or 13; Grey, *x* = unknown. Node 1, *L. neilii*; *L. alba*; Node 2, *L. purpureo-caerulea*; *L. pallida*; Node 3, *L. namaquensis*; *L. splendida*; Node 4, *L. viridiflora*; *L. vanzyliae*; Node 5, *Massonia pustulata*; *M. depressa*; *M. echinata*; *M. jasminiflora.* Correct current citations for *L. pustulata* is *L. pallida,* for *L. rubida* is *L. punctata* and for *L. bulbifera* is *L. bifolia.*

4.5.4 Existence of basic chromosome numbers

The evolution and even existence of certain chromosome numbers (such as *x* = 5, 6, 12, 13, 14 and 15) have not been investigated to the same extend as *x* = 7, 8, 9 and 11. With basic chromosome numbers of 5, 6, 7, 8, 9, 10, 11, 12, 13,14 and 15 recorded, it is still speculated whether basic numbers of *x* = 5, 6, 10, 12, 13, 14 and 15 exists.

There are very few reports for *n* or *x* = 5 in *Lachenalia*, and usually when *x* = 5 has been reported for a species, it was based only on one accession. Both *L. violacea* and *L. aloides* are *x* = 7 species, with a single 2*n* = 15 reported, indicating possible miss counts in these species. *Lachenalia mutabilis* has chromosome counts of *x* = 5, 6 and 7. This is the only species where numerous counts have been recorded for all three these numbers. This species is morphologically distinct and wrong identification could not attribute to the differences in counts. All reports for *x* = 5 for *L. mutabilis* are from the same geographical distribution area (Clanwilliam in the Western Cape Province), but there are also reports of *x* = 7 from Clanwilliam. Other species from the Clanwilliam district include *x* = 7 (*L. sauveolens*, *L. thomasiae* and *L. violaceae*); *x* = 8 (*L. pallida*); *x* = 10 (*L. marginata* and *L. undulata*) and *x* = 11 (*L. hirta* and *L. unifolia*). It was suggested that the three basic numbers for *L. mutabilis* form an aneuploidy series (Spies *et al*., 2000), but there is no proof of what attributed to the chromosome diversity in this species. Based on molecular systematics, *L. mutabilis* specimens always group with other *x* = 7 species, regardless of their chromosome number (Spies, 2004, Hamatani *et al.,* 2008); are karyotypically similar to *L. punctata* (*x* = 7) and has the highest number of *x* = 7 counts recorded, thus supporting the theory of an aneuploid series in the species.

Johnson & Brandham (1997) studied the karyotypes of *x* = 7-13 and 15, and reported that all the species studied formed structural diploids and thus concluded that 2*n* = 20 rather represents a diploid based on *x* = 10 than a tetraploid based on *x* = 5. They did state that 2*n* = 30 (*x* = 15) could be an allotetraploid derived from taxa with *x* = 7 and 8, following hybridization and doubling of the chromosome number. Considering this theory, it would be expected that *x* = 10 taxa have a phylogenetic grouping either with *x* = 7 or *x* = 8 taxa, but this have not been observed in the *trnL-F* cladogram (Spies, 2004). The fact that the cross-ability between *x* = 10 and 8 is relatively high could be an indication of the validity of this theory. The existence of the basic number *x* = 10, however, seem to be a reality, proven by the fact that some species has chromosome counts of 2*n* = 20, 40 (*L. alba*) and 2*n* = 30, 40 (*L. isopetala* – not grouped in this study) indicating the existence of polyploids. After all the evidence, it is still not clear whether *x* = 5 exist in any other species than *L. mutabilis*.

Reports for six species with either *x* = 6 or 2*n* = 24 were mostly based on only one accession and differed from the majority number of counts for these species. *Lachenalia nervosa* has counts of *n* = 8 and 2*n* = 24, indicating that this species has a basic number of *x* = 8 and have a triploid somatic number. *Lachenalia stayneri* is also 2*n* = 24, and the lack of meiotic studies in this species may lead to the conclusion that this species represents a tetraploid based on *x* = 6 or also a triploid with *x* = 8. Therefore *x* = 6 should also be considered as a basic number. Based on *trnL-F* sequences, both these species indicate close relations with *L. mediana* (*x* = 9 and 13) and do not group with *x* = 8 (Spies, 2004). Therefore, species with 2*n* = 24 cannot be considered as “typical” *x* = 8 species, and might even be considered as being miss counts based on *x* = 13. None of the 2*n* = 24 species has its own monophyletic grouping and it seems as if *x* = 6 does not exist except maybe in *L. mutabilis*.

Somatic counts of 2*n* = 28 and 56 have been reported by several authors (Moffett, 1936, de Wet, 1957, Crosby, 1986, Hancke & Liebenberg 1990, Johnson & Brandham, 1997, Hamatani *et al*., 1998, Kleynhans & Spies, 1999, Spies *et al*., 2002, Hamatani *et al*., 2007, Spies *et al*., 2008, Spies *et al*., 2009, Hamatani *et al.* 2010). Somatic numbers of 2*n* = 28 as sole chromosome number have been reported for *L. cernua,* and *L. longituba*. For lack of further evidence *L. cernua* was included in the *x* = 7 group, but *L. longituba* was included in the *x* = 14 group based on the bimodal nature of the ideogram as reported by Hamatani *et al.* 2010. *L. congesta* similarly seem to have a basic chromosome number of *x* = 14 based on its bimodal idiogram and FISH and DAPI staining results as presented by Hamatani *et al*. (2012). It seems as if the latest results by Hamatani *et al.* (2010, 2012) thus confirms the existence of an *x* = 14 basic number.

4.5.5 Existence of hybrid species

The question of natural hybridization in the genus has been raised several times. Both the morphological and *trnL-F* cladograms had monophyletic groups consisting of a mixture of chromosome numbers *x* = 6, 7, 8, 9, 10 and 13 and no consistent patterns regarding similar groupings. Spies (2004) concluded that hybridization might have a role in speciation, but it was not proven.

Some species (*L. pusilla*, *L. rosea* and *L. carnosa*) do not follow the rule of grouping into monophyletic groups with similar chromosome numbers (Figure 4.6). Considering the positions of these species in the networks drawn (Figures 4.8, 4.9) the first two species is intermediate to the *x* = 7 and *x* = 8 groups in both networks. The position of *L. carnosa* (*x* = 8) fluctuate between *x* = 7 (Figure 4.8) and *x* = 8 (Figure 4.7). Within the *trnL-F* cladogram, *L. carnosa*, *L. punctata* and *L. bifolia* is a sister clade with the rest of the *x* = 7 species. *Lachenalia punctata* is intermediate to *x* = 7 and 8 in both networks. To conclude, based on karyotypic and molecular data, some species are intermediate between *x* = 7 and 8, and can either be considered as predecessor species or as hybrid species.

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Lachenalia carnosa (x = 8) is an example of a possible hybrid species, grouping with either x = 7 or 8, depending on the type of sequencing data (nuclear or cytoplasmic). Spies (2004) reported what seemed to be B-chromosomes in the meiotic divisions if *L. carnosa*, which may have been unidentified univalents, also observed in cultivated *Lachenalia* hybrids (Hancke & Liebenberg, 1998). Cross-ability data, however, strongly links *L. carnosa* with other members of the x = 8 group, successfully crossing with at least five different x = 8 species (data not shown), producing regular meiosis with 8 bivalents (Du Preez *et al*., 2002) as well as fertile hybrids. Natural hybridization may be present in the genus *Lachenalia* but this should be investigated further.

4.6 CONCLUSION

This review accentuates the complex nature of the genus *Lachenalia*. Besides the extensive morphological variation that complicates the taxonomy of the genus, the genus is also exceptionally diverse in chromosome numbers. *Lachenalia* has different basic chromosome numbers (x = 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15 reported in literature), contains polyploidy (ranging from triploids to octoploids), and includes B-chromosomes. Chromosome counts for the 92 species reported in literature varied from $2n$ = 10 to 56 and from n = 5 to 28. Polyploidy was reported in 21 taxa (24%), and is most common in the x = 7 group.

The low cross-ability (only 18% successful inter-species crosses) reiterates this variation and stresses the importance of investigating the variation in order to develop breeding strategies to overcome the existing crossing barriers. Morphological and molecular phylogenetic studies confirm the complexity of the genus, but also assisted in drawing some conclusions on the relationship between species within the genus and the possible evolutionary history of the genus.

Phylogenetic studies has assisted in finding the phylogenetic position of *Lachenalia* in relation to other genera (Pfosser & Speta, 1999, Pfosser *et al.,* 2003, Manning *et al.,* 2004) and placed the genus within the Asparagaceae family (APG III group, 2009). Morphological (Duncan *et al.,* 2005) and phylogenetic studies within the genus (Spies, 2004, Hamatani *et al.,* 2008) supported the inclusion of *Polyxena* in *Lachenalia*, and this inclusion contributed towards the increased of the number of recognised *Lachenalia* species to 133.

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Molecular studies on the *trnL-F* as well as *ITS* regions revealed monophyletic groupings of species containing the same basic chromosome numbers. This indicated a strong correlation between the phylogeny and basic chromosome numbers in the genus, although there were some exceptions in the larger *trnL-F* data set (Spies, 2004). The good correlation between basic chromosome numbers and phylogenetic groupings could in the future assist to confirm basic numbers for species. The improved cross-ability when crosses were made between individual species within the same phylogenetic groupings confirms the phylogeny. Phylogenetic groupings, thus has to be taken into account when crossing combinations are planned to achieve better crossing success rates in the breeding programme.

When comparing the different studies, *Lachenalia* might have evolved from a common ancestor and the two largest basic chromosome number groups, x = 7 and 8 have evolved from a common predecessor. The studies also indicated a close relationship between these two basic numbers, which is supported by higher success rates in cross-ability between these two groups. It seems as if the higher basic numbers (x = 9, 10, 11 and 13) evolved independently from the lower numbers and that basic numbers x = 9 and 10 could be the bridge from the lower to the higher numbers or *vice versa* (Figure 4.6), but evidence of this is not conclusive (Figures 4.7, 4.8).

Dysploidy and hybridization might be the modes of speciation in some *Lachenalia* species but this could not be proven with molecular data and further studies are required to draw conclusions. The existence of some of the basic chromosome numbers reported (such as x = 5, 6, 10, 12 and 15) can been disputed. Only a few species can be linked to x = 5 and 6 and it is possible that these two basic numbers only exist as part of an aneuploid series in the species *L. mutabilis.* Further studies on species from these disputed basic chromosome numbers is needed to resolve the existence of all the reported numbers.

This review indicates that different genetic studies on *Lachenalia* reveal similar results and stresses the importance of assessing the variation within complex genera to aid in decisions around breeding programme strategies. It is clear that inter-species crosses within phylogentic groups in the genus can improve the success rate of crossing combinations, but there are still many questions that remain unanswered. Further multidisciplinary studies are needed in the genus *Lachenalia* to solve the evolutionary history of this complex genus, to answer questions around species placement and the existence of basic chromosome number groups and to overcome crossing barriers.

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4.7 STATEMENT OF RESEARCH QUESTIONS ADDRESSING THE DEVELOPMENT OF NEW *LACHENALIA* CULTIVARS

Research question: What is the extent of the germplasm variation available in the genus?

Based on this review of the cytogenetic and phylogenetic variation in the genus *Lachenalia* the following conclusions can be drawn regarding the main research question, but also addressing additional questions posed in Chapter 3:

- Besides the phenotypic variation the genus is exceptionally varied in terms of its genetics
- The extent of this variation include different basic chromosome numbers, polyploidy and B-chromosomes that complicates breeding in the genus
- Species with the same basic chromosome numbers groups together during phylogenetic analysis indicating closer relationships
- These relationships are supported by cross-ability data, with higher success rates when crosses are made within phylogenetic groups
- The value of the generation of basic information on the cytogenetic and molecular systematics of the genus contributing towards the development of breeding strategies is clear
- Future breeding strategies are dependent on the availability of basic genetic information as well as data on the relatedness among the different species.
- Research on various aspects are needed to answer the many questions around the placement of species, evolutionary development and relatedness among species.

Kleynhans, R., Spies, P. & Spies J.J. (2012) Phylogenentic and Cytogenetic Review of *Lachenalia*. In *Floriculture and Ornamental Biotechnology* 6 (special issue 1) pp. 98–115. Eds. Van Tuyl J.M. & Krens F.A. Global Science books

CHAPTER 5

DEVELOPMENT OF NEW *LACHENALIA* CULTIVARS USING CONVENTIONAL AND MUTATION BREEDING TECHNIQUES

ABSTRACT

Genera from the Hyacinthaceae family have been utilized in breeding programs at the Agricultural Research Council for many years with the aim to develop new products for the international floriculture market. Through conventional breeding, several *Lachenalia* and *Ornithogalum* cultivars were released. The *Lachenalia* breeding program was the only active breeding program during the period 2004-2009 and several potential new lines (comprising of different colour combinations and flower forms) were developed for commercial evaluation. Besides conventional breeding, a project on the use of mutation technology has also resulted in the availability of new lines. Members of the Hyacinthaceae are particularly suitable for mutation breeding because two of the positive circumstances for mutation breeding can be combined: Vegetative propagation and single cell origin of adventitious buds on leaf tissue. A method combining irradiation and tissue culture was developed to induce mutations in four genera, namely *Lachenalia*, *Ornithogalum*, *Eucomis* and *Veltheimia*. Four potential new varieties were identified from three of the four genera. These lines were initiated in tissue culture for multiplication purposes and commercial establishment.

PREFACE

This chapter is adapted from an *Acta Horticulturae* publication, published in 2011. The chapter discusses information on the development of new *Lachenalia* lines, through the use of both conventional and mutation breeding techniques. As sole author of this publication I was responsible for the publication in its totality. The title of the chapter was changed to address the purpose of the thesis. Although references to this publication was made in previous chapters it contains detailed information on the processes utilized in the development of new cultivars and it is included as part of the thesis to indicate that new *Lachenalia* cultivars have been developed. The information on the cytogentics and phylogenetics were not updated with the newest information as it was discussed in detail in Chapter 4. Since this publication was written six new *Lachenalia* cultivars (some of the lines

Kleynhans, R. (2011) Potential new lines in the Hyacinthaceae. *Acta Horticulturae.* (ISHS) 886: 139–145

mentioned in this publication) were registered with Plant Breeder's Rights in South Africa. These lines are currently being multiplied for commercial production and release.

5.1 INTRODUCTION

South Africa contains ± 10% of the world's plant species (Coetzee, 2002). The Cape Floral Kingdom, with its more than 8500 different flowering species, is one of the six major floral kingdoms of the world (Coetzee et al., 2002, Wesgro, 2006). The Agricultural Research Council (ARC) has played an important role in utilizing this diversity for development of new floriculture crops. Within the Hyacinthaceae family breeding programs focused on the two species, namely, *Lachenalia* J.Jacq. ex Murray and *Ornithogalum* L.

Lachenalia is a bulbous genus endemic to southern Africa with approximately 120 described species (Duncan, 2005a). *Ornithogalum* is closely related to *Lachenalia* and the genus contains approximately 200 species from Africa, Europe and Asia (Littlejohn, 2006). Both genera have been utilized in conventional breeding programs with the aim to develop new pot plant (*Lachenalia* and *Ornithogalum*) and cut flower (*Ornithogalum*) products. These breeding programs led to the release of 33 cultivars (Bester *et al*., 2009).

During the last 5 years the only active breeding program was on *Lachenalia*. The genus is unusually variable (Kleynhans, 2006), creating numerous possibilities for new combinations in flower colour and flower form. The extent of the variation, however, also causes several natural crossing barriers influencing cross-ability among species. External and internal crossing barriers exist (Lubbinge, 1980, Kleynhans, 2006).

Besides the huge phenotypic variation the genus also has a remarkable variability with regards to chromosome number. Somatic chromosome numbers ranging from $2n = 10$ to $2n = 56$ have been reported in the literature (Moffett, 1936, Sato, 1942, Therman, 1956, De Wet, 1957, Riley, 1962, Mogford, 1978, Ornduff & Watters, 1978, Nordenstam, 1982, Crosby, 1986, Hancke & Liebenberg, 1990, Hancke, 1991, Johnson & Brandham, 1997, Kleynhans, 1997, Hamatani *et al*., 1998, Hancke & Liebenberg, 1998, Kleynhans & Spies, 1999, Spies *et al*., 2000, Du Preez *et al*., 2002; Spies *et al*., 2002, Van Rooyen *et al*., 2002, Hamatami *et al*., 2004). The basic chromosome numbers of $x = 7$ or 8 are the most frequent, but $x = 5$, 9, 10, 11, 12, 13 and 15 have also been reported (Ornduff & Watters, 1978, Johnson & Brandham, 1997, Hancke *et al*., 2001). Polyploidy is also fairly common in the genus (Johnson & Brandham, 1997, Kleynhans & Spies, 1999, Spies *et al*., 2000, Spies *et*

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al., 2002). Polyploidy seems to be more common in species with x = 7 as basic chromosome number (Spies *et al*., 2002).

This cytogenetic variation played an important role in the success rate of interspecies crosses (Kleynhans *et al*., 2009b). Crosses between species and hybrids within the same basic chromosome number gave higher success rates than combinations between different chromosome numbers (Kleynhans *et al*., 2009b). Combining several species within the x = 7 and x = 8 group gave rise to several new colour combinations. It, however, became clear that certain colour and flower form combinations would not be reached by conventional breeding methods. The research team, thus, investigated the possibility of mutation breeding to achieve specific goals in the genus *Lachenalia*. Three other genera within the family Hyacinthaceae, *Ornithogalum*, *Eucomis* and *Veltheimia*, were also included in the mutation breeding project.

For various reasons vegetatively propagated crops (like genera in the Hyacinthaceae) are very suitable for the application of mutation breeding. The main advantage of mutation breeding for these crops is the ability to change one, or a few characteristics of an otherwise outstanding variety without altering the remaining, and often unique part of the genotype (Broertjes & Van Harten, 1978). Mutation breeding is, thus, an obvious way to perfect leading products of conventional breeding (often the result of many years of painstaking work). One of the main bottlenecks in mutation breeding of vegetatively propagated crops is the occurrence of chimera formation and diplontic selection (competition between mutated and normal cells). Both complications are caused by the multi cellular nature of the bud apex and the fact that mutation is a one cell event. The result can be a low mutation frequency, while selection cannot be applied before the stable chimera stage has been reached (Broertjes & Van Harten, 1978).

Members of the Hyacinthaceae and Liliaceae are particularly suitable for mutation breeding because two of the positive circumstances for mutation breeding can be combined: Vegetative propagation (Nel, 1981, Lennox, 1990, Niederwieser & Ndou, 2002) and single cell origin of adventitious buds on leaf tissue (Niederwieser & Van Staden, 1990). Difficulties related to diplontic competition and chimera formation can largely be avoided by clever use of *in vivo* and *in vitro* systems to generate adventitious buds. Large numbers of solid, non chimeral mutants can be produced if leaves, bulb scales or explants are irradiated before regeneration of adventitious shoots. Early detection, selection and vegetative propagation are then relatively easy, provided that good selection procedures are available. The aim of the mutation breeding project was, thus, mainly to develop new flower colors from existing flower bulb cultivars or selections.

5.2 MATERIAL AND METHODS

5.2.1 Conventional Breeding

Material utilized in the conventional breeding crossing program in *Lachenalia* included both species and hybrids. When flowering times of parental plants differed, pollen was stored at -5ºC until used. Two plants each with 10 flowers per inflorescence were prepared for crosses. Anthers were removed before pollen dehiscence and pistils were pollinated three to six days after emasculation. Seedpods were left on the plants, until brown and collected just before seed dispersal. Seed were stored at room temperature until the next growth season (March-April in the Southern Hemisphere) and sown just below the soil surface. Seeds germinated within four to eight weeks after they were sown. Seedlings were grown for two seasons before bulbs flowered in the third season. Upon flowering, selections were made according to standard selection procedures, including characters such as flower colour, density and size, inflorescence length and sturdiness, and good leaf to inflorescence relationships.

5.2.2 Mutation Breeding

Some of the most beautiful under-utilised indigenous flower bulbs belong to the Hyacinthaceae. Four genera were selected for the mutation breeding project, *viz*, *Lachenalia*, *Ornithogalum*, *Veltheimia and Eucomis.*

Besides vegetative propagation and single cell origin of explants, two additional positive circumstances for mutation breeding can be added for *Lachenalia*: heterozygosis and polyploidy (Kleynhans & Hancke, 2002). The existing cultivars 'Rupert and Romaud' have excellent overall characteristics and a high level of heterozygosis. In the other genera the following material was used: A yellow flowering *Ornithogalum* cultivar 'Rollow', a selection of *Eucomis bicolor* and a yellow flowering selection of *Veltheimia*.

Tissue culture, leaf explants were irradiated with different dosages of gamma rays (0, 5, 10, 15 and 20 Gy) to determine the optimum dosage. Optimum dosages were determined by calculating the viability of irradiated explants as compared to the control. A dosage with a 40-60% reduction in viability was used for irradiation of large numbers of leaf explants.

Thirty thousand plantlets of each cultivar/species selection were regenerated from irradiated material, rooted and established in the glasshouse (25/10ºC day/night temperature) or outside under a shade net (ambient temperature). Plantlets were grown to flowering size and evaluated for flower colour changes, flower size, leaf markings and growth abnormalities. Flower colour/size mutants were selected and initiated in tissue culture for multiplication. Multiplied material of the mutants were established to verify the stable nature of the mutant and to do further evaluations. Standard Murashige and Skoog media (Murashige & Skoog, 1962) for initiation and rooting were used in all tissue culture steps (Nel 1983; Niederwieser & Vcelar, 1990).

5.3 RESULTS AND DISCUSSION

5.3.1 Conventional Breeding

The high chromosome number diversity present in *Lachenalia* makes it essential to carefully plan the crossing strategy to obtain new hybrids. Results from inter species crosses indicated that the success rate is higher when crosses are made between species with a similar basic chromosome number (Kleynhans *et al*., 2009b). The cross-ability between species with different basic chromosome numbers were all below 25% (Kleynhans *et al*., 2009b). Most of the crossing combinations made concentrated on species within the x = 7 and x = 8 basic chromosome numbers. In the crossing program the best results, in terms of new flower form and colour combinations, were obtained when hybrid-hybrid crosses were made.

Within the basic chromosome number x = 7 group of species, various complex crossing combinations gave rise to new colour forms:

Green hyacinth type flowers (Figure 5.1a) –

[(*L. orchioides* x *L. aloides*) x (*L. orchioides* x *L. aloides*)] x (*L. aloides* x *L. aloides*)

Bright pink tubular flowers (Figure 5.1b) –

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[*L. bifolia* x (*L. aloides* x *L. punctata*)] x
[(*L. bifolia* x *L. punctata*) x *L. bifolia*]

[(*L. orchioides* x *L. bifolia*) self pollinated] x
[(*L. orchioides* x *L. punctata*) self pollinated

[(*L. aloides* x *L. punctata*) self pollinated] x
[(*L. orchioides* x *L. bifolia*) self pollinated]

x

x

Blue tubular flowers (Figure 5.1c)–

(*L. orchioides* x *L. bifolia*) self pollinated x
(*L. orchioides* x *L punctata*) self pollinated

(*L. aloides* x *L. punctata*) self pollinated x
[(*L. orchioides* x *L. bifolia*) self pollinated

x

x

L. viridiflora

Specific genotype combinations can also give rise to new flower forms. Although more than 50 *L. bifolia* x *L. punctata* crosses were made, one specific parent combination gave rise to red bell shaped flowers. The rest of the combinations all had tubular flowers. A similar result was obtained with a specific *L. flava* x *L. quadricolor* combination which gave rise to a tricolour (orange-yellow-green) bell shaped flower with upward curving tips (Figure 5.1d).

Within the basic chromosome *x* = 8 group of species, good results were obtained with inter specific crosses. A *L. bachmanii* x *L. carnosa* cross gave rise to a white hyacinth like inflorescence (Figure 5.1e). Different combinations of *L. splendida*, *L. unicolor* and *L. carnosa* also gave rise to different hyacinth like hybrids ranging from blue purple to pink purple.

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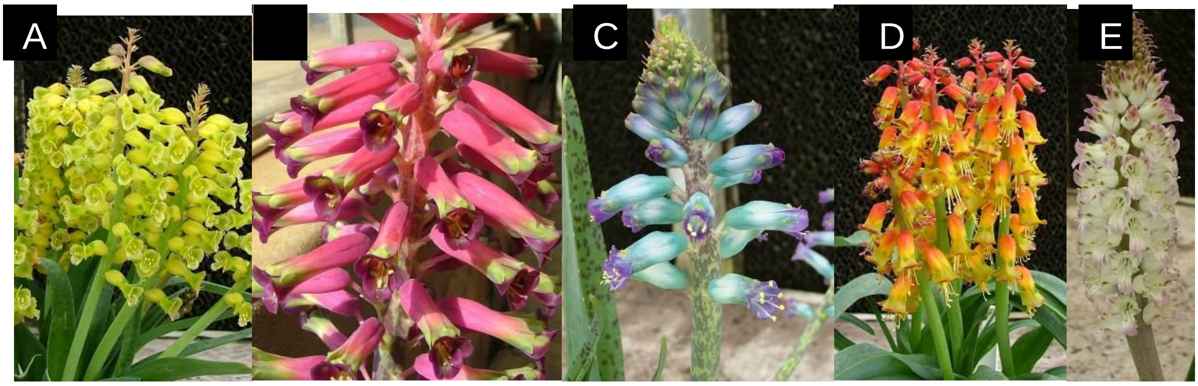

Figure 5.1: New hybrids in *Lachenalia* resulting from conventional breeding. A-C) complex hybrid-hybrid combinations used for development of new colours (species used all had x = 7 chromosome complement), D) specific genotype combination of *L. flava* x *L. quadricolor* and E) *L. carnosa* x *L. bachmanii* inter species crossing combination utilizing species with a basic x=8 chromosome number.

5.3.2 Mutation Breeding

Four genera, *Lachenalia* (two cultivars), *Ornithogalum*, *Eucomis* and *Veltheimia*, were used for mutation breeding. Optimal dosages of irradiation were determined for each genus. The optimal dosage varied from 15 Gy (*Lachenalia*), to 10 Gy (*Ornithogalum*) to 5 Gy (*Eucomis* and *Veltheimia*).

Plants were evaluated for mutants during flowering. The time from planting to flowering varied from genus to genus. Some of the *Ornithogalum* plants already flowered within 6 months from planting. The rest of the plants flowered after the bulbs were re-established for a second growth season. The *Lachenalia* plants only flowered during the second growth season. The *Eucomis* and *Veltheimia* plants were even slower, and only flowered in the third and fourth growth season.

In *Lachenalia* 'Romaud' no major flower colour changes were observed. A large number of infertile plants were observed as well as small changes in flower form and leaf markings. One of the plants with plain yellow flower were selected, but this line will have to be compared to 'Romaud' to determine if it is superior in terms of other pot plant characteristics.

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A large variation of flower colour and flower colour combinations was observed in *Lachenalia* 'Rupert'. Flower colour varied from almost cream to purple with cream tips, to pink and even blue (Figure 5.2 a-c). More than thirty plants were selected. All plants selected were multiplied and re-established to determine the stability of the mutation. All the mutants are stable, except the blue coloured mutant. These mutants will be evaluated for other pot plant characteristics to select the most promising lines.

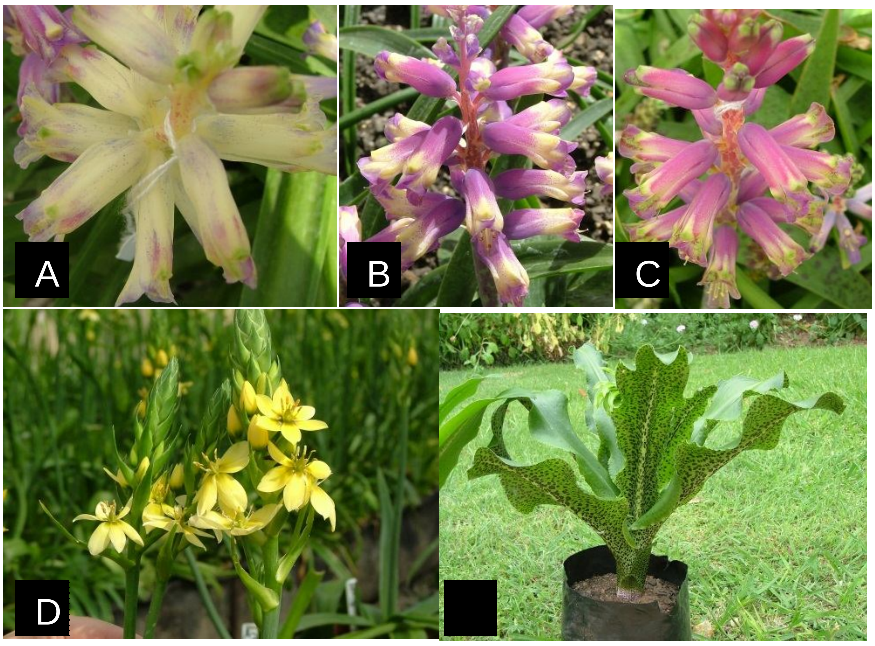

Figure 5.2: New hybrids in the Hyacinthaceae, resulting from mutation breeding. A-C) mutants from *Lachenalia* 'Rupert', D) larger flowered mutant (right) of *Ornithogalum* and E) spotted *Eucomis* mutant.

In *Ornithogalum* no major flower colour changes occurred. There were, however, several plants with a substantial increase in flower size (Figure 5.2d). This increase could reach 15 mm in diameter larger than the original. Several selections were made based on this increase in combination with stem length and dense inflorescences. Material were multiplied and established for further evaluation. One selection was registered with plant breeder's rights in 2010.

No flower colour changes were observed in *Eucomis*, but a mutant with extensive spotting on the leaves and flower stem was identified and multiplied (Figure 5.2e). This mutant was also multiplied for further evaluation. No mutations were observed in *Veltheimia*.

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5.4 CONCLUSION

In conclusion, a method was developed to induce mutations in the Hyacinthaceae. This method can be utilized for other flower crops as well. New lines are available for commercial evaluation, both from mutation breeding as well as conventional breeding. From the conventional breeding program on *Lachenalia* it is clear that hybrid-hybrid combinations give rise to new colours and flower forms. Hybrids developed should be evaluated under commercial conditions before commercialization.

5.5 STATEMENT OF RESEARCH QUESTIONS ADDRESSING THE DEVELOPMENT OF NEW *LACHENALIA* CULTIVARS

Research question: Can new cultivars be developed? Based on this chapter on the development of new lines in *Lachenalia* the following conclusions can be drawn:

- New *Lachenalia* hybrids can be developed through both conventional breeding and mutation breeding
- Complex crossing combinations gives rise to new colour combinations

However, taking into account the genetic diversity in the genus as discussed in Chapter 4 it is clear that the basic information on chromosome numbers and relatedness among species is essential for planning these complex combinations.

Future research needs as identified from this work and not addressed in this thesis includes:

- Develop knowledge on the biochemical pathways of colour in these genera to assist in the selection of lines for mutation breeding.
- Specific investigation on post fertilization barriers is needed to facilitate the development of methods to overcome these

CHAPTER 6

CROSS-ABILITY IN THE GENUS *LACHENALIA*

ABSTRACT

Lachenalia is a bulbous genus endemic to southern Africa. The genus has been utilized in a breeding program with the aim to develop a new pot plant product for the international floriculture market. The genus has 133 described species and is unusually variable. The variation in terms of flower-form, -colour, -length and -posture opens up a range of possibilities in terms of pot plant types as well as cut flower potential. The extent of the variation, however, also causes several natural crossing barriers influencing the cross-ability among species. The genus is just as varied in chromosome number as in phenotype. Various basic chromosome numbers are present in the genus *Lachenalia*, i.e. x = 5, 6, 7, 8, 9, 10, 11 and 13. Ploidy levels range from diploid to octoploid and polyploidy is present in several species. A large number of interspecies crosses have been made. The results of these and the implication on the cross-ability of different species are discussed. Cross-ability between species with the same basic chromosome number is fairly successful. Cross-ability between species with different basic chromosome numbers is, however, low. The crossing data are compared to results from studies on the phylogeny of the genus as determined using sequencing of the transfer RNA intergenic spacer (*trnL-F*) sequencing and chromosome numbers. The same tendency can be observed if the inter-species crosses are linked to the phylogenetic groups identified within the genus. Within groups cross-ability is fairly successful, whilst between groups cross-ability is low. The crossing data, thus in most cases correlate with the phylogenetic data. Where discrepancies occur further phylogenetic analyses are required.

PREFACE

This chapter is unchanged from an *Acta Horticulturae* publication, published in 2009. It is included here to serve as basis for the more complete and extended information presented in chapter 7. Only the format was changed to conform to the rest of the thesis as well as the species (according to the new citations – Duncan, 2012) to ensure consistent referencing to species names throughout the thesis. As first author of this publication I was responsible for most of the work, with the use of cladograms from co-authors to link the cross-ability to the phylogeny of the genus. The chapter concludes with the research questions that will be addressed in more detail in chapter 7.

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6.1 INTRODUCTION

Lachenalia J.Jacq. ex Murray is a bulbous genus endemic to southern Africa. The genus has been utilized in a breeding program at the Agricultural Research Council's Vegetable and Ornamental Plant Institute (ARC-Roodeplaat VOPI) with the aim to develop a new pot plant product for the international floriculture market. The genus has approximately 133 described species (Duncan, 2012) and is unusually variable (Kleynhans, 2006). The extent of the variation, however, also causes several natural crossing barriers influencing cross-ability among species.

External and internal crossing barriers exist (Lubbinge, 1980, Kleynhans, 2006). The external barriers can easily be overcome by growing the plants in controlled conditions and the successful storage of pollen for a 12-month period (Kleynhans, 2006). Stored pollen is used to overcome the diverse flowering times (April – Nov) of the species in the genus. The internal barriers have not been studied in detail.

Closely linked to the internal barriers is the remarkable variability with regards to chromosome number found in the genus. Somatic chromosome numbers ranging from $2n = 10$ to $2n = 56$ have been reported in the literature (Moffett, 1936; Sato, 1942; Therman, 1956; De Wet, 1957; Fernandes & Neves, 1962; Riley, 1962; Mogford, 1978; Ornduff & Watters, 1978; Nordenstam, 1982; Crosby, 1986; Hancke & Liebenberg, 1990; Hancke, 1991; Johnson & Brandham, 1997; Kleynhans, 1997; Hamatani *et al*., 1998; Hancke & Liebenberg, 1998; Kleynhans & Spies, 1999; Spies *et al*., 2000; Du Preez *et al*., 2002; Spies *et al*., 2002; Van Rooyen *et al*., 2002; Hamatami *et al*., 2004). The basic chromosome numbers of $x = 7$ or 8 are the most frequent, but $x = 5$, 9, 10, 11, 12, 13 and 15 have also been reported (Ornduff & Watters, 1978; Johnson & Brandham, 1997; Hancke *et al*., 2001). Polyploidy is also fairly common in the genus (Johnson & Brandham, 1997; Kleynhans & Spies, 1999; Spies *et al*., 2000; Spies *et al*., 2002). Polyploidy seems to be more common in species with $x = 7$ as basic chromosome number (Spies *et al*., 2002).

To assess the genomic variability, studies were initiated to determine the phylogeny of the genus (Minnaar, 2004 and Spies, 2004). The *trnL-F* region was sequenced and phylogenetic analysis was done (Spies *et al.,* 2002). From the initial results it was clear that none of the sub-generic taxonomic systems applied (Barker, 1897, Crosby, 1986; Duncan, 1988) conformed to the natural phylogeny of the genus.

The first inter-species crosses of the genus, in the ARC-VOPI breeding programme, were made in 1968. Since then approximately 25 cultivars have been released and

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hundreds of crossing combinations have been made. The results of the inter-species crosses are used to indicate the cross-ability among species. The cross-ability is linked to the phylogeny of the genus (Spies, 2004) as determined using transfer RNA intergenic spacer (*trnL-F*) sequencing and chromosome numbers.

6.2 MATERIALS AND METHODS

Crosses are made via hand pollinations after emasculation of flowers (Lubbinge, 1980). Emasculation takes place one or two days before anther dehiscence. Anther dehiscence varies from species to species. The correct time of emasculation, thus has to be determined for each species. Even ecotypes within a species might differ with regard to time of dehiscence (Kleynhans, 2006).

Anthers are collected in gelatine capsules and left in a desiccator overnight to dehisce. Capsules are then closed and stored in tightly sealed glass bottles in the refrigerator at -4^{0}C. Storage of pollen is important because of the diverse flowering times (April-November) among the species (Duncan, 1988). Pollen germination tests are done by the hanging drop technique with 10% sucrose and 0.01% boric acid (Hancke & Liebenberg, 1998).

Stigmas are receptive from one to seven days after anthesis (defined as anther dehiscence for this discussion). In trials performed on six species (*L. aloides* (L.f.) Engl., *L. bifolia* (Burm. f.) W.F. Barker ex G.D. Duncan, *L. liliflora* Jacq., *L. mutabilis* Sweet, *L. punctata* Jacq., and *L. pallida* Aiton) the optimum period of receptiveness varied greatly (Kleynhans, 2006). According to these results the optimal time for pollination was three to five days after emasculation.

6.3 RESULTS AND DISCUSSION

More than 1498 inter-species crosses were made at ARC-Roodeplaat VOPI from 1974 to 2005 (Table 6.1). The chromosome numbers of all the accessions used in the crosses are not available. The basic chromosome numbers reported in the literature, and as used by Spies (2004), were used to assess the cross-ability between groups with similar or different basic chromosome numbers. Cross-ability was determined as the percentage of successful crosses made. Seventy seven percent of all inter-species crosses made at ARC-Roodeplaat VOPI were unsuccessful, either because no seed (possible pre-fertilisation barrier) or non-viable seed (possible post-fertilisation barrier) were formed (Table 6.1). The extent and exact processes causing these failures needs further investigation.

Table 6.1: Inter-species crosses made between different *Lachenalia* species. Results are linked to the basic chromosome complement of the species.

Inter-specific cross type – related to basic chromosome numbers	Successful crosses	Unsuccessful – no seed set [a]	Unsuccessful - abnormal seed [b]	Total per crossing type
7 x 7	172 (31%)	227 (41%)	157 (28%)	556
8 x 8	79 (53%)	32 (21%)	38 (26%)	149
7 x 8 / 8 x 7	67 (14%)	249 (50%)	178 (36%)	494
7 x 11 / 11 x 7	13 (24%)	30 (56%)	11 (20%)	54
8 x 11/ 11 x 8	4 (17%)	10 (43%)	9 (40%)	23
11 x 11	1 (50%)	1 (50%)	0	2
11 x 13	0	5 (50%)	5 (50%)	10
7 x 13 / 13 x 7	1 (1%)	46 (50%)	45 (49%)	92
8 x 13 / 13 x 8	1 (3%)	15 (38%)	23 (59%)	39
13 x 13	3 (75%)	0	1 (25%)	4
10 x 7 / 7 x 10	1 (2%)	23 (49%)	23 (49%)	47
10 x 8 / 8 x 10	1 (4%)	13 (50%)	12 (46%)	26
11 x 10	1 (50%)	1 (50%)	0	2
Total per success rate	344 (23%)	652 (44%)	502 (33%)	1498

[a] – possible pre-fertilization barriers

[b] – possible post-fertilization barriers

The success rate is higher when crosses are made between species with a similar basic chromosome number (Table 6.1). A few crosses were made between species with a basic chromosome number of 11 and 13, thus making it difficult to comment on the cross-ability between these species. The cross-ability between species with a basic chromosome number of 8 was more than 50% (Table 6.1). The cross-ability between species with different basic chromosome numbers were all below 25%, except for the x = 11 cross x = 10 group. Only two crosses were, however, made within this group, thus making it difficult to comment on the cross-ability.

Within the basic chromosome group of x = 7 the cross-ability was also fairly low (31%). The highest number of polyploidy are, however, found within the basic x = 7 group (Spies, 2004). Approximately 15 tetraploid taxa as well as hexaploids and octoploids are found within this group (Kleynhans & Spies, 1999, Spies, 2004). This fact, thus complicates crosses within the basic x = 7 group. Most inter-specific crosses (66%) where polyploid *L. bulbifera* plants were used as the pollen parent were unsuccessful because of the production of abnormal or non-viable seed. The crossing barrier is, thus at the post fertilisation stage, and reduced hybrid viability is most probably caused by disharmony either between the parental sets of chromosomes or between the developing embryo and endosperm. The specific chromosome numbers and polyploidy level of many of the specific accessions used in these crosses are unknown, making it difficult to take ploidy level out of the equation.

Spies (2004) identified four distinct groups within the Adams consensus cladogram determined from the *trnL-F* sequencing data. These groups were provisionally named the *L. juncifolia* group, the *Lachenalia* 1 group, the *Lachenalia* 2 group and the *L. zebrina* group (Figure 6.1). The data from the interspecies crosses were divided between the four groups to see what the success rate between these groups was (Table 6.2). The numbers in Table 6.2 do not correlate with those in Table 6.1, since not all of the species were included in the phylogenetic analysis. The success rate is higher when species within a provisional group are crossed with each other (Table 6.2). The success rate dropped from above 25% to below 15% when crosses between species from different groups were attempted. Most of the inter-species crosses made were between species within the *Lachenalia* 1 group.

Table 6.2: Inter-species crosses made between different *Lachenalia* species. Results are linked to the four phylogenetic groups in the genus as previously identified. Source: Spies (2004).

Inter-specific cross type – related to phylogenetic grouping	Successful crosses	Unsuccessful – no seed set [a]	Unsuccessful - abnormal seed [b]	Total per crossing type
L. juncifolia group X *Lachenalia* 1 group	3 (4%)	41 (52%)	34 (44%)	78
L. juncifolia group X *Lachenalia* 2 group	1 (14%)	4 (57%)	2 (29%)	7
Lachenalia group 1 X *Lachenalia* 1 group	303 (27%)	475 (41%)	369 (32%)	1147
Lachenalia 1 group X *Lachenalia* 2 group	8 (4%)	86 (46%)	95 (50%)	189
Lachenalia 2 group X *Lachenalia* 2 group	3 (33%)	2 (22%)	4 (45%)	9
Total	318	608	504	1430

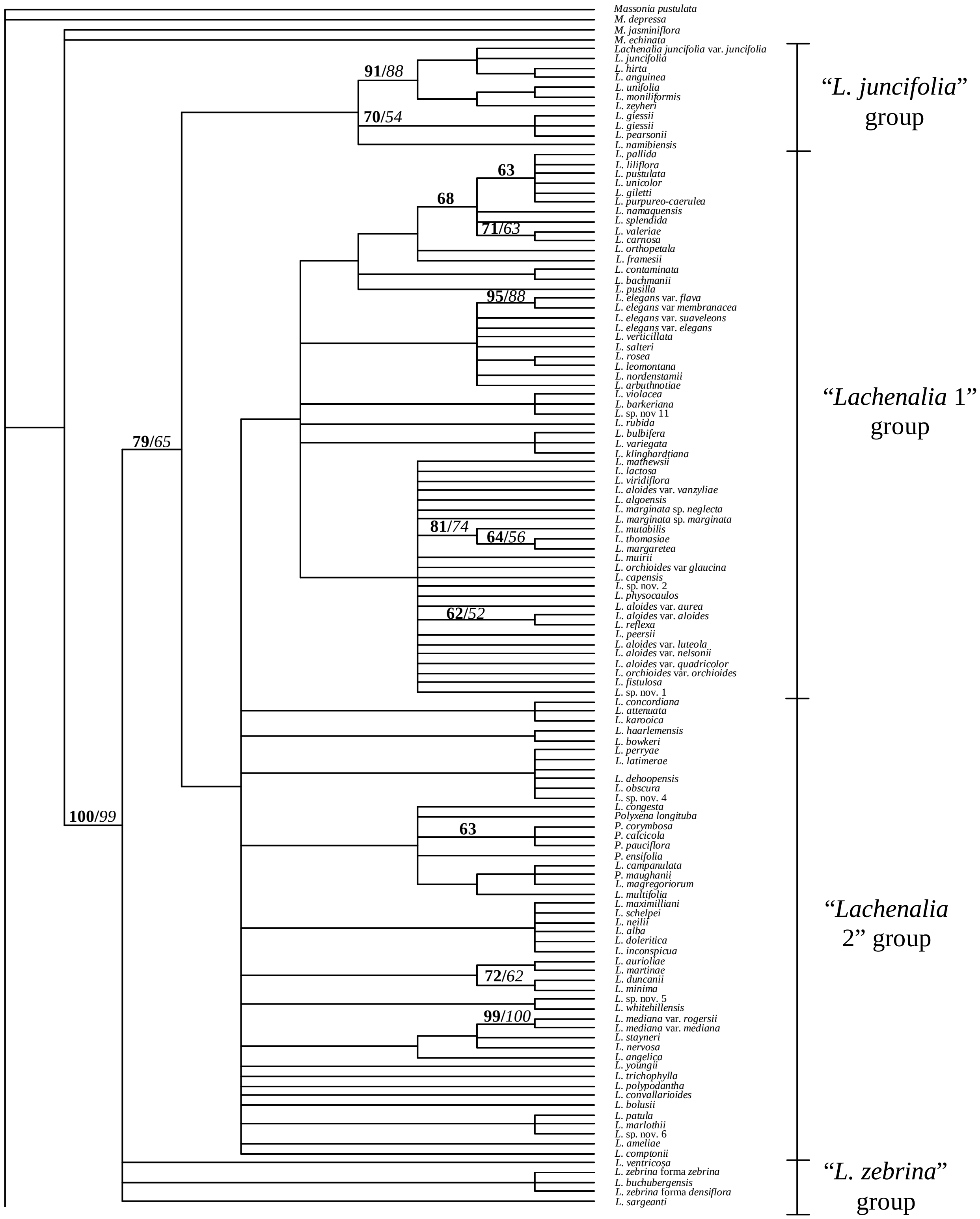

Figure 6.1: The Adams consensus cladogram of the genera *Lachenalia, Massonia* and *Polyxena*. Bootstrap (first value in bold) and Jackknife confidence values (second value in italic) greater than 50% are shown. Source: Spies, (2004). The correct current citation for *L. aloides* var*. aurea* is *L. flava,* for *L. aloides* var*. vanzyliae* is *L. vanzyliae,*

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for *L. aloides* var. *quadricolor* is *L. quadricolor,* for *L. bulbifera* is *L. bifolia,* for *L. orchioides var. orchioides is L. orchioides subsp. orchioides, for L. orchioides var. glaucina is L. orchioides subsp. glaucina,* for *L. rubida* is *L. punctata,* for *L. elegans* var. *flava* is *L. karoopoortensis*, for *L. elegans* var. *membranacea* is *L. membranacea*, for *L. elegans* var. *sauveolens* is *L. sauveolens*, for *L. mediana* var*. mediana* is *L. mediana* subsp. *mediana*, for *L. mediana* var. *rogersii* is *L. mediana* subsp. *rogersii,* for *L. unicolor, L. giletti* and *L. pustulata* is *L. pallida,* for *Polyxena longituba* is *L. longituba,* for *P. corymbosa* is *L. corymbosa,* for *P. calcicola* is *L. calcicola,* for *P. paucifolia* is *L. paucifolia* and for *P. maughanii* is *L. ensifolia* subsp*. ensifolia*.

Table 6.3: Interspecies crosses made between different *Lachenalia* species. Results are linked to the phylogenetic sub-groups within the *Lachenalia* 1 group in the genus as previously identified (Spies, 2004).

Inter-specific cross type – related to phylogenetic grouping: sub groups within the *Lachenalia* 1 group	**Successful crosses**	**Unsuccessful – no seed set [a]**	**Unsuccessful - abnormal seed [b]**	**Total per crossing type**
L. pallida sub group X *L. pallida* sub group	78 (53%)	32 (22%)	38 (25%)	148
L. pallida sub group X *L. elegans* sub group	1 (10%)	6 (60%)	3 (30%)	10
L. pallida sub group X *L. bulbifera* sub group	16 (11%)	83 (56%)	50 (33%)	149
L. pallida sub group X *L. mathewsii* sub group	47 (15%)	112 (36%)	155 (49%)	314
L. elegans sub group X *L. bulbifera* sub group	0	9 (75%)	3 (25%)	12
L. elegans sub group X *L. mathewsii* sub group	0	27 (87%)	4 (13%)	31
L. bulbifera sub group X *L. bulbifera* sub group	37 (61%)	13 (22%)	10 (17%)	60
L. bulbifera sub group X *L. mathewsii* sub group	83 (31%)	84 (32%)	99 (37%)	266
L. mathewsii sub group X *L. mathewsii* sub group	47 (30%)	76 (48%)	34 (22%)	157
Total	309	442	396	1147

Within the *Lachenalia* 1 group, six sub-groups could be identified (Spies, 2004). These are the *L. pallida*, *L. elegans, L. violaceae, L. punctata, L. bifolia* and *L. mathewsii* sub-groups (Figure 6.2). The crossing data of species in the group was linked to these sub-groups to indicate the cross-ability. For this purpose the two sub-groups (sister groups in the cladogram) *L. bifolia* and *L. punctata* (consisting of a single species) were combined. Sixty one percent of all crosses made between these two species succeeded despite the fact that in 98% of these crosses, a polyploidy *L. bifolia* accession was used.

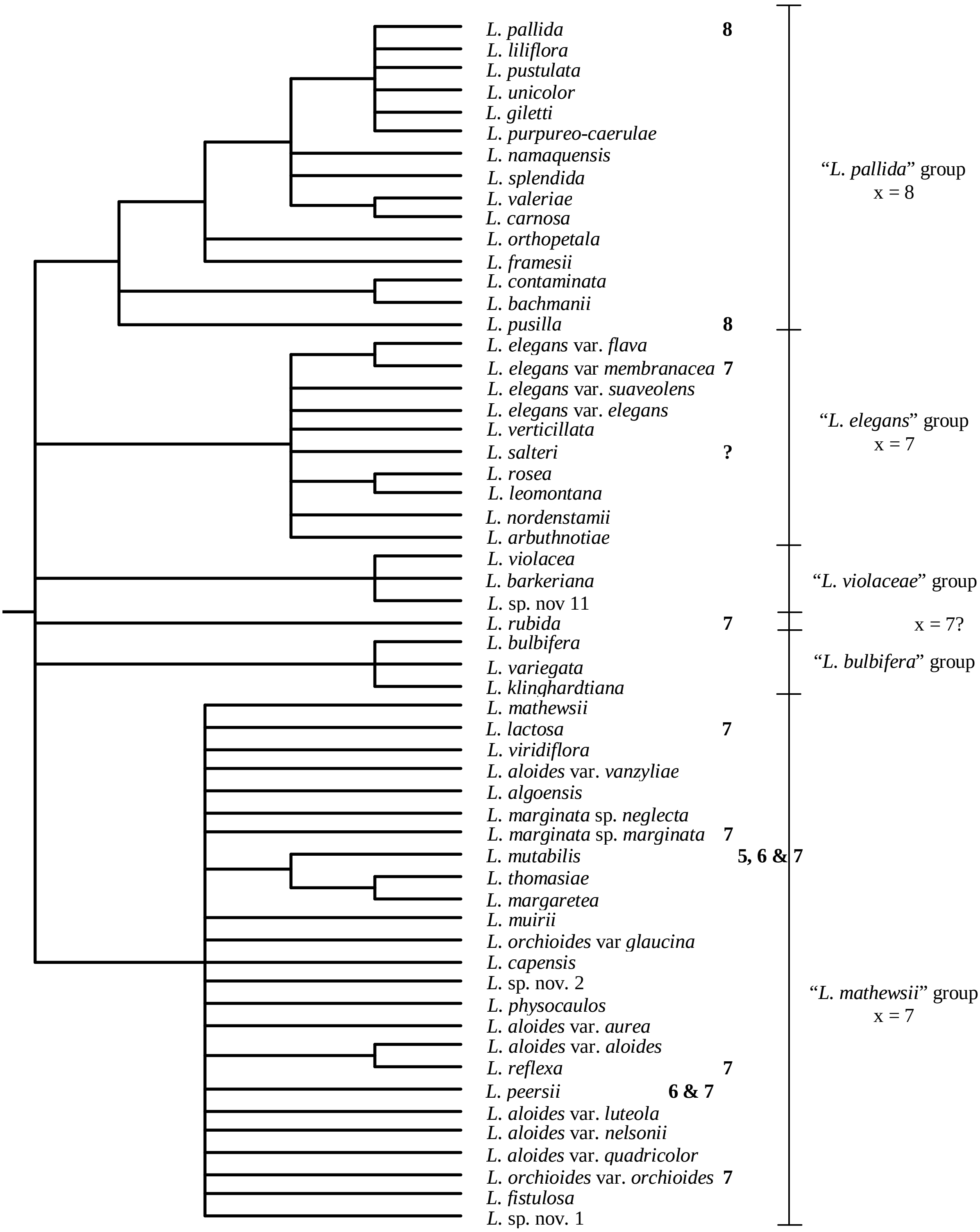

Figure 6.2: The *Lachenalia* 1 group from the Adams consensus cladogram with the six sub-groups indicated, as well as their basic chromosome number. Source: Spies, 2004. The correct current citation for *L. aloides* var. *aurea* is *L. flava,* for *L. aloides* var. *vanzyliae* is *L. vanzyliae,* for *L. aloides* var. *quadricolor* is *L. quadricolor,* for *L. bulbifera* is *L. bifolia,* for *L. orchioides var. orchioides is L. orchioides subsp.*

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orchioides, for L. orchioides var. glaucina is L. orchioides subsp. glaucina, for *L. rubida* is *L. punctata,* for *L. elegans* var. *flava* is *L. karoopoortensis*, for *L. elegans* var. *membranacea* is *L. membranacea*, for *L. elegans* var. *sauveolens* is *L. sauveolens*, and for *L. unicolor, L. giletti* and *L. pustulata* is *L. pallida*

The within group cross-ability was again higher than the between group cross-ability, with success rates above 50%. The only exception was the *L. mathewsii* within group success rate. The *L. bifolia* x *L. mathewsii* (sister groups) between group success rate was high, indicating a stronger relationship between the species of these two groups. This stresses the fact that an additional gene should be sequenced to increase the resolution of the different groupings and species. The lower success rate when the *L. mathewsii* within group cross-ability is viewed can be ascribed to the presence of polyploids as well as to the external crossing barrier of flower size. Lubbinge (1980) was first to describe this mechanical isolation. Large flowered species of *Lachenalia* have flowers of over 25mm long, whilst in smaller flowered species the flower length can be less than 10mm. Pollen from small flowered species is, thus not adapted to traverse the long distance from the stigma to the ovary of large flowered species (Stebbins, 1950).

6.4 CONCLUSIONS

This study indicates a correlation between the cross-ability of *Lachenalia* species and their basic chromosome numbers, as well as their phylogenetic relationships. In general, the inter-species cross-ability, as determined by crossing successes, confirms the phylogenetic groupings identified by Spies (2004). Sequencing another gene to obtain better resolution in the cladogram and making more crosses with species not included in the *Lachenalia* 1 group is, however, needed to confirm these links. A study on the relevant crossing barriers involved will assist breeders to understand the low cross-ability, especially within the *L. mathewsii* sub-group.

6.5 STATEMENT OF RESEARCH QUESTIONS ADDRESSING THE DEVELOPMENT OF NEW *LACHENALIA* CULTIVARS

Research question: What are the cross-ability and compatibility issues in the genus?

Based on this publication on the cross-ability of the genus *Lachenalia* the following conclusions can be drawn:

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- The success rate of interspecies crosses in the genus is less than 30% indicating incompatibility and genetic diversity amongst species

- Cross-ability improves if crosses are made between species within the same basic chromosome number group

- Improved cross-ability is also observed when species in the same phylogenetic clades are used in intra-species combinations

However, cross-ability in this publication was only measured as successful or not, based on the formation of normal seed. The number of seeds formed may vary from 1 to several 100 and this can be used as further identification of cross-ability. Additional research questions thus develop:

- What is the extent of the cross-ability of crosses that do succeed measured in terms of seed set?
- How does this link to chromosome numbers of the species used?
- Can these results shed light on the relatedness of different species?
- Do the results correlate with published information on the molecular systematics?
- How does the combined information effect the development of *Lachenalia* hybrids?

Future research needs as identified from this work and not addressed in this thesis includes:

- Investigating self-compatibility and the factors influencing the cross compatibility

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CHAPTER 7

CROSS-ABILITY AMONG *LACHENALIA* SPECIES AND BREEDING STRATEGIES FOR THE DEVELOPMENT OF NEW *LACHENALIA* CULTIVARS

ABSTRACT

The generation of variation is the basis of any breeding program. In the ornamental industry one of the most important methods of generating new variation is the utilization of inter-species crosses. New flower-colours, flower forms, leaf forms and growth habits constitute novel products, which have value in the industry. Inter-species crosses often give rise to intermediate forms that has these characteristics and these novel products that can result in new cultivars. Inter-species crosses, however, often do not succeed because of existing crossing barriers. In a genus as diverse as *Lachenalia*, crossing barriers are evident and it is essential to generate the basic genetic information as well as the cross-ability among species in order to progress towards the development of new cultivars. The genetic variation and known evolutionary relationships have been discussed in previous chapters and some links have been established with the cross-ability between different species. The existence of extensive crossing barriers at both the pre- and post-fertilization level is evident from the cross-ability data presented. The cross-ability can be link to the evolutionary relationship among species and the effect of different basic chromosome numbers as well as polyploidy on the success of crosses is evident from the results. Unilateral cross-ability is present in some species and specific species was identified that act as better male of female parents were identified. Different accessions of the same species can differ in their cross-ability with other species, clearly illustrating the importance of maintaining multiple, well-characterized germplasm accessions for breeding. The establishment of pre-breeding evaluation processes to identify cross compatible species and species accession can add value to the germplasm material and guide breeders when choosing suitable accessions. The availability of data on the somatic chromosome numbers for each accession is essential for breeding, since the best cross-ability are achieved when species with the same basic chromosome number are crossed. In this regard the cross-ability data confirms the evolutionary relationship. Good cross-ability among species with different basic chromosome numbers was only obtained between specific species of $x = 7$ and $x = 8$. More intermediate cross-ability confirmed the closer relationship between $x = 7$ and $x = 8$ with the only other basic chromosome number combinations giving some intermediate result $x = 11/8$

and *x* = 11/7. When combining different basic chromosome numbers the species with the higher number should be used as the female parent, as results show an increased success rate in these crossing combinations. The use of polyploid accessions influences the level of success of crossing combinations and needs to be taken into account when planning specific combinations. The identification of the specific level of pre- and post-fertilization barriers needs further investigation to facilitate the bridging of these barriers through the use of specific *in vitro* techniques. The development of new cultivars from the genus *Lachenalia* is feasible, but will require more and more advanced breeding techniques to generate new variation, as well as clear indications on the phylogenetic relationships among species. The *Lachenalia* species key is useful for identification of species, but does not correlate with basic chromosome numbers or cross-ability and cannot be used to predict cross-ability. Basic chromosome numbers are currently the best tool to predict the success of inter-species combinations and investigations on the cross-ability of species with other basic chromosome numbers (not covered extensively in this study) can assist breeders to develop crossing strategies. Additional molecular systematic studies as well as *in situ* hybridization techniques are needed to determine the evolutionary relationships between the different basic chromosome numbers within the genus. The generation of this basic information thus plays an important role in future breeding.

PREFACE

This chapter gives a summary of the cross-ability data (measured as successful or not-successful crosses) of all *Lachenalia* interspecies crosses made over a period of almost 40 years. This more complete data on the tables in Chapters 4 & 6 includes the adapted data after the renaming of species by Duncan (Duncan 2012), that led to the split of *L. aloides,* amongst others into several species. These changes in species names increased the number of inter species crosses. From these crosses a sub-section of crosses among 15 species made for this study are discussed in more detail representing new data and incorporating additional analysis.

The cross-ability data is furthermore linked to the known chromosome numbers of the species similar to the information in Chapters 4 & 6. Additional basic chromosome number combinations were added based on additional published data or data generated during this study. Ploidy levels were included to determine the effect of ploidy on the cross-ability. Based on the data of the sub-set of crossing combinations a multivariate cluster analysis was performed to group the combinations into clusters, indicting the relationships between specific species.

The data is linked to the requirements for new floriculture crops as discussed in Chapter 2, the variation and breeding barriers as discussed in Chapter 3 and the molecular systematic data as discussed in Chapter 4 and conclusions are drawn on the value of the information for the development of new cultivars in *Lachenalia* with reference to Chapters 5 & 6. The chapter is finally concluded with strategies for the development of new cultivars in future as well as additional research to be addressed to facilitate and support this.

7.1 INTRODUCTION

The regular development of novel cultivars is a pre-requisite for sustainable marketing of floriculture crops. The generation of inter-species hybrids is one of the major methods of creating new variation in floriculture breeding. *Lachenalia* is a genus endemic to South Africa and Namibia and one of only a few genera targeted for local development in South Africa. Breeding progress has resulted in the registration of new cultivars that are currently sold on the international market as flowering pot plant products. To sustain these initiatives it is important to continue with the breeding of new cultivars to keep the market interested.

The aim of this chapter is to present new information on the cross-ability among *Lachenalia* species, to link this information to the genetic variation in the genus and to conclude on the necessary future strategies for the development of new cultivars from this genus.

7.2 MATERIALS AND METHODS

7.2.1 Materials

The accessions of *Lachenalia* species used in crosses during this study are listed in Appendix B. The geographic origin and chromosome numbers of the specific accessions (reported in literature or determined during this study) is included where known. All the plants used were grown in greenhouses at ARC-Roodeplaat VOPI in Pretoria in pots.

7.2.2 Chromosome numbers

Mitotic chromosome numbers for this study was determined from root tip squashes according to the method reported by Kleynhans & Spies (1999). Published chromosome numbers are indicated with the relevant literature reference in Appendix B.

7.2.3 Crosses

A complete list of inter- and intra-specific crossing combinations attempted during the course of the development of new *Lachenalia* cultivars were used to determine the success rate of different combinations (Appendix C). A subset of 15 species (Appendix D) was selected for this study based on different basic chromosome numbers, the availability of various accessions per species and the availability of enough material per accession. For these crossing combinations additional data on seed set, number of seeds produced and seedling germination were taken as described below. Some species were not used in all combinations of crosses due to the limited availability of material over time. The crossing combinations in Appendix D is also included in Appendix C to get an overall view of the inter species cross-ability.

Pollen collection and emasculation: The flowering time of the different species is spread over a period from April to September (see Chapter 3). In order to facilitate crosses in species with different flowering times, pollen was collected and stored. For all crosses anthers were removed from the flowers before anthesis (pollen shed) using a pointed forceps. Anthers were collected in gelatine capsules and left in a desiccator with silica gel overnight to dehisce. Capsules containing pollen were closed and stored in air tight containers in the refrigerator at -4°C until use. Stored pollen was tested for germination before use with the hanging drop technique (Hancke & Liebenberg, 1998) on a medium consisting of 10% sucrose and 0,01% Boric acid. Pollen with a germination percentage of above 50% was used where ever possible for subset of crossing combinations.

Crossing combinations: All pollinations were manually executed during early morning, 3-4 days after emasculation using stored pollen. To ensure that crossing results were accurate, crossing combinations where conducted on at least two different inflorescences and with at least 10 flowers per inflorescence. If this could not be obtained the cross was repeated on more inflorescences or in a following season. Due to the limited availability of plant material and slow multiplication rate of some species, crosses for the selected subset of species combinations were conducted over several seasons from 2001-2010.

Seed collection: Seed pods are ready for collection approximately two months after pollination. Seed capsules turn brown and are harvested before they split open. In most crosses seed set was noted for each flower on the inflorescence and the number of seeds per flower was counted. Normal (solid black) seeds and abnormal (dry or hollow) seeds were indicated separately for each flower.

Seed germination: Seed collected for each cross was sown during March of the following season just below the soil surface in finely milled bark compost medium in a pad-fan glasshouse. A single leaf emerges after four to eight weeks from the seeds and the number of seedlings was counted to calculate a germination percentage. Seedlings were transplanted to larger pots (10 cm) after one year of growth. Flowering only occurs in the third growing season.

Data parameters:

Larger cross-combination list (Appendix C): Crossing combinations were indicated as successful based on the formation of normal seeds. Unsuccessful crosses were indicated when no seeds or abnormal seeds were formed. The number of seeds produces per flower was indicated as few (EN) if less than 5 seeds per flower pollinated were observed and as many (N) if more than 5 seeds per flower pollinated were obtained. Abnormal seeds were indicated similarly with ED or D. If no seed set were obtained, results were indicated as GS. Where seedlings died within the first year after germination the possibility of seedling lethality was added as a reason for not succeeding.

Specific subset of crosses amongst 15 selected species made for this study (Appendix D): For the sub-set of crossing combinations, detail data on the number of flowers pollinated and seeds produced per flower were taken. The data were summarized (Appendix D) with the following data parameters/variables:

- the total number of flowers pollinated,
- the number of flowers containing normal seeds,
- the number of flowers containing only abnormal seeds,
- the number of flowers with no seed set,
- the number of normal seeds per crossing event,
- the number of abnormal seeds per crossing event,
- the flower set (= fruit set) percentage (calculated as the no of flowers with normal seed and abnormal seed/ the total number of flowers pollinated*100),
- the number of normal seeds per flower pollinated (calculated as the number of normal seeds/the number of flowers pollinated),

- the number of normal seeds per flower that set seed (calculated as the number of normal seeds/(the number of flowers with normal seeds + the number of flowers with abnormal seeds)
- and the germination percentage of seed sown (number of seedlings/number of normal seeds * 100)

This data were subjected to statistical analysis using XLSTAT (an Excel add-on statistical module). The averages of each Female/Male combination (repeated over years) were calculated through the use of Pivot tables and each variable was standardized. A Agglomerative hierarchical clustering (AHC) analysis were performed on the standardized values using Euclidean distances according to Ward's method to identify specific clusters. This was followed by a discriminant analysis to determine which of the variables contributed as drivers to cluster the data into the three groups.

7.3 RESULTS AND DISCUSSION

7.3.1 Chromosome numbers and pollen fertility

The chromosome numbers of 42 additional accessions were added to the published list of chromosome numbers (Appendix B). These include 12 *L. aloides* accessions (2*n* = 14); 1 *L. aloides* accession (2*n* = 21); 2 *L. bachmanii* accessions (2*n* = 16); 2 *L. bifolia* accessions (2*n* = 28), 1 *L. bifolia* accession (2*n* = 56); 1 *L. bifolia* accession (2*n* = 42); 2 *L. contaminata* accessions (2*n* = 16); 1 *L. elegans* accessions (2*n* = 28); 2 *L. flava* accessions (2*n* = 14); 1 *L. liliflora* accession (2*n* = 16);1 *L. longibracteata* accession (2*n* =14); 7 *L. punctata* accessions (2*n* = 14), 1 *L. pusilla* accession (2*n* = 14), 1 *L. quadricolor* accession (2*n* = 21); 4 *L. quadricolor* accessions (2*n* = 14); 1 *L. splendida* accession (2*n* = 16) and 2 *L. vanzyliae* accessions (2*n* = 28). All numbers agree with published chromosome counts and basic chromosome numbers for species.

Pollen viability of stored pollen varied from below 10% to above 90%, but capsules with a percentage of above 50% was present for each species and these were used for crosses. The causes for the differences in pollen viability between different stored capsules were either due to the collection of immature pollen or the loss of pollen viability during storage. The major causes leading to a loss in pollen viability includes 1) deficiency of respiratory substrates, 2) irreversible loss of membrane permeability and 3) inactivation of enzymes and growth hormones (Shivanna & Johri 1985). Any addition of moisture during the storage period immediately influences the membrane permeability and results in the loss of viability. This was experienced when loss of power led to the defrosting of material in the refrigerator and this on several occasions led to the fact that crosses could not be done in a specific season and had to wait for the next season.

7.3.2 Seed set in inter- and intra-specific crosses (larger data set)

Seed set results from the 2021 inter-specific and 334 intra-specific (including some self-pollinations) crossing combinations made are given in Tables 7.1 and 7.2. From the raw data (Appendix C) it is clear that in almost all crosses some flowers with no seed set were observed indicating the importance of pollinating several flowers to verify the cross-ability between two species.

Table 7.1: Complete list of inter-species crossing combinations indicating the % success based on the number of successful attempts out of the total number of attempts for a specific combination. An indication of the level of success (few seeds = EN or many seeds = N) as well as the reason for not succeeding (GS = no seed set, ED = few abnormal seeds, D = many abnormal seeds, SL = seedling lethality) is given for each combination. Numbers indicate the number of crossing events per inter-species combination having a specific result. Letters next to species names indicate the taxonomic sections in which the species was placed according to the species key of Duncan (2012). L = section *Lachenalia*, O = section *Oblongae*, A = section *Angustae*, La = sections *Latae* and U = section *Urceolatae*

Female parent	Male parent	% success	No of Successful crosses with indication of level of success			No of Crosses not succeeding with indication of reason for non-success				
			Number	EN	N	Number	GS	ED	D	SL
L. alba										
alba (O)	*pallida (O)*	100	2	1	1	0				
L. aloides										
aloides (L)	*bifolia (L)*	0	0			3			3	
aloides^{m}*(L)*	*carnosa (U)*	0	0			1	1			
aloides (L)	*concordiana (O)*	0	0			2	1	1		
aloides^{m}*(L)*	*elegans (U)*	0	0			1		1		
aloides (L)	*flava (L)*	50	1		1	1		1		
aloides^{m} *(L)*	*mutabilis (U)*	0	0			4	4			
aloides (L)	*orchioides (L)*	0	0			3	3			
aloides (L)	*punctata (L)*	86	6	4	2	1		1		
aloides (L)	*quadricolor (L)*	81	29	7	22	7	4	1	2	
aloides (L)	*splendida (O)*	0	0			6	6			
aloides (L)	*viridiflora (L)*	0	0			1	1			
L. anguinea										
anguinea	*bifolia (L)*	0	0			2	2			
L. bachmanii										
bachmanii (A)	*bifolia (L)*	10	1	1		9	7	3		

Female parent	Male parent	% success	No of Successful crosses with indication of level of success			No of Crosses not succeeding with indication of reason for non-success				
			Number	EN	N	Number	GS	ED	D	SL
bachmanii (A)	*carnosa (U)*	100	1		1	0				
bachmanii (A)	*contaminata (A)*	100	2	2		0				
bachmanii (A)	*elegans (U)*	0	0			2	2			
bachmanii (A)	*flava (L)*	0	0			7	4	3		
bachmanii (A)	*liliflora (A)*	60	3	3		2	1	1		
bachmanii (A)	*mediana (O)*	0	0			5	3	2		
bachmanii (A)	*mutabilis (U)*	14	1	1		6		6		
bachmanii (A)	*orchioides (L)*	0	0			3	1	1	1	
bachmanii (A)	*pallida (O)*	14	1	1		6	3	3		
bachmanii (A)	*perryae (O)*	0	0			3	3			
bachmanii (A)	*punctata (L)*	0	0			10	5	4	1	
bachmanii (A)	*quadricolor (L)*	0	0			13	5	8		
bachmanii (A)	*splendida (O)*	0	0			5	2	3		
bachmanii (A)	*thomasiae (O)*	0	0			1		1		
bachmanii (A)	*unifolia (L)*	0	0			3	3			
bachmanii (A)	*vanzyliae (L)*	0	0			1	1			
bachmanii (A)	*viridiflora (L)*	0	0			4	2	2		
L. bifolia										
bifolia (L)	*aloides (L)*	50	1	1		1		1		
bifolia^m *(L)*	*bachmanii (A)*	0	0			6	6			
bifolia^m *(L)*	*carnosa (U)*	0	0			2	2			
bifolia^m *(L)*	*contaminata (A)*	0	0			4	4			
bifolia^m *(L)*	*elegans (U)*	0	0			1	1			
bifolia (L)	*flava (L)*	18	2	2		9	6	3		
bifolia (L)	*liliflora (A)*	0	0			8	7	1		
bifolia (L)	*mediana (O)*	0	0			9	8	1		
bifolia^m *(L)*	*mutabilis (U)*	5	1	1		21	15	1		5
bifolia (L)	*orchioides (L)*	13	2	2		13	11	2		
bifolia (L)	*pallida (O)*	0	0			9	6	3		
bifolia (L)	*perryae (O)*	0	0			4	3	1		
bifolia (L)	*punctata (L)*	70	35	25	10	15	11	4		
bifolia (L)	*quadricolor (L)*	24	6	6		19	14	5		
bifolia (L)	*splendida (O)*	0	0			11	9	1	1	
bifolia^m *(L)*	*undulata (O)*	0	0			7	7			
bifolia (L)	*unifolia (L)*	0	0			6	3	3		
bifolia (L)	*viridiflora (L)*	0	0			10	9	1		
L. bolusii										
bolusi (U)	*splendida (O)*	0	0			1		1		
L. capensis										
capensis^m *(L)*	*juncifolia (O)*	0	0			1	1			
capensis (L)	*orthopetala (A)*	0	0			1		1		
L. carnosa										
carnosa (U)	*aloides (L)*	0	0			1			1	
carnosa (U)	*bachmanii (A)*	100	1	1		0				
carnosa (U)	*bifolia (L)*	0	0			2	1	1		
carnosa (U)	*elegans (U)*	0	0			1		1		
carnosa (U)	*framesii (U)*	67	2	1	1	1			1	
carnosa (U)	*orchioides (L)*	0	0			1	1			
carnosa (U)	*orthopetala (A)*	0	0			1		1		

Female parent	Male parent	% success	No of Successful crosses with indication of level of success			No of Crosses not succeeding with indication of reason for non-success				
			Number	EN	N	Number	GS	ED	D	SL
carnosa (U)	*pallida (O)*	83	5	1	4	1			1	
carnosa (U)	*patula (La)*	0	0			2	1	1		
carnosa (U)	*punctata (L)*	0	0			1		1		
carnosa (U)	*pusilla (L)*	0	0			1		1		
carnosa (U)	*splendida (O)*	100	2		2	0				
carnosa (U)	*viridiflora (L)*	67	2	2		1			1	
L. comptonii										
comptonii (La)	*bifolia (L)*	0	0			2	1	1		
comptoni (La)	*capensis (L)*	0	0			1		1		
comptonii (La)	*contaminata (A)*	0	0			1	1			
comptonii (La)	*liliflora (A)*	0	0			1			1	
comptonii (La)	*orthopetala (A)*	0	0			1			1	
comptonii (La)	*punctata (L)*	0	0			4		3	1	
L. concordiana										
concordiana (O)	*aloides (L)*	0	0			1		1		
concordiana (O)	*bifolia (L)*	0	0			2	1	1		
concordiana (O)	*orchioides (L)*	0	0			1		1		
concordiana (O)	*pallida (O)*	0	0			1				1
concordiana (O)	*punctata (L)*	0	0			2	1	1		
L. contaminata										
contaminata (A)	*bachmanii (A)*	67	2	2		1		1		
contaminata (A)	*bifolia (L)*	0	0			6	3	3		
contaminata (A)	*comptonii (La)*	0	0			1	1			
contaminata (A)	*elegans (U)*	0	0			1	1			
contaminata (A)	*flava (L)*	0	0			5	2	3		
contaminata (A)	*liliflora (A)*	0	0			5	2	3		
contaminata (A)	*mediana (O)*	0	0			4	1	3		
contaminata (A)	*mutabilis (U)*	0	0			4	2	2		
contaminata (A)	*orchioides (L)*	0	0			1		1		
contaminata (A)	*orthopetala (A)*	0	0			1		1		
contaminata (A)	*pallida (O)*	33	2	2		4	1	3		
contaminata (A)	*perryae (O)*	0	0			2	2			
contaminata (A)	*punctata (L)*	0	0			5	3	2		
contaminata (A)	*pusilla (L)*	0	0			1		1		
contaminata (A)	*quadricolor (L)*	0	0			10	5	3	2	
contaminata (A)	*splendida (O)*	25	1	1		3		3		
contaminata (A)	*unifolia (L)*	0	0			2	2			
contaminata (A)	*viridiflora (L)*	0	0			1		1		
L. elegans										
elegans (U)	*aloides (L)*	0	0			1	1			
elegans (U)	*bachmanii (A)*	0	0			1		1		
elegans (U)	*bifolia (L)*	0	0			3	3			
elegans (U)	*carnosa (U)*	0	0			1	1			
elegans (U)	*flava (L)*	0	0			2	2			
elegans (U)	*orchioides (L)*	0	0			3	2		1	
elegans (U)	*pallida (O)*	0	0			1	1			
elegans (U)	*punctata (L)*	0	0			5	5			
elegans (U)	*quadricolor (L)*	0	0			4	4			
elegans (U)	*sauveolens (U)*	100	2	1	1	0				

Female parent	Male parent	% success	No of Successful crosses with indication of level of success			No of Crosses not succeeding with indication of reason for non-success				
			Number	EN	N	Number	GS	ED	D	SL
elegans (U)	*vanzyliae (L)*	0	0			1			1	
elegans (U)	*viridiflora (L)*	0	0			2	2			
L. fistulosa										
fistulosa (U)	*viridiflora (L)*	0	0			1	1			
L. flava										
flava (L)	*aloides (L)*	67	2	1	1	1		1		
flava^{m} *(L)*	*bachmanii (A)*	0	0			7	7			
flava (L)	*bifolia (L)*	42	5	5		7	2	1	4	
flava^{m} *(L)*	*contaminata (A)*	0	0			4	4			
flava^{m} *(L)*	*elegans (U)*	0	0			3	3			
flava (L)	*liliflora (A)*	0	0			8	8			
flava (L)	*mediana (O)*	0	0			7	7			
flava^{m} *(L)*	*mutabilis (U)*	0	0			8	8			
flava (L)	*orchioides (L)*	0	0			5	4	1		
flava (L)	*pallida (O)*	0	0			7	7			
flava (L)	*perryae (O)*	0	0			3	3			
flava (L)	*punctata (L)*	90	9	5	4	1		1		
flava (L)	*splendida (O)*	0	0			6	6			
flava (L)	*unifolia (L)*	0	0			4	4			
flava (L)	*viridiflora (L)*	0	0			4	2	2		
L. framesii										
framesii (U)	*bifolia (L)*	0	0			1		1		
framesii (U)	*orchioides (L)*	100	1	1		0				
framesii (U)	*punctata (L)*	100	1	1		0				
framesii (U)	*splendida (O)*	0	0			1				1
L. hirta										
hirta (O)	*aloides (L)*	67	2	2		1	1			
hirta (O)	*bifolia (L)*	0	0			1			1	
hirta (O)	*pallida (O)*	0	0			1	1			
hirta (O)	*splendida (O)*	0	0			1			1	
hirta (O)	*viridiflora (L)*	0	0			1	1			
L. isopetala										
isopetala (L)	*mutabilis (U)*	0	0			1	1			
isopetala (L)	*vanzyliae (L)*	0	0			1		1		
L. magentea										
magentea (A)	*bifolia (L)*	0	0			3		2		1
magentea (A)	*punctata (L)*	0	0			2		2		
L. klinghardtiana										
klinghardtiana (O)	*aloides (L)*	0	0			1				1
L. liliflora										
liliflora (A)	*aloides (L)*	0	0			1				1
liliflora (A)	*bachmanii (A)*	0	0			7	6	1		
liliflora (A)	*bifolia (L)*	22	2	2		7	4	3		
liliflora (A)	*comptonii (La)*	0	0			1			1	
liliflora (A)	*contaminata (A)*	0	0			5	2	2	1	
liliflora (A)	*elegans (U)*	0	0			1	1			
liliflora (A)	*flava (L)*	22	2	2		7	4	3		
liliflora (A)	*mediana (O)*	13	1	1		7	6		1	
liliflora (A)	*mutabilis (U)*	13	1	1		7	6	1		

Female parent	Male parent	% success	No of Successful crosses with indication of level of success			No of Crosses not succeeding with indication of reason for non-success				
			Number	EN	N	Number	GS	ED	D	SL
liliflora (A)	*orchioides (L)*	40	2	2		3	1	2		
liliflora (A)	*orthopetala (A)*	0	0			1			1	
liliflora (A)	*pallida (O)*	70	7	6	1	3	1	2		
liliflora (A)	*perryae (O)*	0	0			4	3	1		
liliflora (A)	*punctata (L)*	23	3	3		10	4	5	1	
liliflora (A)	*quadricolor (L)*	28	5	5		13	5	8		
liliflora (A)	*splendida (O)*	33	3	3		6	3	3		
liliflora (A)	*thomasiae (O)*	0	0			1		1		
liliflora (A)	*unifolia (L)*	0	0			4	2	1	1	
liliflora (A)	*viridiflora (L)*	50	2	2		2		2		
L. longibracteata										
longibracteata (O)	*orhcioides (L)*	100	1		1	0				
longibracteata (O)	*viridiflora (L)*	100	2		2	0				
L. mediana										
mediana (O)	*bachmanii (A)*	0	0			6	3	3		
mediana (O)	*bifolia (L)*	0	0			8	4	3	1	
mediana (O)	*contaminata (A)*	0	0			4	3	1		
mediana (O)	*elegans (U)*	0	0			1	1			
mediana (O)	*flava (L)*	0	0			10	3	7		
mediana (O)	*liliflora (A)*	0	0			7	2	5		
mediana (O)	*mutabilis (U)*	0	0			8	5	3		
mediana (O)	*orchioides (L)*	0	0			5	1	4		
mediana (O)	*pallida (O)*	0	0			9	5	4		
mediana (O)	*perryae (O)*	0	0			4	3	1		
mediana (O)	*punctata (L)*	0	0			10	2	6	2	
mediana (O)	*quadricolor (L)*	0	0			17		14	3	
mediana (O)	*splendida (O)*	0	0			7	2	4	1	
mediana (O)	*unifolia (L)*	0	0			4	3	1		
mediana (O)	*viridiflora (L)*	14	1	1		6	3	1	2	
L. mutabilis										
mutabilis (U)	*aloides (L)*	100	1	1		0				0
mutabilis (U)	*bachmanii (A)*	57	4	4		3	1	2		
mutabilis (U)	*bifolia (L)*	0	0			12	10	2		
mutabilis (U)	*carnosa (U)*	100	1		1	0				
mutabilis (U)	*contaminata (A)*	0	0			4	1	3		
mutabilis (U)	*elegans (U)*	0	0			2	1	1		
mutabilis (U)	*flava (L)*	40	2	2		3	3			
mutabilis (U)	*hirta (O)*	0	0			1	1			
mutabilis (U)	*liliflora (A)*	9	1	1		10	4	6		
mutabilis (U)	*mediana (O)*	0	0			7	6	1		
mutabilis (U)	*orchioides (L)*	0	0			8	3	5		
mutabilis (U)	*pallida (O)*	18	2	2		9	4	4	1	
mutabilis (U)	*perryae (O)*	0	0			4	3	1		
mutabilis (U)	*punctata (L)*	21	4	2	2	15	11	4		
mutabilis (U)	*quadricolor (L)*	38	6	6		10	4	5		1
mutabilis (U)	*splendida (O)*	0	0			9	5	4		
mutabilis (U)	*unifolia (L)*	0	0			5	4	1		
mutabilis (U)	*viridiflora (L)*	27	3	3		8	7	1		
L. namaquensis										

Female parent	Male parent	% success	No of Successful crosses with indication of level of success			No of Crosses not succeeding with indication of reason for non-success				
			Number	EN	N	Number	GS	ED	D	SL
namaquensis (U)	*bifolia (L)*	0	0			3	1	2		
namaquensis (U)	*liliflora (A)*	0	0			1	1			
namaquensis (U)	*pallida (O)*	100	1	1		0				
namaquensis (U)	*punctata (L)*	0	0			3		3		
namaquensis (U)	*quadricolor (L)*	50	1	1		1			1	
namaquensis (U)	*splendida (O)*	100	2	2		0				
L. orchioides										
orchioides (L)	*aloides (L)*	63	5	4	1	3	1	2		
orchioides^m (L)	*bachmanii (A)*	0	0			4	4			
orchioides (L)	*bifolia (L)*	90	9	4	5	1		1		
orchioides^m (L)	*carnosa (U)*	0	0			1	1			
orchioides (L)	*concordiana (O)*	0	0			2	2			
orchioides^m (L)	*contaminata (A)*	0	0			2	2			
orchioides^m (L)	*elegans (U)*	0	0			4	4			
orchioides (L)	*flava (L)*	13	1	1		7	4	3		
orchioides (L)	*framesii (U)*	0	0			2	2			
orchioides (L)	*liliflora (A)*	0	0			7	3	4		
orchioides (L)	*mediana (O)*	0	0			3	2	1		
orchioides^m (L)	*mutabilis (U)*	40	4	2	2	6	4	2		
orchioides (L)	*pallida (O)*	14	1	1		6	1	3	1	1
orchioides (L)	*perryae (O)*	0	0			2	2			
orchioides (L)	*punctata (L)*	21	4	3	1	15	2	8	4	1
orchioides (L)	*quadricolor (L)*	19	3	3		13	9	4		
orchioides (L)	*splendida (O)*	0	0			3	3			
orchioides (L)	*unifolia (L)*	0	0			2	2			
orchioides (L)	*viridiflora (L)*	17	1	1		5	4		1	
L. orthopetala										
orthopetala (A)	*bifolia (L)*	0	0			2	2			
orthopetala (A)	*capensis (L)*	0	0			1		1		
orthopetala (A)	*comptonii (La)*	0	0			1		1		
orthopetala (A)	*contaminata (A)*	0	0			1	1			
orthopetala (A)	*liliflora (A)*	0	0			1			1	
orthopetala (A)	*pallida (O)*	0	0			1	1			
orthopetala (A)	*punctata (L)*	0	0			2		1	1	
L. pallida										
pallida (O)	*alba (O)*	0	0			1		1		
pallida (O)	*aloides (L)*	0	0			5	1	1	2	1
pallida (O)	*bifolia (L)*	0	0	0		13	7	6		
pallida (O)	*bachmanii (A)*	30	3	3		7	7			
pallida (O)	*carnosa (U)*	100	5	2	3	0				
pallida (O)	*concordiana (O)*	0	0			1		1		
pallida (O)	*contaminata (A)*	0	0			3	1	2		
pallida (O)	*elegans (U)*	50	1	1		1			1	
pallida (O)	*flava (L)*	25	2	2		6		5		1
pallida (O)	*liliflora (A)*	75	3	2	1	1	1			
pallida (O)	*mediana (O)*	0	0			7	7			
pallida (O)	*mutabilis (U)*	13	1	1		7	6	1		
pallida (O)	*namaquensis (U)*	100	1	1		0				
pallida (O)	*orchioides (L)*	10	1	1		9	2	4	3	

Female parent	Male parent	% success	No of Successful crosses with indication of level of success			No of Crosses not succeeding with indication of reason for non-success				
			Number	EN	N	Number	GS	ED	D	SL
pallida (O)	*patula (La)*	0	0			2	1	1		
pallida (O)	*perryae (O)*	33	1	1		2	2			
pallida (O)	*punctata (L)*	22	2	2		7	2	4	1	
pallida (O)	*quadricolor (L)*	40	4	4		6	1	3	2	
pallida (O)	*reflexa (L)*	33	1	1		2	1	1		
pallida (O)	*splendida (O)*	70	7	3	4	3	2		1	
pallida (O)	*unifolia (L)*	0	0			3	2	1		
pallida (O)	*vanzyliae (L)*	0	0			1	1			
pallida (O)	*viridiflora (L)*	60	3	3		2	1	1		
L. patula										
patula (La)	*aloides (L)*	0	0			1			1	
patula (La)	*bifolia (L)*	100	1	1		0				
patula (La)	*carnosa (U)*	0	0			1			1	
patula (La)	*concordiana (O)*	100	1	1		0				
patula (La)	*pallida (O)*	0	0			1			1	
patula (La)	*punctata (L)*	0	0			1				1
L. peersii										
peersii (U)	*pallida (O)*	0	0			1		1		
peersii (U)	*punctata (L)*	0	0			1	1			
peersii (U)	*thomasiae (O)*	0	0			1		1		
L. perryae										
perryae (O)	*bachmanii (A)*	0	0			3		3		
perryae (O)	*bifolia (L)*	0	0			4		4		
perryae (O)	*contaminata (A)*	50	1	1		1		1		
perryae (O)	*flava (L)*	0	0			5		3	2	
perryae (O)	*liliflora (A)*	0	0			4	2	2		
perryae (O)	*mediana (O)*	0	0			4	1	3		
perryae (O)	*mutabilis (U)*	25	1	1		3	1	2		
perryae (O)	*orchioides (L)*	0	0			2		1	1	
perryae (O)	*pallida (O)*	0	0			4	1	3		
perryae (O)	*punctata (L)*	0	0			4		1	3	
perryae (O)	*quadricolor (L)*	0	0			9	2	6	1	
perryae (O)	*splendida (O)*	0	0			4	1	3		
perryae (O)	*unifolia (L)*	100	1	1		0				
perryae (O)	*viridiflora (L)*	0	0			2	1	1		
L. punctata										
punctata (L)	*aloides (L)*	67	2	1	1	1			1	
punctata^{m} *(L)*	*bachmanii (A)*	0	0			3	3			
punctata (L)	*bifolia (L)*	16	3	3		16	1	2	13	
punctata^{m} *(L)*	*carnosa (U)*	0	0			5	4			1
punctata (L)	*contaminata (A)*	0	0			4	4			
punctata (L)	*comptonii (La)*	0	0			2	2			
punctata (L)	*concordiana (O)*	0	0			1	1			
punctata^{m} *(L)*	*elegans (U)*	0	0			4	2	1		1
punctata (L)	*flava (L)*	82	9	3	6	2			2	
punctata (L)	*liliflora (A)*	9	1	1		10	10			
punctata (L)	*mediana (O)*	17	1	1		5	5			
punctata^{m} *(L)*	*mutabilis (U)*	0	0			10	9	1		
punctata (L)	*orchioides (L)*	6	1	1		15	9	5	1	

Female parent	Male parent	% success	No of Successful crosses with indication of level of success			No of Crosses not succeeding with indication of reason for non-success				
			Number	EN	N	Number	GS	ED	D	SL
punctata (L)	*pallida (O)*	11	1	1		8	7	1		
punctata (L)	*perryae (O)*	0	0			3	3			
punctata (L)	*orthopetala (A)*	0	0			4	4			
punctata (L)	*quadricolor (L)*	24	5	1	4	16	3	6	7	
punctata (L)	*reflexa (L)*	0	0			1			1	
punctata (L)	*splendida (O)*	0	0			9	8	1		
punctata (L)	*undulata (O)*	0	0			7	7			
punctata (L)	*unifolia (L)*	0	0			2	2			
punctata (L)	*viridiflora (L)*	25	1	1		3	2	1		
L. purpureo-caerulea										
purpureo-caerulea (O)	*vanzyliae (L)*	0	0			1			1	
L. pusilla										
pusilla (L)	*punctata (L)*	0	0			1	1			
pusilla (L)	*unifolia (L)*	33	1	1		2		2		
pusilla (L)	*viridiflora (L)*	0	0			1			1	
L. quadricolor										
quadricolor (L)	*aloides (L)*	84	26	4	22	5	4	1		
quadricolor^{m} *(L)*	*bachmanii (A)*	0	0			15	15			
quadricolor (L)	*bifolia (L)*	10	3	3		27	2	13	12	
quadricolor^{m} *(L)*	*contaminata (A)*	0	0			9	9			
quadricolor^{m} *(L)*	*elegans (U)*	0	0			4	4			
quadricolor (L)	*flava (L)*	75	15	7	8	5		2	3	
quadricolor (L)	*liliflora (A)*	0	0			23	23			
quadricolor (L)	*mediana (O)*	5	1	1		21	21			
quadricolor^{m} *(L)*	*mutabilis (U)*	0	0			17	17			
quadricolor (L)	*orchioides (L)*	0	0	0		11	8	2	1	
quadricolor (L)	*pallida (O)*	4	1	1		25	24	1		
quadricolor (L)	*perryae (O)*	0	0			13	13			
quadricolor (L)	*punctata (L)*	46	11	5	6	13		3	10	
quadricolor (L)	*splendida (O)*	5	1	1		21	20	1		
quadricolor (L)	*unifolia (L)*	0	0			11	11			
quadricolor (L)	*viridiflora (L)*	40	4	2	2	6		6		
L. reflexa										
reflexa (L)	*aloides (L)*	100	3	3		0				
reflexa (L)	*bifolia (L)*	0	0			1				1
L. rosea										
rosea (O)	*bifolia (L)*	0	0			1			1	
L. sauveolens										
sauveolens (U)	*elegans (U)*	100	1	1		0				
sauveolens (U)	*flava (L)*	0	0			1	1			
sauveolens (U)	*quadricolor (L)*	0	0			1	1			
sauveolens (U)	*patula (La)*	0	0			2	1	1		
L. splendida										
splendida (O)	*aloides (L)*	0	0			2			1	1
splendida (O)	*bachmanii (A)*	0	0			5	3	2		
splendida (O)	*bifolia (L)*	29	4	2	2	10	5	3	2	
splendida (O)	*carnosa (U)*	100	3	1	2	0				
splendida (O)	*contaminata (A)*	50	1	1		1	1			

Female parent	Male parent	% success	No of Successful crosses with indication of level of success			No of Crosses not succeeding with indication of reason for non-success				
			Number	EN	N	Number	GS	ED	D	SL
splendida (O)	*flava (L)*	38	3	3		5	1	4		
splendida (O)	*framesii (U)*	67	2	2		1	1			
splendida (O)	*liliflora (A)*	25	1	1		3	1	2		
splendida (O)	*mediana (O)*	0	0			4	4			
splendida (O)	*mutabilis (U)*	33	2	2		4	4			
splendida (O)	*namaquensis (U)*	100	3	3		0				
splendida (O)	*orchioides (L)*	25	1	1		3	2		1	
splendida (O)	*pallida (O)*	70	7	5	2	3	3			
splendida (O)	*perryae (O)*	0	0			1	1			
splendida (O)	*punctata (L)*	30	3	2	1	7			6	1
splendida (O)	*quadricolor (L)*	18	3	2	1	14	3	10		1
splendida (O)	*unifolia (L)*	0	0			2	2			
splendida (O)	*viridiflora (L)*	29	2	1	1	5	2	2	1	
L. thomasiae										
thomasiae (O)	*liliflora (A)*	100	1	1		0				
L. undulata										
undulata (O)	*aloides (L)*	0	0			2	1		1	
undulata (O)	*bifolia (L)*	0	0			2	2			
undulata (O)	*concordiana (O)*	50	1	1		1			1	
undulata (O)	*orchioides (L)*	0	0			3		1	2	
undulata (O)	*pallida (O)*	0	0			1				1
undulata (O)	*punctata (L)*	0	0			4	1		2	1
L. unifolia										
unifolia (L)	*alba (O)*	0	0			1	1			
unifolia^{m} *(L)*	*bachmanii (A)*	0	0			3	3			
unifolia (L)	*bifolia (L)*	0	0			6	4	2		
unifolia^{m} *(L)*	*contaminata (A)*	0	0			2	2			
unifolia (L)	*flava (L)*	50	2	2		2		1	1	
unifolia (L)	*liliflora (A)*	0	0			3	2	1		
unifolia (L)	*mediana (O)*	0	0			4	3	1		
unifolia^{m} *(L)*	*mutabilis (U)*	0	0			4	4			
unifolia (L)	*orchioides (L)*	0	0			1				1
unifolia (L)	*pallida (O)*	0	0			4	1	3		
unifolia (L)	*perryae (O)*	50	1	1		1		1		
unifolia (L)	*punctata (L)*	0	0			6	3	1	1	1
unifolia (L)	*pusilla (L)*	0	0			1	1			
unifolia (L)	*quadricolor (L)*	20	2	2		8	2	4	2	
unifolia (L)	*splendida (O)*	0	0			3	2	1		
unifolia (L)	*vanzyliae (L)*	0	0			1	1			
unifolia (L)	*viridiflora (L)*	33	1	1		2	1	1		
L. vanzyliae										
vanzyliae (L)	*aloides (L)*	100	1	1		0	0			
vanzyliae (L)	*viridiflora (L)*	0	0			1	1			
L. violacea										
violacea (O)	*quadricolor (L)*	0	0			1	1			
L. viridiflora										
viridiflora (L)	*aloides (L)*	100	2	2		0				
viridiflora^{m} *(L)*	*bachmanii (A)*	33	1	1		2	2			
viridiflora (L)	*bifolia (L)*	9	1	1		10		3	6	1

Female parent	Male parent	% success	No of Successful crosses with indication of level of success			No of Crosses not succeeding with indication of reason for non-success				
			Number	EN	N	Number	GS	ED	D	SL
viridiflora (L)	*comptonii (La)*	0	0			1	1			
viridiflora[m] *(L)*	*contaminata (A)*	0	0			2	2			
viridiflora[m] *(L)*	*elegans (U)*	0	0			1	1			
viridiflora (L)	*flava (L)*	100	2	2		0				
viridiflora (L)	*liliflora (A)*	40	2	2		3	2	1		
viridiflora (L)	*longibracteata (O)*	100	1		1	0				
viridiflora (L)	*mediana (O)*	0	0			4	4			
viridiflora[m] *(L)*	*mutabilis (U)*	0	0			4	4			
viridiflora (L)	*orchioides (L)*	25	1	1		3	1	1	1	
viridiflora (L)	*pallida (O)*	33	3	2	1	6	5	1		
viridiflora (L)	*perryae (O)*	0	0			2	2			
viridiflora (L)	*punctata (L)*	100	4	1	3	0				
viridiflora (L)	*quadricolor (L)*	100	4	2	2	0				
viridiflora (L)	*reflexa (L)*	100	1	1		0				
viridiflora (L)	*splendida (O)*	14	1	1		6	3		3	
viridiflora (L)	*unifolia (L)*	0	0			2	1	1		
L. zeyheri										
zeyheri (A)	*quadricolor (L)*	0	0			1			1	
zeyheri (A)	*viridiflora (L)*	0	0			1			1	
Total	**2021**	**21**	**433**	**284**	**149**	**1588**	**936**	**465**	**160**	**27**
% per category				66	34		59	29	10	2

[m] Combinations where mechanical barriers (long style x short style) could influence the success rate

From the total number of 2021 inter-species crossing combinations only 21% was successful. Two thirds or 284 of these crosses had limited success with only a few seeds formed per crossing combination. With a few exceptions the species combinations with a percentage success of 50 and above all gave many normal seed confirming the closer relationships between these species. The majority of the crosses that did not succeed were due to the absence of seed set whilst almost 40% of the non-successful crosses resulted from the formation of abnormal or non-viable seeds (Table 7.1). The success rate increased to 79% when intra-species (crosses between different accessions of the same species) were attempted (Table 7.2). Self-pollinations of specific species, however, are not as good with a success rate of only 43% (Table 7.2).

Clear differences were observed when reciprocal combinations were studied (Table 7.1). *Lachenalia aloides* for example was not a good female parent with only combinations with *L. punctata, L. flava* and *L. quadricolor* succeeding. When *L. aloides* was used as male parent success rates of above 50% were achieved with 10 other species including the ones above. *Lachenalia bachmanii* on the other hand succeeded in producing viable seeds in both directions, but successes are limited to specific species (*L. carnosa, L. contaminata, L. mutabilis* and *L. pallida*). Some species (e.g. *L. capensis* and *L. comptonii*) were not compatible with any of the species they were crossed with (Table 7.1) and other species only succeed in a limited number of combinations (e.g. *L. contaminata* and *L. mediana*).

The same crossing combination, repeated on more than one occasion, does not necessarily always give the same result as clearly illustrated by the limited percentage success of some combinations (e.g. *L. bachmani x L. bifolia; L. bifolia x L. orchioides; L. punctata x L. bifolia; L. mutabilis x L. punctata; L. quadricolor x L. pallida;* etc.). The opposite where most crosses (5 or more successful attempts and success rate of above 50%) within a specific combination succeeded are only true for a few of the combinations (e.g. *L. aloides x punctata; L. aloides x quadricolor; L. quadricolor x L. aloides; L. bifolia x L. punctata; L. orchioides x L. bifolia; L. carnosa x L. pallida; L. pallida x L. carnosa; L. flava x L. punctata, L. punctata x L. flava, L. flava x L. quadricolor; L. quadricolor x L. flava; L. liliflora x L. pallida; L. pallida x L. splendida; L. splendida x L. pallida*). This highlights the importance of repeating combinations with more than one accession as well as over different seasons when crosses are made to obtain new hybrids. Where limited success was obtained, there was normally also the formation of abnormal seeds (Appendix C) indicating some crossing barriers that occur at the post fertilization level.

Table 7.2: List of intra-species (crosses between different accessions of the same species) and self-pollination crosses indicating the % success based on the number of successful attempts out of the total number of attempts for a specific cross. An indication of the level of success (few seeds = EN or many seeds = N) as well as the reason for not succeeding (GS = no seed set, ED = few abnormal seeds, D = many abnormal seeds, SL = seedling lethality) is indicated for each combination. Numbers indicate the number of crossing events per inter-species combination having a specific result.

Species	% success	No of Successful crosses with indication of level of success			No of Crosses not succeeding with indication of reason for non-success				
		Number	EN	N	Number	GS	ED	D	SL
L. aloides	88	88	25	63	12	8	2	2	
L. bachmanii	50	1		1	1		1		
L. bachmanii self	0	0			2	2			
L. bifolia	80	24	4	20	6	6			
L. bifolia self	100	2	1	1	0				
L. contaminata	50	1	1		1		1		
L. contaminata self	100	1	1		0				
L. elegans	50	1		1	1		1		
L. elegans self	100	1	1		0				
L. flava	100	15	3	12	0				

Species	% success	No of Successful crosses with indication of level of success			No of Crosses not succeeding with indication of reason for non-success				
		Number	EN	N	Number	GS	ED	D	SL
L. flava self	33	1	1		2	1	1		
L. framesii	100	2		2	0				
L. liliflora	100	4	4		0				
L. liliflora self	75	3	3		1	1			
L. mediana	100	4	4		0				
L. mediana self	0	0			3	1	2		
L. mutabilis (7x7)	50	4	1	3	4	3	1		
L. mutabilis (6x7)	0	0			2	1	1		
L. mutabilis (7x6)	100	2		2	0				
L. mutabilis self	25	1	1		3	3			
L. orchioides	79	11	2	9	3	2	1		
L. orchioides self	100	2		2	0				
L. pallida	80	4	3	1	1		1		
L. pallida self	33	2	2		4	3	1		
L. perryeae self	0	0			2	1	1		
L. punctata	100	6		6	0				
L. punctata self	100	2		2	0				
L. quadricolor	66	48	15	33	27	15	7	4	1
L. quadricolor self	23	3		3	10	7	3		
L. splendida	100	6	5	1	0				
L. splendida self	67	2	2		1		1		
L. unifolia	50	1	1		1	1			
L. viridiflora	100	2		2	0				
L. viridiflora self	60	3	3		2	2			
Totals for intra-species crosses									
281	**79**	**222**	**68**	**154**	**59**	**36**	**16**	**6**	**1**
%		**79**	**31**	**69**		**61**	**27**	**10**	**2**
Totals for self-pollinations									
53	**43**	**23**	**15**	**8**	**30**	**21**	**9**	**0**	**0**
% per category			**65**	**35**		**70**	**30**		

The percentage formation of few or many normal seeds of self-pollinations were similar to that of the inter-species crosses, but the formation of many normal seeds increased dramatically once intra-species crosses were made explaining the higher overall success rate. The percentage of intra-species crosses with no seed set or abnormal seeds are again similar to the inter-species cross results, but the percentage of non-successful crosses as a result of no seed set increased when self-pollinations were made. This can indicate that there is some form of self-incompatibility in some species (e.g. *L. mediana* and *L. bachmanii*) as well as in specific accessions of a species (e.g. *L. flava* [with only 1/3 successful self-pollinations], *L. mutabilis* [1/4], *L. quadricolor* [3/13, all three successful attempts arising from the same accessions] and *L. pallida* [2/6, both successful attempts from the same accession]).

7.3.3 Seed set in inter- and intra-specific crosses (subset of 15 species)

The AHC cluster analyses, performed on the standardized average means for each female/male combination, clustered the crossing combinations into three classes (Figure 7.1). A discriminant analysis was performed to identify the principle components (data parameters) that contributed towards the clustering of the crossing combinations on the two factor axis (Table 7.3). From the discriminant analysis it was clear that the percentage flower set played the most important role in discriminating the three classes. Percentage fruit set (synonym to % flower set in this study or % pod/capsule set in other studies) is often used to measure cross-ability (Riseman *et al*., 2006, Abebrese *et al*., 2011, Valdiani *et al*., 2012, Naik *et al*., 2013). If not used on its own fruit/pod/capsule set is used as part of cross-ability indices to measure cross-ability along with no of seed per fruit/pod/capsule and the germination rate (Sheng *et al.,* 2000, Ackerman *et al*., 2008, Miyachita *et al.,* 2012).

Table 7.3: Correlations between the different variables and the two factors involved in the cluster analysis indicating the variables that played a role in the clustering of *Lachenalia* species crossing combinations. Factor 1 explained 67% of the variation with 4 variables playing a significant role and factor two explained 33% of the variation with only one variable that played a significant role. The number of seeds also contributed towards the variation of Factor 1 although not with a contribution of above 0.7

	Factors (100%)	
Variables	F1 (66.96%)	F2 (33.05%)
Flowers	0.268	0.353
No of flowers with normal seed	0.773	-0.268
No of flowers with abnormal seed	0.288	0.837
No of flowers with no seed set	-0.157	0.247
No of normal seeds	0.667	-0.327
% Flower Set	0.851	0.387
No of normal seeds per flower pollinated	0.750	-0.374
No of normal seeds per flower set	0.780	-0.359

The other three parameters that played a significant role to explain the Factor 1 variation were average number of seed per flower set, number of flowers with normal seeds and average no of seeds per flower pollinated (Table 7.3). The statistical clustering thus confirmed the importance of these characters in the determination of the cross-ability between species. Both Alfares *et al*. (2009) and Miyachita *et al.* (2012) used the number of seed per capsule/pod as part of their evaluation of cross-ability in *Triticum* and *Vaccinium* respectively. The number of flowers with abnormal seed was the fifth variable that played a significant role in explaining the variation of factor 2.

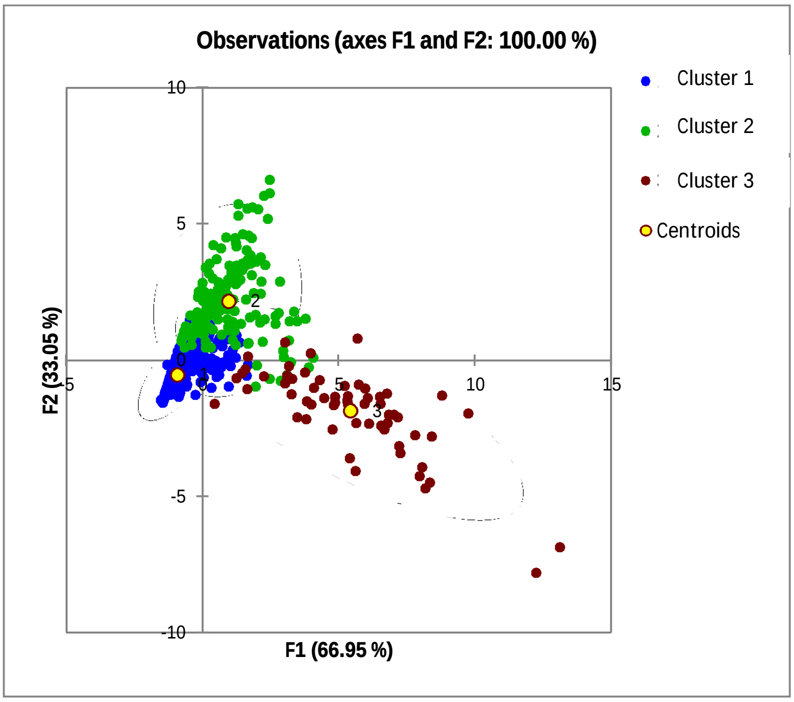

Figure 7.1: A principle component analysis of all female/male *Lachenalia* crossing combination observations indicating how the clusters are discriminated by the two factor axis and the percentage variation explained by each axis. The overlap of clusters indicates that some combinations could not be grouped accurately.

Figure 7.1 represents the observations (female/male crossing combinations) indicating that there are some overlapping areas where combinations could be clustered wrongly. This was confirmed by the confusion matrix (Table 7.4), indicating that cluster 3 is the strongest with 100% of the observations placed correctly. The overlap among the three clusters was, however, responsible for incorrectly placed observations in cluster 1 and 2. These clusters had and accuracy of 91% and 87% respectively. Observations that did not fit with the class descriptions as given below could be explained by wrongly placed combinations. This was confirmed when data was cross-validated and observations were re-classified to the cluster where it belonged most likely.

Table 7.4: Confusion matrix indicating that, overall only 91% of the female/male *Lachenalia* crossing combinations could be grouped accurately.

	1	2	3	Total	% correct
1	389	34	2	425	91.53%
2	12	131	8	151	86.75%
3	0	0	58	58	100.00%
Total	401	165	68	634	91.01%

The average results of the five variables for each female/male combination are given in Appendix E Tables E.1-15. Each table was compiled for a specific species used as female parent and the cluster to which it belongs are given along with the principle component data. Where the cluster changed after validation of the data, the changes was indicated in brackets.

Cluster 3 was the smallest of the three clusters containing 58 of the combinations (Table 7.4). Most of the female/male combinations in cluster 3 produced a percentage flower set of above 50% linked with more than 4 normal seeds per flower pollinated (Appendix E Tables E.1-15). Where either of the two is lower the other variable is usually much higher or the number of normal seeds per flower set or/and the number of flowers with normal seed is high (Appendix E Tables E.1-15). With the exception of one combination (*L. punctata* L277 x *L. quadricolor* L122 (Appendix E Table E.11) all these combinations produced viable seed usually with good germination rates (Appendix E Table E.1-15) indicating good cross-ability. The fact that the seed of the specific *L. punctata/L. quadricolor* cross did not germinate, was most probably due to the production of unviable seed. The specific combination was attempted three times and produced many abnormal seeds in other attempts. This combination most probably better belong in cluster 2. Twenty of the combinations resulted from intra species crosses and five from self-pollinations (totalling 43% of the crosses).

Cluster 2 is the second largest group and consists of 151 combinations (Table 7.4). This cluster consists mainly of two different groups of crossing combinations: firstly crossing combinations that did not succeed but produced larger numbers of abnormal seed and secondly crossing combinations that did succeed, but with lower flower set percentages and smaller numbers of normal seed per flower and usually also some abnormal seed. A number of the combinations do not seem to fit in with these criteria and these were wrongly clustered as explained by the confusion matrix (Table 7.4). Nine of these combinations were excluded from cluster 2 and included in cluster 3 as they were clearly not clustered correctly with either no flower set at all or a % flower set of below 2. These combinations are indicated in red in Appendix E (Tables E.1-15). The clustering after cross-validation of the data as shown in brackets, confirmed the wrong clustering of these observations. Four of the successful crosses resulted from self-pollinations and two from intra-species crosses (totalling 4% of the crosses).

Cluster 1 is the largest of the three clusters consisting of 425 combinations (Table 7.4). These crossing combinations were a mix of crosses that:

- did not set seed at all,
- crosses that set seed at low percentages or with very few normal seeds often combined with abnormal seed
- and crosses that did not set seed but produced smaller numbers of abnormal seed.

The AHC clustering thus discriminated between combinations that succeeded well (good cross-ability) with the production of many normal seeds and combinations that succeeded (intermediate cross-ability), but with only a few normal seed, indicating possible reproductive barriers. Although cluster 1 consists of a mixture of results it is clear that where crosses did succeed the cross-ability was low and reproductive barriers are evident. The division of crossing combinations with many abnormal seeds (cluster 2) from the ones with smaller numbers of abnormal seeds (cluster 1) also indicates some form of compatibility between species, but with clear post fertilization barriers that prevents the formation of normal seeds and seedlings.

Where mechanical isolation due to the flower size (Chapter 3) could play a role, crossing combinations were indicated with an ^{m} in Table 7.5 and Appendix E. No seed set was observed in most of these combinations. These crosses need to be followed up with pollen tube studies to confirm the mechanical isolation and cut style methods can be used to overcome this barrier. Cut style methods have previously been applied in a *L. bifolia* (large flowered ♀) and *L. mutabilis* (small flowered ♂) cross, with the successful production of hybrids.

Table 7.5: Summary of crossing combinations per species and per accession. Colours indicate the cluster and success rate of cross combinations. Orange – cluster 3 and successful with large numbers of normal seed (accept for one combination indicated with a question mark). Green – cluster 2 and successful. Blue – cluster 2 and not successful with many abnormal seed. Yellow – cluster 1 and successful but with only a few normal seed. Uncoloured – cluster 1 and not successful either no seed set or only a few abnormal seeds. Species abbreviations as follow *Lba = L. bachmanii, Lbi = L. bifolia, Lc = L. contaminate, Lf = L. flava, Ll = L. liliflora, Lme = L. mediana, Lmu = L. mutabilis, Lo = L. orchioides, Lpa = L. pallida, Lpe = L. perryae, Lpu = L. punctata, Lq = L. quadricolor, Ls = L. splendida, Lu = L. unifolia and Lv = L. viridiflora.* Basic chromosome numbers are indicated. Only the two *L. bifolia* accessions represented polyploids (6*x*). Letters next to species names indicate the taxonomic sections in which the species was placed according to the species key of Duncan (2012). L = section *Lachenalia*, O = section *Oblongae*, A = section *Angustae*, La = sections *Latae* and U = section *Urceolatae.*

Female ♀	Male ♂	*Lba (A) x = 8*	*Lbi (L) x = 7*		*Lc (A) x = 8*	*Lf (L) x = 7*		*Ll (A) x = 8*		*Lme (O) X = 13 x = 11/13*		*Lmu (U) x = 7*		*Lo (O) x = 7*	*Lpa (O) x = 8*		*Lpe (O) x = 11*	*Lpu (L) x = 7*		*Lq (L) x = 7*				*Ls (O) x = 8*		*Lu (L) x = 11*	*Lv (L) x = 7*	Total successfull accession	Total successfull /species
		L016	L389	L801	L082	L124	L144	L290	L804	L158	L418	L161	L318	L802	L049	L406	L053	L277	L381	L101	L122	L155	L212	L417	L419	L229	L194		
Lba (A)	L016																											2	2
Lbi (L)	L389	m			m							m	m															3	9
	L801	m			m								m															6	
Lc (A)	L082																											4	4
Lf (L)	L124	m			m							m	m															10	18
	L144	m			m							m	m															8	
Ll (A)	L290																											13	27
	L804																											14	
Lme (O)	L158																											2	5
	L418																											3	
Lmu	L161																											10	17

Female ♀ / Male ♂		Lba (A) x = 8	Lbi (L) x = 7		Lc (A) x = 8	Lf (L) x = 7		Ll (A) x = 8		X = 13 Lme (O) x = 11/13		Lmu (U) x = 7		Lo (O) x = 7	Lpa (O) x = 8		Lpe (O) x = 11	Lpu (L) x = 7		Lq (L) x = 7				Ls (O) x = 8		Lu (L) x = 11	Lv (L) x = 7	Total successful/ accession	Total successful /species
		L016	L389	L801	L082	L124	L144	L290	L804	L158	L418	L161	L318	L802	L049	L406	L053	L277	L381	L101	L122	L155	L212	L417	L419	L229	L194		
(U)	L318																											7	
Lo (L)	L802	m			m							m	m															6	6
Lpa (O)	L049																											8	22
	L406																											14	
Lpe (O)	L053																											3	3
Lpu (L)	L277	m			m							m	m								?							8	14
	L381	m			m							m	m															6	
Lq (L)	L101	m			m							m	m															12	29
	L122	m			m							m	m															4	
	L155	m			m							m	m															9	
	L212	m			m							m	m															4	
Ls (O)	L417																											8	16
	L419																											8	
Lu (L)	L229	m			m							m	m															8	8
Lv (L)	L194	m			m							m	m															11	11
Total successful /accession		4	10	5	4	13	14	6	7	3	2	5	2	4	6	9	2	12	14	13	12	10	10	7	6	2	10		
Total successful /species		4	15		4	27		13		5		7		4	15		2	26		45				13		2	10		

m Combinations where mechanical barriers (long style x short style) could influence the success rate

If this pre-fertilization barrier was of a purely mechanical nature the reciprocal combination should result in success. In most cases (Table 7.5) this is not the case and additional barriers are present between most of the large x small flowered species. Both *L. bachmanii* and *L. contaminata* are small flowered with a basic chromosome number of 8 thus explaining why possible reciprocal crosses, where these species were used as maternal parents, also did not succeed with the larger flowered species in the x = 7 basic chromosome number group. Mechanical barriers do, however, seem to be present between *L. punctata* (♀) and *L. mutabilis* (♂), *L. flava* (♀) and *L. mutabilis* (♂) and *L. quadicolor* (♀) and *L. mutabilis* (♂) where reciprocal crosses did succeed. The four species are all in the x = 7 basic chromosome number group and closer relationships within this group has been confirmed (Chapter 4).

The taxonomic sections within the sub-genus *Lachenalia* as reported by Duncan (2012) in the *Lachenalia* species key is purely based on phenotypic characteristics. The species with very short styles are mostly found in section *Angustae* and *Urceolatae*. There is, however, no obvious correlation between cross-ability and the sections, besides maybe predicting the possible existence of mechanical barriers. Crosses form all section combinations succeed and fail (Tables 7.1 and 7.5) and this classification thus do not necessarily indicate close relationships, but has application for species identification. The sections also do not correlate with the basic chromosome numbers of the species. The success rate thus cannot be predicted by making crosses within specific taxonomic sections within the genus. It is clear from Table 7.5 that crosses in cluster 3 (good cross-ability) results from many different section combinations. A high number of cluster 3 crosses resulted from crosses between species within the *Lachenalia* section, but this does not guarantee success (e.g. none of the combinations of *L. unifolia* or *L. bifolia* with other species in the *Lachenalia* section succeeded in cluster 3. Basic chromosome numbers and polyploidy seem to play a larger role in the prediction of successful combinations as discussed in 7.3.5.

There are clear differences when specific accessions of the same species were used in the same inter-species crossing combination. Accession L101 from *L. quadricolor* for example was more compatible with various species when used as female parent than the other three *L. quadricolor* accessions (Appendix E, Tables E.4 and Table 7.5). Similarly accession L406 of *L. pallida* gave better success than the L049 accession when used as female parent (Appendix E, Tables E.9 & Table 7.5). In addition there are specific combination differences, for example *L. mutabilis* (L161♀) succeeded with all four *L. quadricolor* (♂) accessions, but *L. mutabilis* L318 did not succeed with any of the *L. quadricolor* accessions (Appendix E, Tables E.7 & Table 7.5). The other extreme was where only one specific combination e.g. *L. punctata* (L277♀)/*L. bifolia* (L389♂) succeeded from the four possible combinations (Appendix E, Tables E.11 & Table 7.5). This again stresses the importance of having more than one accession of a species for breeding purposes.

7.3.4 Unilateral-compatibility and self-incompatibility

Unilateral-incompatibility or -incongruity is a term used to describe inter-species combinations that only succeed in one direction (Hogenboom, 1975). Unilateral incompatibility is usually found when self-incompatible (SI) and self-compatible (SC) species are crossed. Although not always true, crosses normally succeed when the SC species is used as maternal parent (Hogenboom, 1975). Page *et al.* (2010) mentioned the differences between unilateral incompatibility and unilateral incongruity on the basis of the involvement of the SI genes or not. If the SI genes were involved in the unilateral basis of the cross-ability the term incompatibility was used, whereas unilateral incongruity on the other hand is seen as the absence of suitable genetic information in one partner that most probably results in pre-zygotic barriers.

Similar to the reciprocal differences reported in the larger data set, differences were observed between reciprocal combinations in the 15 species diallel cross (Appendix E, Tables E.1-15). Clear unilateral cross-ability is found between a number of *Lachenalia* species (Table 7.5). Some examples successful crosses include *L. bachmanii* (SI♀) and *L. mutabilis* (SC♂); *L. bifolia* (SC♀) and *L. flava* (SC♂); *L. bifolia* (SC♀) and *L. liliflora* (SC♂); *L. contaminata* (SC♀) and *L. pallida* (SC♂); *L. contaminata* (SC♀) and *L. perryae* (SI♂) and *L. flava* (SC♀) and *L. liliflora* (SC♂). It is thus clear from these examples as well as the others in Table 7.5 that self-compatibility or incompatibility does not play a role in the unilateral cross-ability in *Lachenalia* and that unilateral incongruity exists. Unilateral incompatibility/incongruity has been reported in many other species like *Vaccinium* (Wenslaff & Lyrene 2003), *Hibuscus* (Van Leare *et al*., 2007), *Kunzea* (Page *et al.,* 2010) and *Streptocarpus* (Afkhami-Sarvestani *et al*., 2012).

Overall reciprocal differences for species include *L. flava* with 18 successful combinations when used as female parent in comparison to 27 successful combinations when used as male parent (Table 7.5). The same conclusion can be drawn for *L.*

quadricolor with 29 successful combinations as female parent against 45 as male parent; *L. bifolia* with 9 as female parent against 15 as male parent and *L. punctata* with 14 as female parent against 26 male parent. All four these species should, thus be used as male parents when attempting inter-species crosses to improve the successful generation of hybrids. *Lachenalia liliflora* in contrast was a better female parent with 27 successful combinations in comparison to only 13 when used as male parent. Similar to *L. liliflora* is *L. mutabilis* with 17 successful crosses as female parent against only seven as male parent and *L. unifolia* with eight successful crosses as female parent against only two as male parent (Table 7.5).

The presence of self-incompatibility also seems to be present in some species as well as specific accession of a species. This includes: *L. bachmanii, L. flava* (accessions L144), *L. mediana, L. mutabilis* (accessions L161), *L. pallida* (accessions L049), *L. perryae and L. quadricolor* (all accessions accept L101). The self-incompatibility can easily be overcome (Table 7.5 and Appendix E) by making intra-species crosses (crosses between different accessions of the same species).

7.3.5 Cross-ability results linked to basic chromosome numbers and polyploidy

The inter-species crosses reported in Table 7.1 where re-organized to link results to the basic chromosome numbers of species involved (Table 7.6). As reported in Chapters 4 & 6 it is clear that the success rate increases if crossing combinations are made within specific basic chromosome number groups (Table 7.6). Additional basic chromosome number combinations were added in this chapter. The fact that the success rate is higher if species with higher basic numbers is used as maternal parent in comparison to the reciprocal combinations is confirmed with the additional basic numbers added (Table 7.6). The differences in success rates reported here and in Chapters 4 & 6 results from the re-classification of species (Duncan, 2012) as well as the addition of some crossing combinations.

All the combinations in Table 7.1 with a success rate of above 50% and containing more than five specific crossing events are between species with the same basic chromosome number. Basic chromosome number thus plays an important role to obtain good cross-ability. The data from the AHC analysis represented in Table 7.5 confirms the overall results from Table 7.1. All the combinations in cluster 3 (good cross-ability), except four, were from combinations within the same basic chromosome number. This data also confirms the closer relationships between species that are within the same basic chromosome number group as indicated by the molecular systematic data (Chapter 4).

Table 7.6: Effect of basic chromosome number on the success rate of *Lachenalia* inter-species crossing combinations

Basic chromosome number of parents (♀X♂)	Total no of crosses	No. of successful crosses	No of unsuccessful crosses		
			No. of crosses with no seed set	No. of crosses with abnormal seed	No. of crosses with seedling death
6x7	2	0	1 (50%)	1 (50%)	
7x6	5	1 (20%)	4 (80%)		
7x7	728	261 (36%)	259 (36%)	197 (27%)	11 (1%)
8x8	164	72 (44%)	46 (28%)	45 (27%)	1 (1%)
11x11	3	2 (67%)		1 (33%)	
7x8	320	20 (6%)	252 (79%)	45 (14%)	3 (1%)
8x7	332	59 (18%)	111 (33%)	155 (47%)	7 (2%)
7x10	17	0	17 (100%)		
10x7	19	1 (5%)	5 (26%)	12 (63%)	1 (5%)
7x11	70	1 (2%)	59 (85%)	10 (14%)	
11x7	78	8 (10%)	23 (29%)	44 (56%)	3 (4%)
7x13	32	0	30 (94%)	2 (6%)	
13x7	32	0	5 (16%)	27 (84%)	
9x8	1	0		1(100%)	
8x10	4	0	1 (25%)	3 (75%)	
10x8	6	2 (33%)	1 (17%)	2 (33%)	1 (17%)
8x11	24	1 (4%)	20 (82%)	3 (14%)	
11x8	34	1 (3%)	14 (41%)	19 (56%)	
8x13	15	1 (7)	11 (73%)	3 (20%)	
13x8	18	0	6 (33%)	12 (67%)	
11x10	1	0	1 (100%)		
11x13	4	0	2 (50%)	2 (50%)	
13x11	4	0	3 (75%)	1 (25%)	
15x7	2	0	2 (100%)		
Unknown basic numbers in one or both of the parents	106	3 (3%)	63 (62%)	40 (35%)	
Total	2021	432 (21%)	937 (46%)	625 (31%)	27 (1%)

All the crossing combinations (Table 7.1) with a percentage success of above 50 (not taking the number of combination events into consideration) are again combinations from species with the same basic chromosome number except for (*L. hirta* x *L. aloides* [2/3 successful]; *L. mutabilis* x *L. bachmanii* [4/7 successful]; *L. patula* x *L. bifolia* [only one attempt]; *L. mutabilis* x *L. carnosa* [only one attempt]; *L. carnosa* x *L. viridiflora* [2/3 successful]; *L. patula* x *L. concordiana* [only one attempt]; *L. framesii* x *L. orchioides* [only one attempt], *L. framesii* x *L. punctata* [only one attempt] and *L. pallida* x *L. viridiflora* [3/5 successful]). All these combinations are between basic x = 7 and basic x = 8 chromosome numbers, except for the *L. hirta* x *L. aloides* crosses. Five of these species (*L. patula, L. mutabilis, L. carnosa, L. framesii,* and *L. viridiflora*) were involved in more than one combination and these should be investigated further to determine specific possible relationships between the x = 8 and x = 7 basic numbers. It is difficult to conclude on the results where only one attempt was successful and these crossing combinations should be repeated to ensure valid hybrid nature of the progeny and investigated further.

The four exceptions from cluster 3 are a *L. quadricolor(♀)/L. pallida(♂)* and a *L. viridiflora(♀)/L. pallida(♂)* cross (both *x* = 7 / *x* = 8) and a *L. pallida(♀)/L. quadricolor(♂)* and *L. splendia(♀)/L. quadricolor(♂)* cross (both *x* = 8 / x = 7). The fact that *L. quadricolor* and *L. pallida* succeeds in both reciprocal directions suggests a close relationship between these two species. This confirms the findings of Hancke *et al*. (2001), who found a genome affinity index of 0.9 and 0.93 for two hybrids between a *L. aloides* intra-species cross (*L. quadricolor* was previously a variety of *L. aloides*) and *L. unicolor* (now classified as *L. pallida*). These cross-abilities as well as the ones from Table 7.1 confirm the close relationship between the two basic chromosome number groups as suggested by the molecular systematic data in Chapter 4 and has application for the breeding of inter-specific hybridization between the two groups.

With the addition of the successful cluster 2 data, the within basic chromosome number group relationships are strengthened even further. The cluster 3 successes are confirmed in most cases with many specific species-species combination in both clusters. The differences are linked to specific accession combinations. Some additional combinations are, however, added including specifically nine more *x* = 8 / *x* = 7 species combinations as well as three *x* = 11/*x* = 7 combinations and 1 *x* = 11/ *x*= 8 combination (Table 7.5). The reported relationship between *x* = 8 and *x* = 7 is thus strengthened further. The addition of relative good cross-ability between the *x* = 11 accessions with both *x* = 7 and *x* = 8 from the cluster two data indicate a relationship between these basic chromosome number groups. The fact that three *x* = 11 / *x* = 7 combinations succeeded with relative good success can be a possible confirmation for the existence of hybrid species with *x* = 9 as was suggested for *L. latimerae* in Chapter 4. It definitely confirms that hybrids between these species are possible and further studies are needed to clarify these relationships.

If the principle that more distinct taxa display crossing barriers at an earlier level (pre-zygotic) is taken into account, then species combinations displaying abnormal seed should be closer related than those that gave no seed set at all. When considering the Cluster 2 data (abnormal seeds) most of the combinations supported relationships that was already established by the cluster 3 and cluster 2 (successful) data. However, a large number of *x* = 13 / *x* = 7, *x* = 13 / *x* = 8 and *x* = 11 / *x* = 7 and *x* = 11 / *x* = 8 combinations is included. The formation of abnormal seed (due to embryo abortion) in these crosses could have resulted from endosperm breakdown or endosperm imbalances as reported in *Chrysanthemum* (Deng *et al*., 2010) and carnation (Zhou *et al.,* 2013). The molecular systematic data (Chapter 4) suggests that x = 11/13 is basal to the lower chromosome numbers. The cross-ability data thus confirm some relationship between the higher basic chromosome numbers and the lower numbers. Successful hybrids between these species could thus be generated through the application of embryo rescue techniques. These techniques are used widely in the floriculture industry to overcome post fertilization barriers (Mii, 2009; Morgan *et al*., 2009, Grassottie *et al*., 2011). The successful crossing combination form cluster 1 again confirms the above discussion on relationships.

Polyploidy is most common in the x = 7 basic chromosome number group (Chapter 4) and where polyploidy accessions were used in inter-species crosses they all resulted from this basic chromosome number group (Table 7.7). It is clear that crosses within the same ploidy level increased the success rate. As expected crosses with the triploid *L. aloides* accession (only triploid used) were not successful, due the absence of viable gametes.

Table 7.7: Effect of polyploidy in one or both of the parents of *Lachenalia* inter- and intra-species crossing combinations and self-pollination on the success rate of these combinations.

Basic chromosome number and ploidy level of parents	No. of successful crosses	No of unsuccessful crosses		
		No. of crosses with no seed set	No. of crosses with abnormal seed	No. of crosses with seedling death
Inter-species crosses				
7x6 (4*x* x 2*x*)	0	3 (100%)[m]		
7x6 (6*x* x 2*x*)	0	1 (100%)[m]		
7x7 (2*x* x 3*x*)	0	2 (100%)		
7x7 (3*x* x 2*x*)	0	1 (100%)		
7x7 (2*x* x 4*x*)	0	9 (69%)	4 (31%)	
7x7 (2*x* x 6*x*)	15 (21%)	11 (15%)	47 (64%)	
7x7 (2*x* x 8*x*)	2 (29%)	1 (14%)	4 (57%)	
7x7 (4*x* x 2*x*)	9 (32%)	19 (68%)		
7x7 (4*x* x 4*x*)	3 (75%)	1 (25%)		
7x7 (6*x* x 2*x*)	33 (32%)	57 (54%)	13 (12%)	2 (2%)
7x7 (6*x* x 6*x*)	2 (67%)	1 (33%)		
7x7 (8*x* x 2*x*)	6 (60%)	3 (30%)	1 (10%)	
7x8 (4*x* x 2*x*)	0	4 (80%)	1 (20%)	
7x8 (6*x* x 2*x*)	0	30 (86%)	5 (14%)	
7x8 (8*x* x 2*x*)	0	1 (100%)		
7x10 (6*x* x 2*x*)	0	4 (100%)		
7x10 (8*x* x 2*x*)	0	3 (100%)		
7x11 (6*x* x 2*x*)	0	6 (60%)	4 (40%)	
7x13 (6*x* x 2*x*)	0	5 (83%)	1 (17%)	
8x7 (2*x* x 3*x*)	0		1 (100%)	
8x7 (2*x* x 4*x*)	3 (18%)	6 (35%)	8 (47%)	

Basic chromosome number and ploidy level of parents	No. of successful crosses	No of unsuccessful crosses		
		No. of crosses with no seed set	No. of crosses with abnormal seed	No. of crosses with seedling death
8x7 (2*x* x 6*x*)	4 (9%)	25 (54%)	17 (37%)	
8x7 (2*x* x 8*x*)	2 (22%)	2 (22%)	5 (56%)	
10x7 (2*x* x 3*x*)	0		1(100%)	
10x7 (2*x* x 6*x*)	0	1 (50%)	1 (50%)	
10x7 (2*x* x 8*x*)	0	3 (50%)	2 (33%)	1 (17%)
11x7 (2*x* x 4*x*)	0	1 (100%)		
11x7 (2*x* x 6*x*)	4 (33%)	8 (67%)		
11x7 (2*x* x 8*x*)	0		1 (100%)	
13x7 (2*x* x 4*x*)	0	1 (100%)		
13x7 (2*x* x 6*x*)	0	1 (25%)	3 (75%)	
Total	83 (20%)	210 (50%)	119 (29%)	3 (1%)
Intra-species crosses (*L. bifolia*)				
7x7 (4*x* x 4*x*)	6 (67%)	3 (33%)		
7x7 (4*x* x 6*x*)	3 (100%)			
7x7 (6*x* x 4*x*)	0	1 (50%)	1 (50%)	
7x7 (6*x* x 6*x*)	14 (100%)			
7x7 (8*x* x 4*x*)	3 (75%)	1 (25%)		
7x7 (8*x* x 8*x*)	2 (100%)			
Total	28 (82%)	5 (15%)	1 (3%)	
Self-pollinations (*L. bifolia*)				
7x7(4*x* x 4*x*)	2 (100%)			
7x7(6*x* x 6*x*)	2 (100%)			
Total	4 (100%)			

In general the success rate of crosses, where polyploidy accessions were used as one of the parents, did not differ from the overall success rate of inter-species crosses indicating that polyploidy did not contribute extensively towards the failure of cross combinations. Most of the successful crosses resulted from combinations within the basic $x = 7$ group with some $x = 8$ / $x = 7$ (polyploid) and $x = 11$ / $x = 7$ (polyploid) combinations also succeeding (Table 7.6). Interploid crosses in plants often do not succeed and result in embryo abortion. Genomic imbalances in the endosperm are considered to be one of the most important reasons for this abortion (Greiner & Oberprieler, 2012). These genomic imbalances can explain the 79% unsuccessful crosses when polyploidy parents were used. Only about 400 of the total crossing combinations included polyploidy and additional barriers not linked to polyploidy are still evident. The existence of crossing combinations that resulted in abnormal seed also indicate that the crossing barriers could be complex and at various levels as reported for *Dianthus* (Zhou *et al.,* 2013) and *Leucanthemum* (Greiner & Oberprieler, 2012).

The only polyploidy species in the 15 species diallel was *L. bifolia* and it was clear that, although *L. bifolia* was compatible with various species in the $x = 7$ and two species in the $x = 8$ group, none of these crosses were clustered in Cluster 3. The lower seed set and many abnormal seeds produced suggest that there is a barrier and that the polyploid nature of the species can play a role. Further studies are needed to confirm this and a study of the fertility of the hybrids could shed some light on the processes involved in the incompatible combinations.

7.4 CONCLUSION

In the drive to develop new cultivars with application in the floriculture industry, inter-specific hybridization plays an important role (Mii, 2009; Morgan *et al*., 2009, Grassottie *et al*., 2011). In an industry where novelty in flower colour, flower- plant- and leaf-shape has commercial value, the creation of variability is essential. Inter-specific hybridization generally gives rise to intermediate plant forms that as new novelty can be utilized in the ornamental industry, but the generation of these hybrids is often difficult due to crossing barriers. The utilization of inter-species crosses in the development of *Lachenalia* cultivars is also an important breeding objective and the evaluation of the cross-ability between species and the identification of breeding barriers is needed to facilitate future development.

The fundamental barriers that prevent successful inter-species hybridization can be either at the pre- or post-fertilization level (Hogenboom, 1973) and the difficulty in creating inter-specific hybrids increases when more genetic distinct species are crossed (Shivanna & Johri, 1985, Sharma, 1995). With an overall inter-species success rate of only 21% the existence of these barriers among *Lachenalia* species are evident. With the extensive morphological and cytogenetic variation present in the genus, as well as the identification of distinct clades in the molecular systematics of the genus (Chapters 3 & 4), this is not surprising. The hybridization barriers observed in *Lachenalia* were discussed in Chapter 3 and 4 and results in this chapter confirmed the presence of these barriers, although further investigation is needed to quantify and describe the exact nature of these barriers.

Clear unilateral cross-ability was identified between specific species combinations and some species were identified that is better male or female parents when crossed with other species. This information can be utilized by breeders to plan inter species crosses. Different accessions of the same species can differ in their cross-ability with other species, clearly illustrating the importance of maintaining multiple, well-characterized germplasm accessions for breeding. The establishment of pre-breeding evaluation processes to identify cross compatible species and species accession can add value to the germplasm material and guide breeders when choosing suitable accessions.

It is clear from the results that basic chromosome numbers constitutes the best possible criterion to predict the success-rate of inter-species crosses. Higher inter-species success rates when species with the same basic number is crossed are evident. Close relationships between the $x = 7$ and $x = 8$ chromosome numbers as indicted by the molecular systematic data were confirmed by the cross-ability data. It is clear that chances of successful inter-species hybridization increases when species with higher basic chromosome numbers are used as female parents. When polyploid accessions were used in inter-species crosses the success rate did not differ much from the overall success rate, but the formation of many abnormal seeds indicate embryo abortion challenges often found in interploid crosses. The importance of determining the chromosome number of all accessions used for breeding is thus evident and crosses between species within the same basic chromosome number should be attempted before venturing to crosses between different basic chromosome numbers.

Some successful combinations between $x = 11/13$ and the lower numbers confirms the possible basal nature of these numbers (Chapter 4). The high number of combinations involving $x = 11$ or 13 resulting in large scale seed abortion (many abnormal seeds) also indicate some relationship, between these basic chromosome numbers. The successful generation of hybrids between various species confirms that natural hybridization could have been involved in the evolution of specific species in the genus.

The development of new cultivars from the genus *Lachenalia* is feasible, but will require more and more advanced breeding techniques to generate new variation, as well as clear indications on the phylogenetic relationships among species. The *Lachenalia* species key is useful for identification of species, but does not correlate with basic chromosome numbers or cross-ability and cannot be used to predict cross-ability. Basic chromosome numbers are currently the best tool to predict the success of inter-species combinations and investigations on the cross-ability of species with other basic chromosome numbers (not covered extensively in this study) can assist breeders to develop crossing strategies. Additional molecular systematic studies as well as *in situ* hybridization techniques are needed to determine the evolutionary relationships between the different basic chromosome numbers within the genus. The generation of this basic information is thus important for future breeding.

7.5 Important strategies and future research for the development of *Lachenalia* cultivars

As mentioned in Chapter 2 the requirements for the breeding of new cultivars include multiple aspects. Knowledge on the market and the requirements of customers and growers is essential to establish breeding goals and evaluation criteria. These goals and criteria are guided by market research and producer and consumer requirements. To address these breeders need to have regular contact with producers as well as the market environment to ensure that any problems and trends are targeted. This contact will facilitate the development of specific breeding goals. Current production challenges identified in *Lachenalia* e.g. include virus susceptibility, improved production of marketable size bulbs in some cultivars and even flowering. These challenges need specific cultivation and pathological research, but does also form part of the selection process for superior hybrids. These can also form part of future breeding goals. Other market requirements include the development of e.g. a white flowering cultivar and an improved red flowering cultivar that speaks directly to breeding and selection.

In terms of the actual breeding and selection, as discussed in chapter 2, the steps as described by Krens & Van Tuyl (2011) include:

i) Knowing the germplasm available;
ii) Knowing the compatibility and crossing ability of the material;
iii) Performing crosses;
iv) Selecting the best candidates;
v) Testing for the stability of the phenotype and for propagation potential;
vi) Finalizing the cultivar, applying for breeder's rights and bringing it to the market.

The results of this thesis clearly show the importance of the establishment of valuable basic information specifically related to the first two points above. Performing crosses to generate variation carries the development of new cultivars along with the availability of good selection criteria. Although breeding processes should always be linked to the market the core start of the generation of variation lies in the availability of germplasm.

For the selection of breeding parents to achieve specific goals, the availability of the required germplasm and its characteristics is essential (Kleynhans, 2009). The availability of the germplam along with the required information related to specific accessions can thus ensure that optimal use of the valuable genetic resource encompassed in the 133 *Lachenalia* species is made. The first important strategies around the development of new *Lachenalia* cultivars thus centre on the maintenance and characterization of germplasm.

Germplasm - maintenance – **Multiple accessions**: The availability of various accessions from a single species for the breeding of new *Lachenalia* cultivars is a necessity. The clear differences in cross-ability when specific accessions are combined (Table 7.5) proves the importance of maintaining several accessions to obtain specific results. The natural variation in terms of flower size, colour, etc. present in many of the species (Chapter 3) is an additional factor that confirms the importance of the maintenance of multiple accessions. Specific examples from this study include the use of *L. quadricolor* (accession L101) and *L. pallida* (accession L406). Both these accessions have a good cross-ability with various species although the other accessions of the same species are not as compatible. Examples of specific accession combinations succeeding whilst other accession combinations of the same species were not successful include: *L. bifolia* (L801)/*L. quadricolor* (L101), *L. liliflora* (L290)/*L. mutabilis* (L161) and *L. punctata* (L381)/*L. pallida* (L049). Various other examples are included in Table 7.5.

Germplasm - characterization and evaluation: The characterization and evaluation of species accessions are a pre-requisite for utilization of the germplasm. Besides the phenotypic characteristics, knowledge on the production aspects related to multiplication, disease resistance/susceptibility, forcing ability and the keeping quality is important in the selection of material for breeding (Krens & Van Tuyl 2011). This characterization and evaluation information should be available in a database for the breeder to utilize when selecting breeding parents. In addition pre-breeding evaluation of the cross-ability of accessions maintained will add value to the germplasm material by readily making information available for breeders to select parental species for specific breeding objectives. Clear examples of cross-ability differences are the use of *L. liliflora* as maternal parent (27 successes against only 13 as paternal parent) and *L. quadricolor* as paternal parent (45 successes against 29 as maternal parent).

In addition the fertility of resulting F1 hybrids should be determined and included in the database to ensure that lines can be utilized in hybrid-hybrid crosses to facilitate new colour variations. Hybrid/hybrid crosses or hybrid/species back crosses are responsible for four of the new *Lachenalia* cultivars registered with plant breeder’s rights in 2010 giving rise to new colours or new colour combinations.

Germplasm – genetic evaluation: The extensive genetic variation in the genus *Lachenalia* was discussed in detail in Chapter 4 and the effect of this on the cross-ability is evident from the results in Chapters 4, 6 and 7. The availability of chromosome numbers of all accessions to verify the ploidy level and basic chromosome numbers is thus essential for the planning of crossing strategies to reach specific breeding objectives. Di-basic F1 hybrids are usually infertile (Hancke *et al*., 2001 and results not shown) and combining species with the same basic chromosome number first before attempting crosses between hybrids with different basic chromosome numbers is thus important. Multiplication of *Lachenalia* hybrids are done by vegetative means and the infertility of commercial hybrids are thus not a problem and have the added advantage of improved keeping quality. Strategies to overcome infertility are available and can be utilized when required for further breeding.

The presence of different molecular systematic clades within especially the x = 7 basic chromosome number group of species (Chapter 4 and 6) provides additional information on the relatedness among species that can be exploited in the breeding (Chapters 4, 6 & 7). In general crosses within these groups have a higher cross-ability success rate. Additional karyotypic and molecular cytogenetic studies are, however, needed to clarify relationships among *Lachenalia* species (Spies *et al*., 2011) and to establish the validity of all the reported basic chromosome numbers. These studies need to be approached on a multi-disciplinary level and should include various cytogenetic and molecular systematic techniques.

The extensive review on the genetic variation and the data presented here lays an important foundation for further multi-disciplinary research work. This research, however, has to be needs driven and currently the market share of *Lachenalia* is still very small. Future planning for cultivar development is, however, dependant on the availability of basic genetic information.

Knowledge on the **compatibility and cross-ability** of the genus *Lachenalia* as second important criteria for breeding are presented in this thesis. The availability of data on the cross-ability between species is valuable for the breeding and will inform breeders to select appropriate accessions for the breeding of new cultivars. The examples given above of specific accession combinations that give higher success rates apply here as well. The existence of unilateral cross-ability in *Lachenalia* was shown. Pre- and post-fertilization barriers preventing inter-species hybridization in *Lachenalia* is clear. The exact nature of these barriers needs further investigation, but the use of well-known techniques like cut-style pollination and embryo rescue to overcome these barriers are possible and will be more important for the generation of new variation in future.

Performing crosses to generate variation in *Lachenalia* and develop new cultivars can be done successfully as illustrated by the registration of new cultivars from both conventional and mutation breeding. The development of successful inter-species hybrids has been sown and these hybrids can be utilized in complex crosses to generate hybrids with new colours. All the current cultivars were developed from species with the basic x = 7 chromosome number, but the use of species from other basic chromosome number groups can add new variation and additional target markets. Valuable information for the selection of breeding parents was thus generated from the data presented. Basic chromosome numbers are the best criterion to use in predicting the success rate of crosses, but do not guarantee success. When crossing species with different basic chromosome numbers the species with the higher number should be used as female parent to have an improved chance of success. Clear indications of specific accessions that give better results were obtained and indications of species that should be used as male or female parents are available.

The utilization of techniques to overcome crossing barriers, should form part of the new crossing strategies to combine additional characters in the development of new hybrids. There is for example still no good white cultivar and many of the white flowering species are difficult to cross (Table 7.5). To achieve this breeding goal advanced techniques will have to be utilized.

Hybrid evaluation procedures have been established and can be applied to select **superior candidates**. These procedures should, however, constantly be adapted and revised to ensure that market-, producer- and consumer requirements are addressed. One of the major issues in the production of *Lachenalia* cultivars is virus infections and a study on the identification of viruses and the development of techniques to test for these viruses is essential to ensure commercial sustainability. *In vitro* and *in vivo* **propagation methods** have been established to multiply selected hybrids for release and new cultivars are protected by Plant Breeders' Rights in targeted countries.

A strong foundation is thus available for breeders in terms of basic information presented in this thesis along with the requirements from the market, consumers and producers to formulate specific breeding objectives. Breeding strategies for the selection and use of genetic material can be planned with more accuracy for formulated objectives.

This will assist the development of suitable cultivars that address the relevant requirements. The continued generation of additional basic genetic information, cross-ability information and reproductive barrier information is, however, essential to support and fast track the breeding of *Lachenalia*.

CHAPTER 8

SUMMARY

The floriculture and ornamental industry is constantly looking for new products. South Africa is blessed with an exceptional rich bio-diversity and many South African plants have found their way onto international markets. The local development of products for the international market unfortunately is limited. The genus *Lachenalia* is one of the exceptions, with local development and production of cultivars for the international pot plant market. This thesis thus aimed to establish the different aspects and requirements needed for the development of new *Lachenalia* cultivars and to use the basic genetic information generated through research to develop specific breeding strategies for the development of new cultivars.

The thesis established the wider requirements of the complete value chain for the development of new floriculture crops and identified the strong need to establish basic research information in order to successfully develop new cultivars in the genus *Lachenalia*. The diversity amongst the 133 described species of *Lachenalia* and the breeding and research on production that facilitated the release of cultivars to the international market indicated the suitability of the genus for development. The genetic variation present in the genus includes various different basic chromosome numbers, polyploidy, B-chromosomes, different karyotypes within the same basic chromosome number, different phylogenetic groups and the existence of possible hybrid species. Relationships between specific basic chromosome numbers were shown and possible evolutionary history was proposed, but conclusions in this regard needs further investigation.

The development of new cultivars is possible from both conventional and mutation breeding processes, but the availability of basic genetic information is essential for future progress. Inter-specific as well as complex hybrid/hybrid crosses are used for the development of new cultivars. To facilitate future crosses the cross-ability among *Lachenalia* species was investigated. The cross-ability data supports the phylogenetic relationships identified by various authors and both are strongly linked to basic chromosome numbers. Phenotypic characters cannot be used to predict the success of inter-species crosses, except where clear mechanical isolation (female long style species crossed with

male short style species) is present.

Clear unilateral cross-ability is present among several species and this is not linked to self-incompatibility. Self-incompatibility seems to be present in specific species, but can be overcome by crossing different accessions of the same species. Clear differences in the level of success of crossing combinations were statistical shown through AHC cluster and principle component analysis. A limited number of crosses showed good cross-ability with the production of many normal seeds. Most of these crosses were between species with the same basic chromosome number with only four exceptions, which were between basic x = 7 and x = 8, confirming the close relationship between these two basic chromosome numbers. Some intermediate success rates between basic x = 11 with both x = 7 and x = 8 was also present possible supporting the basal nature of x = 11. Basic chromosome numbers are currently the best criterion for predicting the success rate of inter-species crossing combinations but it does not guarantee success.

The data presented clearly indicated the importance of well characterized (phenotypic and genotypic) germplasm material, including the maintenance of various accessions of a species. Good breeding parents were identified to assist breeders to reach specific goals. The importance of an in-depth investigation on the nature and extent of the crossing barriers and continued research on the genetics and molecular systematic of the genus was determined. This study clearly shows that the availability of basic genetic information and data on the cross-ability among species is essential for the selection of breeding parents to ensure better success rates for inter-species crossing combinations and the future development of new *Lachenalia* cultivars.

Keywords: basic chromosome number, breeding, cross-ability, cytogenetic, inter-specific crosses, *Lachenalia*, molecular systematics, phylogeny

SAMEVATTING

Die blom- en sierplantbedryf soek voortdurend nuwe produkte. Suid-Afrika het ŉ besondere ryk biodiversiteit en verskeie Suid-Afrikaanse plante word op internasionale markte verkoop. Min plaaslike ontwikkeling van produkte vir die internasionale mark kom voor. Die genus *Lachenalia* is egter ŉ uitsondering en word plaaslik ontwikkel en verbou vir die internasionale potplantmark. Die doel van hierdie proefskrif was dus om die data en verskillende vereistes nodig vir die ontwikkeling van nuwe *Lachenalia* kultivars te ondersoek en om die basiese genetiese inligting wat deur navorsing ontwikkel is te gebruik om spesifieke teelstrategieë vir die ontwikkeling van nuwe kultivars te bepaal.

Die proefskrif beskryf die vereistes van die volledige waardeketting in die ontwikkeling van nuwe blomgewasse en identifiseer die behoefte vir basiese navorsing. Albei is nodig vir die ontwikkeling van nuwe kultivars. Die bestaande diversiteit in die 133 beskryfde *Lachenalia* spesies en die teling en produksienavorsing wat die vrystelling van nuwe kultivars in die internasionale mark moontlik gemaak het, bewys dat die genus geskik is vir ontwikkeling. Die genetiese variasie sluit verskillende basiese chromosoom aantalle, poliploïdie, B-chromosome, verskillende kariotipes binne dieselfde basiese chromosoom aantal, verskillende filogenetiese groepe en die bestaan van moontlike basterspesies in. Verwantskappe tussen spesifieke basiese chromosoom aantalle bestaan en die moontlike ewolusionêre ontwikkeling van die genus word bespreek, hoewel verdere navorsing nodig is om bewyse hieroor te kry.

Die ontwikkeling van nuwe kultivars is moontlik deur beide mutasie en konvensionele teling te gebruik, maar die beskikbaarheid van basiese genetiese inligting is noodsaaklik vir toekomstige vordering. Inter-spesie en meer komplekse baster/basterkruisings word vir die ontwikkeling van nuwe kultivars gebruik. Om toekomstige kruisings te beplan, is die kruisbaarheid tussen verskeie *Lachenalia* spesies ondersoek. Die kruisbaarheidsdata ondersteun die beskryfde filogenetiese verwantskappe deur verskeie outeurs en daar is ŉ sterk verband tussen basiese chromosoom aantalle en beide die kruisbaarheid en die filogenie. Fenotipiese eienskappe kan nie gebruik word om die sukses van inter-spesie kruisings te voorspel nie, behalwe vir die teenwoordigheid van moontlike meganiese isolasie (lang styl moederlike ouer gekruis met kort styl vaderlike ouer).

Duidelike eenrigting kruisbaarheid bestaan tussen verskeie spesies, maar dit word

nie gekoppel aan self-onverenigbaarheid nie. Self-onverenigbaarheid kom wel by sekere spesies voor, maar word oorkom deur verskillende aanwinste van dieselfde spesie met mekaar te kruis. Die wisselende vlak van sukses van kruisingskombinasies is statisties deur hiërargiese groeperingsanalise en hoofkomponentanalises bewys. ʼn Beperkte aantal kruisingskombinasies het goeie kruisbaarheid getoon met die produksie van baie normale sade. Met die uitsondering van vier kombinasies tussen die basiese chromosoom aantalle $x = 7$ en 8, was al die kruisingskombinasies tussen spesies met dieselfde basiese chromosoom aantal. Die geslaagde $x = 7$ en $x = 8$ kombinasies bevestig die nouer verwantskap tussen die twee basiese chromosoom aantalle. Kruisings met intermediêre sukses sluit ook kruisings tussen $x = 11$ en beide $x = 7$ en $x = 8$ in, wat die moontlike basale posisie van $x = 11$ kan bevestig. Basiese chromosoom aantalle is die beste maatstaf om die sukses van inter-spesie kruisings te voorspel, alhoewel die nie sukses kan waarborg nie.

Die data verkry tydens hierdie studie bewys duidelik die belang van goed gekarakteriseerde (fenotipies en genotipies) genebronmateriaal en die instandhouding van verskeie aanwinste per spesie. Goeie teelouers is geïdentifiseer wat telers kan help om spesifieke doelwitte te bereik. Die belang van ʼn in-diepte ondersoek oor die soort en omvang van isolasiemeganismes en voortgesette navorsing oor die genetiese variasie en molekulêre verwantskappe is bevestig. Die studie het onomwonde bewys dat die beskikbaarheid van basiese genetiese inligting en data oor die kruisbaarheid tussen spesies noodsaaklik is vir die keuse van teelouers om die sukses van inter-spesie kruisings te verhoog en die ontwikkeling van nuwe *Lachenalia* kultivars te ondersteun.

Sleutelwoorde: basiese chromosoom aantalle, filogenie, inter-spesie kruisings, *Lachenalia*, kruisbaarheid, molekulêre verwantskappe, sitogenetika, teling

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APPENDIX A: Front pages of five published articles

Philos. Trans. Genet. 1: 80-101 (2011)

Requirements for the development and breeding of new flower bulb crops

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Abstract

South Africa has an indigenous floriculture plant heritage that is unique in many ways and consists of approximately 10% of the world's plant species. The potential to develop some of these into commercial products exist. The crop *Lachenalia* is an example of a crop native to South Africa that was not developed abroad as is the case with many other indigenous flowers like *Freesia, Gerbera* and *Gladiolus*. In order to address development of new crops successfully, the specific requirements of the floriculture industry in terms of production, the global trade and consumer preferences have to be taken into account. The floriculture industry is a multi-billion dollar trade and flower bulbs as a section within the wider floriculture market is worth an estimated US$ 1 billion. South Africa captures less than one present of the global market. The South African market can, however, be expanded by addressing the major requirements for growth and export as well as the development of new niche crops of which new flower bulbs is one example. During the development of new crops the overall requirements need to be taken into account even when the selection of the genus to be developed is made. Successful development requires a multi-disciplinary approach on many research areas, followed by an equal expanded approach for commercialization. In contrast to the large commercial bulbous crops like tulips, basic information on new crops is often very limited. Basic genetic information in terms of genetic variation, cytology and crossability is one of the areas where basic information must be generated. Without this basic information the chain of development in terms of breeding, selection, propagation, cultivation, commercialization and marketing is at risk. Continued innovation requires basic information on many different research areas. Although the generation of genetic information might be perceived to be non-essential by the end-users in the floriculture value chain, it forms an integral starting point for the innovations that realize as new cultivars and products commercialized on global floriculture markets.

Keywords: Developmental requirements, floriculture, flower bulbs, *Lachenalia*

Chapter 18

LACHENALIA

Lachenalia spp.

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Abstract: *Lachenalia* species are geophytic endemics of South Africa and Namibia. This chapter includes a short overview of the taxonomic and breeding history of the genus. Diversity present in the genus is discussed in terms of morphology, distribution, propagation and genetics. The large diversity and absence of a key for the identification of species emphasizes the importance of investigating the diversity within species and establishing species boundaries. Crossing mechanisms and available information on the reproductive biology of *Lachenalia* are mentioned. The influence of production methods on the selection criteria and selection procedures is discussed. Information on the extent of reproductive barriers in the genus is included. Present and future breeding strategies and research needed to overcome these barriers are discussed. The chapter concludes with future perspectives for research and breeding in the genus.

Key words: bulbs, geophytes, Hyacinthaceae.

1. INTRODUCTION

The genus *Lachenalia* Jacq. f. ex Murray consists of small bulbous geophytes endemic to South Africa and Namibia. This winter-growing genus belongs to the Hyacinthaceae and consists of more than 100 described species (Dold & Philipson, 1998, Duncan, 1998).

Although *Lachenalia* has a long history, commercial products are relatively new to the international flower market. The Roodeplaat Vegetable and Ornamental Plant Institute of the Agricultural Research Council (ARC-Roodeplaat) developed commercial potted plants from the genus in South Africa (Niederwieser *et al.*, 1998). The breeding history and slow commercialization discussed are thus related

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Cytogenetic and Phylogenetic Review of the Genus *Lachenalia*

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ABSTRACT

The genus *Lachenalia* (family Asparagaceae), endemic to southern Africa, is a horticultural diverse genus, with many species featuring in the red data list of southern Africa. The extensive morphological variation within some species complicates species delimitation and has led to taxonomic confusion. The genus is utilised in a breeding programme where cytogenetic and phylogenetic information is important for the development of breeding strategies. Chromosome numbers of 89 species have been recorded in literature, with $2n$ = 10 to 56 and n = 5 to 28. B-chromosomes have been described in some species. Basic chromosome numbers include x = 5, 6, 7, 8, 9, (probably 10), 11, (probably 12), 13 and (probably 15). Polyploidy was reported in 19 taxa (23%), and is most common in the x = 7 group. Molecular cytogenetic studies using 5S rDNA, 18S rDNA probes and DAPI staining, as well as molecular systematic studies using *trnL-F* and *ITS1-2* were used to assess the phylogeny of the genus. All these studies indicated that species with the same basic chromosome number are closely related. The one deviation is that it appears as if there are two separate groups within the x = 7 group. The cytogenetic and molecular studies are further supported by breeding studies, where improved results are generally obtained from crosses within a phylogenetic group or between closely related groups. This review of the literature reveals how different studies obtain similar results regarding the phylogenetic relationships within the genus and how these results can be utilized to improve breeding strategies. It also accentuates that further multidisciplinary studies are needed to solve the evolutionary history of the complex genus *Lachenalia*.

Keywords: chromosome numbers, cladograms, cross-ability, phylogeny, polyploidy

Abbreviations: APG, Angiosperm Phylogeny Group; ***atpB***, ATPase beta chain; **DAPI**, 4',6-diamidino-2-phenylindole; **FISH**, Fluorescent *in situ* hybridization; ***ITS1-2***, Internal transcribed spacer 1 and 2; **MEGA**, Molecular Evolutionary Genetics Analysis; ***n***, gametic chromosome number; **RAPD**, Random amplified polymorphic DNA; ***rbcL*** ribulose bisophosphate carboxylase (large); **SANBI**, South African National Biodiversity Institute; ***trnL***, leucyl-transfer RNA intron; ***trnF***, phenylalanine-transfer RNA; **VOPI**, Vegetable and Ornamental Plant Institute; ***x***, basic chromosome number; **2*n***, somatic chromosome number; **5S rDNA** and **18S rDNA**, 5S and 18S ribosomal DNA

CONTENTS

INTRODUCTION

The genus *Lachenalia* Jacq. *f.* ex Murray, previously a member of the family Hyacinthaceae (Manning *et al.* 2004; Duncan and Edwards 2006, 2007), but since 2009 reclassified under the family Asparagaceae Juss. (APG III group 2009), is endemic to southern Africa. The genus now also includes the former genus *Polyxena* (Manning *et al.* 2004). *Lachenalia* is a horticultural diverse genus, with a distribution range extending from the south-western coast of Namibia, southward throughout the Northern, Western and Eastern Cape provinces of South Africa (Duncan 1998). One species extends as far inland as the south western part of the Free State Province (Duncan 1996). Of the 126 species and

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Invited Review

Potential New Lines in the *Hyacinthaceae*

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Keywords: *Lachenalia*, *Ornithogalum*, *Eucomis*, mutation breeding, hybrids

Abstract

Genera from the *Hyacinthaceae* family have been utilized in breeding programs at the Agricultural Research Council for many years with the aim to develop new products for the international floriculture market. Through conventional breeding, several *Lachenalia* and *Ornithogalum* cultivars were released. The *Lachenalia* breeding program was the only active breeding program during the past 5 years and several potential new lines (comprising of different colour combinations and flower forms) are available for commercial evaluation. Besides conventional breeding, a project on the use of mutation technology has also resulted in the availability of new lines. Members of the *Hyacinthaceae* are particularly suitable for mutation breeding because two of the positive circumstances for mutation breeding can be combined: vegetative propagation and single cell origin of adventitious buds on leaf tissue. A method combining irradiation and tissue culture was developed to induce mutations in four genera, namely *Lachenalia*, *Ornithogalum*, *Eucomis* and *Veltheimia*. To date at least four potential new varieties have been identified from three of the four genera. These lines have been initiated in tissue culture for multiplication purposes. When large quantities of material are available, application for Plant Breeders Rights and commercial establishment will take place.

INTRODUCTION

South Africa contains ±10% of the world's plant species (Coetzee, 2002). The Cape Floral Kingdom, with its more than 8500 different flowering species, is one of the six major floral kingdoms of the world (Coetzee et al., 2002; Wesgro, 2006). The Agricultural Research Council (ARC) has played an important role in utilizing this diversity for development of new floriculture crops. Within the *Hyacinthaceae* family breeding programs focused on the two species, namely, *Lachenalia* J.Jacq. ex Murray and *Ornithogalum* L.

Lachenalia is a bulbous genus endemic to southern Africa with approximately 120 described species (Duncan, 2005). *Ornithogalum* is closely related to *Lachenalia* and the genus contains approximately 200 species from Africa, Europe and Asia (Littlejohn, 2006). Both genera have been utilized in conventional breeding programs with the aim to develop new pot plant (*Lachenalia* and *Ornithogalum*) and cut flower (*Ornithogalum*) products. These breeding programs led to the release of 33 cultivars (Bester et al., 2008).

During the last 5 years the only active breeding program was on *Lachenalia*. The genus is unusually variable (Kleynhans, 2006), creating numerous possibilities for new combinations in flower colour and flower form. The extent of the variation, however, also causes several natural crossing barriers influencing cross-ability among species. External and internal crossing barriers exist (Lubbinge, 1980; Kleynhans, 2006).

Besides the huge phenotypic variation the genus also has a remarkable variability with regards to chromosome number. Somatic chromosome numbers ranging from 2n=10 to 2n=56 have been reported in the literature (Moffett, 1936; Sato, 1942; Therman, 1956; De Wet, 1957; Riley, 1962; Mogford, 1978; Ornduff and Watters, 1978; Nordenstam, 1982; Crosby, 1986; Hancke and Liebenberg, 1990, 1998; Hancke, 1991; Johnson and Brandham, 1997; Kleynhans, 1997; Hamatani et al., 1998, 2004; Kleynhans and Spies, 1999; Spies et al., 2000, 2002; Du Preez et al., 2002; Van Rooyen et al., 2002). The basic

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Cross-Ability in the genus *Lachenalia*

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Keywords: cross-ability, chromosome numbers, crossing barriers, phylogeny

Abstract

Lachenalia **is a bulbous genus endemic to southern Africa. The genus has been utilized in a breeding program with the aim to develop a new pot plant product for the international floriculture market. The genus has approximately 120 described species and is unusually variable. The variation in terms of flower-form, -colour, -length and -posture opens up a range of possibilities in terms of pot plant types as well as cut flower potential. The extent of the variation, however, also causes several natural crossing barriers influencing the cross-ability among species. The genus is just as varied in chromosome number as in phenotype. The basic chromosome numbers present in the genus are x=5, 6, 7, 8, 9, 10, 11 and 13. Ploidy levels range from diploid to octoploid and polyploidy is present in several species. A large number of interspecies crosses have been made. The results of these and the implication on the cross-ability of different species are discussed. Cross-ability between species with the same basic chromosome number is fairly successful. Cross-ability between species with different basic chromosome numbers is, however, low. The crossing data are compared to results from studies on the phylogeny of the genus as determined using sequencing of the transfer RNA intergenic spacer (trnL-F) sequencing and chromosome numbers. The same tendency can be observed if the inter-species crosses are linked to the phylogenetic groups identified within the genus. Within groups cross-ability is fairly successful, whilst between groups cross-ability is low. The crossing data thus, in most cases, correlate with the phylogenetic data. Where discrepancies occur further phylogenetic analysis is required.**

INTRODUCTION

Lachenalia J.Jacq. ex Murray is a bulbous genus endemic to southern Africa. The genus has been utilized in a breeding program at the Agricultural Research Council's Vegetable and Ornamental Plant Institute (ARC-VOPI) with the aim to develop a new pot plant product for the international floriculture market. The genus has approximately 120 described species (Duncan, 2005) and is unusually variable (Kleynhans, 2006). The extent of the variation, however, also causes several natural crossing barriers influencing cross-ability among species.

External and internal crossing barriers exist (Lubbinge, 1980 and Kleynhans, 2006). The external barriers can be easily overcome by growing the plants in controlled conditions and the successful storage of pollen for a 12-month period (Kleynhans, 2006). Stored pollen is used to overcome the diverse flowering times (April – Nov) of the species in the genus. The internal barriers have not been studied in detail.

Closely linked to the internal barriers is the remarkable variability of chromosome numbers found in the genus. Somatic chromosome numbers ranging from 2n=10 to 2n=56 have been reported in the literature (Moffett, 1936; Sato, 1942; Therman, 1956; De Wet, 1957; Fernandes and Neves, 1962; Riley, 1962; Mogford, 1978; Ornduff and Watters, 1978; Nordenstam, 1982; Crosby, 1986; Hancke and Liebenberg, 1990; Hancke, 1991; Johnson and Brandham, 1997; Kleynhans, 1997; Hamatani et al., 1998; Hancke and Liebenberg, 1998; Kleynhans and Spies, 1999; Spies et al., 2000; Du Preez et al., 2002; Spies et al., 2002; Van Rooyen et al., 2002; Hamatami et al., 2004). The basic

APPENDIX B: List of accessions used in crosses with their chromosome numbers as published or determined during this study

Species	2n	n	Locality	Reference
L. alba				
T1997/001			NORTHERN CAPE.–3119 (Calvinia): 9,5km south of Nieuwoudtville on the road to Botterkloof (–AC)	
L. aloides				
L022	14	7	Unknown	Hancke, 1991
L033			Unknown	
L125			Unknown	
T1992/010			Unknown	
T1983/418 (L057)	14		Unknown	This study
T1983/419 (L058)	14		Unknown	This study
T1983/410 (L042)	14		Unknown	This study
T1983/407 (L039)	14		Unknown	Hancke, 1991 & this study
T1983/408 (L040)	14		Unknown	This study
T1983/406 (L038)	14		Unknown	This study
T1983/404 (L032)	14		Unknown	This study
T1983/875 (L213)	14		Unknown	This study
T1990/020 (L426)	14		Unknown	This study
T1983/409 (L041)	14			Hancke, 1991
T1983/421 (L063)	14		WESTERN CAPE.–3218 (Clanwilliam) Kasteelberg (–BD)	This study
T1983/496 (L202)	14		WESTERN CAPE.–3420 (Bredasdorp) Bredasdorp (–CA)	This study
T1983/426 (L076)	14		WESTERN CAPE.–3420 (Bredasdorp) Bredasdorp (–CA)	This study
T1983/456 (L126) (Spies 7059)	14		WESTERN CAPE.–3318 (Cape Town): Riebeeck Wes (–BD)	This study
T1983/412 (L045)	21		Unknown	This study
L. aloides* var. *luteola				
T1988/037 (L440) (Spies 7061)	14		WESTERN CAPE.–3318 (Cape Town): Voorberg jail, Porterville (–BB)	Spies *et al.*, 2009
L. anguineae				
L087			Unknown	
L. bachmanii				
T1985/061 (L016)	16		WESTERN CAPE.–3218 (Clanwilliam): Half way between Piketberg en Citrusdal (–DD)	This study
T1983/457 (L127)	16		WESTERN CAPE.–3318 (Cape Town): Moreesburg (–BC)	This study
T1983/465 L135			WESTERN CAPE.–3319 (Worcester): Tulbach, (–AC)	
L. bifolia				
T1983/402 (L023)	56		Unknown	Kleynhans & Spies, 1999
T1983/427 L078			WESTERN CAPE.–3420 (Bredasdorp): Sandkraal (–	

Species	2n	n	Locality	Reference
			AC)	
T1983/483 (L175)			WESTERN CAPE.–3418 (Simons Town): Cape Pinninsula (–AD)	
T1983/371(L296)	28		WESTERN CAPE.–3418 (Simons Town): Seekoeivlei (–BA)	This study
T1983/373 (L298)	28		WESTERN CAPE.–3420 (Bredasdorp): Agulhas (–CC)	This study
T1983/514 (L301)	28		WESTERN CAPE. –3318 (Cape Town) On the Malmesbury to Hopefield road , 10 km from Hopefield (–AB)	Kleynhans & Spies, 1999
T1987/194 (L389) (Spies 7322)	42		WESTERN CAPE.–3418 (Simons Town): Seekoeivlei (-BA)	Kleynhans & Spies, 1999
T1987/170 (L390) (Spies 7064)	28		WESTERN CAPE.–3419 (Caledon): Pearly Beach (–CB)	Kleynhans & Spies, 1999
T1991/046	42		WESTERN CAPE.–3318 (Cape Town): Bloubergstrand (-CD)	Kleynhans & Spies, 1999
T1991/047	42		WESTERN CAPE.–3318 (Cape Town): Bloubergstrand (–CD)	This study
T1991/048	42		WESTERN CAPE.–3318 (Cape Town): Bloubergstrand at the Sir David Baird offramp from Otto du Plessis (-CC)	Kleynhans & Spies, 1999
T1991/049 L801	42		WESTERN CAPE.–3318 (Cape Town): Melkbosstrand (–CB)	Kleynhans & Spies, 1999
T1991/059	42		WESTERN CAPE.–3218 (Clanwilliam): Clanwilliam nature reserve (–BB)	Kleynhans & Spies, 1999
T1991/064	56		WESTERN CAPE.–3418 (Simons Town): Between Betty's Bay and Heroldt Porter at old Harbour (–BD)	Kleynhans & Spies, 1999
T1991/069	56		WESTERN CAPE.–3419 (Caledon): Kleinbaai near the old harbour. (–CD)	This study
T1991/070	56		WESTERN CAPE.–3419 (Caledon): Kleinbaai near the old harbour. (–CD)	Kleynhans & Spies, 1999
L. capensis				
L355	2n>18		NORTHERN CAPE.–2917 (Springbok): On the road between Steinkopf and Port Nolloth (–AB)	This study
***L. carnosa*.**				
L280			NORTHERN CAPE.–2917 (Springbok): Wildepaardehoek (–DC)	
T1983/227 (L335) (Spies 6933/6991)	16		Unknown	Du Preez *et al.*, 2002
T1985/224 (L331) (Spies 6993	16		NORTHERN CAPE.–3018	Du Preez *et al.*,

Species	2n	n	Locality	Reference
			(Kamiesberg): Leliefontein (–AC)	2002
T1985/260 (L349) (Spies 6994)			NORTHERN CAPE.–2917 (Springbok): Springbok (–DB)	
T1985/207 (L338) (Spies 6992)	16	8	NORTHERN CAPE.– 3017 (Hondeklipbaai): 30km south of Kamieskroon (–BD)	Du Preez *et al.*, l 2002
T1985/254 L393			NORTHERN CAPE.–2917 (Springbok): On the road from Kamieskroon to Springbok (–DD)	
T1986/237 (L400) (Spies 6934/6995)	16	8+0-2B	NORTHERN CAPE.–3018 (Kamiesberg): Road between Garies and Leliefontein (–AC)	Spies *et al.*, 2009
T1992/297 (Spies 6997)			NORTHERN CAPE.–3017 (Hondeklipbaai): Soebatsfontein road 8km from Kamieskroon (–BB)	
T1992/306			NORTHERN CAPE.–2917 (Springbok): Springbok airport (–DB)	
T1992/315			NORTHERN CAPE.–2917 (Springbok): On the farm Koringhuis south west of Springbok (–DD)	
T1992/325 (Spies 6999)	16		NORTHERN CAPE.–2917 (Springbok): Behind the copper mines at Nababeep (–DB)	Du Preez *et al.*, 2002
L. comptonii				
T1983/359 (L284) (Spies 7066)		10	unknown	Spies 2004
L. concordiana				
T1992/296			NORTHERN CAPE.–2917 (Springbok): Springbok airport (–DB)	
L. contaminata				
T1983/428 (L082)	16		NORTHERN CAPE.–3119 (Calvinia): Lockenburg (–CA)	This study
T1983/448 (L114) (Spies 7353)	16		Ex ante Kirstenbosch	This study
T1983/871 L207			WESTERN CAPE.–3318 (Cape Town): Durbanville (–DC)	
T1992/015 L805			Unknown	
L. elegans				
L140			NORTHERN CAPE.–3119 (Calvinia): Vanrhyns Pass (–AC)	
L226			Unknown lauranos	
T1983/917 (L272)	C28		WESTERN CAPE.–3319 (Worcester) Karoopoort (–BC)	This study
T1985/193/2 (L392/2) (Spies 8015)	28	14	WESTERN CAPE.–3118 (Vanrhynsdorp): On top of Gifberg (–DC)	Spies *et al.*, 2009
T1983/562 L308			NORTHERN CAPE.–3119	

Species	2n	n	Locality	Reference
			(Calvinia): On top of Vanrhyns Pass (–AC)	
T1983/579 (L309) (Spies 8014)	28	14	NORTHERN CAPE.–3119 (Calvinia): On top of Vanrhyns Pass (–AC)	Spies *et al.,* 2009
T1983/762 L323			Unknown	
T1985/097 (L333) (spies 8017)	42	21	WESTERN CAPE.–3218 (Clanwilliam): On the road from Clanwilliam to Pakhuis Pass. (–BB)	Minnaar, 2004
L. flava				
T1983/441 (L102)			Unknown	
T1983/472 (L144)	14		Unknown	This study
T1983/422 (L068)	14		WESTERN CAPE.–3319 (Worcester): Ceres (–AC)	This study
T1983/455 (L124) (Spies 7060)	14		WESTERN CAPE.–3319 (Worcester): Bainskloof (–AC)	Spies *et al.,* 2009 &this study
L. framesii				
T1992/005 (Spies 7008)	16		Unknown	Du Preez *et al.,* 2002
T1992/270			WESTERN CAPE.–3118 (Vanrhynsdorp): Nuwerus	
T1993/025 (Spies 7009, 7010)	16		unknown	Du Preez *et al.,* 2002
L. hirta				
L008			WESTERN CAPE.–3218 (Clanwilliam): Eendekuil (–DB)	
L. isopetala				
L227			unknown	
L. klinghardtiana				
L210			NORTHERN CAPE.–2916 (Springbok): Port Nolloth (–BB)	
L. liliflora				
L011			WESTERN CAPE.–3419 (Caledon): Fisantekraal (–AA)	
T1983/365 (L290) (Spies 6937)	16		unknown	Spies, 2004
T1992/342	16		WESTERN CAPE.–3318 (Cape Town): Between Stellenbosch and Malmesbury (–DB)	This study
T1993/032 (L804)			Unknown	
T2004/031 (Spies 8163)	16		WESTERN CAPE.–3318 (Cape Town): Stellenbosch (–DD)	Spies *et al.,* 2009
L. longibracteata				
T1991/060	14		WESTERN CAPE.–3318 (Cape Town): Potsdam behind Killarney race track. (–DC)	This study
L. magentea				
T1983/368/1 (L328/1) (Spies 7380/7069)	22/44		Unknown	Spies, 2004
L. mediana				
T1983/857 (L158) (Spies			WESTERN CAPE.–3418	

Species	2n	n	Locality	Reference
7078)			(Simons Town): Sir Lowry's Pass (–BB)	
L. mediana* subsp. *rogersii				
T1986/118 (L418) (Spies 7079)		13	WESTERN CAPE.–3318 (Cape Town): Darling (–AD)	Spies *et al.*, 2009
L. mutabilis				
L015			unknown	
T1983/400 (L018) (Spies 6749)	14		Unknown	Spies *et al.*, 2000
T1983/545 L307 (Spies 6744)	12		WESTERN CAPE.–3118 (Vanrhynsdorp): On road to Bonteheuwel from Vanrhynsdorp (–DA)	Spies *et al.*, 2000
T1983/561 L330 (Spies 6746)	12		NORTHERN CAPE.–3119 (Calvinia): On top of Vanrhyns Pass (–AC)	Spies *et al.*, 2000 & this study
T1983/716 L318 (Spies6745)	14		WESTERN CAPE.–3219 (Wuppertal): On the farm Karringmelkfontein, Citrusdal (–CA)	Spies *et al.*, 2000 and this study
T1983/859 L161 (Spies 6747)	14	7	WESTERN CAPE.–3218 (Clanwilliam): Clanwilliam (–BB)	Hancke & Liebenberg, 1990 & Spies *et al.*, 2000
T1983/860 L162 (Spies 6753)	14		WESTERN CAPE.–3118 (Vanrhynsdorp): Vanrhynsdorp (–DA)	Spies *et al.*, 2000 & this study
T1983/886 L231 (Spies 6748)	14		WESTERN CAPE.–3218 (Clanwilliam): Clanwilliam Botanical garden (–BB)	Spies *et al.*, 2000 & this study
T1983/900 L251 (Spies 6750)	12/24		NORTHERN CAPE.–3017 (Hondeklipbaai) Hondeklipbaai, (–AC)	Spies *et al.*, 2000
T1992/273 (Spies 6771, 6772)	12	6	WESTERN CAPE.–3218 (Clanwilliam): Bulshoekdam (–BB)	Minaar, 2004
T1992/267			WESTERN CAPE.–3319 (Worcester) 15km on the Worcester-Ceres road (–CD)	
T1994/048			unknown	
L. namaquensis				
T1983/403 L028 (Spies 6969)	16	8	NORTHERN CAPE.–2917 (Springbok): Steinkopf, (–BD)	Du Preez *et al.*, 2002 & Spies *et al.*, 2009
T1983/906 L258 (Spies 6970)	16	8	NORTHERN CAPE.–2917 (Springbok): Springbok, (–DB)	Du Preez *et al.*, 2002 & Spies *et al.*, 2009
***L. nervosa*.**				
T1983/851 L147 (Spies 7360)	16		WESTERN CAPE.–3420 (Bredasdorp): Swellendam (–AB)	
***L. orchioides*.**				
T1983/398 L007 (Spies 8084)	14	7	WESTERN CAPE.–3318 (Cape Town): Stellenbosch (–DD)	Spies *et al.*, 2009
T1983/420 L061			unknown	
T1983/689 L316 (Spies 8086)	14	7	WESTERN CAPE.–3218 (Clanwilliam): Pakhuis Pass (–BB)	Spies *et al.*, 2009

Species	2n	n	Locality	Reference
T1983/758 L322 (Spies 8087)	14	7	Unknown	Minaar, 2004
T1990/028 L434 (Spies 8088)	14	7	Unknown	Minaar, 2004
T1990/048			WESTERN CAPE.–3318 (Cape Town): Jonkershoek forestry station up in the mountains (–DD)	
T1990/050			WESTERN CAPE.–3318 (Cape Town): Jonkershoek forestry station up in the mountains (–DD)	
T1990/052			WESTERN CAPE.–3318 (Cape Town): Jonkershoek forestry station up in the mountains (–DD)	
T1990/058			WESTERN CAPE.–3419 (Caledon): Leeurivier mountains (–AB)	
T1992/032 L802 (Spies 8095, 8092, 8090, 8093)	14	7	WESTERN CAPE.–3318 (Cape Town): Klapmuts (–DD)	Spies *et al.*, 2009
T1992/262 (Spies 8096)	14	7	Unknown	Minaar, 2004
T1992/267 (Spies 8068, 8069)	14	7	WESTERN CAPE.–3319 (Worcester): along road to Ceres (–CC)	Spies *et al.*, 2009
T1992/282			WESTERN CAPE.–3319 (Worcester): At the beginning of the Dutoitskloof pass (–CA)	
T1996/089 L803 (Spies 8101)	14	7	WESTERN CAPE.–3319 (Worcester): Brandvlei Dam (–CB)	Spies *et al.*, 2009
T1996/091 (Spies 8080, 8079, 8073)	14	7	WESTERN CAPE.–3319 (Worcester): Goudini (–CB)	Spies *et al.*, 2009
L. orchioides* subsp. *glaucina				
L005			unknown	
L143			WESTERN CAPE.–3318 (Cape Town): Darling (–AD)	
L450			Ex ante kirstenbosch	
T1993/105 (Spies 8066)			Ex ante Kirstenbosh	
T1993/106 (Spies 8067)			WESTERN CAPE.–3418 (Simons Town): Cecelia forestry station (–AB)	
L. orthopetala				
T1983/475 L164 (Spies 7358)			WESTERN CAPE.–3318 (Cape Town): On the farm Klipheuwel (–BA)	
T1983/476 L165			WESTERN CAPE.–3318 (Cape Town): Durbanville (–DC)	
L. pallida				
T1983/413 L46			Unknown	
T1983/360 L285 (Spies 6824)	16		Unknown	Spies *et al.*, 2000
T1983/414 L047			Unknown	
T1983/415 L048			WESTERN CAPE.–3218 (Clanwilliam): Leipoldtville (–AB)	
T1983/416/2 L49 (Spies 6825)	16	8	WESTERN CAPE.–3218 (Clanwilliam): Piketberg (–DD)	Spies *et al.*, 2000

Species	2n	n	Locality	Reference
T1983/438 L98 (Spies 6857)	16		WESTERN CAPE.–3218 (Clanwilliam) Clanwilliam (–BB)	Spies *et al.*, 2000
T1983/446 L109 (Spies 6826)	16		Ex ante kirstenbosh	Hancke *et al.*, 2001
T1983/498 L192 (Spies 6830)	16		unknown	Spies *et al.*, 2000
T1986/137 L397			WESTERN CAPE.–3318 (Cape Town): Darling (–AD)	
T1986/205 L399 (Spies 6982)	16		WESTERN CAPE.–3118 (Vanrhynsdorp): Gifberg (–DC)	Du Preez *et al.*, 2002
T1986/335 L372			unknown	Spies *et al.*, 2000
T1988/039 L406 (6833)	16		WESTERN CAPE.–3318 (Cape Town): Voorberg jail, Porterville (–BB)	Spies *et al.*, 2000 & Du Preez *et al.*, 2002
T1991/055 (Spies 6798-6804, 6814-6823)	16		WESTERN CAPE.–3318 (Cape Town): Langebaan nature reserve, Potsberg (–AA).	Spies et al 2000
T1991/056 (Spies 6837, 6838)	16	8	WESTERN CAPE.–3218 (Clanwilliam) Laaiplek road next to beach in the Veldtdrif region (–CC)	Spies *et al.*, 2000 & Du Preez *et al.*, 2002
T1991/061 (Spies 7089)	16		WESTERN CAPE.–3318 (Cape Town): Potsdam behind Killarney race course (–DC	Spies *et al.*, 2009
T1992/012			unknown	
T1992/284			WESTERN CAPE.–3319 (Worcester): Bainskloof pass (–CA)	
T1992/330			WESTERN CAPE.–3318 (Cape Town): On the farm Klipheuwel (–BA)	
T1992/328			WESTERN CAPE.–3318 (Cape Town): Tienie versfeld nature reserve, Darling (–AD)	
T1996/110			WESTERN CAPE.–3319 (Worcester): Tulbach (–AC)	
L. patula				
T1992/301			WESTERN CAPE.–3118 (Vanrhynsdorp): Donated by Vanrhynsdorp cactus nursery (–DA)	
L. peersii				
T1984/183 L360			WESTERN CAPE.–3419 (Caledon): Hermanus, Fernkloof. (–AC)	
L. perryae				
T1983/417 L53 (Spies 6861)	22		WESTERN CAPE.–3218 (Clanwilliam): Paleisheuwel (–BC)	Van Rooyen *et al.*, 2002
L. punctata				
T1983/482 L174 (Spies 7344)	14		WESTERN CAPE.–3418 (Simons Town): Cape pinninsula (–BD)	This study
T1983/709 L317 (Spies 7092)	14		WESTERN CAPE.–3218 (Clanwilliam): 19km form Clanwilliam (–BB)	This study

Species	2n	n	Locality	Reference
T1983/920 L276	14		unknown	This study
T1983/921 L277	14		unknown	This study
T1985/208 L381	14		NORTHERN CAPE.–3017 (Hondeklipbaai): Approximately 30km south of Kammieskroon (–BB)	This study
T1985/288 L379	14		WESTERN CAPE.–3418 (Simons Town): 60km from Faure turn off, Cape Town area (–BB)	This study
T1985/289 L380 (Spies 7093)	14		WESTERN CAPE.–3418 (Simons Town): 60km from Faure turn off, Cape Town area (–BB)	Spies *et al.*, 2009
T1991/050	14		WESTERN CAPE.–3318 (Cape Town) Swartriet beach resort (–BB)	This study
L. purpureo-caerulea				
L178			WESTERN CAPE.–3318 (Cape Town): Darling (–AD)	
L. pusilla				
T1983/449 L115 (Spies 7382)	14		Ex ante kirstenbosh	This study
T1998/010			unknown	
L. quadricolor				
T1983/874 (L212)	14		NORTHERN CAPE.–2917 (Springbok): Springbok, (–DB)	This study
T1983/855 (L155)	14	7	WESTERN CAPE.–3218 (Clanwilliam) St Helena Bay (–CC)	Hancke & Liebenberg, 1990
T1983/454 (L123)	14		WESTERN CAPE.–3318 Cape Town): Darling (–AD)	This study
T1983/453 (L122) (Spies 7062)	14+(0-1B)		WESTERN CAPE.–3318 Cape Town): Darling (–AD)	Hancke & Liebenberg, 1990 & Spies *et al.*, 2009 & this study
T1983/440 (L101) (Spies 7359)	14		Unknown *ex hort. Kirstenbosch*	This study
T1983/439 (L100)	21		Unknown *ex hort. Kirstenbosch*	This study
T1993/009			Unknown	
T1992/17	14		Unknown	This study
L. reflexa				
T1983/485 L181 (Spies 7090)	14	7	WESTERN CAPE.–3418 (Simons Town): Dassenberg (–AB)	Hancke & Liebenberg, 1990 and Spies *et al.*, 2009
L222			hadeco	
T1987/008 L387 (Spies 7091)	14		WESTERN CAPE.–3322 (Oudtshoorn): Between Oudtshoorn and Mossel Bay (–CC)	Spies *et al.*, 2009
T1993/050			unknown	
***L. rosea*.**				
L185			WESTERN CAPE.–3419 (Caledon) Caledon (–AB)	
L. sauveolens				
L187			NORTHERN CAPE.–3119	

Species	2n	n	Locality	Reference
			(Calvinia): Vanrhyns Pass (–AC)	
T1985/193/1 (L392/1) (Spies 8015)	28	14	WESTERN CAPE.–3118 (Vanrhynsdorp): On top of Gifberg (–DC)	Spies *et al.*, 2009
T1992/265			NORTHERN CAPE.–3119 (Calvinia) On the oorlogskloof road near Nieuwoudtville (–AC)	
***L. splendida*.**				
L030	16		unknown	Hancke, 1991
L107			Ex ante kirstenbosh	
L183			WESTERN CAPE.–3118 (Vanrhynsdorp) Vredendal (–CB)	
L185			WESTERN CAPE.–3419 (Caledon): Caledon (–AB)	
T1983/530 L305			WESTERN CAPE.–3118 (Vanrhynsdorp) 11km sign from Vredendal to Vanryndorp (–CB)	
T1984/177 L325			unknown	
T1986/180 L417 (Spies 6977)	16	8	WESTERN CAPE.–3118 (Vanrhynsdorp) Vanrhynsdorp, (–CB)	Du Preez *et al.*, 2002 & Spies *et al.*, 2009
T1986/184 L419	16		WESTERN CAPE.–3118 (Vanrhynsdorp): Road between Vanrhynsdorp and Gifberg (–CB)	This study
T1990/031 L437			Unknown	
T1992/319			WESTERN CAPE.–3118 (Vanrhynsdorp): Between Lutzville and Vredendal (–CB)	
L. thomasiae				
T1996/085 (Spies 6985, 6986)	16		WESTERN CAPE.–3319 (Worcester): Brandvleidam (–CB)	Du Preez *et al.*, 2002
L. undulata				
T1983/443 L105			Ex ante kirstenbosh	
L211			Unknown awenant pass	
T1983/877 L216			Unknown steinkloof	
T1983/915 L269			NORTHERN CAPE.–3119 (Calvinia): Nieuwoudtville (–AC)	
T1985/270 L342			NORTHERN CAPE.–2917 (Springbok): Between Springbok and Gamoeb (–DB)	
L. unifolia				
L110			Ex ante kirstenbosh	
T1983/684 L315 (Spies 6889)	22		WESTERN CAPE.–3219 (Wupperthal) at Strauss's farm 6km from Wupperthal at Bidouw crossing (–AC)	Van Rooyen *et al.*, 2002 & Spies *et al.*, 2009
T1983/884 L229 (Spies 6864)	22	11	WESTERN CAPE.–3218 (Clanwillam): Clanwilliam botanical gardens (–BB)	Van Rooyen *et al.*, 2002 & Spies *et al.*, 2009

Species	2n	n	Locality	Reference
T1988/026 L404 (Spies 6871)	22	11	WESTERN CAPE.–3319 (Worcester): North of Gouda (–AC)	Van Rooyen *et al.*, 2002 & Spies *et al.*, 2009
T1993/057 L806 (Spies 6882)	22		unknown	Spies, 2004
T1996/088 (Spies 7094, 7095, 7096)			WESTERN CAPE.–3319 (Worcester): Brandvlei Dam (–CB)	
L. vanzyliae				
T1983/872 (L208)	28		WESTERN CAPE.–3318 (Cape Town): Porterville (–BB)	This study
T1983/883 (L228) (Spies 7361)	28		WESTERN CAPE.–3319 (Worcester): Porterville mountains (–AA)	This study
L. violacea				
L196			Unknown	
L. viridiflora				
T1983/447 L111			Kirstenbosh	
T1983/452 L119	14		Unknown	Hancke, 1991
T1983/492 L194 (Spies 7098)	14		WESTERN CAPE.–3419 (Caledon): Stanford (–AC)	Hancke & Liebenberg, 1990 & Spies, 2004
T1983/922 L279			Unknown	
T1993/060 L800			Ex seed from Rust en Vrede Nursery	
L. zeyheri				
L118			Ex ante kirstenbosh	

APPENDIX C: Complete list of crossing combination used for the study, with general results indicated as compiled from Microsoft access database

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2001/032	L. ALBA	T1997/001/003	L. PALLIDA	L192	SUCCESSFUL	FEW	FEW	Y	
2001/033	L. ALBA	T1997/001/001	L. PALLIDA	T1996/110/001	SUCCESSFUL	Y	FEW	Y	
1994/106	L. ALOIDES	L032	L. ALOIDES VAR.	L038	SUCCESSFUL	FEW	FEW		
1994/117	L. ALOIDES	L057	L. ALOIDES	L039	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1994/118	L. ALOIDES	L038	L. ALOIDES	L057	SUCCESSFUL	Y	FEW		
1995/068	L. ALOIDES	L039	L. ALOIDES	T1992/010	NOT SUCCESSFUL				NO SEEDSET
1997/001	L. ALOIDES	L039	L. ALOIDES	L040	SUCCESSFUL	Y		Y	
1997/004	L. ALOIDES	L040	L. ALOIDES	L039	SUCCESSFUL	Y		Y	
1998/001	L. ALOIDES	L057	L. ALOIDES	L032	SUCCESSFUL	Y	FEW	Y	
1998/002	L. ALOIDES	L032	L. ALOIDES	L057	SUCCESSFUL	Y			
1998/003	L. ALOIDES	L058	L. ALOIDES	L426	SUCCESSFUL	Y			
1998/004	L. ALOIDES	L426	L. ALOIDES	L058	SUCCESSFUL	Y			
1998/005	L. ALOIDES	L426	L. ALOIDES	L041	SUCCESSFUL	Y			
1998/006	L. ALOIDES	L426	L. ALOIDES	L038	SUCCESSFUL	Y			
1998/007	L. ALOIDES	L426	L. ALOIDES	L076	SUCCESSFUL	Y		Y	
1998/008	L. ALOIDES	L041	L. ALOIDES	L426	SUCCESSFUL	FEW	FEW	Y	
1998/009	L. ALOIDES	L038	L. ALOIDES	L426	SUCCESSFUL	FEW		Y	
1998/010	L. ALOIDES	L038	L. ALOIDES	L202	SUCCESSFUL	FEW		Y	
1998/011	L. ALOIDES	L076	L. ALOIDES	L426	SUCCESSFUL	FEW	FEW	Y	
1998/012	L. ALOIDES	L202	L. ALOIDES	L426	SUCCESSFUL	Y	FEW		
1998/013	L. ALOIDES	L202	L. ALOIDES	L076	SUCCESSFUL	FEW		Y	
1998/014	L. ALOIDES	L040	L. ALOIDES	L213	SUCCESSFUL	Y			
1998/016	L. ALOIDES	L213	L. ALOIDES	L040	SUCCESSFUL	FEW	Y		
1999/001	L. ALOIDES	L058	L. ALOIDES	L041	SUCCESSFUL	Y	Y		
1999/002	L. ALOIDES	L058	L. ALOIDES	L038	SUCCESSFUL	Y		Y	
1999/003	L. ALOIDES	L063	L. ALOIDES	L058	SUCCESSFUL	Y	FEW	Y	
1999/004	L. ALOIDES	L063	L. ALOIDES	L426	SUCCESSFUL	Y	Y		
1999/005	L. ALOIDES	L426	L. ALOIDES	L063	SUCCESSFUL	Y			

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1999/006	L. ALOIDES	L426	L. ALOIDES	L202	SUCCESSFUL	Y	FEW	Y	
1999/007	L. ALOIDES	L041	L. ALOIDES	L058	SUCCESSFUL	FEW	Y	Y	
1999/008	L. ALOIDES	L038	L. ALOIDES	L058	SUCCESSFUL	Y			
1999/009	L. ALOIDES	L038	L. ALOIDES	L063	SUCCESSFUL	Y			
1999/010	L. ALOIDES	L038	L. ALOIDES	L041	SUCCESSFUL	Y	Y		
1999/011	L. ALOIDES	L076	L. ALOIDES	L058	SUCCESSFUL	FEW	FEW	Y	
1999/012	L. ALOIDES	L076	L. ALOIDES	L202	SUCCESSFUL	Y		Y	
1999/013	L. ALOIDES	L202	L. ALOIDES	L038	SUCCESSFUL	Y			
1999/014	L. ALOIDES	L202	L. ALOIDES	L041	SUCCESSFUL	FEW	FEW	Y	
2000/174	L. ALOIDES	L032	L. ALOIDES	L038	SUCCESSFUL	Y	FEW		
2000/175	L. ALOIDES	L032	L. ALOIDES	L041	SUCCESSFUL	Y			
2000/176	L. ALOIDES	L057	L. ALOIDES	L038	SUCCESSFUL	Y			
2000/177	L. ALOIDES	L057	L. ALOIDES	L041	SUCCESSFUL	Y			
2000/178	L. ALOIDES	L058	L. ALOIDES	L032	NOT SUCCESSFUL				NO SEEDSET
2000/179	L. ALOIDES	L058	L. ALOIDES	L057	SUCCESSFUL	Y			
2000/180	L. ALOIDES	L058	L. ALOIDES	L076	SUCCESSFUL	FEW			
2000/181	L. ALOIDES	L058	L. ALOIDES	L202	SUCCESSFUL	Y			
2000/182	L. ALOIDES	L063	L. ALOIDES	L032	SUCCESSFUL	Y			
2000/183	L. ALOIDES	L063	L. ALOIDES	L041	SUCCESSFUL	Y			
2000/184	L. ALOIDES	L063	L. ALOIDES	L038	SUCCESSFUL	Y			
2000/185	L. ALOIDES	L063	L. ALOIDES	L057	SUCCESSFUL	Y	FEW		
2000/186	L. ALOIDES	L041	L. ALOIDES	L032	SUCCESSFUL	FEW			
2000/187	L. ALOIDES	L041	L. ALOIDES	L057	SUCCESSFUL	FEW			
2000/188	L. ALOIDES	L041	L. ALOIDES	L063	SUCCESSFUL	Y			
2000/189	L. ALOIDES	L041	L. ALOIDES	L038	NOT SUCCESSFUL				NO SEEDSET
2000/190	L. ALOIDES	L041	L. ALOIDES	L076	SUCCESSFUL	Y			
2000/191	L. ALOIDES	L038	L. ALOIDES	L076	SUCCESSFUL	Y	FEW		
2000/192	L. ALOIDES	L038	L. ALOIDES	L057	SUCCESSFUL	Y			
2000/193	L. ALOIDES	L076	L. ALOIDES	L032	SUCCESSFUL	Y	FEW		
2000/194	L. ALOIDES	L076	L. ALOIDES	L063	SUCCESSFUL	Y			
2000/195	L. ALOIDES	L076	L. ALOIDES	L041	SUCCESSFUL	Y			
2000/196	L. ALOIDES	L076	L. ALOIDES	L057	SUCCESSFUL	FEW			

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2000/197	L. ALOIDES	L202	L. ALOIDES	L057	SUCCESSFUL	FEW			
2000/198	L. ALOIDES	L202	L. ALOIDES	L058	SUCCESSFUL	FEW			
2000/199	L. ALOIDES	L202	L. ALOIDES	L063	SUCCESSFUL	Y			
2000/200	L. ALOIDES	L426	L. ALOIDES	L032	SUCCESSFUL	Y			
2000/201	L. ALOIDES	L426	L. ALOIDES	L057	SUCCESSFUL	Y			
2000/202	L. ALOIDES	L426	L. ALOIDES	L058	SUCCESSFUL	Y			
2000/203	L. ALOIDES	L039	L. ALOIDES	L213	SUCCESSFUL	Y			
2000/231	L. ALOIDES	L213	L. ALOIDES	L039	SUCCESSFUL	Y			
2000/235	L. ALOIDES	L202	L. ALOIDES	L032	SUCCESSFUL	Y			
2001/055	L. ALOIDES	L63	L. ALOIDES	L202	SUCCESSFUL	Y			
2001/059	L. ALOIDES	L32	L. ALOIDES	L426	SUCCESSFUL	FEW			
2001/061	L. ALOIDES	L32	L. ALOIDES	L202	SUCCESSFUL	FEW			
2001/062	L. ALOIDES	L38	L. ALOIDES	L32	SUCCESSFUL	Y			
2001/063	L. ALOIDES	L57	L. ALOIDES	L58	SUCCESSFUL	Y	Y		
2001/065	L. ALOIDES	L57	L. ALOIDES	L426	NOT SUCCESSFUL				MANY ABNORMAL SEEDS
2001/066	L. ALOIDES	L32	L. ALOIDES	L58	SUCCESSFUL	Y		Y	
2001/067	L. ALOIDES	L76	L. ALOIDES	L38	SUCCESSFUL	FEW			
2001/071	L. ALOIDES	L32	L. ALOIDES	L76	SUCCESSFUL	Y			
2001/075	L. ALOIDES	L57	L. ALOIDES	L426	SUCCESSFUL	FEW	FEW		
2001/076	L. ALOIDES	L41	L. ALOIDES	L202	NOT SUCCESSFUL				NO SEEDSET
2001/078	L. ALOIDES	L57	L. ALOIDES	L63	NOT SUCCESSFUL				NO SEEDSET
2001/079	L. ALOIDES	L32	L. ALOIDES	L76	NOT SUCCESSFUL				NO SEEDSET
2001/082	L. ALOIDES	L63	L. ALOIDES	L76	SUCCESSFUL	FEW			
2001/098	L. ALOIDES	L32	L. ALOIDES	L63	SUCCESSFUL	Y			
2001/099	L. ALOIDES	L76	L. ALOIDES	L202	SUCCESSFUL	FEW			
2002/323	L. ALOIDES	L058	L. ALOIDES	L063	SUCCESSFUL	FEW			
2002/326	L. ALOIDES	L057	L. ALOIDES	L076	SUCCESSFUL	FEW			
1999/017	L. ALOIDES	L042	L. ALOIDES	L213	SUCCESSFUL	FEW	FEW	Y	
1995/067	L. ALOIDES	L042	L. ALOIDES	T1992/010	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1997/002	L. ALOIDES	L039	L. ALOIDES	L042	SUCCESSFUL	Y	FEW		
1997/007	L. ALOIDES	L042	L. ALOIDES	L039	SUCCESSFUL	Y	FEW	Y	

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1997/008	L. ALOIDES	L042	L. ALOIDES	L040	SUCCESSFUL	Y	FEW	Y	
1998/017	L. ALOIDES	L213	L. ALOIDES	L042	SUCCESSFUL	Y			
1997/005	L. ALOIDES	L040	L. ALOIDES	L042	SUCCESSFUL	Y	FEW	Y	
1994/134	L. ALOIDES VAR. NELSONII	L440	L. ALOIDES	L076	SUCCESSFUL	Y	FEW		
1995/062	L. ALOIDES VAR. NELSONII	L440/2	L. ALOIDES	L126	SUCCESSFUL	Y	FEW	Y	
1995/063	L. ALOIDES VAR. NELSONII	L440/2	L. ALOIDES	L076	SUCCESSFUL	Y	FEW	Y	
1995/073	L. ALOIDES	L041	L. ALOIDES VAR. NELSONII	L440	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2000/233	L. ALOIDES	L126	L. ALOIDES VAR. NELSONII	L440	SUCCESSFUL	Y			
2000/234	L. ALOIDES VAR. NELSONII	L440	L. ALOIDES VAR.	L126	SUCCESSFUL	Y			
1974/005	L. ALOIDES	L032	L. BIFOLIA	L023	NOT SUCCESSFUL				ABNORMAL SEEDS
1974/015	L. ALOIDES	L057	L. BIFOLIA	L023	NOT SUCCESSFUL				ABNORMAL SEEDS
1974/014	L. ALOIDES	L042	L. BIFOLIA	L023	NOT SUCCESSFUL				ABNORMAL SEEDS
1992/195	L. ALOIDES	L440	L. CARNOSA	L349	NOT SUCCESSFUL				NO SEEDSET
1994/130	L. ALOIDES VAR. NELSONII	L440	L. CONCORDIANA	T1992/296/006	NOT SUCCESSFUL				NO SEEDSET
1994/131	L. ALOIDES VAR. NELSONII	L440	L. CONCORDIANA	T1992/296/002	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1992/196	L. ALOIDES	L440	L. ELEGANS	L272	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/119	L. ALOIDES	L039	L. FLAVA	L068	SUCCESSFUL	Y	FEW	Y	
1994/136	L. ALOIDES VAR. NELSONII	L440	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1974/020	L. ALOIDES	L057	L. MUTABILIS	L015	NOT SUCCESSFUL				NO SEEDSET
1974/022	L. ALOIDES	L033	L. MUTABILIS	L015	NOT SUCCESSFUL				NO SEEDSET
1974/019	L. ALOIDES	L045	L. MUTABILIS	L015	NOT SUCCESSFUL				NO SEEDSET
1974/023	L. ALOIDES	L042	L. MUTABILIS	L015	NOT SUCCESSFUL				NO SEEDSET
1974/021	L. ALOIDES	L057	L. ORCHIOIDES	L061	NOT SUCCESSFUL				NO SEEDSET
1974/017	L. ALOIDES	L042	L. ORCHIOIDES	L061	NOT SUCCESSFUL				NO SEEDSET
1994/129	L. ALOIDES VAR. NELSONII	L440	L. ORCHIOIDES	T1990/058/003	NOT SUCCESSFUL				NO SEEDSET
1992/197	L. ALOIDES	L440	L. PUNCTATA	L277	SUCCESSFUL	Y			
1994/105	L. ALOIDES	L032	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/111	L. ALOIDES VAR. NELSONII	L202	L. PUNCTATA	L380	SUCCESSFUL	Y	Y		
1993/223	L. ALOIDES VAR. NELSONII	L440	L. PUNCTATA	T1991/050/009	SUCCESSFUL	FEW	FEW	Y	
1994/128	L. ALOIDES VAR. NELSONII	L440	L. PUNCTATA	T1991/050/013	SUCCESSFUL	FEW	FEW	Y	
1994/132	L. ALOIDES VAR. NELSONII	L440	L. PUNCTATA	L380	SUCCESSFUL	FEW	Y	Y	
1994/133	L. ALOIDES VAR. PEARSONII	L440	L. PUNCTATA	L317	SUCCESSFUL	FEW	Y	Y	
1999/015	L. ALOIDES	L039	L. QUADRICOLOR	L155	SUCCESSFUL	Y			
1999/016	L. ALOIDES	L040	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
1999/018	L. ALOIDES	L042	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
1999/019	L. ALOIDES	L042	L. QUADRICOLOR	L123	SUCCESSFUL	FEW	FEW	Y	
1999/020	L. ALOIDES	L213	L. QUADRICOLOR	L123	NOT SUCCESSFUL				NO SEEDSET
1999/021	L. ALOIDES	L213	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2000/230	L. ALOIDES	L213	L. QUADRICOLOR	L123	SUCCESSFUL	FEW		Y	
1994/120	L. ALOIDES	L040	L. QUADRICOLOR	L101	SUCCESSFUL	Y	FEW		
1994/121	L. ALOIDES	L063	L. QUADRICOLOR	L122	SUCCESSFUL	Y	FEW	Y	
1994/122	L. ALOIDES	L076	L. QUADRICOLOR	L212	SUCCESSFUL	Y	Y		
1994/138	L. ALOIDES	L126	L. QUADRICOLOR	T1992/017	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1997/003	L. ALOIDES	L039	L. QUADRICOLOR	L101	SUCCESSFUL	Y	FEW	Y	
1997/006	L. ALOIDES	L040	L. QUADRICOLOR	L155	SUCCESSFUL	FEW	FEW	Y	
1997/009	L. ALOIDES	L042	L. QUADRICOLOR	L101	SUCCESSFUL	Y	FEW	Y	
1997/010	L. ALOIDES	L042	L. QUADRICOLOR	L155	SUCCESSFUL	FEW		Y	
1998/015	L. ALOIDES	L040	L. QUADRICOLOR	L101	SUCCESSFUL	Y		Y	
1998/018	L. ALOIDES	L213	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	FEW	Y	
2000/204	L. ALOIDES	L039	L. QUADRICOLOR	L122	SUCCESSFUL	Y			
2000/205	L. ALOIDES	L039	L. QUADRICOLOR	L123	SUCCESSFUL	Y			
2000/206	L. ALOIDES	L040	L. QUADRICOLOR	L123	SUCCESSFUL	Y			
2000/207	L. ALOIDES	L040	L. QUADRICOLOR	L212	SUCCESSFUL	Y			
2000/208	L. ALOIDES	L040	L. QUADRICOLOR	T1992/017	SUCCESSFUL	Y	FEW		
2000/209	L. ALOIDES	L042	L. QUADRICOLOR	L212	SUCCESSFUL	Y			
2000/210	L. ALOIDES	L042	L. QUADRICOLOR	T1992/017	SUCCESSFUL	Y	Y		
2000/211	L. ALOIDES	L042	L. QUADRICOLOR	T1993/009/007	SUCCESSFUL	Y			
2000/232	L. ALOIDES	L213	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
2001/054	L. ALOIDES	L40	L. QUADRICOLOR	T1993/009	SUCCESSFUL	Y			
2001/058	L. ALOIDES	L39	L. QUADRICOLOR	T1992/017	SUCCESSFUL	Y	Y		
2001/064	L. ALOIDES	L213	L. QUADRICOLOR	T1993/009	SUCCESSFUL	Y			
2001/068	L. ALOIDES	L213	L. QUADRICOLOR	T1992/017	SUCCESSFUL	FEW	FEW		
2001/070	L. ALOIDES	L40	L. QUADRICOLOR	T1993/009	SUCCESSFUL	Y			
2001/083	L. ALOIDES	L39	L. QUADRICOLOR	L212	SUCCESSFUL	FEW			
2001/085	L. ALOIDES	L213	L. QUADRICOLOR	L123	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
2001/093	L. ALOIDES	L039	L. QUADRICOLOR	T1993/009	SUCCESSFUL	Y			
1994/137	L. ALOIDES VAR. NELSONII	L440	L. QUADRICOLOR	L155	SUCCESSFUL	Y	FEW	Y	
1995/061	L. ALOIDES VAR. NELSONII	L440/1	L. QUADRICOLOR	L155	SUCCESSFUL	Y		Y	

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1974/004	L. ALOIDES	L032	L. SPLENDIDA	L030	NOT SUCCESSFUL				NO SEEDSET
1974/006	L. ALOIDES	L032	L. SPLENDIDA	L030	NOT SUCCESSFUL				NO SEEDSET
1974/008	L. ALOIDES	L038	L. SPLENDIDA	L030	NOT SUCCESSFUL				NO SEEDSET
1974/009	L. ALOIDES	L041	L. SPLENDIDA	L030	NOT SUCCESSFUL				NO SEEDSET
1974/012	L. ALOIDES	L057	L. SPLENDIDA	L030	NOT SUCCESSFUL				NO SEEDSET
1974/011	L. ALOIDES	L042	L. SPLENDIDA	L030	NOT SUCCESSFUL				NO SEEDSET
1992/247	L. ALOIDES	L440	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1984/021	L. ANGUINEA	L087	L. BIFOLIA		NOT SUCCESSFUL				NO SEEDSET
1984/021	L. ANGUINEA	L087	L. BIFOLIA		NOT SUCCESSFUL				NO SEEDSET
2001/515	L. BACHMANII	L127	L. BACHMANII	L16	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2002/299	L. BACHMANII	L016	L. BACHMANII	L127	SUCCESSFUL	Y	FEW	Y	
2004/451	L. BACHMANII	L016	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2005/383	L. BACHMANII	L016	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
1993/185	L. BACHMANII	L016	L. BIFOLIA	T1991/046/011	NOT SUCCESSFUL				NO SEEDSET
1993/262	L. BACHMANII	L016	L. BIFOLIA	T1991/049/013	NOT SUCCESSFUL				NO SEEDSET
2003/203	L. BACHMANII	L016	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/332	L. BACHMANII	L016	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2004/445	L. BACHMANII	L016	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/446	L. BACHMANII	L016	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/480	L. BACHMANII	L127	L. BIFOLIA	L389	SUCCESSFUL	FEW		Y	
2004/481	L. BACHMANII	L127	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2005/370	L. BACHMANII	L016	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2007/097	L. BACHMANII	L016	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
1992/108	L. BACHMANII	L016	L. CARNOSA	L331	SUCCESSFUL	Y	FEW		

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2003/338	L. BACHMANII	L016	L. CONTAMINATA	L082	SUCCESSFUL	FEW	FEW	Y	
2005/374	L. BACHMANII	L016	L. CONTAMINATA	L082	SUCCESSFUL	FEW	FEW	Y	
1993/189	L. BACHMANII	L135	L. ELEGANS	L323	NOT SUCCESSFUL				NO SEEDSET
2003/341	L. BACHMANII	L016	L. ELEGANS	L272	NOT SUCCESSFUL				NO SEEDSET
2001/437	L. BACHMANII	L16	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET
2001/438	L. BACHMANII	L16	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
2001/511	L. BACHMANII	L127	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/512	L. BACHMANII	L127	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/440	L. BACHMANII	L016	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/104	L. BACHMANII	L016	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET
2006/105	L. BACHMANII	L016	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
2005/379	L. BACHMANII	L016	L. LILIFLORA	L290	SUCCESSFUL	FEW	FEW	Y	
2005/380	L. BACHMANII	L016	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/113	L. BACHMANII	L016	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2008/264	L. BACHMANII	L016	L. LILIFLORA	L290	SUCCESSFUL	FEW		Y	
2008/266	L. BACHMANII	L016	L. LILIFLORA	T1993/032	SUCCESSFUL	FEW	FEW	Y	
2003/336	L. BACHMANII	L016	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/450	L. BACHMANII	L016	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2005/372	L. BACHMANII	L016	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/337	L. BACHMANII	L016	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2005/373	L. BACHMANII	L016	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2003/334	L. BACHMANII	L016	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/335	L. BACHMANII	L016	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET AND FEW

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
									ABNORMAL SEEDS
2004/448	L. BACHMANII	L016	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/449	L. BACHMANII	L016	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/483	L. BACHMANII	L127	L. MUTABILIS	L161	SUCCESSFUL	FEW	FEW	Y	
2004/484	L. BACHMANII	L127	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/371	L. BACHMANII	L016	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/333	L. BACHMANII	L016	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/447	L. BACHMANII	L016	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2004/482	L. BACHMANII	L127	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET
1993/190	L. BACHMANII	L135	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/051	L. BACHMANII	L135	L. PALLIDA	T1996/110/003	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/339	L. BACHMANII	L016	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2003/340	L. BACHMANII	L016	L. PALLIDA	L406	SUCCESSFUL	FEW	FEW	Y	
2005/375	L. BACHMANII	L016	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2005/376	L. BACHMANII	L016	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2008/263	L. BACHMANII	L016	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2003/342	L. BACHMANII	L016	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2005/377	L. BACHMANII	L016	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2006/111	L. BACHMANII	L016	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
1993/186	L. BACHMANII	L016	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
1993/187	L. BACHMANII	L016	L. PUNCTATA	L380	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/192	L. BACHMANII	L016	L. PUNCTATA	L277	NOT SUCCESSFUL				MANY ABNORMAL SEEDS
2003/202	L. BACHMANII	L016	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2003/417	L. BACHMANII	L127	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
2003/418	L. BACHMANII	L127	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2004/442	L. BACHMANII	L016	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/443	L. BACHMANII	L016	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/107	L. BACHMANII	L016	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
2006/108	L. BACHMANII	L016	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2001/398	L. BACHMANII	L16	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/399	L. BACHMANII	L16	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/439	L. BACHMANII	L16	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/440	L. BACHMANII	L16	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/489	L. BACHMANII	L127	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/510	L. BACHMANII	L127	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2001/513	L. BACHMANII	L127	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/514	L. BACHMANII	L127	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/441	L. BACHMANII	L016	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/103	L. BACHMANII	L016	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2007/093	L. BACHMANII	L016	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET
2007/094	L. BACHMANII	L016	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2007/095	L. BACHMANII	L016	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
1993/188	L. BACHMANII	L016	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/485	L. BACHMANII	L016	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/381	L. BACHMANII	L016	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2006/114	L. BACHMANII	L016	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2008/265	L. BACHMANII	L016	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEED

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2001/052	L. BACHMANII	L135	L. THOMASIAE	T1996/085/004	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/343	L. BACHMANII	L016	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2005/378	L. BACHMANII	L016	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2006/112	L. BACHMANII	L016	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
1979/043	L. BACHMANII	L127	L. VANZYLIAE	L208	NOT SUCCESSFUL				NO SEEDSET
2007/096	L. BACHMANII	L016	L. VIFIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2003/331	L. BACHMANII	L016	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/419	L. BACHMANII	L127	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2004/444	L. BACHMANII	L016	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1975/005	L. BIFOLIA	L023	L. ALOIDES	L039	SUCCESSFUL				
1975/028	L. BIFOLIA	L175	L. ALOIDES	L045	NOT SUCCESSFUL				NO SEEDSET
2003/194	L. BIFOLIA	L389	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2003/195	L. BIFOLIA	L389	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2005/041	L. BIFOLIA	L389	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2005/042	L. BIFOLIA	L389	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2005/071	L. BIFOLIA	T1991/049/028	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2006/048	L. BIFOLIA	T1991/049/29	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
1990/029	L. BIFOLIA	L175	L. BIFOLIA	L301	NOT SUCCESSFUL				NO SEEDSET
1990/030	L. BIFOLIA	L298	L. BIFOLIA	L301	NOT SUCCESSFUL				NO SEEDSET
1990/031	L. BIFOLIA	L301	L. BIFOLIA	L175	NOT SUCCESSFUL				NO SEEDSET
1990/032	L. BIFOLIA	L301	L. BIFOLIA	L298	NOT SUCCESSFUL				NO SEEDSET
1990/034	L. BIFOLIA	L389	L. BIFOLIA	L301	NOT SUCCESSFUL				NO SEEDSET
1990/036	L. BIFOLIA	L023	L. BIFOLIA	L301	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1990/037	L. BIFOLIA	L296	L. BIFOLIA	L301	NOT SUCCESSFUL				NO SEEDSET
1990/095	L. BIFOLIA	L301	L. BIFOLIA	L301	SUCCESSFUL	Y	Y		
1993/049	L. BIFOLIA	T1991/070/013	L. BIFOLIA	L390	SUCCESSFUL	Y	FEW	Y	
1993/050	L. BIFOLIA	T1991/070/007	L. BIFOLIA	L301	SUCCESSFUL	FEW		Y	
1993/051	L. BIFOLIA	T1991/070/013	L. BIFOLIA	T1991/064/014	SUCCESSFUL	Y	FEW		
1993/055	L. BIFOLIA	L390	L. BIFOLIA	T1991/070/013	SUCCESSFUL	Y	Y		
1993/056	L. BIFOLIA	L390	L. BIFOLIA	L301	SUCCESSFUL	Y	Y		
1993/057	L. BIFOLIA	L390	L. BIFOLIA	L296	SUCCESSFUL	Y	FEW		
1993/058	L. BIFOLIA	L301	L. BIFOLIA	T1991/070/007	SUCCESSFUL	FEW	Y	Y	
1993/059	L. BIFOLIA	L301	L. BIFOLIA	T1991/064/012	SUCCESSFUL	FEW	Y		
1993/060	L. BIFOLIA	L301	L. BIFOLIA	L390	SUCCESSFUL	Y			
1993/061	L. BIFOLIA	L389	L. BIFOLIA	T1991/049/033	SUCCESSFUL	Y			
1993/064	L. BIFOLIA	T1991/049/033	L. BIFOLIA	L389	SUCCESSFUL	Y			
1993/072	L. BIFOLIA	T1991/064/014	L. BIFOLIA	T1991/070/013	SUCCESSFUL	Y	FEW	Y	
1993/078	L. BIFOLIA	L296	L. BIFOLIA	L301	SUCCESSFUL	Y		Y	
1993/079	L. BIFOLIA	L301	L. BIFOLIA	L296	SUCCESSFUL	Y			
1993/080	L. BIFOLIA	L296	L. BIFOLIA	L390	SUCCESSFUL	FEW		Y	
1993/081	L. BIFOLIA	T1991/064/012	L. BIFOLIA	L301	SUCCESSFUL	Y	Y	Y	
1993/082	L. BIFOLIA	T1991/059/068	L. BIFOLIA	L389	SUCCESSFUL	Y			
1993/083	L. BIFOLIA	T1991/059/076	L. BIFOLIA	L389	SUCCESSFUL	Y			
1993/084	L. BIFOLIA	T1991/059/080	L. BIFOLIA	L389	SUCCESSFUL	Y			
1993/085	L. BIFOLIA	T1991/059/028	L. BIFOLIA	L389	SUCCESSFUL	Y			
1993/102	L. BIFOLIA	L389	L. BIFOLIA	T1991/059/082	SUCCESSFUL	Y			
2001/355	L. BIFOLIA	L389	L. BIFOLIA	T1991/049/009	SUCCESSFUL	Y	Y	Y	
2001/356	L. BIFOLIA	T1991/049/028	L. BIFOLIA	L389	SUCCESSFUL	Y	FEW		
2004/006	L. BIFOLIA	L389	L. BIFOLIA	L389	SUCCESSFUL	FEW	FEW	Y	
2004/010	L. BIFOLIA	T1991/049/013	L. BIFOLIA	T1991/049/013	SUCCESSFUL	Y	FEW	Y	
1990/038	L. BIFOLIA	L301	L. CARNOSA	L331	NOT SUCCESSFUL				NO SEEDSET
1990/039	L. BIFOLIA	L301	L. CARNOSA	L338	NOT SUCCESSFUL				NO SEEDSET
2003/196	L. BIFOLIA	L389	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2005/066	L. BIFOLIA	L389	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2005/072	L. BIFOLIA	T1991/049/025	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2007/029	L. BIFOLIA	T1991/049/029	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2003/197	L. BIFOLIA	L389	L. ELEGANS	L272	NOT SUCCESSFUL				NO SEEDSET
1993/068	L. BIFOLIA	T1991/049/013	L. FLAVA	L144	SUCCESSFUL	FEW		Y	
1993/073	L. BIFOLIA	T1991/046/007	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS AND SEEDLING LETHALITY
1993/075	L. BIFOLIA	T1991/046/014	L. FLAVA	L144	SUCCESSFUL	FEW	FEW	Y	
2001/311	L. BIFOLIA	L389	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET
2001/312	L. BIFOLIA	L389	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
2001/358	L. BIFOLIA	T1991/049/029	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET
2001/359	L. BIFOLIA	T1991/049/029	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2002/022	L. BIFOLIA	L389	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEED
2002/024	L. BIFOLIA	T1991/049/029	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET
2005/065	L. BIFOLIA	L389	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET
2006/040	L. BIFOLIA	T1991/049/15	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
2003/217	L. BIFOLIA	L389	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2003/218	L. BIFOLIA	L389	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET
2005/047	L. BIFOLIA	L389	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/048	L. BIFOLIA	L389	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET
2005/075	L. BIFOLIA	T1991/049/029	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2006/052	L. BIFOLIA	T1991/049/28	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2008/012	L. BIFOLIA	T1991/049/29	L. LILIFLORA	T1993/032/001	NOT SUCCESSFUL				NO SEEDSET
2010/003	L. BIFOLIA	T1991/049/029	L. LILIFLORA	T1993/032/001	NOT SUCCESSFUL				NO SEEDSET
2003/187	L. BIFOLIA	L389	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/188	L. BIFOLIA	L389	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2005/039	L. BIFOLIA	L389	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2005/040	L. BIFOLIA	L389	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2005/070	L. BIFOLIA	T1991/049/028	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2005/274	L. BIFOLIA	T1991/049/029	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2006/038	L. BIFOLIA	L389	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2006/047	L. BIFOLIA	T1991/049/29	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2007/028	L. BIFOLIA	T1991/049/029	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
1986/002	L. BIFOLIA	L298	L. MUTABILIS	L162	NOT SUCCESSFUL				NO SEEDSET
1990/040	L. BIFOLIA	L301	L. MUTABILIS	L162	NOT SUCCESSFUL				NO SEEDSET
1990/041	L. BIFOLIA	L301	L. MUTABILIS	L162	NOT SUCCESSFUL				NO SEEDSET
1990/042	L. BIFOLIA	L301	L. MUTABILIS	L251	NOT SUCCESSFUL				NO SEEDSET
1990/043	L. BIFOLIA	L301	L. MUTABILIS	L307	NOT SUCCESSFUL				NO SEEDSET
1990/044	L. BIFOLIA	L301	L. MUTABILIS	L330	NOT SUCCESSFUL				NO SEEDSET
1990/045	L. BIFOLIA	L389	L. MUTABILIS	L162	NOT SUCCESSFUL				NO SEEDSET
1990/046	L. BIFOLIA	L389	L. MUTABILIS	L330	NOT SUCCESSFUL				NO SEEDSET
1991/002	L. BIFOLIA	L389	L. MUTABILIS	L162	NOT SUCCESSFUL				SEEDLING LETHALITY
1991/003	L. BIFOLIA	L390	L. MUTABILIS	L162	SUCCESSFUL				
1991/004	L. BIFOLIA	L301	L. MUTABILIS	L231	NOT SUCCESSFUL				SEEDLING LETHALITY
1991/005	L. BIFOLIA	L301	L. MUTABILIS	L162	NOT SUCCESSFUL				
1991/006	L. BIFOLIA	L390	L. MUTABILIS	L231	NOT SUCCESSFUL				SEEDLING LETHALITY
1991/051	L. BIFOLIA	L389	L. MUTABILIS	L231	NOT SUCCESSFUL				SEEDLING LETHALITY
2003/185	L. BIFOLIA	L389	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2003/186	L. BIFOLIA	L389	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2004/009	L. BIFOLIA	L389	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2004/017	L. BIFOLIA	T1991/049/013	L. MUTABILIS	L161	SUCCESSFUL	FEW	FEW	Y	
2005/038	L. BIFOLIA	L389	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/069	L. BIFOLIA	T1991/049/028	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2006/045	L. BIFOLIA	T1991/049/29	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2006/046	L. BIFOLIA	T1991/049/29	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2008/011	L. BIFOLIA	T1991/049/029	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1990/047	L. BIFOLIA	L298	L. ORCHIOIDES	L316	NOT SUCCESSFUL				NO SEEDSET
1990/048	L. BIFOLIA	L301	L. ORCHIOIDES	L316	NOT SUCCESSFUL				NO SEEDSET
1990/049	L. BIFOLIA	L298	L. ORCHIOIDES	L316	NOT SUCCESSFUL				NO SEEDSET
1991/009	L. BIFOLIA	L301	L. ORCHIOIDES	L434	NOT SUCCESSFUL				NO SEEDSET
1993/052	L. BIFOLIA	T1991/070/002	L. ORCHIOIDES	T1992/032	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/054	L. BIFOLIA	T1991/070/005	L. ORCHIOIDES	T1992/032	NOT SUCCESSFUL				NO SEEDSET
1993/067	L. BIFOLIA	T1991/049/014	L. ORCHIOIDES	T1992/032	NOT SUCCESSFUL				NO SEEDSET
1993/071	L. BIFOLIA	T1991/049/019	L. ORCHIOIDES	T1992/032	NOT SUCCESSFUL				NO SEEDSET
1993/074	L. BIFOLIA	T1991/046/012	L. ORCHIOIDES	T1992/032	SUCCESSFUL	FEW		Y	
1993/130	L. BIFOLIA	T1991/064/005	L. ORCHIOIDES	T1992/032	SUCCESSFUL	FEW	FEW	Y	
2003/174	L. BIFOLIA	L389	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET
2005/037	L. BIFOLIA	L389	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/037	L. BIFOLIA	L389	L. ORCHIOIDES	T1992/032/6	NOT SUCCESSFUL				NO SEEDSET
2006/044	L. BIFOLIA	T1991/049/29	L. ORCHIOIDES	T1992/032/6	NOT SUCCESSFUL				NO SEEDSET
2007/027	L. BIFOLIA	T1991/049/029	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET
2003/191	L. BIFOLIA	L389	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2003/193	L. BIFOLIA	L389	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2005/043	L. BIFOLIA	L389	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2005/044	L. BIFOLIA	L389	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2005/073	L. BIFOLIA	T1991/049/029	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2005/276	L. BIFOLIA	T1991/049/029	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2007/022	L. BIFOLIA	L389	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2007/030	L. BIFOLIA	T1991/049/029	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2007/031	L. BIFOLIA	T1991/049/029	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND SINGLE ABNORMAL SEEDS
2003/198	L. BIFOLIA	L389	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2005/045	L. BIFOLIA	L389	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET AND FEW

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
									ABNORMAL SEEDS
2005/074	L. BIFOLIA	T1991/049/029	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2006/051	L. BIFOLIA	T1991/049/28	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
1966/026	L. BIFOLIA		L. PUNCTATA		SUCCESSFUL				
1967/039	L. BIFOLIA		L. PUNCTATA		SUCCESSFUL				
1990/018	L. BIFOLIA	L301	L. PUNCTATA	L174	SUCCESSFUL	Y	Y		
1990/019	L. BIFOLIA	L301	L. PUNCTATA	L276	SUCCESSFUL	Y	Y		
1990/020	L. BIFOLIA	L301	L. PUNCTATA	L277	SUCCESSFUL	Y	Y		
1990/021	L. BIFOLIA	L301	L. PUNCTATA	L317	SUCCESSFUL	Y	Y		
1990/022	L. BIFOLIA	L301	L. PUNCTATA	L379	SUCCESSFUL	Y	Y		
1990/023	L. BIFOLIA	L301	L. PUNCTATA	L380	SUCCESSFUL	Y	Y		
1990/024	L. BIFOLIA	L301	L. PUNCTATA	L381	SUCCESSFUL	Y	Y		
1990/026	L. BIFOLIA	L389	L. PUNCTATA	L174	SUCCESSFUL	Y	Y		
1990/027	L. BIFOLIA	L389	L. PUNCTATA	L276	SUCCESSFUL	Y	Y		
1990/028	L. BIFOLIA	L389	L. PUNCTATA	L317	NOT SUCCESSFUL				NO SEEDSET
1992/027	L. BIFOLIA	T1991/070/007	L. PUNCTATA	L174	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1992/028	L. BIFOLIA	T1991/070/007	L. PUNCTATA	L379	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1992/029	L. BIFOLIA	T1991/070/013	L. PUNCTATA	L379	SUCCESSFUL	FEW	FEW	Y	
1992/030	L. BIFOLIA	T1991/049/021	L. PUNCTATA	L174	SUCCESSFUL	FEW	FEW	Y	
1992/032	L. BIFOLIA	T1991/059/085	L. PUNCTATA	L277	SUCCESSFUL	Y(ENKEL		Y	
1992/033	L. BIFOLIA	T1991/059/050	L. PUNCTATA	L277	SUCCESSFUL	Y(ENKEL		Y	
1992/035	L. BIFOLIA	T1991/069/001	L. PUNCTATA	L174	NOT SUCCESSFUL				NO SEEDSET
1992/039	L. BIFOLIA	T1991/064/013	L. PUNCTATA	L277	SUCCESSFUL	FEW		Y	
1993/062	L. BIFOLIA	L389	L. PUNCTATA	L276	SUCCESSFUL	Y	FEW	Y	
1993/063	L. BIFOLIA	L389	L. PUNCTATA	L277	SUCCESSFUL	FEW	FEW	Y	
1993/097	L. BIFOLIA	T1991/059/013	L. PUNCTATA	L276	SUCCESSFUL	FEW		Y	
1993/098	L. BIFOLIA	T1991/059/046	L. PUNCTATA	L276	NOT SUCCESSFUL				NO SEEDSET
1993/099	L. BIFOLIA	T1991/059/105	L. PUNCTATA	L276	SUCCESSFUL	FEW	FEW	Y	
1993/100	L. BIFOLIA	T1991/059/009	L. PUNCTATA	L276	SUCCESSFUL	FEW		Y	
1993/101	L. BIFOLIA	T1991/059/025	L. PUNCTATA	L277	SUCCESSFUL	FEW		Y	

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1993/138	L. BIFOLIA	T1991/059/061	L. PUNCTATA	L277	SUCCESSFUL	FEW	FEW	Y	
1994/064	L. BIFOLIA	T1991/049/006	L. PUNCTATA	L380	SUCCESSFUL	FEW	FEW	Y	
1994/065	L. BIFOLIA	T1991/049/009	L. PUNCTATA	L381	SUCCESSFUL	FEW		Y	
1994/066	L. BIFOLIA	T1991/046/004	L. PUNCTATA	T1991/050/009	SUCCESSFUL	FEW	FEW	Y	
1994/067	L. BIFOLIA	T1991/046/003	L. PUNCTATA	L379	SUCCESSFUL	FEW	FEW	Y	
1994/068	L. BIFOLIA	T1991/047/002	L. PUNCTATA	L380	SUCCESSFUL	FEW		Y	
1994/069	L. BIFOLIA	T1991/047/002	L. PUNCTATA	T1991/050/009	SUCCESSFUL	FEW	FEW	Y	
1994/070	L. BIFOLIA	T1991/048/002	L. PUNCTATA	L381	SUCCESSFUL	FEW	FEW	Y	
1995/045	L. BIFOLIA	T1991/048/001	L. PUNCTATA	L379	SUCCESSFUL	FEW	FEW	Y	
2003/171	L. BIFOLIA	L389	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
2003/172	L. BIFOLIA	L389	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2003/201	L. BIFOLIA	T1991/049/029	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/219	L. BIFOLIA	T1991/049/029	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2004/003	L. BIFOLIA	L389	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/004	L. BIFOLIA	L389	L. PUNCTATA	L381	SUCCESSFUL	FEW	FEW	Y	
2004/012	L. BIFOLIA	T1991/049/029	L. PUNCTATA	L277	SUCCESSFUL	FEW	FEW	Y	
2004/013	L. BIFOLIA	T1991/049/025	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2004/014	L. BIFOLIA	T1991/049/028	L. PUNCTATA	L381	SUCCESSFUL	FEW	FEW	Y	
2006/036	L. BIFOLIA	L389	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2006/042	L. BIFOLIA	T1991/049/16	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
2007/002	L. BIFOLIA	L389	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2007/025	L. BIFOLIA	T1991/049/029	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
2007/026	L. BIFOLIA	T1991/049/029	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2008/009	L. BIFOLIA	L389	L. PUNCTATA	L381	SUCCESSFUL	FEW	FEW	Y	
1975/053	L. BIFOLIA	L175	L. QUADRICOLOR	L122	SUCCESSFUL				
1993/065	L. BIFOLIA	T1991/049/023	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/066	L. BIFOLIA	T1991/049/009	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	FEW	Y	
1993/069	L. BIFOLIA	T1991/049/025	L. QUADRICOLOR	L122	SUCCESSFUL	FEW		Y	
1993/070	L. BIFOLIA	T1991/049/029	L. QUADRICOLOR	L122	SUCCESSFUL	FEW		Y	

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1993/076	L. BIFOLIA	T1991/046/011	L. QUADRICOLOR	L122	SUCCESSFUL	FEW		Y	
2001/309	L. BIFOLIA	L389	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/310	L. BIFOLIA	L389	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2001/313	L. BIFOLIA	T1991/049/009	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2001/352	L. BIFOLIA	L389	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET
2001/353	L. BIFOLIA	L389	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
2001/357	L. BIFOLIA	T1991/049/028	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET
2001/360	L. BIFOLIA	T1991/049/029	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2001/361	L. BIFOLIA	T1991/049/029	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2002/023	L. BIFOLIA	L389	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2004/007	L. BIFOLIA	L389	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/008	L. BIFOLIA	L389	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/011	L. BIFOLIA	T1991/049/029	L. QUADRICOLOR	L101	SUCCESSFUL	FEW		Y	
2005/036	L. BIFOLIA	L389	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
2005/067	L. BIFOLIA	T1991/049/029	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET
2005/068	L. BIFOLIA	T1991/049/013	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2006/035	L. BIFOLIA	L389	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET
2006/039	L. BIFOLIA	T1991/049/15	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET
2006/041	L. BIFOLIA	T1991/049/16	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2007/024	L. BIFOLIA	T1991/049/029	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
1974/002	L. BIFOLIA	L023	L. SPLENDIDA	L030	NOT SUCCESSFUL				NO SEEDSET
1974/003	L. BIFOLIA	L078	L. SPLENDIDA	L030	NOT SUCCESSFUL				ABNORMAL SEEDS
1986/001	L. BIFOLIA	L298	L. SPLENDIDA	L325	NOT SUCCESSFUL				NO SEEDSET
2003/189	L. BIFOLIA	L389	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2003/190	L. BIFOLIA	L389	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2005/049	L. BIFOLIA	L389	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2005/050	L. BIFOLIA	L389	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2005/279	L. BIFOLIA	T1991/049/029	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2006/053	L. BIFOLIA	T1991/049/28	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2009/007	L. BIFOLIA	T1991/049/029	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2010/002	L. BIFOLIA	T1991/049/029	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1992/026	L. BIFOLIA	T1991/070/004	L. UNDULATA	L269/2	NOT SUCCESSFUL				NO SEEDSET
1992/031	L. BIFOLIA	T1991/049/002	L. UNDULATA	L342/2	NOT SUCCESSFUL				NO SEEDSET
1992/034	L. BIFOLIA	T1991/059/082	L. UNDULATA	L269/1	NOT SUCCESSFUL				NO SEEDSET
1992/036	L. BIFOLIA	T1991/046/011	L. UNDULATA	L269/1	NOT SUCCESSFUL				NO SEEDSET
1992/037	L. BIFOLIA	T1991/064/008	L. UNDULATA	L342/2	NOT SUCCESSFUL				NO SEEDSET
1992/038	L. BIFOLIA	T1991/064/019	L. UNDULATA	L342/1	NOT SUCCESSFUL				NO SEEDSET
1992/040	L. BIFOLIA	T1991/047/005	L. UNDULATA	L269/2	NOT SUCCESSFUL				NO SEEDSET
2003/199	L. BIFOLIA	L389	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/046	L. BIFOLIA	L389	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/277	L. BIFOLIA	T1991/049/013	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2007/023	L. BIFOLIA	L389	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2007/032	L. BIFOLIA	T1991/049/029	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2008/010	L. BIFOLIA	L389	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/090	L. BIFOLIA	T1991/059/004	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1993/092	L. BIFOLIA	T1991/059/021	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1993/095	L. BIFOLIA	T1991/059/018	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1993/140	L. BIFOLIA	T1991/059/086	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1993/142	L. BIFOLIA	T1991/059/000	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2003/173	L. BIFOLIA	L389	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2003/220	L. BIFOLIA	T1991/049/029	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2004/005	L. BIFOLIA	L389	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/015	L. BIFOLIA	T1991/049/025	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2004/016	L. BIFOLIA	T1991/049/028	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1986/021	L. BOLUSII	L352	L. SPLENDIDA	L325	NOT SUCCESSFUL				ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1993/242	L. CAPENSIS	L355	L. MAGENTEA	L328	NOT SUCCESSFUL				NO SEEDSET
1993/243	L. CAPENSIS	L355	L. ORTHOPETALA	L164	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
1992/204	L. CARNOSA	L400	L. ALOIDES	L440	NOT SUCCESSFUL				ABNORMAL SEEDS
1992/107	L. CARNOSA	L331	L. BACHMANII	L016	SUCCESSFUL	FEW		Y	
1993/177	L. CARNOSA	L331	L. BIFOLIA	T1991/046/011	NOT SUCCESSFUL				NO SEEDSET
1993/178	L. CARNOSA	T1992/297/001	L. BIFOLIA	T1991/064/015	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1992/203	L. CARNOSA	L349	L. ELEGANS	L392	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/180	L. CARNOSA	T1992/315/002	L. FRAMESII	T1992/270/001	SUCCESSFUL	FEW	FEW		
1994/215	L. CARNOSA	L331/001	L. FRAMESII	T1992/270/001	NOT SUCCESSFUL				ABNORMAL SEEDS
1995/071	L. CARNOSA	T1992/315/001	L. FRAMESII	T1993/025	SUCCESSFUL	Y		Y	
1992/205	L. CARNOSA	L400	L. ORCHIOIDES	L316	NOT SUCCESSFUL				NO SEEDSET
1993/243	L. CARNOSA	L335	L. ORTHOPETALA	L164	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
1981/042	L. CARNOSA	L280	L. PALLIDA	L047	NOT SUCCESSFUL				ABNORMAL SEEDS
1992/112	L. CARNOSA	L393	L. PALLIDA	L285	SUCCESSFUL	Y		Y	
1992/113	L. CARNOSA	L393	L. PALLIDA	T1991/056/002	SUCCESSFUL	Y			
1993/179	L. CARNOSA	T1992/297/001	L. PALLIDA	L397	SUCCESSFUL	Y		Y	
1993/181	L. CARNOSA	T1992/306/001	L. PALLIDA	T1992/330/005	SUCCESSFUL	Y			
2001/007	L. CARNOSA	L338	L. PALLIDA	T1996/110/001	SUCCESSFUL	FEW	FEW	Y	
1993/191	L. CARNOSA	L400	L. PATULA	T1992/301/003	NOT SUCCESSFUL				NO SEEDSET
1993/192	L. CARNOSA	L400	L. PATULA	T1992/301/008	NOT SUCCESSFUL				NO SEEDSET AND FEW

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
									ABNORMAL SEEDS
1994/214	L. CARNOSA	L349	L. PUNCTATA	L277	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
1994/217	L. CARNOSA	T1992/325/005	L. PUSILLA	L115	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1992/098	L. CARNOSA	L331	L. SPLENDIDA	L417	SUCCESSFUL	Y	Y		
1992/106	L. CARNOSA	L393	L. SPLENDIDA	L419	SUCCESSFUL	Y			
1981/043	L. CARNOSA	L280	L. VIRIDIFLORA	L279	NOT SUCCESSFUL				ABNORMAL SEEDS
1984/001	L. CARNOSA	L280	L. VIRIDIFLORA	L194	SUCCESSFUL				
1984/002	L. CARNOSA	L280	L. VIRIDIFLORA	L119	SUCCESSFUL				
1993/252	L. COMPTONII	L284	L. BIFOLIA	T1991/070/003	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/253	L. COMPTONII	L284	L. BIFOLIA	T1991/049/023	NOT SUCCESSFUL				NO SEEDSET
1993/249	L. COMPTONII	L284	L. CAPENSIS	L355	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
1992/276	L. COMPTONII	L284	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
1992/279	L. COMPTONII	L284	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1992/278	L. COMPTONII	L284	L. ORTHOPETALA	L164	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1992/277	L. COMPTONII	L284	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1993/250	L. COMPTONII	L284	L. PUNCTATA	T1991/050/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/251	L. COMPTONII	L284	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/212	L. COMPTONII	L284	L. PUNCTATA	T1991/050/013	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1993/236	L. CONCORDIANA	T1992/296/011	L. ALOIDES VAR. NELSONII	L440	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
1993/235	L. CONCORDIANA	T1992/296/007	L. BIFOLIA	T1991/070/003	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
1994/208	L. CONCORDIANA	T1992/296/007	L. BIFOLIA	T1991/070/004	NOT SUCCESSFUL				NO SEEDSET
1993/237	L. CONCORDIANA	T1992/296/008	L. ORCHIOIDES	L322	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/233	L. CONCORDIANA	T1992/296/006	L. PALLIDA	L406	NOT SUCCESSFUL				FEW ABNORMAL SEEDS AND SEEDLING LETHALITY
1993/234	L. CONCORDIANA	T1992/296/002	L. PUNCTATA	T1991/050/009	NOT SUCCESSFUL				NO SEEDSET
1994/209	L. CONCORDIANA	T1992/296/006	L. PUNCTATA	T1991/050/013	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
2003/354	L. CONTAMINATA	L082	L. BACHMANII	L016	SUCCESSFUL	FEW	FEW	Y	
2003/355	L. CONTAMINATA	L082	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/473	L. CONTAMINATA	L082	L. BACHMANII	L127	SUCCESSFUL	FEW	FEW	Y	
2003/347	L. CONTAMINATA	L082	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/348	L. CONTAMINATA	L082	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/601	L. CONTAMINATA	L082	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2006/602	L. CONTAMINATA	L082	L. BIFOLIA	T1991/049/29	NOT SUCCESSFUL				NO SEEDSET
2009/019	L. CONTAMINATA	L082	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/323	L. CONTAMINATA	L082	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
1992/282	L. CONTAMINATA	L082	L. COMPTONII	L284	NOT SUCCESSFUL				NO SEEDSET
2001/508	L. CONTAMINATA	L82	L. CONTAMINATA	L207	SUCCESSFUL	FEW	FEW	Y	
2001/509	L. CONTAMINATA	T1992/015	L. CONTAMINATA	L82	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2004/479	L. CONTAMINATA	L082	L. CONTAMINATA	L082	SUCCESSFUL	FEW	Y	Y	
2003/358	L. CONTAMINATA	L082	L. ELEGANS	L272	NOT SUCCESSFUL				NO SEEDSET
2001/488	L. CONTAMINATA	L82	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/505	L. CONTAMINATA	L82	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/470	L. CONTAMINATA	L082	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET
2004/471	L. CONTAMINATA	L082	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/327	L. CONTAMINATA	L028	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET
1992/281	L. CONTAMINATA	L082	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2003/361	L. CONTAMINATA	L082	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/362	L. CONTAMINATA	L082	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/477	L. CONTAMINATA	L082	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/328	L. CONTAMINATA	L028	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2009/025	L. CONTAMINATA	L082	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/352	L. CONTAMINATA	L082	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2003/353	L. CONTAMINATA	L082	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEED
2009/022	L. CONTAMINATA	L082	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/350	L. CONTAMINATA	L082	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/351	L. CONTAMINATA	L082	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/603	L. CONTAMINATA	L082	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2008/329	L. CONTAMINATA	L082	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2003/349	L. CONTAMINATA	L082	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1992/280	L. CONTAMINATA	L082	L. ORTHOPETALA	L164	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/356	L. CONTAMINATA	L082	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/357	L. CONTAMINATA	L082	L. PALLIDA	L406	SUCCESSFUL	FEW	FEW	Y	
2004/474	L. CONTAMINATA	L082	L. PALLIDA	L049	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/475	L. CONTAMINATA	L082	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/324	L. CONTAMINATA	L082	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2009/024	L. CONTAMINATA	L082	L. PALLIDA	L049/1	SUCCESSFUL	ONE	FEW	Y	
2003/359	L. CONTAMINATA	L082	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2004/476	L. CONTAMINATA	L082	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2003/344	L. CONTAMINATA	L082	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEED
2003/345	L. CONTAMINATA	L082	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/599	L. CONTAMINATA	L082	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
2006/600	L. CONTAMINATA	L082	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2008/325	L. CONTAMINATA	L082	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
1994/218	L. CONTAMINATA	L114	L. PUSILLA	L115	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1975/051	L. CONTAMINATA	L082	L. QUADRICOLOR	L122	NOT SUCCESSFUL				ABNORMAL SEEDS
2001/486	L. CONTAMINATA	L82	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/506	L. CONTAMINATA	L82	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/291	L. CONTAMINATA	L082	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
2004/468	L. CONTAMINATA	L082	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/469	L. CONTAMINATA	L082	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2004/472	L. CONTAMINATA	L082	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
									ABNORMAL SEEDS
2006/596	L. CONTAMINATA	L082	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2006/598	L. CONTAMINATA	L082	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2008/326	L. CONTAMINATA	L082	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2003/363	L. CONTAMINATA	L082	L. SPLENDIDA	L417	SUCCESSFUL	FEW	FEW	Y	
2003/364	L. CONTAMINATA	L082	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/478	L. CONTAMINATA	L082	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2009/021	L. CONTAMINATA	L082	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/360	L. CONTAMINATA	L082	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2009/023	L. CONTAMINATA	L082	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2003/346	L. CONTAMINATA	L082	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1992/212	L. ELEGANS	L392/2	L. ALOIDES	L440	NOT SUCCESSFUL				NO SEEDSET
1993/207	L. ELEGANS	L323	L. BACHMANII	L135	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/203	L. ELEGANS	L333	L. BIFOLIA	T1991/046/011	NOT SUCCESSFUL				NO SEEDSET
1993/204	L. ELEGANS	L333	L. BIFOLIA	T1991/070/003	NOT SUCCESSFUL				NO SEEDSET
1994/139	L. ELEGANS	L333/001	L. BIFOLIA	T1991/070/004	NOT SUCCESSFUL				NO SEEDSET
1992/214	L. ELEGANS	L392/2	L. CARNOSA	L349	NOT SUCCESSFUL				NO SEEDSET
1992/210	L. ELEGANS	L272	L. ELEGANS	L309	SUCCESSFUL	Y		Y	
2001/479	L. ELEGANS	L333/001	L. ELEGANS	L272	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2007/098	L. ELEGANS	L333/1	L. ELEGANS	L333/1	SUCCESSFUL	FEW	FEW	Y	

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2002/300	L. ELEGANS	L272	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
2002/303	L. ELEGANS	L272	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET
1988/011	L. ELEGANS	L323	L. ORCHIOIDES	L322	NOT SUCCESSFUL				NO SEEDSET
1992/211	L. ELEGANS	L308	L. ORCHIOIDES	L316	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1988/009	L. ELEGANS	L323	L. ORCHIOIDES SUBSP. GLAUCINA	L450	NOT SUCCESSFUL				NO SEEDSET
1992/213	L. ELEGANS	L392/2	L. PALLIDA	L399	NOT SUCCESSFUL				NO SEEDSET
1992/207	L. ELEGANS	L309	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
1992/215	L. ELEGANS	L392/2	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
1993/205	L. ELEGANS	L333	L. PUNCTATA	L380	NOT SUCCESSFUL				NO SEEDSET
1993/206	L. ELEGANS	L333	L. PUNCTATA	T1991/050/009	NOT SUCCESSFUL				NO SEEDSET
1994/140	L. ELEGANS	L333/001	L. PUNCTATA	T1991/050/013	NOT SUCCESSFUL				NO SEEDSET
2001/463	L. ELEGANS	L272/1	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET
2001/478	L. ELEGANS	L272	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2002/301	L. ELEGANS	L272	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2002/302	L. ELEGANS	L272	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
1992/206	L. ELEGANS	L309	L. SAUVEOLENS	L392/1	SUCCESSFUL	FEW		Y	
1992/208	L. ELEGANS	L272	L. SAUVEOLENS	L392/1	SUCCESSFUL	Y		Y	
1976/027	L. ELEGANS	L140	L. VANZYLIAE	L208	NOT SUCCESSFUL				ABNORMAL SEEDS
1981/044	L. ELEGANS	L226	L. VIRIDIFLORA	L279	NOT SUCCESSFUL				NO SEEDSET
1986/023	L. ELEGANS	L308	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1984/023	L. FISTULOSA.		L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1994/114	L. FLAVA	L144	L. ALOIDES	L202	SUCCESSFUL	FEW		Y	

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1994/125	L. FLAVA	L068	L. ALOIDES	L040	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1992/201	L. FLAVA	L124	L. ALOIDES VAR. NELSONII	L440	SUCCESSFUL	Y		Y	
2001/455	L. FLAVA	L144	L. BACHMANII	L16	NOT SUCCESSFUL				NO SEEDSET
2002/259	L. FLAVA	L124	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2002/260	L. FLAVA	L144	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2002/311	L. FLAVA	L124	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2004/425	L. FLAVA	L144	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2005/299	L. FLAVA	L144	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2008/019	L. FLAVA	L124	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
1966/014	L. FLAVA		L. BIFOLIA		SUCCESSFUL				
1993/127	L. FLAVA	L144	L. BIFOLIA	T1991/046/007	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/128	L. FLAVA	L144	L. BIFOLIA	T1991/049/033	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/129	L. FLAVA	L144	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/296	L. FLAVA	L144	L. BIFOLIA	L398	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS
2005/297	L. FLAVA	L144	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2005/309	L. FLAVA	L144	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/339	L. FLAVA	L144	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2001/448	L. FLAVA	L124	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2001/449	L. FLAVA	L124	L. BIFOLIA	T1991/049/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/452	L. FLAVA	L144	L. BIFOLIA	T1991/049/009	NOT SUCCESSFUL				NO SEEDSET
2004/044	L. FLAVA	L144	L. BIFOLIA	L389	SUCCESSFUL	FEW	Y	Y	
2004/045	L. FLAVA	L144	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND MANYABNORMAL SEEDS
2004/419	L. FLAVA	L124	L. BIFOLIA	L389	SUCCESSFUL	FEW	FEW	Y	
2004/420	L. FLAVA	L124	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2007/049	L. FLAVA	L124	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2007/059	L. FLAVA	L124	L. BIFOLIA	L389	SUCCESSFUL	FEW		Y	
2008/018	L. FLAVA	L124	L. BIFOLIA	T1991/049/029	SUCCESSFUL	FEW	MANY	Y	
2002/142	L. FLAVA	L144	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2002/258	L. FLAVA	L124	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2005/298	L. FLAVA	L144	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2007/051	L. FLAVA	L124	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
1992/200	L. FLAVA	L124	L. ELEGANS	L272	NOT SUCCESSFUL				
2001/456	L. FLAVA	L144	L. ELEGANS	L272/1	NOT SUCCESSFUL				NO SEEDSET
2002/312	L. FLAVA	L124	L. ELEGANS	L272	NOT SUCCESSFUL				NO SEEDSET
1995/269	L. FLAVA	L068	L. FLAVA	L124	SUCCESSFUL	Y	FEW		
1995/270	L. FLAVA	L068	L. FLAVA	L144	SUCCESSFUL	Y	FEW		
1995/271	L. FLAVA	L124	L. FLAVA	L068	SUCCESSFUL	Y			
1995/272	L. FLAVA	L124	L. FLAVA	L144	SUCCESSFUL	Y			
1995/273	L. FLAVA	L144	L. FLAVA	L068	SUCCESSFUL	Y		Y	
1995/274	L. FLAVA	L144	L. FLAVA	L124	SUCCESSFUL	Y		Y	
1996/042	L. FLAVA	L068	L. FLAVA	L102	SUCCESSFUL	Y			
1996/043	L. FLAVA	L102	L. FLAVA	L144	SUCCESSFUL	Y			
1996/044	L. FLAVA	L144	L. FLAVA	L102	SUCCESSFUL	Y		Y	
1996/045	L. FLAVA	L124	L. FLAVA	L102	SUCCESSFUL	Y			
2000/173	L. FLAVA	L102	L. FLAVA	L068	SUCCESSFUL	Y	FEW		
2001/386	L. FLAVA	L144	L. FLAVA	L124	SUCCESSFUL	FEW	FEW	Y	
2002/267	L. FLAVA	L144	L. FLAVA	L124	SUCCESSFUL	FEW	FEW	Y	
2002/268	L. FLAVA	L144	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/280	L. FLAVA	L124	L. FLAVA	L124	SUCCESSFUL	FEW	FEW	Y	
2003/281	L. FLAVA	L124	L. FLAVA	L144	SUCCESSFUL	Y	FEW		
2004/052	L. FLAVA	L144	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
2008/028	L. FLAVA	L144	L. FLAVA	L124	SUCCESSFUL	FEW		Y	

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2002/261	L. FLAVA	L144	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET
2002/262	L. FLAVA	L144	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2002/317	L. FLAVA	L124	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET
2005/303	L. FLAVA	L144	L. LILIFLIORA	L290	NOT SUCCESSFUL				NO SEEDSET
2008/021	L. FLAVA	L124	L. LILIFLORA	T1993/032	NOT SUCCESSFUL				NO SEEDSET
2008/022	L. FLAVA	L124	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2008/024	L. FLAVA	L124	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET
2005/338	L. FLAVA	L124	L. LILIFORA	L290	NOT SUCCESSFUL				NO SEEDSET
2001/425	L. FLAVA	L144	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2002/145	L. FLAVA	L144	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2002/315	L. FLAVA	L124	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2002/316	L. FLAVA	L124	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2004/049	L. FLAVA	L144	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2004/423	L. FLAVA	L124	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2005/302	L. FLAVA	L144	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2008/020	L. FLAVA	L124	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2001/424	L. FLAVA	L144	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2001/451	L. FLAVA	L124	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2001/454	L. FLAVA	L144	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2002/257	L. FLAVA	L124	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2003/279	L. FLAVA	L124	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2004/047	L. FLAVA	L144	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2004/048	L. FLAVA	L144	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2004/422	L. FLAVA	L124	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2001/450	L. FLAVA	L124	L. ORCHIOIDES	T1992/032/006/006	NOT SUCCESSFUL				NO SEEDSET
2001/453	L. FLAVA	L144	L. ORCHIOIDES	T1992/032/006/006	NOT SUCCESSFUL				NO SEEDSET
2004/046	L. FLAVA	L144	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET
2004/421	L. FLAVA	L124	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET AND FEW

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
									ABNORMAL SEEDS
2007/050	L. FLAVA	L124	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET
1988/002	L. FLAVA	L095	L. PALLIDA	L372	NOT SUCCESSFUL				NO SEEDSET
1992/199	L. FLAVA	L124	L. PALLIDA	L399	NOT SUCCESSFUL				NO SEEDSET
2002/143	L. FLAVA	L144	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2002/144	L. FLAVA	L144	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2002/313	L. FLAVA	L124	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2007/052	L. FLAVA	L124	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2007/053	L. FLAVA	L124	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2002/265	L. FLAVA	L144	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2003/211	L. FLAVA	L124	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2008/025	L. FLAVA	L124	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
1992/198	L. FLAVA	L124	L. PUNCTATA	L277	SUCCESSFUL	Y			
1994/112	L. FLAVA	L144	L. PUNCTATA	L317	SUCCESSFUL	FEW	FEW	Y	
1994/113	L. FLAVA	L144	L. PUNCTATA	L277	SUCCESSFUL	FEW	FEW	Y	
1994/123	L. FLAVA	L068	L. PUNCTATA	L381	SUCCESSFUL	Y	FEW		
1994/124	L. FLAVA	L068	L. PUNCTATA	T1991/050/013	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/126	L. FLAVA	L124	L. PUNCTATA	T1991/050/013	SUCCESSFUL	Y	FEW	Y	
2001/336	L. FLAVA	L144	L. PUNCTATA	L277	SUCCESSFUL	FEW	FEW	Y	
2001/337	L. FLAVA	L144	L. PUNCTATA	L381	SUCCESSFUL	FEW	FEW	Y	
2001/345	L. FLAVA	L124	L. PUNCTATA	L277	SUCCESSFUL	FEW	Y		
2001/346	L. FLAVA	L124	L. PUNCTATA	L381	SUCCESSFUL	Y	Y		
1966/012	L. FLAVA		L. QUADRICOLOR		SUCCESSFUL				
1966/016	L. FLAVA		L. QUADRICOLOR		SUCCESSFUL				
1994/127	L. FLAVA	L124	L. QUADRICOLOR	L123	SUCCESSFUL	Y	FEW		
2001/384	L. FLAVA	L144	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/385	L. FLAVA	L144	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2001/387	L. FLAVA	L144	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/388	L. FLAVA	L144	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
2003/213	L. FLAVA	L124	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET
2003/214	L. FLAVA	L124	L. QUADRICOLOR	L122	SUCCESSFUL	FEW	FEW	Y	
2003/282	L. FLAVA	L124	L. QUADRICOLOR	L155	SUCCESSFUL	Y	FEW		
2003/283	L. FLAVA	L124	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/050	L. FLAVA	L144	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	FEW	Y	
2004/051	L. FLAVA	L144	L. QUADRICOLOR	L122	SUCCESSFUL	FEW		Y	
2004/053	L. FLAVA	L144	L. QUADRICOLOR	L155	SUCCESSFUL	FEW		Y	
2004/054	L. FLAVA	L144	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/424	L. FLAVA	L124	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	FEW	Y	
2005/308	L. FLAVA	L144	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2006/077	L. FLAVA	L144	L. QUADRICOLOR	L101	SUCCESSFUL	Y	FEW	Y	
2006/635	L. FLAVA	L144	L. QUADRICOLOR	L212	SUCCESSFUL	FEW		Y	
2007/055	L. FLAVA	L124	L. QUADRICOLOR	L101	SUCCESSFUL	Y		Y	
2007/056	L. FLAVA	L124	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2007/057	L. FLAVA	L124	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2007/058	L. FLAVA	L124	L. QUADRICOLOR	L212	SUCCESSFUL	FEW		Y	
2008/027	L. FLAVA	L124	L. QUADRICOLOR	L212	SUCCESSFUL	FEW	FEW	Y	
2002/263	L. FLAVA	L144	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2002/264	L. FLAVA	L144	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2003/165	L. FLAVA	L124	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2003/166	L. FLAVA	L124	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2005/304	L. FLAVA	L144	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2009/006	L. FLAVA	L124	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2008/023	L. FLAVA	L124	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2002/266	L. FLAVA	L144	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2003/212	L. FLAVA	L124	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2007/054	L. FLAVA	L124	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2008/026	L. FLAVA	L124	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2001/338	L. FLAVA	L144	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/447	L. FLAVA	L124	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2004/043	L. FLAVA	L144	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/418	L. FLAVA	L124	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2000/009	L. FRAMESII	T1993/025/002	L. ORCHIOIDES	T1992/032/006	SUCCESSFUL	FEW	Y	Y	
1993/174	L. FRAMESII	T1992/005	L. PUNCTATA	T1991/050/018	SUCCESSFUL	FEW	FEW	Y	
1993/261	L. FRAMESII	T1992/005/000	L. BIFOLIA	T1991/064/014	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1995/069	L. FRAMESII	T1992/005	L. FRAMESII	T1992/270/001	SUCCESSFUL	Y	FEW	Y	
1995/070	L. FRAMESII	T1993/025	L. FRAMESII	T1992/270/001	SUCCESSFUL	Y			
1994/219	L. FRAMESII	T1992/270/001	L. SPLENDIDA	L417	NOT SUCCESSFUL				SEEDLING LETHALITY
1974/031	L. HIRTA	L008	L. ALOIDES	L042	NOT SUCCESSFUL				NO SEEDSET
1975/020	L. HIRTA	L008	L. ALOIDES	L043	SUCCESSFUL				
1975/021	L. HIRTA	L008	L. ALOIDES	L022	SUCCESSFUL				
1974/038	L. HIRTA	L008	L. BIFOLIA	L023	NOT SUCCESSFUL				ABNORMAL SEEDS
1982/045	L. HIRTA		L. PALLIDA	L049	NOT SUCCESSFUL				NO SEEDSET
1974/039	L. HIRTA	L008	L. SPLENDIDA	L030	NOT SUCCESSFUL				ABNORMAL SEEDS
1982/046	L. HIRTA		L. VIRIDIFLORA		NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1982/052	L. ISOPETALA		L. MUTABILIS	L015	NOT SUCCESSFUL				NO SEEDSET
1980/055	L. ISOPETALA	L227	L. VANZYLIAE	L228	NOT SUCCESSFUL				NO SEEDSET
1975/033	L. KLINGHARDTIANA	L210	L. ALOIDES	L022	NOT SUCCESSFUL				SEEDLING LETHALITY
1975/080	L. LILIFLORA	L011	L. ALOIDES	L125	NOT SUCCESSFUL				SEEDLING LETHALITY
2003/383	L. LILIFLORA	T1993/032/001/1	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2003/384	L. LILIFLORA	T1993/032/001/1	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2004/527	L. LILIFLORA	T1993/032/009/4	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2004/528	L. LILIFLORA	T1993/032/009/3	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2004/592	L. LILIFLORA	L290	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2004/593	L. LILIFLORA	L290	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2008/361	L. LILIFLORA	L290	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/376	L. LILIFLORA	T1993/032/001/3	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2003/377	L. LILIFLORA	T1993/032/001/2	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/521	L. LILIFLORA	T1993/032/001/1	L. BIFOLIA	L389	SUCCESSFUL	FEW	FEW	Y	
2004/522	L. LILIFLORA	T1993/032/001/3	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2004/585	L. LILIFLORA	L290	L. BIFOLIA	L389	SUCCESSFUL	FEW	FEW	Y	
2004/586	L. LILIFLORA	L290	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/005	L. LILIFLORA	T1993/032/004	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2008/346	L. LILIFLORA	L290	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2008/348	L. LILIFLORA	L290	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1992/270	L. LILIFLORA	L290	L. COMPTONII	L284	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2008/362	L. LILIFLORA	L290	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1992/271	L. LILIFLORA	L290	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2003/385	L. LILIFLORA	T1993/032/009/5	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2004/529	L. LILIFLORA	T1993/032/001/4	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2004/594	L. LILIFLORA	L290	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/388	L. LILIFLORA	T1993/032/009/5	L. ELEGANS	L272	NOT SUCCESSFUL				NO SEEDSET
2001/499	L. LILIFLORA	T1993/032/009/002	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/500	L. LILIFLORA	T1993/032/009/004	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
2001/501	L. LILIFLORA	T1993/032/009/005	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
2001/527	L. LILIFLORA	L290	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/528	L. LILIFLORA	L290	L. FLAVA	L144	SUCCESSFUL	FEW	FEW	Y	
2003/295	L. LILIFLORA	T1993/032/001/3	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET
2003/296	L. LILIFLORA	T1993/032/001/3	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
2008/356	L. LILIFLORA	L290	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2009/029	L. LILIFLORA	T1993/032/001	L. FLAVA	L124	SUCCESSFUL	FEW	FEW	Y	
2001/543	L. LILIFLORA	L290	L. LILIFLORA	T1993/032/009	SUCCESSFUL	FEW	FEW	Y	
2001/544	L. LILIFLORA	T1993/032/004	L. LILIFLORA	L290	SUCCESSFUL	FEW	FEW	Y	
2004/534	L. LILIFLORA	T1993/032/009/5	L. LILIFLORA	T1993/032/009/5	SUCCESSFUL	FEW		Y	
2008/015	L. LILIFLORA	T1993/032/004	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET
2008/013	L. LILIFLORA	T1993/032/004	L. LILIFLORA	T1993/032/004	SUCCESSFUL	FEW	FEW	Y	
2008/350	L. LILIFLORA	L290	L. LILIFLORA	L290	SUCCESSFUL	FEW	FEW	Y	
2009/026	L. LILIFLORA	L290	L. LILIFLORA	L290	SUCCESSFUL	FEW		Y	
2009/028	L. LILIFLORA	T1993/032/1	L. LILIFLORA	T1993/032/001	SUCCESSFUL	FEW		Y	
2003/381	L. LILIFLORA	T1993/032/001/1	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2004/526	L. LILIFLORA	T1993/032/001/2	L. MEDIANA	L418	SUCCESSFUL	FEW		Y	

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2004/590	L. LILIFLORA	L290	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2008/345	L. LILIFLORA	L290	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2003/382	L. LILIFLORA	T1993/032/001/1	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2004/591	L. LILIFLORA	L290	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2004/603	L. LILIFLORA	T1993/032/004	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2008/353	L. LILIFLORA	L290	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2003/379	L. LILIFLORA	T1993/032/001/2	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2003/380	L. LILIFLORA	T1993/032/001/2	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2004/524	L. LILIFLORA	T1993/032/001/2	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2004/525	L. LILIFLORA	T1993/032/001/2	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2004/588	L. LILIFLORA	L290	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2004/589	L. LILIFLORA	L290	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2008/347	L. LILIFLORA	L290	L. MUTABILIS	L161	SUCCESSFUL	FEW	FEW	Y	
2008/351	L. LILIFLORA	L290	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/378	L. LILIFLORA	T1993/032/001/2	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET
2004/523	L. LILIFLORA	T1993/032/001/1	L. ORCHIOIDES	T1992/032/005	SUCCESSFUL	FEW	FEW	Y	
2004/587	L. LILIFLORA	L290	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/388	L. LILIFLORA	T1993/032/001	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/349	L. LILIFLORA	L290	L. ORCHIOIDES	T1992/032/006	SUCCESSFUL	FEW	FEW	Y	
1992/272	L. LILIFLORA	L290	L. ORTHOPETALA	L164	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2001/048	L. LILIFLORA	T1992/342/001	L. PALLIDA	T1996/110/003	SUCCESSFUL	FEW	FEW	Y	
2003/387	L. LILIFLORA	T1993/032/009/5	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2004/530	L. LILIFLORA	T1993/032/009/3	L. PALLIDA	L049	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/531	L. LILIFLORA	T1993/032/009/4	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/595	L. LILIFLORA	L290	L. PALLIDA	L049/1	SUCCESSFUL	FEW	FEW	Y	

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2004/596	L. LILIFLORA	L290	L. PALLIDA	L406	SUCCESSFUL	FEW	FEW	Y	
2008/007	L. LILIFLORA	T1993/032/004	L. PALLIDA	L049/1	SUCCESSFUL	FEW	FEW	Y	
2008/358	L. LILIFLORA	L290	L. PALLIDA	L406	SUCCESSFUL	FEW	FEW	Y	
2008/363	L. LILIFLORA	L290	L. PALLIDA	L049/1	SUCCESSFUL	Y	FEW	Y	
2008/365	L. LILIFLORA	T1933/032/004	L. PALLIDA	L406	SUCCESSFUL	FEW	FEW	Y	
2003/389	L. LILIFLORA	T1993/032/009/5	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2004/532	L. LILIFLORA	T1993/032/009/1	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2004/597	L. LILIFLORA	L290	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2008/344	L. LILIFLORA	L290	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/298	L. LILIFLORA	T1993/032/006	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
2003/299	L. LILIFLORA	T1993/032/006	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/373	L. LILIFLORA	T1993/032/009/1	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
2003/374	L. LILIFLORA	T1993/032/001/1	L. PUNCTATA	L381	SUCCESSFUL	FEW	FEW	Y	
2004/519	L. LILIFLORA	T1993/032/001/1	L. PUNCTATA	L277	SUCCESSFUL	FEW	FEW	Y	
2004/582	L. LILIFLORA	L290	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/583	L. LILIFLORA	L290	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/644	L. LILIFLORA	L290	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
2006/645	L. LILIFLORA	L290	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2008/355	L. LILIFLORA	L290	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL DEES
2009/027	L. LILIFLORA	L290	L. PUNCTATA	L381	SUCCESSFUL	FEW	FEW	Y	
2010/013	L. LILIFLORA	T1993/032/001	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2010/014	L. LILIFLORA	L290	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/497	L. LILIFLORA	T1993/032/001/003	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/498	L. LILIFLORA	T1993/032/009/003	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2001/502	L. LILIFLORA	T1993/032/009/001	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2001/503	L. LILIFLORA	T1993/032/001/001	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/504	L. LILIFLORA	T1993/032/001/002	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/525	L. LILIFLORA	L290	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/526	L. LILIFLORA	L290	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/541	L. LILIFLORA	L290	L. QUADRICOLOR	L155	SUCCESSFUL	FEW	FEW	Y	
2001/542	L. LILIFLORA	L290	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/293	L. LILIFLORA	T1993/032/001/3	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/294	L. LILIFLORA	T1993/032/001/3	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/297	L. LILIFLORA	T1993/032/001/3	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
2004/517	L. LILIFLORA	T1993/032/001/1	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	FEW	Y	
2004/518	L. LILIFLORA	T1993/032/001/1	L. QUADRICOLOR	L122	SUCCESSFUL	FEW	FEW	Y	
2006/642	L. LILIFLORA	L290	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
2008/343	L. LILIFLORA	L290	L. QUADRICOLOR	L122	SUCCESSFUL	FEW	FEW	Y	
2008/354	L. LILIFLORA	L290	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
2008/364	L. LILIFLORA	L290	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	FEW	Y	
2003/391	L. LILIFLORA	T1993/032/001/4	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEED
2003/392	L. LILIFLORA	T1993/032/009/4	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/533	L. LILIFLORA	T1993/032/009/3	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2004/599	L. LILIFLORA	L290	L. SPLENDIDA	L417	SUCCESSFUL	FEW	FEW	Y	
2004/600	L. LILIFLORA	L290	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2006/643	L. LILIFLORA	L290	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2008/352	L. LILIFLORA	L290	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/359	L. LILIFLORA	L290	L. SPLENDIDA	L419	SUCCESSFUL	FEW		Y	
2010/017	L. LILIFLORA	T1993/032/004	L. SPLENDIDA	L419	SUCCESSFUL	FEW	FEW	Y	
2001/047	L. LILIFLORA	T1992/342/001	L. THOMASIAE	T1996/085/004	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2003/390	L. LILIFLORA	T1993/032/009/4	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2004/598	L. LILIFLORA	L290	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2004/602	L. LILIFLORA	T1993/032/004	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2008/360	L. LILIFLORA	L290	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/375	L. LILIFLORA	T1993/032/001/2	L. VIRIDIFLORA	L194	SUCCESSFUL	FEW	FEW	Y	
2004/520	L. LILIFLORA	T1993/032/001/1	L. VIRIDIFLORA	L194	SUCCESSFUL	FEW	FEW	Y	
2004/584	L. LILIFLORA	L290	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/357	L. LILIFLORA	L290	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1992/216	L. LONGIBRACTEATA	T1991/060/003	L. ORCHIOIDES	L316	SUCCESSFUL	Y	Y		
1992/060	L. LONGIBRACTEATA	T1991/060/006	L. VIRIDIFLORA	L194	SUCCESSFUL	Y			
1992/217	L. LONGIBRACTEATA	T1991/060/003	L. VIRIDIFLORA	L194	SUCCESSFUL	Y			
1993/240	L. MAGENTEA	L328	L. BIFOLIA	T1991/070/003	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/241	L. MAGENTEA	L328	L. BIFOLIA	T1991/046/023	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
1994/210	L. MAGENTEA	L328	L. BIFOLIA	T1991/070/004	NOT SUCCESSFUL				NO SEEDSET AND SEEDLING LETHALITY
1993/238	L. MAGENTEA	L328	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/239	L. MAGENTEA	L328	L. PUNCTATA	L380	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/317	L. MEDIANA	L418	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/318	L. MEDIANA	L418	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2005/392	L. MEDIANA	L418	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2003/458	L. MEDIANA	L158	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET AND FEW

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
									ABNORMAL SEEDS
2003/459	L. MEDIANA	L158	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2004/558	L. MEDIANA	L158	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/312	L. MEDIANA	L418	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/313	L. MEDIANA	L418	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2004/456	L. MEDIANA	L418	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/391	L. MEDIANA	L418	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/442	L. MEDIANA	L158	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2003/443	L. MEDIANA	L158	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2004/555	L. MEDIANA	L158	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2008/341	L. MEDIANA	L158	L. BIFOLIA	T191/049/029	NOT SUCCESSFUL				NO SEEDSET
2003/319	L. MEDIANA	L418	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/460	L. MEDIANA	L158	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2007/116	L. MEDIANA	L418	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2008/332	L. MEDIANA	L158	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2003/322	L. MEDIANA	L418	L. ELEGANS	L272	NOT SUCCESSFUL				NO SEEDSET
2005/390	L. MEDIANA	L418	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/410	L. MEDIANA	L418	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/411	L. MEDIANA	L418	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/453	L. MEDIANA	L418	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/529	L. MEDIANA	L158	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/530	L. MEDIANA	L158	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/549	L. MEDIANA	L158	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2004/550	L. MEDIANA	L158	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
2006/633	L. MEDIANA	L158	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
2008/333	L. MEDIANA	L158	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/325	L. MEDIANA	L418	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/326	L. MEDIANA	L418	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/397	L. MEDIANA	L418	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2007/118	L. MEDIANA	L418	L. LILIFLORA	T1993/032/001	NOT SUCCESSFUL				NO SEEDSET AND SINGLE ABNORMAL SEED
2004/561	L. MEDIANA	L158	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/331	L. MEDIANA	L158	L. LILIFLORA	t1993/032	NOT SUCCESSFUL				NO SEEDSET
2008/339	L. MEDIANA	L158	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2009/018	L. MEDIANA	L158	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/533	L. MEDIANA	L158	L. MEDIANA	L418	SUCCESSFUL	FEW	Y	Y	
2004/460	L. MEDIANA	L418	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/402	L. MEDIANA	L418	L. MEDIANA	L158	SUCCESSFUL	FEW	FEW	Y	
2006/121	L. MEDIANA	L418	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2002/154	L. MEDIANA	L418	L. MEDIANA	L158	SUCCESSFUL	FEW	FEW	Y	
2008/262	L. MEDIANA	L418	L. MEDIANA	L158	SUCCESSFUL	FEW	FEW	Y	
2008/330	L. MEDIANA	L158	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2003/315	L. MEDIANA	L418	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/316	L. MEDIANA	L418	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/459	L. MEDIANA	L418	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/229	L. MEDIANA	L418	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2003/456	L. MEDIANA	L158	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2003/457	L. MEDIANA	L158	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2004/557	L. MEDIANA	L158	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2008/338	L. MEDIANA	L158	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2003/314	L. MEDIANA	L418	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/458	L. MEDIANA	L418	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/398	L. MEDIANA	L418	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET
2003/455	L. MEDIANA	L158	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/556	L. MEDIANA	L158	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/320	L. MEDIANA	L418	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2003/321	L. MEDIANA	L418	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEED
2005/393	L. MEDIANA	L418	L. PALLIDA	L49/1	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/394	L. MEDIANA	L418	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2007/117	L. MEDIANA	L418	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET AND SINGLE ABNORMAL SEED
2003/461	L. MEDIANA	L158	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2003/462	L. MEDIANA	L158	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2008/336	L. MEDIANA	L158	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2008/340	L. MEDIANA	L158	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2003/323	L. MEDIANA	L418	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2004/559	L. MEDIANA	L158	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/395	L. MEDIANA	L418	L. PERRYAE	L53	NOT SUCCESSFUL				NO SEEDSET
2008/342	L. MEDIANA	L158	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2003/243	L. MEDIANA	L418	L. PUNCTATA	L277	NOT SUCCESSFUL				MANY ABNORMAL SEEDS
2003/244	L. MEDIANA	L418	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
									ABNORMAL SEEDS
2007/113	L. MEDIANA	L418	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND 2 ABNORMAL SEED
2007/114	L. MEDIANA	L418	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2008/242	L. MEDIANA	L418	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEESET AND FEW ABNORMAL SEED
2003/329	L. MEDIANA	L158	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/330	L. MEDIANA	L158	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/553	L. MEDIANA	L158	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/634	L. MEDIANA	L158	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2008/334	L. MEDIANA	L158	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/390	L. MEDIANA	L418	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/391	L. MEDIANA	L418	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/412	L. MEDIANA	L418	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/441	L. MEDIANA	L418	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/075	L. MEDIANA	L418	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS
2004/452	L. MEDIANA	L418	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/454	L. MEDIANA	L418	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/455	L. MEDIANA	L418	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2007/112	L. MEDIANA	L418	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND 1 ABNORMAL SEED
2001/495	L. MEDIANA	L158	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/496	L. MEDIANA	L158	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/531	L. MEDIANA	L158	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/532	L. MEDIANA	L158	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/547	L. MEDIANA	L158	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2004/548	L. MEDIANA	L158	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/551	L. MEDIANA	L158	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2004/552	L. MEDIANA	L158	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2003/327	L. MEDIANA	L418	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2004/535	L. MEDIANA	L418	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/399	L. MEDIANA	L418	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2005/400	L. MEDIANA	L418	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS
2004/562	L. MEDIANA	L158	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/563	L. MEDIANA	L158	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2009/017	L. MEDIANA	L158	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/324	L. MEDIANA	L418	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEED
2004/560	L. MEDIANA	L158	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2005/396	L. MEDIANA	L418	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2008/335	L. MEDIANA	L158	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
1992/122	L. MEDIANA	L418	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2003/245	L. MEDIANA	L418	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2007/115	L. MEDIANA	L418	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2003/441	L. MEDIANA	L158	L. VIRIDIFLORA	L194	SUCCESSFUL	FEW	FEW	Y	
2004/554	L. MEDIANA	L158	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2006/641	L. MEDIANA	L158	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2008/337	L. MEDIANA	L158	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1975/013	L. MUTABILIS	L015	L. ALOIDES	L022	SUCCESSFUL				

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2003/311	L. MUTABILIS	L318	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/406	L. MUTABILIS	L318	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2004/438	L. MUTABILIS	L161	L. BACHMANII	L016	SUCCESSFUL	FEW	FEW	Y	
2004/545	L. MUTABILIS	L318	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/352	L. MUTABILIS	L318	L. BACHMANII	127	SUCCESSFUL	FEW		Y	
2005/360	L. MUTABILIS	L161	L. BACHMANII	L127	SUCCESSFUL	FEW	FEW	Y	
2008/043	L. MUTABILIS	L318	L. BACHMANII	L016	SUCCESSFUL	FEW	FEW	Y	
1990/056	L. MUTABILIS	L162	L. BIFOLIA	L175	NOT SUCCESSFUL				NO SEEDSET
1990/057	L. MUTABILIS	L162	L. BIFOLIA	L301	NOT SUCCESSFUL				NO SEEDSET
1991/001	L. MUTABILIS	L162	L. BIFOLIA	L301	NOT SUCCESSFUL				NO SEEDSET
1991/007	L. MUTABILIS	L162	L. BIFOLIA	L390	NOT SUCCESSFUL				NO SEEDSET
2003/300	L. MUTABILIS	L161	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2003/301	L. MUTABILIS	L161	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2003/306	L. MUTABILIS	L318	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2003/307	L. MUTABILIS	L318	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2004/067	L. MUTABILIS	L318	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2004/071	L. MUTABILIS	L161	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/072	L. MUTABILIS	L161	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2004/544	L. MUTABILIS	L318	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1990/058	L. MUTABILIS	L161	L. CARNOSA	L331	SUCCESSFUL	Y	Y		
2003/407	L. MUTABILIS	L318	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/361	L. MUTABILIS	L161	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2007/078	L. MUTABILIS	L318	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET AND SINGLE ABNORMAL SEEDS
2007/085	L. MUTABILIS	L161	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEED

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1990/066	L. MUTABILIS	L161	L. ELEGANS	L309	NOT SUCCESSFUL				NO SEEDSET
2003/410	L. MUTABILIS	L318	L. ELEGANS	L272	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/394	L. MUTABILIS	L318	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET
2001/395	L. MUTABILIS	L318	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
2001/433	L. MUTABILIS	L161	L. FLAVA	L124	SUCCESSFUL	FEW	FEW	Y	
2001/434	L. MUTABILIS	L161	L. FLAVA	L144	SUCCESSFUL	FEW	FEW	Y	
2004/431	L. MUTABILIS	L318	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
1982/028	L. MUTABILIS	L161	L. HIRTA		NOT SUCCESSFUL				NO SEEDSET
2003/413	L. MUTABILIS	L318	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/414	L. MUTABILIS	L318	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/355	L. MUTABILIS	L318	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/366	L. MUTABILIS	L161	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/367	L. MUTABILIS	L161	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET
2006/100	L. MUTABILIS	L161	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2007/090	L. MUTABILIS	L161	L. LILIFLORA	T1993/032/001	SUCCESSFUL	FEW		Y	
2007/429	L. MUTABILIS	L161	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2008/044	L. MUTABILIS	L318	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/045	L. MUTABILIS	L161	L. LILIFLORA	T1993/032	NOT SUCCESSFUL				NO SEEDSET
2003/309	L. MUTABILIS	L318	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2004/074	L. MUTABILIS	L161	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2004/436	L. MUTABILIS	L318	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2003/310	L. MUTABILIS	L318	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/359	L. MUTABILIS	L161	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2007/077	L. MUTABILIS	L318	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2007/084	L. MUTABILIS	L161	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1990/060	L. MUTABILIS	L161	L. MUTABILIS	L162	NOT SUCCESSFUL				NO SEEDSET
1990/064	L. MUTABILIS	L162	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
1995/074	L. MUTABILIS	L018	L. MUTABILIS	L161	SUCCESSFUL	Y	FEW	Y	
1995/075	L. MUTABILIS	L018	L. MUTABILIS	L330	SUCCESSFUL	Y		Y	
1995/076	L. MUTABILIS	L018	L. MUTABILIS	L307	SUCCESSFUL	Y	FEW	Y	
1995/080	L. MUTABILIS	L330	L. MUTABILIS	L018	NOT SUCCESSFUL				NO SEEDSET
1995/081	L. MUTABILIS	L307	L. MUTABILIS	L018	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1995/077	L. MUTABILIS	L018	L. MUTABILIS	T1992/267/004	SUCCESSFUL	Y	FEW	Y	
2000/017	L. MUTABILIS	L162	L. MUTABILIS	T1992/267/004	SUCCESSFUL	Y	Y	Y	
2001/462	L. MUTABILIS	L161	L. MUTABILIS	L318	SUCCESSFUL	Y	FEW	Y	
2001/477	L. MUTABILIS	L318	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/437	L. MUTABILIS	L318	L. MUTABILIS	L318	SUCCESSFUL	FEW	FEW	Y	
2004/439	L. MUTABILIS	L161	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2004/467	L. MUTABILIS	L318	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2005/358	L. MUTABILIS	L318	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2007/083	L. MUTABILIS	L318	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
1990/067	L. MUTABILIS	L161	L. ORCHIOIDES	L316	NOT SUCCESSFUL				NO SEEDSET
2000/018	L. MUTABILIS	T1992/273/003	L. ORCHIOIDES	T1996/091/008	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2000/020	L. MUTABILIS	L162	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET
2000/021	L. MUTABILIS	T1992/273/003	L. ORCHIOIDES	T1992/032/004	NOT SUCCESSFUL				NO SEEDSET
2003/302	L. MUTABILIS	L161	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/308	L. MUTABILIS	L318	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/073	L. MUTABILIS	L161	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/435	L. MUTABILIS	L318	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1981/051	L. MUTABILIS	L161	L. PALLIDA	L047	NOT SUCCESSFUL				ABNORMAL SEEDS
1995/079	L. MUTABILIS	L161	L. PALLIDA	T1992/328/010	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2003/408	L. MUTABILIS	L318	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/409	L. MUTABILIS	L318	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/362	L. MUTABILIS	L161	L. PALLIDA	L49/1	SUCCESSFUL	FEW	FEW	Y	
2005/363	L. MUTABILIS	L161	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2006/098	L. MUTABILIS	L161	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2007/079	L. MUTABILIS	L318	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2007/080	L. MUTABILIS	L318	L. PALLIDA	L406	SUCCESSFUL	FEW		Y	
2007/086	L. MUTABILIS	L161	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2007/087	L. MUTABILIS	L161	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND TWO ABNORMAL SEEDS
2003/411	L. MUTABILIS	L318	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2005/353	L. MUTABILIS	L318	L. PERRYAE	L53	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2007/081	L. MUTABILIS	L318	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2007/088	L. MUTABILIS	L161	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
1990/050	L. MUTABILIS	L161	L. PUNCTATA	L174	SUCCESSFUL	Y			
1990/052	L. MUTABILIS	L161	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
1990/053	L. MUTABILIS	L161	L. PUNCTATA	L317	NOT SUCCESSFUL				NO SEEDSET
1990/054	L. MUTABILIS	L161	L. PUNCTATA	L380	SUCCESSFUL	Y			
1994/230	L. MUTABILIS	T1994/048	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
1994/231	L. MUTABILIS	T1994/048	L. PUNCTATA	L317	NOT SUCCESSFUL				NO SEEDSET
2003/240	L. MUTABILIS	L161	L. PUNCTATA	L277	SUCCESSFUL	FEW		Y	
2003/241	L. MUTABILIS	L161	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2003/303	L. MUTABILIS	L318	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
2003/304	L. MUTABILIS	L318	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2004/068	L. MUTABILIS	L161	L. PUNCTATA	L277	SUCCESSFUL	FEW	FEW	Y	
2004/069	L. MUTABILIS	L161	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/300	L. MUTABILIS	L318	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/433	L. MUTABILIS	L318	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
									ABNORMAL SEEDS
2005/349	L. MUTABILIS	L318	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
2005/350	L. MUTABILIS	L318	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2006/096	L. MUTABILIS	L161	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2007/075	L. MUTABILIS	L318	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2008/042	L. MUTABILIS	L318	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEED
1975/056	L. MUTABILIS	L161	L. QUADRICOLOR	L155	SUCCESSFUL				
1975/060	L. MUTABILIS	L161	L. QUADRICOLOR	L122	NOT SUCCESSFUL				SEEDLING LETHALITY
2001/392	L. MUTABILIS	L318	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	FEW	Y	
2001/393	L. MUTABILIS	L318	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/396	L. MUTABILIS	L318	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/397	L. MUTABILIS	L318	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/413	L. MUTABILIS	L161	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	FEW	Y	
2001/414	L. MUTABILIS	L161	L. QUADRICOLOR	L122	SUCCESSFUL	FEW	FEW	Y	
2001/435	L. MUTABILIS	L161	L. QUADRICOLOR	L155	SUCCESSFUL	FEW	FEW	Y	
2001/436	L. MUTABILIS	L161	L. QUADRICOLOR	L212	SUCCESSFUL	FEW		Y	
2003/216	L. MUTABILIS	L318	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEED
2004/430	L. MUTABILIS	L318	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2004/432	L. MUTABILIS	L318	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/348	L. MUTABILIS	L318	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2007/073	L. MUTABILIS	L318	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2007/074	L. MUTABILIS	L318	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
2003/415	L. MUTABILIS	L318	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/416	L. MUTABILIS	L318	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2004/546	L. MUTABILIS	L318	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/356	L. MUTABILIS	L318	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2005/357	L. MUTABILIS	L318	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/369	L. MUTABILIS	L161	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2006/101	L. MUTABILIS	L161	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2007/091	L. MUTABILIS	L161	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2007/092	L. MUTABILIS	L161	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2003/412	L. MUTABILIS	L318	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2005/354	L. MUTABILIS	L318	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/365	L. MUTABILIS	L161	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2007/082	L. MUTABILIS	L318	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2007/089	L. MUTABILIS	L161	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
1981/050	L. MUTABILIS	L161	L. VIRIDIFLORA	L279	NOT SUCCESSFUL				NO SEEDSET
1982/037	L. MUTABILIS	L161	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1984/022	L. MUTABILIS		L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1984/026	L. MUTABILIS		L. VIRIDIFLORA	L119	NOT SUCCESSFUL				NO SEEDSET
1986/025	L. MUTABILIS	L162	L. VIRIDIFLORA	L194	SUCCESSFUL				
2003/242	L. MUTABILIS	L161	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2003/305	L. MUTABILIS	L318	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2004/070	L. MUTABILIS	L161	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2004/434	L. MUTABILIS	L318	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/351	L. MUTABILIS	L318	L. VIRIDIFLORA	L194	SUCCESSFUL	FEW		Y	
2007/076	L. MUTABILIS	L318	L. VIRIDIFLORA	L194	SUCCESSFUL	FEW		Y	
1993/219	L. NAMAQUENSIS	L028	L. BIFOLIA	T1991/049/023	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/220	L. NAMAQUENSIS	L028	L. BIFOLIA	T1991/070/003	NOT SUCCESSFUL				NO SEEDSET
1994/207	L. NAMAQUENSIS	L028	L. BIFOLIA	T1991/070/004	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/221	L. NAMAQUENSIS	L028	L. PALLIDA	L406	SUCCESSFUL	FEW	FEW		

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1993/217	L. NAMAQUENSIS	L028	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/218	L. NAMAQUENSIS	L028	L. PUNCTATA	T1991/050/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/206	L. NAMAQUENSIS	L028	L. PUNCTATA	T1991/050/013	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1967/038	L. NAMAQUENSIS		L. QUADRICOLOR		SUCCESSFUL				
1975/061	L. NAMAQUENSIS	L028	L. QUADRICOLOR	L155	NOT SUCCESSFUL				ABNORMAL SEEDS
1993/215	L. NAMAQUENSIS	L258	L. SPLENDIDA	L417	SUCCESSFUL	FEW	FEW	Y	
1993/216	L. NAMAQUENSIS	L258	L. SPLENDIDA	L419	SUCCESSFUL	FEW	FEW		
1976/058	L. NERVOSA	L147	L. VANZYLIAE	L208	NOT SUCCESSFUL				ABNORMAL SEEDS
1975/004	L. ORCHIOIDES	L061	L. ALOIDES	L041	SUCCESSFUL				
1992/249	L. ORCHIOIDES	T1990/048/000	L. ALOIDES	L440	SUCCESSFUL	FEW	Y	Y	
1992/250	L. ORCHIOIDES	L322	L. ALOIDES	L440	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1974/048	L. ORCHIOIDES SUBSP. GLAUCINA	L007	L. ALOIDES	L045	NOT SUCCESSFUL				NO SEEDSET
1993/210	L. ORCHIOIDES	T1990/058/003	L. ALOIDES VAR. NELSONII	L440	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/211	L. ORCHIOIDES	T1990/058/004	L. ALOIDES VAR. NELSONII	L440	SUCCESSFUL	FEW		Y	
1973/045	L. ORCHIOIDES SUBSP. GLAUCINA	L005	L. ALOIDES	L033	SUCCESSFUL				
1976/011	L. ORCHIOIDES SUBSP. GLAUCINA	L143	L. ALOIDES	L022	SUCCESSFUL				
2003/228	L. ORCHIOIDES	T1992/032/006	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2003/229	L. ORCHIOIDES	T1992/032/005	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2004/414	L. ORCHIOIDES	T1992/032/006	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2005/078	L. ORCHIOIDES	T1992/032/004/5	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
1993/131	L. ORCHIOIDES	T1992/032	L. BIFOLIA	T1991/070/002	SUCCESSFUL	Y	Y	Y	
1993/132	L. ORCHIOIDES	T1992/032	L. BIFOLIA	T1991/064/005	SUCCESSFUL	Y	FEW	Y	

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1993/133	L. ORCHIOIDES	T1992/032	L. BIFOLIA	T1991/046/007	SUCCESSFUL	Y	FEW	Y	
1993/134	L. ORCHIOIDES	T1992/032/008	L. BIFOLIA	T1991/049/033	SUCCESSFUL	FEW	FEW	Y	
1993/135	L. ORCHIOIDES	T1992/032	L. BIFOLIA	L389	SUCCESSFUL	Y	FEW		
1993/136	L. ORCHIOIDES	T1992/032	L. BIFOLIA	T991/059/000	SUCCESSFUL	Y	FEW		
2003/222	L. ORCHIOIDES	T1992/032/005	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/223	L. ORCHIOIDES	T1992/032/005	L. BIFOLIA	T1991/049/029	SUCCESSFUL	FEW	FEW	Y	
1966/035	L. ORCHIOIDES SUBSP. GLAUCINA		L. BIFOLIA		SUCCESSFUL				
1966/042	L. ORCHIOIDES SUBSP. GLAUCINA		L. BIFOLIA		SUCCESSFUL				
1992/221	L. ORCHIOIDES	L316	L. CARNOSA	L349	NOT SUCCESSFUL				NO SEEDSET
1993/212	L. ORCHIOIDES	L322	L. CONCORDIANA	T1992/296/008	NOT SUCCESSFUL				NO SEEDSET
1994/224	L. ORCHIOIDES	L322	L. CONCORDIANA	T1992/296/006	NOT SUCCESSFUL				NO SEEDSET
2003/230	L. ORCHIOIDES	T1992/032/005	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2007/034	L. ORCHIOIDES	T1992/032/006	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
1988/013	L. ORCHIOIDES	L322	L. ELEGANS	L323	NOT SUCCESSFUL				NO SEEDSET
1992/219	L. ORCHIOIDES	L316	L. ELEGANS	L308	NOT SUCCESSFUL				NO SEEDSET
2003/233	L. ORCHIOIDES	T1992/032/005	L. ELEGANS	L272	NOT SUCCESSFUL				NO SEEDSET
1988/006	L. ORCHIOIDES SUBSP. GLAUCINA	L450	L. ELEGANS	L323	NOT SUCCESSFUL				NO SEEDSET
1992/248	L. ORCHIOIDES	T1990/050/000	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/316	L. ORCHIOIDES	T1992/032/004/002	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET
2001/317	L. ORCHIOIDES	T1992/032/005/001	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/322	L. ORCHIOIDES	T1992/032/005/009	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET
2001/323	L. ORCHIOIDES	T1992/032/005/005	L. FLAVA	L144	SUCCESSFUL	FEW	FEW	Y	
2006/055	L. ORCHIOIDES	T1992/032/4/1	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/112	L. ORCHIOIDES	T1992/032/004	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2010/006	L. ORCHIOIDES	T1992/032/005	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
2000/010	L. ORCHIOIDES	T1992/032/006	L. FRAMESII	T1993/025/002	NOT SUCCESSFUL				NO SEEDSET
2000/014	L. ORCHIOIDES	T1992/032/004	L. FRAMESII	T1992/005	NOT SUCCESSFUL				NO SEEDSET
2003/236	L. ORCHIOIDES	T1992/032/005	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/237	L. ORCHIOIDES	T1992/032/005	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/282	L. ORCHIOIDES	T1992/032/006	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/059	L. ORCHIOIDES	T1992/032/3/3	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2008/113	L. ORCHIOIDES	T1992/032/003	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2010/008	L. ORCHIOIDES	T1992/032/005	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2010/009	L. ORCHIOIDES	T1992/032/003	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2003/226	L. ORCHIOIDES	T1992/032/006	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/227	L. ORCHIOIDES	T1992/032/006	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2007/033	L. ORCHIOIDES	T1992/032/006	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
1994/243	L. ORCHIOIDES	T1992/267/004	L. MUTABILIS	L161	SUCCESSFUL	FEW	FEW		
1994/244	L. ORCHIOIDES	T1992/267/003	L. MUTABILIS	L161	SUCCESSFUL	Y	FEW		
2000/011	L. ORCHIOIDES	T1992/267/004	L. MUTABILIS	L162	SUCCESSFUL	FEW	FEW	Y	
2000/013	L. ORCHIOIDES	T1996/091/007	L. MUTABILIS	T1992/273/003	SUCCESSFUL	Y		Y	
2000/019	L. ORCHIOIDES	T1992/032/006	L. MUTABILIS	L162	NOT SUCCESSFUL				NO SEEDSET
2003/224	L. ORCHIOIDES	T1992/032/005	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2003/225	L. ORCHIOIDES	T1992/032/005	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEED
2004/024	L. ORCHIOIDES	T1992/032/005	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2006/057	L. ORCHIOIDES	T1992/032/4/2	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2008/014	L. ORCHIOIDES	T1992/032	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
1992/252	L. ORCHIOIDES	T1990/048/000	L. ORCHIOIDES	L322	SUCCESSFUL	Y			

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1992/253	L. ORCHIOIDES	L322	L. ORCHIOIDES	T1990/048/000	SUCCESSFUL	Y		Y	
1993/259	L. ORCHIOIDES SUBSP. GLAUCINA	T1993/105/002	L. ORCHIOIDES SUBSP. GLAUCINA	T1993/106/001	SUCCESSFUL	Y	FEW		
1995/051	L. ORCHIOIDES	T1990/058/004	L. ORCHIOIDES	T1990/052	SUCCESSFUL	Y	FEW	Y	
1995/052	L. ORCHIOIDES	L316	L. ORCHIOIDES	T1990/052	SUCCESSFUL	Y			
1995/053	L. ORCHIOIDES	T1992/032/005	L. ORCHIOIDES	T1990/052	SUCCESSFUL	Y			
1995/055	L. ORCHIOIDES	T1990/058/004	L. ORCHIOIDES	T1990/050	SUCCESSFUL	Y		Y	
1995/056	L. ORCHIOIDES	L316	L. ORCHIOIDES	T1990/050	SUCCESSFUL	Y			
1995/057	L. ORCHIOIDES	T1992/032/005	L. ORCHIOIDES	T1990/050	SUCCESSFUL	Y			
2000/012	L. ORCHIOIDES	T1992/267/004	L. ORCHIOIDES	T1992/032/006	SUCCESSFUL	FEW	FEW	Y	
2000/015	L. ORCHIOIDES	T1992/032/004	L. ORCHIOIDES	T1992/267/004	NOT SUCCESSFUL				NO SEEDSET
2000/016	L. ORCHIOIDES	T1992/032/006	L. ORCHIOIDES	T1996/091/008	NOT SUCCESSFUL				NO SEEDSET
2001/415	L. ORCHIOIDES	T1992/032/005	L. ORCHIOIDES	T1992/032/006/002	SUCCESSFUL	Y	FEW	Y	
2001/416	L. ORCHIOIDES	T1992/032/005	L. ORCHIOIDES	T1992/032/004/003	SUCCESSFUL	Y	FEW	Y	
2001/475	L. ORCHIOIDES	T1996/089/001	L. ORCHIOIDES	T1992/032/006/002	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/476	L. ORCHIOIDES	T1996/089/001	L. ORCHIOIDES	T1992/032/004/003	SUCCESSFUL	FEW	FEW	Y	
1966/031	L. ORCHIOIDES		L. PALLIDA		SUCCESSFUL				
1992/218	L. ORCHIOIDES	L316	L. PALLIDA	L399	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1994/229	L. ORCHIOIDES	T1990/058/003	L. PALLIDA	L397	NOT SUCCESSFUL				SEEDLING LETHALITY
2003/231	L. ORCHIOIDES	T1992/032/005	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/232	L. ORCHIOIDES	T1992/032/005	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/080	L. ORCHIOIDES	T1992/032/004/5	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/081	L. ORCHIOIDES	T1992/032/004/3	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2003/234	L. ORCHIOIDES	T1992/032/005	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2005/082	L. ORCHIOIDES	T1992/032/005	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
1992/220	L. ORCHIOIDES	L316	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1993/196	L. ORCHIOIDES	T1992/267/002	L. PUNCTATA	L277	SUCCESSFUL	FEW	FEW		

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1993/197	L. ORCHIOIDES	T1992/267/004	L. PUNCTATA	T1991/050/018	SUCCESSFUL	Y	Y		
1994/222	L. ORCHIOIDES	T1992/032/002	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/223	L. ORCHIOIDES	T1992/032/007	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND SEEDLING LETHALITY
1994/226	L. ORCHIOIDES	L322	L. PUNCTATA	L380	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/227	L. ORCHIOIDES	T1990/050	L. PUNCTATA	T1991/050/013	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/228	L. ORCHIOIDES	T1990/050	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1994/237	L. ORCHIOIDES	T1990/058/004	L. PUNCTATA	L381	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
1994/238	L. ORCHIOIDES	T1990/058/004	L. PUNCTATA	L317	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/184	L. ORCHIOIDES	T1992/032/004/1	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/200	L. ORCHIOIDES	T1992/032/004/5	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
1966/036	L. ORCHIOIDES SUBSP. GLAUCINA		L. PUNCTATA		SUCCESSFUL				
1987/015	L. ORCHIOIDES.	L316	L. PUNCTATA	L277	NOT SUCCESSFUL				ABNORMAL SEEDS
1994/232	L. ORCHIOIDES SUBSP. GLAUCINA	T1993/106/002	L. PUNCTATA	L380	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/233	L. ORCHIOIDES SUBSP. GLAUCINA	T1993/106/003	L. PUNCTATA	T1991/050/013	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/234	L. ORCHIOIDES SUBSP. GLAUCINA	T1993/105/002	L. PUNCTATA	L277	SUCCESSFUL	FEW	Y	Y	
1994/235	L. ORCHIOIDES SUBSP. GLAUCINA	T1993/105/003	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2001/314	L. ORCHIOIDES	T1992/032/006/006	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/315	L. ORCHIOIDES	T1992/032/006/002	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/318	L. ORCHIOIDES	T1992/032/001/003	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2001/319	L. ORCHIOIDES	T1992/032/004/003	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/320	L. ORCHIOIDES	T1992/032/005/009	L. QUADRICOLOR	L155	SUCCESSFUL	FEW	FEW	Y	
2001/321	L. ORCHIOIDES	T1992/032/005/004	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	FEW	Y	
2001/324	L. ORCHIOIDES	T1992/032/005/003	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/325	L. ORCHIOIDES	T1992/032/004/001	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2004/018	L. ORCHIOIDES	T1992/032/044	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET
2004/019	L. ORCHIOIDES	T1992/032/005	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET
2004/020	L. ORCHIOIDES	T1992/032/003/3	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2004/021	L. ORCHIOIDES	T1992/032/005	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2004/466	L. ORCHIOIDES	T1992/032/005	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2006/054	L. ORCHIOIDES	T1992/032/4/1	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET
2006/056	L. ORCHIOIDES	T1992/032/4/2	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
1975/054	L. ORCHIOIDES SUBSP. GLAUCINA	L143	L. QUADRICOLOR	L155	SUCCESSFUL				
2003/239	L. ORCHIOIDES	T1992/032/005	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2006/060	L. ORCHIOIDES	T1992/032/5	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2007/035	L. ORCHIOIDES	T1992/032/006	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2003/235	L. ORCHIOIDES	T1992/032/005	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2005/280	L. ORCHIOIDES	T1992/032/006	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
1992/251	L. ORCHIOIDES	L322	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2003/221	L. ORCHIOIDES	T1992/032/005	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2004/022	L. ORCHIOIDES	T1992/032/004/5	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2004/023	L. ORCHIOIDES	T1992/032/005	L. VIRIDIFLORA	L194	SUCCESSFUL	FEW	FEW	Y	
1987/002	L. ORCHIOIDES	L316	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				ABNORMAL SEEDS
2005/076	L. ORCHIOIDES	T1992/032/004/2	L.VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1993/247	L. ORTHOPETALA	L164	L. BIFOLIA	T1991/070/012	NOT SUCCESSFUL				NO SEEDSET
1993/248	L. ORTHOPETALA	L164	L. BIFOLIA	T1991/049/023	NOT SUCCESSFUL				NO SEEDSET
1993/244	L. ORTHOPETALA	L164	L. CAPENSIS	L355	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
1992/273	L. ORTHOPETALA	L164	L. COMPTONII	L284	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1992/274	L. ORTHOPETALA	L164	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1992/275	L. ORTHOPETALA	L164	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1982/074	L. ORTHOPETALA	L165	L. PALLIDA	L109	NOT SUCCESSFUL				NO SEEDSET
1993/245	L. ORTHOPETALA	L164	L. PUNCTATA	L380	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1993/246	L. ORTHOPETALA	L164	L. PUNCTATA	L381	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
2001/031	L. PALLIDA	L192	L. ALBA	T1997/001/003	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1975/011	L. PALLIDA	L047	L. ALOIDES	L042	NOT SUCCESSFUL				
1975/042	L. PALLIDA	L046	L. ALOIDES	L022	NOT SUCCESSFUL				SEEDLING LETHALITY
1992/181	L. PALLIDA	L399	L. ALOIDES	L440	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1975/045	L. PALLIDA	L047	L. ALOIDES	L045	NOT SUCCESSFUL				ABNORMAL SEEDS
1993/224	L. PALLIDA	L406	L. ALOIDES VAR. NELSONII	L440	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1995/078	L. PALLIDA	L406	L. BACHMANII	L135	NOT SUCCESSFUL				NO SEEDSET
2000/239	L. PALLIDA	T1992/012/005	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2001/019	L. PALLIDA	T1996/110/003	L. BACHMANII	L16	SUCCESSFUL	FEW		Y	
2001/040	L. PALLIDA	L192	L. BACHMANII	L16	SUCCESSFUL	FEW	FEW	Y	
2003/431	L. PALLIDA	L406	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2003/432	L. PALLIDA	L406	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2003/446	L. PALLIDA	L049/1	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2004/497	L. PALLIDA	L049/1	L. BACHMANII	L016	SUCCESSFUL	FEW	Y	Y	
2006/623	L. PALLIDA	L049/1	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2008/283	L. PALLIDA	L049/1	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
1993/195	L. PALLIDA	T1992/330/008	L. BIFOLIA	T1991/070/012	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
1993/199	L. PALLIDA	L397	L. BIFOLIA	T1991/049/033	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2003/368	L. PALLIDA	L406	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/369	L. PALLIDA	L406	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2003/423	L. PALLIDA	L049/1	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/424	L. PALLIDA	L049/1	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/492	L. PALLIDA	L049/1	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2004/493	L. PALLIDA	L049/1	L. BIFOLIA	T1991/049/023	NOT SUCCESSFUL				NO SEEDSET
2004/503	L. PALLIDA	L406	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2006/619	L. PALLIDA	L049/1	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2007/101	L. PALLIDA	L406	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2008/281	L. PALLIDA	L049/1	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2008/288	L. PALLIDA	L049/1	L. BIFOLIA	L389	NOT SUCCESSFUL	FEW	FEW	Y	NO SEEDSET AND FEW ABNORMAL SEEDS
1992/111	L. PALLIDA	L285	L. CARNOSA	L393	SUCCESSFUL	Y			
1992/114	L. PALLIDA	T1991/056/002	L. CARNOSA	L331	SUCCESSFUL	Y			
1993/198	L. PALLIDA	L397	L. CARNOSA	L331	SUCCESSFUL	Y	Y		
2001/008	L. PALLIDA	T1996/110/001	L. CARNOSA	L338	SUCCESSFUL	FEW	FEW	Y	
2001/039	L. PALLIDA	L192	L. CARNOSA	L338	SUCCESSFUL	FEW	FEW	Y	
1993/227	L. PALLIDA	L406	L. CONCORDIANA	T1992/296/006	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/433	L. PALLIDA	L406	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/498	L. PALLIDA	L049/1	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/291	L. PALLIDA	L049/1	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
1992/178	L. PALLIDA	L399	L. ELEGANS	L272	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2003/434	L. PALLIDA	L406	L. ELEGANS	L272	SUCCESSFUL	FEW		Y	
1992/177	L. PALLIDA	L399	L. FLAVA	L124	NOT SUCCESSFUL				ABNORMAL SEEDS AND SEEDLING LETHALITY

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2001/485	L. PALLIDA	L406	L. FLAVA	L144	SUCCESSFUL	FEW	FEW	Y	
2001/492	L. PALLIDA	L49/1	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/404	L. PALLIDA	L049/1	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/405	L. PALLIDA	L049/1	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/487	L. PALLIDA	L049/1	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/610	L. PALLIDA	L049/1	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEED
2008/286	L. PALLIDA	L049/1	L. FLAVA	L144	SUCCESSFUL	FEW	FEW	Y	
2003/437	L. PALLIDA	L406	L. LILIFLORA	L290	SUCCESSFUL	FEW		Y	
2003/438	L. PALLIDA	L406	L. LILIFLORA	T1993/032/009	SUCCESSFUL	Y	FEW	Y	
2008/282	L. PALLIDA	L049/1	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2008/290	L. PALLIDA	L049/1	L. LILIFLORA	T1993/032	SUCCESSFUL	FEW		Y	
2003/428	L. PALLIDA	L049/1	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2003/429	L. PALLIDA	L406	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2006/622	L. PALLIDA	L049/1	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2008/289	L. PALLIDA	L049/1	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2003/430	L. PALLIDA	L406	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2008/280	L. PALLIDA	L049/1	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2008/308	L. PALLIDA	L406	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
1982/043	L. PALLIDA	L047	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
1994/245	L. PALLIDA	T1992/328/008	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2003/371	L. PALLIDA	L406	L. MUTABILIS	L161	SUCCESSFUL	FEW		Y	
2003/372	L. PALLIDA	L406	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/426	L. PALLIDA	L049/1	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2003/427	L. PALLIDA	L049/1	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2004/495	L. PALLIDA	L049/1	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2004/496	L. PALLIDA	L049/1	L. MUTABULIS	L318	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1973/044	L. PALLIDA	L049	L. NAMAQUENSIS	L028	SUCCESSFUL				
1992/180	L. PALLIDA	L399	L. ORCHIOIDES	L316	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1994/247	L. PALLIDA	T1992/330/003	L. ORCHIOIDES	T1992/032/004	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/248	L. PALLIDA	L397	L. ORCHIOIDES	T1990/050	SUCCESSFUL	FEW	Y		
2003/370	L. PALLIDA	L406	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/425	L. PALLIDA	L049/1	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/494	L. PALLIDA	L049/1	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/621	L. PALLIDA	L049/1	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET
2007/102	L. PALLIDA	L406	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET
1973/043	L. PALLIDA	L048	L. ORCHIOIDES SUBSP. GLAUCINA	L007	NOT SUCCESSFUL				ABNORMAL SEEDS
1974/053	L. PALLIDA	L047	L. ORCHIOIDES SUBSP. GLAUCINA	L007	NOT SUCCESSFUL				ABNORMAL SEEDS
1994/242	L. PALLIDA	T1991/061/001	L. PALLIDA	T1992/284/004	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2001/518	L. PALLIDA	L49/1	L. PALLIDA	L406	SUCCESSFUL	FEW	FEW	Y	
2001/521	L. PALLIDA	L406	L. PALLIDA	L49/1	SUCCESSFUL	Y	FEW	Y	
2004/502	L. PALLIDA	L049/1	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/636	L. PALLIDA	L406	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2007/100	L. PALLIDA	L049/1	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2007/103	L. PALLIDA	L406	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2004/505	L. PALLIDA	L406	L. PALLIDA	L406	SUCCESSFUL	FEW		Y	
2005/385	L. PALLIDA	L406	L. PALLIDA	L406	SUCCESSFUL	FEW		Y	
2004/505	L. PALLIDA	L406	L. PALLIDA	L406	SUCCESSFUL	FEW		Y	
2005/385	L. PALLIDA	L406	L. PALLIDA	L406	SUCCESSFUL	FEW		Y	
1993/225	L. PALLIDA	L406	L. PATULA	T1992/301/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/226	L. PALLIDA	L406	L. PATULA	T1992/301/001	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2003/435	L. PALLIDA	L406	L. PERRYAE	L053	SUCCESSFUL	FEW		Y	
2004/499	L. PALLIDA	L049/1	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2008/278	L. PALLIDA	L049/1	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
1992/179	L. PALLIDA	L399	L. PUNCTATA	L277	NOT SUCCESSFUL				ABNORMAL SEEDS
2003/365	L. PALLIDA	L406	L. PUNCTATA	L227	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/366	L. PALLIDA	L406	L. PUNCTATA	L381	SUCCESSFUL	FEW	FEW	Y	
2003/420	L. PALLIDA	L049/1	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
2003/421	L. PALLIDA	L049/1	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/489	L. PALLIDA	L049/1	L. PUNCTATA	L277	SUCCESSFUL	FEW	FEW	Y	
2004/490	L. PALLIDA	L049/1	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/253	L. PALLIDA	L049/1	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
2008/287	L. PALLIDA	L049/1	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
1975/052	L. PALLIDA	L049	L. QUADRICOLOR	L122	NOT SUCCESSFUL				ABNORMAL SEEDS
2001/482	L. PALLIDA	L406	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	FEW	Y	
2001/491	L. PALLIDA	L49/1	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2001/516	L. PALLIDA	L49/1	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/519	L. PALLIDA	L406	L. QUADRICOLOR	L155	SUCCESSFUL	FEW	FEW	Y	
2001/520	L. PALLIDA	L406	L. QUADRICOLOR	L212	SUCCESSFUL	FEW	FEW	Y	
2004/486	L. PALLIDA	L049/1	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS
2004/488	L. PALLIDA	L049/1	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/609	L. PALLIDA	L049/1	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEED
2007/099	L. PALLIDA	L049/1	L. QUADRICOLOR	L122	SUCCESSFUL	FEW	FEW	Y	
2000/152	L. PALLIDA	T1992/330/005	L. REFLEXA	T1993/050/002	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2000/153	L. PALLIDA	T1992/330/005	L. REFLEXA	L181	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2001/053	L. PALLIDA	T1992/284/004	L. REFLEXA	T1993/050/002	SUCCESSFUL	FEW	FEW	Y	
1992/093	L. PALLIDA	T1991/056/002	L. SPLENDIDA	L417	NOT SUCCESSFUL				ABNORMAL SEEDS
1992/100	L. PALLIDA	L285	L. SPLENDIDA	L417	SUCCESSFUL	Y			
1992/103	L. PALLIDA	L285	L. SPLENDIDA	L419	SUCCESSFUL	Y			
1993/200	L. PALLIDA	L397	L. SPLENDIDA	L417	SUCCESSFUL	Y	FEW		
2003/439	L. PALLIDA	L406	L. SPLENDIDA	L417	SUCCESSFUL	FEW		Y	
2003/440	L. PALLIDA	L406	L. SPLENDIDA	L419	SUCCESSFUL	Y	FEW	Y	
2004/500	L. PALLIDA	L049/1	L. SPLENDIDA	L417	SUCCESSFUL	FEW	FEW	Y	
2004/501	L. PALLIDA	L049/1	L. SPLENDIDA	L419	SUCCESSFUL	FEW	FEW	Y	
2008/279	L. PALLIDA	L049/1	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2008/284	L. PALLIDA	L049/1	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2003/436	L. PALLIDA	L406	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/285	L. PALLIDA	L049/1	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2009/008	L. PALLIDA	L049/1	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
1979/045	L. PALLIDA	L098	L. VANZYLIAE	L208	NOT SUCCESSFUL				NO SEEDSET
1992/121	L. PALLIDA	T1991/055/011	L. VIRIDIFLORA	L194	SUCCESSFUL	FEW	Y		
2003/367	L. PALLIDA	L406	L. VIRIDIFLORA	L194	SUCCESSFUL	FEW	FEW	Y	
2003/422	L. PALLIDA	L049/1	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2004/491	L. PALLIDA	L049/1	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/612	L. PALLIDA	L049/1	L. VIRIDIFLORA	L194	SUCCESSFUL	FEW	FEW	Y	
1994/220	L. PATULA	T1992/301/011	L. ALOIDES VAR. NELSONII	L440	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1993/231	L. PATULA	T1992/301/003	L. BIFOLIA	T1991/070/000	SUCCESSFUL	FEW	FEW	Y	
1993/230	L. PATULA	T1992/301/009	L. CARNOSA	L400	NOT SUCCESSFUL				ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1993/229	L. PATULA	T1992/301/008	L. CONCORDIANA	T1992/296/010	SUCCESSFUL	FEW	FEW		
1993/228	L. PATULA	T1992/301/001	L. PALLIDA	L406	NOT SUCCESSFUL				ABNORMAL SEEDS
1993/232	L. PATULA	T1992/301/011	L. PUNCTATA	T1991/050/012	NOT SUCCESSFUL				FEW ABNORMAL SEEDS AND SEEDLING LETHALITY
2001/049	L. PEERSII	L360	L. THOMASIAE	T1996/085/004	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/050	L. PEERSII	L360	L. PALLIDA	T1996/110/003	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/221	L. PEERSII	L360	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2005/422	L. PERRYAE	L53	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/423	L. PERRYAE	L53	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/297	L. PERRYAE	L053	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2004/511	L. PERRYAE	L053	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/512	L. PERRYAE	L053	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/270	L. PERRYAE	L053	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2008/301	L. PERRYAE	L053	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2005/424	L. PERRYAE	L53	L. CONTAMINATA	L82	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/295	L. PERRYAE	L053	L. CONTAMINATA	L082	SUCCESSFUL	FEW	FEW	Y	
2003/453	L. PERRYAE	L053	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2003/454	L. PERRYAE	L053	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2006/627	L. PERRYAE	L053	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2007/106	L. PERRYAE	L053	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2007/107	L. PERRYAE	L053	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2005/427	L. PERRYAE	L53	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/428	L. PERRYAE	L53	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET
2008/294	L. PERRYAE	L053	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/306	L. PERRYAE	L053	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2005/420	L. PERRYAE	L53	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/421	L. PERRYAE	L53	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/296	L. PERRYAE	L053	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2008/298	L. PERRYAE	L053	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2004/514	L. PERRYAE	L053	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/419	L. PERRYAE	L53	L. MUTABILIS	L318	SUCCESSFUL	FEW	FEW	Y	
2008/303	L. PERRYAE	L053	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2008/307	L. PERRYAE	L053	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/513	L. PERRYAE	L053	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS
2008/300	L. PERRYAE	L053	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2005/425	L. PERRYAE	L53	L. PALLIDA	L49/1	NOT SUCCESSFUL				NO SEEDSET
2005/426	L. PERRYAE	L53	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/268	L. PERRYAE	L053	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2008/302	L. PERRYAE	L053	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2007/111	L. PERRYAE	L053	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2008/304	L. PERRYAE	L053	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2004/508	L. PERRYAE	L053	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS
2004/509	L. PERRYAE	L053	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2007/109	L. PERRYAE	L053	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEED
2007/110	L. PERRYAE	L053	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEED
2001/494	L. PERRYAE	L53	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/292	L. PERRYAE	L053	L. QUADRICOLOR	L122	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
2004/506	L. PERRYAE	L053	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/507	L. PERRYAE	L053	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/624	L. PERRYAE	L053	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET
2007/104	L. PERRYAE	L053	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2007/105	L. PERRYAE	L053	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2007/108	L. PERRYAE	L053	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND SINGLE ABNORMAL SEED
2007/430	L. PERRYAE	L053	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
2005/429	L. PERRYAE	L53	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/430	L. PERRYAE	L53	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/269	L. PERRYAE	L053	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2008/299	L. PERRYAE	L053	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2008/267	L. PERRYAE	L053	L. UNIFOLIA	L229	SUCCESSFUL	FEW	FEW	Y	
2004/510	L. PERRYAE	L053	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/305	L. PERRYAE	L053	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1975/003	L. PUNCTATA	L174	L. ALOIDES	L039	SUCCESSFUL				
1993/013	L. PUNCTATA	L276	L. ALOIDES VAR. NELSONII	L440	NOT SUCCESSFUL				ABNORMAL SEEDS
1995/014	L. PUNCTATA	L380	L. ALOIDES VAR. NELSONII	L440	SUCCESSFUL	Y	FEW		
2005/009	L. PUNCTATA	L277	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2005/010	L. PUNCTATA	L277	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2006/018	L. PUNCTATA	L381	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
1989/002	L. PUNCTATA	L277	L. BIFOLIA	L390	NOT SUCCESSFUL				ABNORMAL SEEDS
1994/008	L. PUNCTATA	L381	L. BIFOLIA	T1991/049/013	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1994/010	L. PUNCTATA	L380	L. BIFOLIA	T1991/049/013	NOT SUCCESSFUL				ABNORMAL SEEDS
1994/015	L. PUNCTATA	L277	L. BIFOLIA	T1991/059/065	SUCCESSFUL	FEW	Y		
1994/021	L. PUNCTATA	T1991/050/012	L. BIFOLIA	T1991/046/014	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
1994/025	L. PUNCTATA	L276	L. BIFOLIA	L389	NOT SUCCESSFUL				ABNORMAL SEEDS
1994/026	L. PUNCTATA	L379	L. BIFOLIA	T1991/046/014	NOT SUCCESSFUL				ABNORMAL SEEDS
1995/008	L. PUNCTATA	L381	L. BIFOLIA	T1991/048/002	SUCCESSFUL	FEW	FEW	Y	
1995/017	L. PUNCTATA	L380	L. BIFOLIA	T1991/047/002	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2005/002	L. PUNCTATA	L277	L. BIFOLIA	L389	SUCCESSFUL	FEW	Y	Y	
2005/003	L. PUNCTATA	L277	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS
2005/022	L. PUNCTATA	L381	L. BIFOLIA	L389	NOT SUCCESSFUL				MANY ABNORMAL SEEDS
2005/023	L. PUNCTATA	L381	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS
2006/002	L. PUNCTATA	L277	L. BIFOLIA	L389	NOT SUCCESSFUL				MANY ABNORMAL SEEDS
2006/011	L. PUNCTATA	L381	L. BIFOLIA	L389	NOT SUCCESSFUL				MANY ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2006/012	L. PUNCTATA	L381	L. BIFOLIA	T1991/049/29	NOT SUCCESSFUL				MANY ABNORMAL SEEDS
2007/001	L. PUNCTATA	L277	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2008/001	L. PUNCTATA	L277	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2010/004	L. PUNCTATA	L381	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS
1993/010	L. PUNCTATA	L381	L. CARNOSA	L393	NOT SUCCESSFUL				NO SEEDSET
1993/011	L. PUNCTATA	T1991/050/007	L. CARNOSA	L393	NOT SUCCESSFUL				NO SEEDSET
1993/012	L. PUNCTATA	L277	L. CARNOSA	L393	NOT SUCCESSFUL				NO SEEDSET
1995/003	L. PUNCTATA	L381	L. CARNOSA	L331/1	NOT SUCCESSFUL				NO SEEDSET
1995/013	L. PUNCTATA	L380	L. CARNOSA	L331/1	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS AND SEEDLING LETHALITY
1993/017	L. PUNCTATA	L381	L. COMPTONII	L284	NOT SUCCESSFUL				NO SEEDSET
1993/018	L. PUNCTATA	T1991/050/011	L. COMPTONII	L284	NOT SUCCESSFUL				NO SEEDSET
1994/017	L. PUNCTATA	T1991/050/013	L. CONCORDIANA	T1992/296/011	NOT SUCCESSFUL				NO SEEDSET
2005/011	L. PUNCTATA	L277	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2005/028	L. PUNCTATA	L381	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2006/004	L. PUNCTATA	L277	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2006/019	L. PUNCTATA	L381	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
1993/023	L. PUNCTATA	L381	L. ELEGANS	L308	NOT SUCCESSFUL				NO SEEDSET
1993/024	L. PUNCTATA	L277	L. ELEGANS	L309	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/025	L. PUNCTATA	L379	L. ELEGANS	L308	NOT SUCCESSFUL				NO SEEDSET AND SEEDLING LETHALITY
1993/026	L. PUNCTATA	L276	L. ELEGANS	L309	NOT SUCCESSFUL				NO SEEDSET
1995/004	L. PUNCTATA	L381	L. FLAVA	L124	SUCCESSFUL	Y	FEW		
1994/003	L. PUNCTATA	L381	L. FLAVA	L068	SUCCESSFUL	FEW	Y		

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1994/012	L. PUNCTATA	L277	L. FLAVA	L144	SUCCESSFUL	Y			
1994/018	L. PUNCTATA	T1991/050/009	L. FLAVA	L068	NOT SUCCESSFUL				ABNORMAL SEEDS
1994/022	L. PUNCTATA	L317	L. FLAVA	L144	NOT SUCCESSFUL				ABNORMAL SEEDS
2001/201	L. PUNCTATA	L277	L. FLAVA	L124	SUCCESSFUL	Y	FEW		
2001/202	L. PUNCTATA	L277	L. FLAVA	L68	SUCCESSFUL	Y	Y		
2001/205	L. PUNCTATA	L381	L. FLAVA	L68	SUCCESSFUL	Y	FEW		
2002/012	L. PUNCTATA	L277	L. FLAVA	L144	SUCCESSFUL	Y	FEW	Y	
2002/015	L. PUNCTATA	L381	L. FLAVA	L124	SUCCESSFUL	FEW	FEW	Y	
2002/016	L. PUNCTATA	L381	L. FLAVA	L144	SUCCESSFUL	FEW	Y	Y	
1993/031	L. PUNCTATA	L381	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
1993/032	L. PUNCTATA	L277	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
1993/033	L. PUNCTATA	L379	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
1993/034	L. PUNCTATA	T1991/050/004	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2005/016	L. PUNCTATA	L277	L. LILIFLORA	L290	SUCCESSFUL	FEW		Y	
2005/017	L. PUNCTATA	L277	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET
2005/272	L. PUNCTATA	L381	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2006/005	L. PUNCTATA	L277	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2006/024	L. PUNCTATA	L381	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2007/010	L. PUNCTATA	L277	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2007/011	L. PUNCTATA	L277	L. LILIFLORA	T1993/032	NOT SUCCESSFUL				NO SEEDSET
2005/007	L. PUNCTATA	L277	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2005/026	L. PUNCTATA	L381	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2007/005	L. PUNCTATA	L277	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2010/007	L. PUNCTATA	L381	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2005/008	L. PUNCTATA	L277	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2007/006	L. PUNCTATA	L277	L. MEDIANA	L158	SUCCESSFUL	FEW		Y	
2005/005	L. PUNCTATA	L277	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2005/006	L. PUNCTATA	L277	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2005/025	L. PUNCTATA	L381	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2005/337	L. PUNCTATA	L381	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2006/014	L. PUNCTATA	L381	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2006/015	L. PUNCTATA	L381	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2007/003	L. PUNCTATA	L277	L. MUTABILIS	L161	NOT SUCCESSFUL				no seedset and few abnormal seeds
2007/004	L. PUNCTATA	L277	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2008/003	L. PUNCTATA	L277	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2010/001	L. PUNCTATA	L381	L. MUTABILIS	l318	NOT SUCCESSFUL				NO SEEDSET
2005/004	L. PUNCTATA	L277	L. ORCHIODES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET
1993/027	L. PUNCTATA	L380	L. ORCHIOIDES	T1990/048	NOT SUCCESSFUL				NO SEEDSET
1993/028	L. PUNCTATA	L277	L. ORCHIOIDES	T1990/048	NOT SUCCESSFUL				ABNORMAL SEEDS
1993/029	L. PUNCTATA	L379	L. ORCHIOIDES	L316	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/030	L. PUNCTATA	L276	L. ORCHIOIDES	L316	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/004	L. PUNCTATA	L381	L. ORCHIOIDES	T1992/032	NOT SUCCESSFUL				NO SEEDSET
1994/005	L. PUNCTATA	L381	L. ORCHIOIDES	T1990/058/004	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/013	L. PUNCTATA	L277	L. ORCHIOIDES	T1992/032	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/019	L. PUNCTATA	T1991/050/019	L. ORCHIOIDES	T1990/050	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/023	L. PUNCTATA	L317	L. ORCHIOIDES	T1990/058/004	SUCCESSFUL	FEW		Y	
2005/024	L. PUNCTATA	L381	L. ORCHIOIDES	T1992/032/6	NOT SUCCESSFUL				NO SEEDSET
2006/003	L. PUNCTATA	L277	L. ORCHIOIDES	T1992/032/6	NOT SUCCESSFUL				NO SEEDSET
2006/013	L. PUNCTATA	L381	L. ORCHIOIDES	T1992/032/6	NOT SUCCESSFUL				NO SEEDSET
2008/002	L. PUNCTATA	L277	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET
1994/011	L. PUNCTATA	L380	L. ORCHIOIDES SUBSP. GLAUCINA	T1993/105/002	NOT SUCCESSFUL				NO SEEDSET
1994/014	L. PUNCTATA	L277	L. ORCHIOIDES SUBSP. GLAUCINA	T1993/105/002	NOT SUCCESSFUL				NO SEEDSET
1993/035	L. PUNCTATA	L380	L. ORTHOPETALA	L164	NOT SUCCESSFUL				NO SEEDSET
1993/036	L. PUNCTATA	L277	L. ORTHOPETALA	L164	NOT SUCCESSFUL				NO SEEDSET
1993/037	L. PUNCTATA	L276	L. ORTHOPETALA	L164	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1993/038	L. PUNCTATA	T1991/050/018	L. ORTHOPETALA	L164	NOT SUCCESSFUL				NO SEEDSET
1993/019	L. PUNCTATA	L379	L. PALLIDA	L399	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/020	L. PUNCTATA	L276	L. PALLIDA	T1991/056/002	NOT SUCCESSFUL				NO SEEDSET
1993/021	L. PUNCTATA	L277	L. PALLIDA	L399	NOT SUCCESSFUL				NO SEEDSET
1993/022	L. PUNCTATA	L381	L. PALLIDA	T1991/056/002	NOT SUCCESSFUL				NO SEEDSET
2005/012	L. PUNCTATA	L277	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2005/013	L. PUNCTATA	L277	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2005/029	L. PUNCTATA	L381	L. PALLIDA	L049/1	SUCCESSFUL	FEW		Y	
2006/020	L. PUNCTATA	L381	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2007/007	L. PUNCTATA	L277	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2005/014	L. PUNCTATA	L277	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2006/022	L. PUNCTATA	L381	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2007/008	L. PUNCTATA	L277	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
1992/017	L. PUNCTATA	L277	L. PUNCTATA	T1991/050/009	SUCCESSFUL	Y			
1992/018	L. PUNCTATA	L277	L. PUNCTATA	T1991/050/012	SUCCESSFUL	Y			
1992/020	L. PUNCTATA	L277	L. PUNCTATA	T1991/050/014	SUCCESSFUL	Y			
2001/229	L. PUNCTATA	L277	L. PUNCTATA	L381	SUCCESSFUL	Y	FEW		
2001/230	L. PUNCTATA	L381	L. PUNCTATA	L277	SUCCESSFUL	Y		Y	
2001/231	L. PUNCTATA	L277	L. PUNCTATA	L277	SUCCESSFUL	Y	FEW		
2001/232	L. PUNCTATA	L381	L. PUNCTATA	L381	SUCCESSFUL	Y	FEW		
2005/030	L. PUNCTATA	L277	L. PUNCTATA	L381	SUCCESSFUL	Y	FEW	Y	
1994/002	L. PUNCTATA	L381	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1994/009	L. PUNCTATA	L380	L. QUADRICOLOR	L122	NOT SUCCESSFUL				ABNORMAL SEEDS
1995/018	L. PUNCTATA	L277	L. QUADRICOLOR	L101	SUCCESSFUL	Y		Y	
2001/203	L. PUNCTATA	L277	L. QUADRICOLOR	L155	SUCCESSFUL	Y	Y		
2001/204	L. PUNCTATA	L381	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2002/010	L. PUNCTATA	L277	L. QUADRICOLOR	L101	SUCCESSFUL	Y	FEW	Y	
2002/011	L. PUNCTATA	L277	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2002/013	L. PUNCTATA	L277	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS
2002/014	L. PUNCTATA	L381	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS
2002/017	L. PUNCTATA	L381	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS
2002/018	L. PUNCTATA	L381	L. QUADRICOLOR	L212	SUCCESSFUL	FEW	Y	Y	
2003/042	L. PUNCTATA	L381	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2005/020	L. PUNCTATA	L277	L. QUADRICOLOR	L122	SUCCESSFUL	Y	FEW		NO GERMINATION
2005/021	L. PUNCTATA	L277	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/001	L. PUNCTATA	L277	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2006/006	L. PUNCTATA	L381	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/007	L. PUNCTATA	L381	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2006/008	L. PUNCTATA	L381	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2006/009	L. PUNCTATA	L381	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/004	L. PUNCTATA	L277	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2010/010	L. PUNCTATA	L381	L. QUADRICOLOR	L122	NOT SUCCESSFUL				FEW ABNORMAL SEED
1995/015	L. PUNCTATA	L380	L. REFLEXA	L387	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1989/001	L. PUNCTATA	L277	L. SPLENDIDA	L325	NOT SUCCESSFUL				NO SEEDSET
1993/008	L. PUNCTATA	L380	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
1993/009	L. PUNCTATA	L277	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
1994/001	L. PUNCTATA	L381	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
1994/016	L. PUNCTATA	T1991/050/006	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/018	L. PUNCTATA	L277	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2005/019	L. PUNCTATA	L277	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2005/273	L. PUNCTATA	L381	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2006/025	L. PUNCTATA	L381	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
1992/007	L. PUNCTATA	L276	L. UNDULATA	L342	NOT SUCCESSFUL				NO SEEDSET
1992/011	L. PUNCTATA	L174	L. UNDULATA	L269	NOT SUCCESSFUL				NO SEEDSET
1992/012	L. PUNCTATA	L174	L. UNDULATA	L269	NOT SUCCESSFUL				NO SEEDSET
1992/016	L. PUNCTATA	L381	L. UNDULATA	L269/2	NOT SUCCESSFUL				NO SEEDSET
1992/019	L. PUNCTATA	L277	L. UNDULATA	L269/1	NOT SUCCESSFUL				NO SEEDSET
1992/024	L. PUNCTATA	L277	L. UNDULATA	L342/1	NOT SUCCESSFUL				NO SEEDSET
1992/025	L. PUNCTATA	L380	L. UNDULATA	L269/1	NOT SUCCESSFUL				NO SEEDSET
2005/015	L. PUNCTATA	L277	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2007/009	L. PUNCTATA	L277	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
1980/044	L. PUNCTATA	L174	L. VIRIDIFLORA	L119	SUCCESSFUL				
2003/178	L. PUNCTATA	L381	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2006/010	L. PUNCTATA	L381	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2005/001	L. PUNCTATA	L277	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1976/059	L. PURPUREO-CAERULEA	L178	L. VANZYLIAE	L208	NOT SUCCESSFUL				ABNORMAL SEEDS
1994/032	L. PUSILLA	L115	L. PUNCTATA	T1991/050/014	NOT SUCCESSFUL				NO SEEDSET
2001/001	L. PUSILLA	L115	L. UNIFOLIA	L404	SUCCESSFUL	FEW	FEW	Y	
2001/002	L. PUSILLA	L115	L. UNIFOLIA	L315	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/004	L. PUSILLA	T1998/010/010	L. UNIFOLIA	L404	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1978/004	L. PUSILLA	L115	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				ABNORMAL SEEDS
1994/116	L. QUADRICOLOR	L155	L. ALOIDES	L213	SUCCESSFUL	Y	FEW	Y	
1995/065	L. QUADRICOLOR	L122	L. ALOIDES	L426	SUCCESSFUL	Y	FEW	Y	

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1995/066	L. QUADRICOLOR	L155	L. ALOIDES	T1992/010	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2000/212	L. QUADRICOLOR	L101	L. ALOIDES	L039	SUCCESSFUL	Y			
2000/213	L. QUADRICOLOR	L101	L. ALOIDES	L040	SUCCESSFUL	Y			
2000/214	L. QUADRICOLOR	L101	L. ALOIDES	L213	SUCCESSFUL	Y			
2000/215	L. QUADRICOLOR	L122	L. ALOIDES	L039	SUCCESSFUL	Y			
2000/216	L. QUADRICOLOR	L122	L. ALOIDES	L040	SUCCESSFUL	Y	FEW		
2000/217	L. QUADRICOLOR	L122	L. ALOIDES	L042	SUCCESSFUL	Y	FEW		
2000/218	L. QUADRICOLOR	L122	L. ALOIDES	L213	SUCCESSFUL	FEW	FEW		
2000/221	L. QUADRICOLOR	L123	L. ALOIDES	L039	SUCCESSFUL	Y			
2000/222	L. QUADRICOLOR	L123	L. ALOIDES	L040	SUCCESSFUL	Y	Y		
2000/223	L. QUADRICOLOR	L155	L. ALOIDES	L039	SUCCESSFUL	Y	Y		
2000/224	L. QUADRICOLOR	L155	L. ALOIDES	L040	SUCCESSFUL	Y	FEW		
2000/225	L. QUADRICOLOR	L155	L. ALOIDES	L042	NOT SUCCESSFUL				NO SEEDSET
2000/226	L. QUADRICOLOR	L155	L. ALOIDES	L213	SUCCESSFUL	Y			
2000/228	L. QUADRICOLOR	L212	L. ALOIDES	L039	SUCCESSFUL	Y	Y		
2000/229	L. QUADRICOLOR	L212	L. ALOIDES	L040	SUCCESSFUL	Y			
2001/057	L. QUADRICOLOR	T1992/017	L. ALOIDES	L40	SUCCESSFUL	Y			
2001/072	L. QUADRICOLOR	L123	L. ALOIDES	L42	SUCCESSFUL	FEW			
2001/074	L. QUADRICOLOR	L212	L. ALOIDES	L213	SUCCESSFUL	FEW	FEW		
2001/077	L. QUADRICOLOR	T1993/009/002	L. ALOIDES	L40	SUCCESSFUL	Y			
2001/081	L. QUADRICOLOR	L155	L. ALOIDES	L213	NOT SUCCESSFUL				NO SEEDSET
2001/084	L. QUADRICOLOR	T1992/017	L. ALOIDES	L213	NOT SUCCESSFUL				NO SEEDSET
2001/088	L. QUADRICOLOR	T1993/009	L. ALOIDES	L213	SUCCESSFUL	Y	FEW		
2001/090	L. QUADRICOLOR	T1993/009	L. ALOIDES	L042	SUCCESSFUL	Y			
2001/091	L. QUADRICOLOR	T1992/017	L. ALOIDES	L039	NOT SUCCESSFUL				NO SEEDSET
2001/092	L. QUADRICOLOR	T1993/009	L. ALOIDES	L039	SUCCESSFUL	Y			
2001/096	L. QUADRICOLOR	T1992/017	L. ALOIDES	L042	SUCCESSFUL	FEW			
2001/097	L. QUADRICOLOR	L101	L. ALOIDES	L042	SUCCESSFUL	Y			
2002/322	L. QUADRICOLOR	L212	L. ALOIDES	L042	SUCCESSFUL	Y	FEW		
2001/443	L. QUADRICOLOR	L122	L. BACHMANII	L16	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2001/459	L. QUADRICOLOR	L212	L. BACHMANII	L16	NOT SUCCESSFUL				NO SEEDSET
2002/086	L. QUADRICOLOR	L101	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2002/124	L. QUADRICOLOR	L101	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2002/147	L. QUADRICOLOR	L155	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2002/148	L. QUADRICOLOR	L155	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2002/244	L. QUADRICOLOR	L122	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2002/287	L. QUADRICOLOR	L212	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2003/167	L. QUADRICOLOR	L155	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2004/415	L. QUADRICOLOR	L101	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2004/416	L. QUADRICOLOR	L122	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2004/426	L. QUADRICOLOR	L155	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2004/428	L. QUADRICOLOR	L212	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2005/084	L. QUADRICOLOR	L101	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2006/065	L. QUADRICOLOR	L101	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
1993/077	L. QUADRICOLOR	L101	L. BIFOLIA	T1991/049/023	NOT SUCCESSFUL				ABNORMAL SEEDS
1993/112	L. QUADRICOLOR	L122	L. BIFOLIA	T1991/046/007	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1993/113	L. QUADRICOLOR	L122	L. BIFOLIA	T1991/049/033	NOT SUCCESSFUL				ABNORMAL SEEDS
1993/114	L. QUADRICOLOR	L122	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1995/064	L. QUADRICOLOR	L101	L. BIFOLIA	T1991/049/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/329	L. QUADRICOLOR	L101	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2001/330	L. QUADRICOLOR	L101	L. BIFOLIA	T1991/049/009	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2001/334	L. QUADRICOLOR	L155	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/335	L. QUADRICOLOR	L155	L. BIFOLIA	T1991/049/009	SUCCESSFUL	FEW	FEW	Y	
2001/343	L. QUADRICOLOR	L122	L. BIFOLIA	L389	NOT SUCCESSFUL				ABNORMAL SEEDS
2001/344	L. QUADRICOLOR	L122	L. BIFOLIA	T1991/049/009	NOT SUCCESSFUL				MANY ABNORMAL SEEDS
2001/350	L. QUADRICOLOR	L212	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/351	L. QUADRICOLOR	L212	L. BIFOLIA	T1991/049/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2002/284	L. QUADRICOLOR	L212	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2002/285	L. QUADRICOLOR	L212	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2004/026	L. QUADRICOLOR	L101	L. BIFOLIA	L389	SUCCESSFUL	FEW	MANY	Y	
2004/027	L. QUADRICOLOR	L101	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2004/037	L. QUADRICOLOR	L122	L. BIFOLIA	L389	SUCCESSFUL	FEW	FEW	Y	
2004/038	L. QUADRICOLOR	L122	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/056	L. QUADRICOLOR	L155	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/062	L. QUADRICOLOR	L101	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2007/036	L. QUADRICOLOR	L101	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2007/066	L. QUADRICOLOR	L212	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND SINGLE ABNORMAL SEEDS
2008/033	L. QUADRICOLOR	L212	L. BIFOLIA	L389	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
2002/085	L. QUADRICOLOR	L101	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2002/141	L. QUADRICOLOR	L122	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2002/146	L. QUADRICOLOR	L155	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2002/286	L. QUADRICOLOR	L212	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2005/083	L. QUADRICOLOR	L101	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2005/339	L. QUADRICOLOR	L212	L. CONTAMINATA	L82	NOT SUCCESSFUL				NO SEEDSET
2006/064	L. QUADRICOLOR	L101	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2006/071	L. QUADRICOLOR	L122	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2007/067	L. QUADRICOLOR	L212	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2001/444	L. QUADRICOLOR	L122	L. ELEGANS	L272/1	NOT SUCCESSFUL				NO SEEDSET
2001/460	L. QUADRICOLOR	L212	L. ELEGANS	L272/1	NOT SUCCESSFUL				NO SEEDSET
2002/125	L. QUADRICOLOR	L101	L. ELEGANS	L272/1	NOT SUCCESSFUL				NO SEEDSET
2002/149	L. QUADRICOLOR	L155	L. ELEGANS	L272/1	NOT SUCCESSFUL				NO SEEDSET
1966/008	L. QUADRICOLOR		L. FLAVA		SUCCESSFUL				

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1995/072	L. QUADRICOLOR	L123	L. FLAVA	L124	NOT SUCCESSFUL				ABNORMAL SEEDS
2001/421	L. QUADRICOLOR	L122	L. FLAVA	L124	SUCCESSFUL	FEW	Y	Y	
2001/430	L. QUADRICOLOR	L212	L. FLAVA	L124	NOT SUCCESSFUL				ABNORMAL SEEDS
2001/431	L. QUADRICOLOR	L212	L. FLAVA	L144	NOT SUCCESSFUL				ABNORMAL SEEDS
2001/446	L. QUADRICOLOR	L122	L. FLAVA	L144	SUCCESSFUL	FEW	FEW	Y	
2002/138	L. QUADRICOLOR	L101	L. FLAVA	L144	SUCCESSFUL	FEW	FEW	Y	
2002/278	L. QUADRICOLOR	L155	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2002/279	L. QUADRICOLOR	L155	L. FLAVA	L144	SUCCESSFUL	FEW	FEW	Y	
2003/044	L. QUADRICOLOR	L101	L. FLAVA	L124	SUCCESSFUL	Y	FEW	Y	
2003/119	L. QUADRICOLOR	L155	L. FLAVA	L124	SUCCESSFUL	Y	Y		
2003/288	L. QUADRICOLOR	L155	L. FLAVA	L144	SUCCESSFUL	Y	FEW		
2004/032	L. QUADRICOLOR	L101	L. FLAVA	L144	SUCCESSFUL	Y	FEW		
2004/065	L. QUADRICOLOR	L212	L. FLAVA	L144	SUCCESSFUL	Y	Y	Y	
2004/417	L. QUADRICOLOR	L122	L. FLAVA	L124	SUCCESSFUL	FEW	Y	Y	
2004/427	L. QUADRICOLOR	L155	L. FLAVA	L124	SUCCESSFUL	Y	Y	Y	
2004/429	L. QUADRICOLOR	L212	L. FLAVA	L124	SUCCESSFUL	FEW	Y	Y	
2005/294	L. QUADRICOLOR	L122	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/040	L. QUADRICOLOR	L212	L. FLAVA	L124	SUCCESSFUL	Y	FEW	Y	
2008/041	L. QUADRICOLOR	L212	L. FLAVA	L144	SUCCESSFUL	Y	FEW	Y	
2002/130	L. QUADRICOLOR	L101	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET
2002/131	L. QUADRICOLOR	L101	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2002/248	L. QUADRICOLOR	L122	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET
2002/249	L. QUADRICOLOR	L122	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2002/270	L. QUADRICOLOR	L155	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET
2002/271	L. QUADRICOLOR	L155	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2002/291	L. QUADRICOLOR	L212	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET
2002/292	L. QUADRICOLOR	L212	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2003/170	L. QUADRICOLOR	L155	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET
2003/207	L. QUADRICOLOR	L101	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET
2003/215	L. QUADRICOLOR	L155	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2005/289	L. QUADRICOLOR	L122	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET
2005/290	L. QUADRICOLOR	L122	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2005/343	L. QUADRICOLOR	L212	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET
2006/068	L. QUADRICOLOR	L101	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2006/074	L. QUADRICOLOR	L122	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2007/046	L. QUADRICOLOR	L122	L. LILIFLORA	T1993/032	NOT SUCCESSFUL				NO SEEDSET
2007/047	L. QUADRICOLOR	L122	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2007/061	L. QUADRICOLOR	L155	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2008/017	L. QUADRICOLOR	L101	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET
2008/030	L. QUADRICOLOR	L155	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET
2008/037	L. QUADRICOLOR	L212	L. LILIFLORA	T1993/032	NOT SUCCESSFUL				NO SEEDSET
2008/038	L. QUADRICOLOR	L212	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2001/419	L. QUADRICOLOR	L122	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2001/427	L. QUADRICOLOR	L212	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2002/128	L. QUADRICOLOR	L101	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2002/152	L. QUADRICOLOR	L155	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2003/278	L. QUADRICOLOR	L122	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2004/031	L. QUADRICOLOR	L101	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2004/060	L. QUADRICOLOR	L155	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2004/299	L. QUADRICOLOR	L122	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2006/067	L. QUADRICOLOR	L101	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2006/073	L. QUADRICOLOR	L122	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2006/085	L. QUADRICOLOR	L155	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2008/029	L. QUADRICOLOR	L155	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2002/129	L. QUADRICOLOR	L101	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2002/247	L. QUADRICOLOR	L122	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2002/269	L. QUADRICOLOR	L155	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2002/290	L. QUADRICOLOR	L212	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2003/169	L. QUADRICOLOR	L155	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2005/087	L. QUADRICOLOR	L101	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2005/342	L. QUADRICOLOR	L212	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2007/039	L. QUADRICOLOR	L101	L. MEDIANA	L158	SUCCESSFUL	FEW		Y	
2007/045	L. QUADRICOLOR	L122	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2007/068	L. QUADRICOLOR	L212	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2001/418	L. QUADRICOLOR	L122	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2001/426	L. QUADRICOLOR	L212	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2001/442	L. QUADRICOLOR	L122	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2001/458	L. QUADRICOLOR	L212	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2002/083	L. QUADRICOLOR	L101	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2002/084	L. QUADRICOLOR	L101	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2002/088	L. QUADRICOLOR	L155	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2002/089	L. QUADRICOLOR	L155	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2004/029	L. QUADRICOLOR	L101	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2004/030	L. QUADRICOLOR	L101	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2004/040	L. QUADRICOLOR	L122	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2004/041	L. QUADRICOLOR	L122	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2004/058	L. QUADRICOLOR	L155	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2004/059	L. QUADRICOLOR	L155	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2004/063	L. QUADRICOLOR	L212	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2006/081	L. QUADRICOLOR	L155	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2007/060	L. QUADRICOLOR	L155	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2001/354	L. QUADRICOLOR	L101	L. ORCHIOIDES	T1992/032/006/006	NOT SUCCESSFUL				NO SEEDSET
2001/417	L. QUADRICOLOR	L122	L. ORCHIOIDES	T1992/032/006/002	NOT SUCCESSFUL				NO SEEDSET
2001/457	L. QUADRICOLOR	L212	L. ORCHIOIDES	T1992/032/006/006	NOT SUCCESSFUL				NO SEEDSET
2004/028	L. QUADRICOLOR	L101	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2004/039	L. QUADRICOLOR	L122	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET
2004/057	L. QUADRICOLOR	L155	L. ORCHIOIDES	T1992/032/005	SUCCESSFUL	FEW	FEW	Y	
2004/062	L. QUADRICOLOR	L212	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/310	L. QUADRICOLOR	L144	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET
2006/063	L. QUADRICOLOR	L101	L. ORCHIOIDES	T1992/032/6	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2007/037	L. QUADRICOLOR	L101	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET
2008/034	L. QUADRICOLOR	L212	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET
2002/126	L. QUADRICOLOR	L101	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2002/127	L. QUADRICOLOR	L101	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2002/150	L. QUADRICOLOR	L155	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2002/151	L. QUADRICOLOR	L155	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2002/245	L. QUADRICOLOR	L122	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2002/246	L. QUADRICOLOR	L122	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2002/288	L. QUADRICOLOR	L212	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2002/289	L. QUADRICOLOR	L212	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2003/168	L. QUADRICOLOR	L155	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2005/085	L. QUADRICOLOR	L101	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2005/086	L. QUADRICOLOR	L101	L. PALLIDA	L046	NOT SUCCESSFUL				NO SEEDSET
2005/091	L. QUADRICOLOR	L155	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2005/286	L. QUADRICOLOR	L122	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2005/287	L. QUADRICOLOR	L122	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2005/300	L. QUADRICOLOR	L144	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2005/301	L. QUADRICOLOR	L144	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2005/340	L. QUADRICOLOR	L212	L. PALLIDA	L49/1	NOT SUCCESSFUL				NO SEEDSET
2006/066	L. QUADRICOLOR	L101	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2006/072	L. QUADRICOLOR	L122	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2006/083	L. QUADRICOLOR	L155	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2006/084	L. QUADRICOLOR	L155	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2007/038	L. QUADRICOLOR	L101	L. PALLIDA	L406	SUCCESSFUL	Y	FEW	Y	
2007/044	L. QUADRICOLOR	L122	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND SINGLE ABNORMAL SEEDS
2008/016	L. QUADRICOLOR	L101	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2008/035	L. QUADRICOLOR	L212	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2008/036	L. QUADRICOLOR	L212	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2002/134	L. QUADRICOLOR	L101	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2002/274	L. QUADRICOLOR	L155	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2002/294	L. QUADRICOLOR	L212	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2003/115	L. QUADRICOLOR	L122	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2003/209	L. QUADRICOLOR	L101	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2003/286	L. QUADRICOLOR	L155	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2005/292	L. QUADRICOLOR	L122	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2005/305	L. QUADRICOLOR	L144	L. PERRYAE	L53	NOT SUCCESSFUL				NO SEEDSET
2005/345	L. QUADRICOLOR	L212	L. PERRYAE	L53	NOT SUCCESSFUL				NO SEEDSET
2006/069	L. QUADRICOLOR	L101	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2006/076	L. QUADRICOLOR	L122	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2006/086	L. QUADRICOLOR	L155	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2007/069	L. QUADRICOLOR	L212	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
1994/107	L. QUADRICOLOR	L101	L. PUNCTATA	T1991/050/009	SUCCESSFUL	Y	FEW		
1994/108	L. QUADRICOLOR	L101	L. PUNCTATA	L277	SUCCESSFUL	Y	FEW	Y	
1994/109	L. QUADRICOLOR	L122	L. PUNCTATA	L381	NOT SUCCESSFUL				ABNORMAL SEEDS
1994/110	L. QUADRICOLOR	L122	L. PUNCTATA	L380	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/115	L. QUADRICOLOR	L155	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/326	L. QUADRICOLOR	L101	L. PUNCTATA	L277	SUCCESSFUL	Y	Y		
2001/327	L. QUADRICOLOR	L101	L. PUNCTATA	L381	SUCCESSFUL	Y	Y		
2001/331	L. QUADRICOLOR	L155	L. PUNCTATA	L277	SUCCESSFUL	FEW	Y		
2001/332	L. QUADRICOLOR	L155	L. PUNCTATA	L381	SUCCESSFUL	FEW	Y	Y	
2001/340	L. QUADRICOLOR	L122	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2001/341	L. QUADRICOLOR	L122	L. PUNCTATA	L381	NOT SUCCESSFUL				ABNORMAL SEEDS
2001/347	L. QUADRICOLOR	L212	L. PUNCTATA	L277	NOT SUCCESSFUL				ABNORMAL SEEDS
2001/348	L. QUADRICOLOR	L212	L. PUNCTATA	L381	NOT SUCCESSFUL				ABNORMAL SEEDS
2002/081	L. QUADRICOLOR	L101	L. PUNCTATA	L277	SUCCESSFUL	Y	FEW	Y	
2002/082	L. QUADRICOLOR	L101	L. PUNCTATA	L381	SUCCESSFUL	Y	FEW	Y	
2002/153	L. QUADRICOLOR	L212	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2002/282	L. QUADRICOLOR	L212	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEEDS
2004/034	L. QUADRICOLOR	L122	L. PUNCTATA	L277	NOT SUCCESSFUL				MANY ABNORMAL SEEDS
2004/035	L. QUADRICOLOR	L122	L. PUNCTATA	L381	NOT SUCCESSFUL				MANY ABNORMAL SEEDS
2007/065	L. QUADRICOLOR	L212	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2008/032	L. QUADRICOLOR	L212	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEED
1966/010	L. QUADRICOLOR (4X)		L. PUNCTATA		SUCCESSFUL				
1967/037	L. QUADRICOLOR (4X)		L. PUNCTATA		SUCCESSFUL				
1968/030	L. QUADRICOLOR (4X)		L. PUNCTATA		SUCCESSFUL				
1995/275	L. QUADRICOLOR	L101	L. QUADRICOLOR	T1992/017	SUCCESSFUL	FEW		Y	
1995/276	L. QUADRICOLOR	L101	L. QUADRICOLOR	L123	SUCCESSFUL	FEW		Y	
1995/277	L. QUADRICOLOR	L101	L. QUADRICOLOR	L155	SUCCESSFUL	Y		Y	
1995/278	L. QUADRICOLOR	L101	L. QUADRICOLOR	L212	SUCCESSFUL	FEW		Y	
1995/279	L. QUADRICOLOR	L123	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
1995/280	L. QUADRICOLOR	L123	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1995/281	L. QUADRICOLOR	L123	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1995/282	L. QUADRICOLOR	L123	L. QUADRICOLOR	L212	NOT SUCCESSFUL	FEW		Y	SEEDLING LETHALITY
1995/283	L. QUADRICOLOR	L122	L. QUADRICOLOR	L101	SUCCESSFUL	Y	FEW		
1995/284	L. QUADRICOLOR	L122	L. QUADRICOLOR	L123	NOT SUCCESSFUL				NO SEEDSET
1995/285	L. QUADRICOLOR	L122	L. QUADRICOLOR	L155	SUCCESSFUL	Y			
1995/286	L. QUADRICOLOR	L122	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1995/289	L. QUADRICOLOR	L155	L. QUADRICOLOR	T1992/017	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1995/290	L. QUADRICOLOR	L155	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1995/291	L. QUADRICOLOR	L155	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
1995/292	L. QUADRICOLOR	L212	L. QUADRICOLOR	L101	SUCCESSFUL	Y			
1995/293	L. QUADRICOLOR	L212	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1995/294	L. QUADRICOLOR	L212	L. QUADRICOLOR	L123	NOT SUCCESSFUL				NO SEEDSET
1995/295	L. QUADRICOLOR	L212	L. QUADRICOLOR	L155	SUCCESSFUL	Y			
1996/046	L. QUADRICOLOR	L101	L. QUADRICOLOR	L122	SUCCESSFUL	Y			
1996/047	L. QUADRICOLOR	T1992/017	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	FEW	Y	
1996/048	L. QUADRICOLOR	T1992/017	L. QUADRICOLOR	L155	SUCCESSFUL	Y	FEW		
1996/049	L. QUADRICOLOR	L123	L. QUADRICOLOR	T1992/017	SUCCESSFUL	Y			
1996/050	L. QUADRICOLOR	L122	L. QUADRICOLOR	T1992/017	SUCCESSFUL	Y			
1996/051	L. QUADRICOLOR	L155	L. QUADRICOLOR	L123	SUCCESSFUL	FEW	FEW	Y	
1996/052	L. QUADRICOLOR	L155	L. QUADRICOLOR	L212	SUCCESSFUL	FEW	FEW		
1996/053	L. QUADRICOLOR	L212	L. QUADRICOLOR	T1992/017	SUCCESSFUL	Y			
2000/219	L. QUADRICOLOR	L122	L. QUADRICOLOR	T1993/009/005	SUCCESSFUL	Y			
2000/220	L. QUADRICOLOR	L122	L. QUADRICOLOR	T1993/009/003	SUCCESSFUL	Y			
2000/227	L. QUADRICOLOR	L155	L. QUADRICOLOR	T1993/009/003	SUCCESSFUL	Y			
2001/056	L. QUADRICOLOR	T1993/009	L. QUADRICOLOR	T1992/017	SUCCESSFUL	Y			
2001/060	L. QUADRICOLOR	L122	L. QUADRICOLOR	T1993/009	SUCCESSFUL	Y			
2001/069	L. QUADRICOLOR	L101	L. QUADRICOLOR	T1993/009	SUCCESSFUL	Y			
2001/073	L. QUADRICOLOR	L212	L. QUADRICOLOR	T1993/009	SUCCESSFUL	Y			
2001/080	L. QUADRICOLOR	T1993/009	L. QUADRICOLOR	L123	SUCCESSFUL	FEW			
2001/086	L. QUADRICOLOR	T1992/017	L. QUADRICOLOR	L123	NOT SUCCESSFUL				NO SEEDSET
2001/087	L. QUADRICOLOR	T1993/009	L. QUADRICOLOR	L101	SUCCESSFUL	Y			
2001/089	L. QUADRICOLOR	T1992/017	L. QUADRICOLOR	L122	SUCCESSFUL	Y			
2001/094	L. QUADRICOLOR	T1993/009	L. QUADRICOLOR	L212	SUCCESSFUL	Y			
2001/095	L. QUADRICOLOR	T1992/017	L. QUADRICOLOR	L212	SUCCESSFUL	Y			
2001/100	L. QUADRICOLOR	T1993/009	L. QUADRICOLOR	L122	SUCCESSFUL	Y			
2001/101	L. QUADRICOLOR	T1993/009	L. QUADRICOLOR	L155	SUCCESSFUL	Y			
2001/362	L. QUADRICOLOR	L101	L. QUADRICOLOR	L122	SUCCESSFUL	Y	FEW		
2001/383	L. QUADRICOLOR	L155	L. QUADRICOLOR	L101	SUCCESSFUL	Y	FEW		
2001/422	L. QUADRICOLOR	L122	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2001/423	L. QUADRICOLOR	L122	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2001/428	L. QUADRICOLOR	L212	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET
2001/429	L. QUADRICOLOR	L212	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2001/432	L. QUADRICOLOR	L212	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2002/087	L. QUADRICOLOR	L101	L. QUADRICOLOR	L122	SUCCESSFUL	FEW	FEW	Y	
2002/136	L. QUADRICOLOR	L101	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET
2002/139	L. QUADRICOLOR	L101	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2002/140	L. QUADRICOLOR	L101	L. QUADRICOLOR	L212	SUCCESSFUL	Y	FEW	Y	
2002/254	L. QUADRICOLOR	L122	L. QUADRICOLOR	L101	SUCCESSFUL	Y	Y	Y	
2002/255	L. QUADRICOLOR	L122	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2002/256	L. QUADRICOLOR	L122	L. QUADRICOLOR	L155	SUCCESSFUL	FEW	FEW	Y	
2002/276	L. QUADRICOLOR	L155	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	FEW	Y	
2002/277	L. QUADRICOLOR	L155	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2002/280	L. QUADRICOLOR	L155	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2002/281	L. QUADRICOLOR	L155	L. QUADRICOLOR	L212	NOT SUCCESSFUL	FEW		Y	
2002/296	L. QUADRICOLOR	L212	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2002/297	L. QUADRICOLOR	L212	L. QUADRICOLOR	L155	SUCCESSFUL	Y	Y	Y	
2002/298	L. QUADRICOLOR	L212	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
2002/321	L. QUADRICOLOR	L155	L. QUADRICOLOR	T1993/009/3	SUCCESSFUL	Y	FEW		
2002/324	L. QUADRICOLOR	T1992/017	L. QUADRICOLOR	T1993/009	SUCCESSFUL	Y			
2002/325	L. QUADRICOLOR	T1993/009	L. QUADRICOLOR	L155	SUCCESSFUL	Y	FEW		
2003/043	L. QUADRICOLOR	L101	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/289	L. QUADRICOLOR	L155	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2003/117	L. QUADRICOLOR	L122	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/118	L. QUADRICOLOR	L155	L. QUADRICOLOR	L122	SUCCESSFUL	Y	FEW	Y	
2003/290	L. QUADRICOLOR	L155	L. QUADRICOLOR	L212	SUCCESSFUL	Y	FEW		
2004/033	L. QUADRICOLOR	L101	L. QUADRICOLOR	L101	SUCCESSFUL	Y	FEW		
2004/042	L. QUADRICOLOR	L122	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/061	L. QUADRICOLOR	L155	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2004/064	L. QUADRICOLOR	L212	L. QUADRICOLOR	L122	SUCCESSFUL	FEW	FEW	Y	
2004/066	L. QUADRICOLOR	L212	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2005/295	L. QUADRICOLOR	L122	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2005/347	L. QUADRICOLOR	L212	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2004/463	L. QUADRICOLOR	L212	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/070	L. QUADRICOLOR	L101	L. QUADRICOLOR	L101	SUCCESSFUL	Y	FEW	Y	
2001/420	L. QUADRICOLOR	L122	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	Y	Y	
2005/092	L. QUADRICOLOR	L155	L. QUADRICOLOR	L122	SUCCESSFUL	FEW		Y	
2007/043	L. QUADRICOLOR	L101	L. QUADRICOLOR	L101	SUCCESSFUL	Y		Y	
2007/064	L. QUADRICOLOR	L155	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2007/071	L. QUADRICOLOR	L212	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2007/072	L. QUADRICOLOR	L212	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
2008/031	L. QUADRICOLOR	L155	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2005/092	L. QUADRICOLOR	L155	L. QUADRICOLOR	L122	SUCCESSFUL	FEW		Y	
2001/445	L. QUADRICOLOR	L122	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2001/461	L. QUADRICOLOR	L212	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2002/132	L. QUADRICOLOR	L101	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2002/250	L. QUADRICOLOR	L122	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2002/251	L. QUADRICOLOR	L122	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2002/272	L. QUADRICOLOR	L155	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2002/273	L. QUADRICOLOR	L155	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2002/293	L. QUADRICOLOR	L212	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2003/114	L. QUADRICOLOR	L101	L. SPLENDIDA	L417	SUCCESSFUL	FEW		Y	
2003/164	L. QUADRICOLOR	L101	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2003/284	L. QUADRICOLOR	L155	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/285	L. QUADRICOLOR	L155	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2004/461	L. QUADRICOLOR	L122	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2004/462	L. QUADRICOLOR	L212	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2005/088	L. QUADRICOLOR	L101	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2005/291	L. QUADRICOLOR	L122	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2006/075	L. QUADRICOLOR	L122	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2007/040	L. QUADRICOLOR	L101	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2007/041	L. QUADRICOLOR	L101	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2007/048	L. QUADRICOLOR	L122	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2007/062	L. QUADRICOLOR	L155	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2008/039	L. QUADRICOLOR	L212	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2002/253	L. QUADRICOLOR	L122	L. UNIFLOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2002/275	L. QUADRICOLOR	L155	L. UNIFLOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2002/135	L. QUADRICOLOR	L101	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2002/295	L. QUADRICOLOR	L212	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2003/116	L. QUADRICOLOR	L122	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2003/210	L. QUADRICOLOR	L101	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2003/287	L. QUADRICOLOR	L155	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2005/293	L. QUADRICOLOR	L122	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2007/042	L. QUADRICOLOR	L101	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2007/063	L. QUADRICOLOR	L155	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2007/070	L. QUADRICOLOR	L212	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2001/328	L. QUADRICOLOR	L101	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/333	L. QUADRICOLOR	L155	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/342	L. QUADRICOLOR	L122	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/349	L. QUADRICOLOR	L212	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2002/283	L. QUADRICOLOR	L212	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/025	L. QUADRICOLOR	L101	L. VIRIDIFLORA	L194	SUCCESSFUL	Y	FEW	Y	
2004/036	L. QUADRICOLOR	L122	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/055	L. QUADRICOLOR	L155	L. VIRIDIFLORA	L194	SUCCESSFUL	FEW	FEW	Y	
2005/090	L. QUADRICOLOR	L155	L. VIRIDIFLORA	L194	SUCCESSFUL	FEW	FEW	Y	
2006/061	L. QUADRICOLOR	L101	L. VIRIDIFLORA	L194	SUCCESSFUL	Y	FEW	Y	
1975/015	L. REFLEXA	L222	L. ALOIDES	L022	SUCCESSFUL				
1975/016	L. REFLEXA	L222	L. ALOIDES	L045	SUCCESSFUL				

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1975/037	L. REFLEXA	L181	L. ALOIDES	L022	SUCCESSFUL				
1978/006	L. REFLEXA	L181	L. BIFOLIA	L078	NOT SUCCESSFUL				SEEDLING LETHALITY
1978/089	L. ROSEA	L185	L. BIFOLIA	L078	NOT SUCCESSFUL				ABNORMAL SEEDS
2001/481	L. SAUVEOLENS	L392/001	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET
2001/480	L SAUVEOLENS	L392/001	L. ELEGANS	L272	SUCCESSFUL	FEW	FEW	Y	
1993/208	L. SAUVEOLENS	T1992/265/010	L. PATULA	T1992/301/008	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/209	L. SAUVEOLENS	T1992/265/008	L. PATULA	T1992/301/001	NOT SUCCESSFUL				NO SEEDSET
1975/071	L. SAUVEOLENS	L187	L. QUADRICOLOR	L123	NOT SUCCESSFUL				NO SEEDSET
1975/001	L. SPLENDIDA	L030	L. ALOIDES	L039	SUCCESSFUL				
1975/029	L. SPLENDIDA	L107	L. ALOIDES	L022	SUCCESSFUL				
1976/013	L. SPLENDIDA	L185	L. ALOIDES	L022	NOT SUCCESSFUL				SEEDLING LETHALITY
1975/024	L. SPLENDIDA	L107	L. ALOIDES	L045	NOT SUCCESSFUL				ABNORMAL SEEDS
1993/170	L. SPLENDIDA	T1992/319/005	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/260	L. SPLENDIDA	L419	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2004/540	L. SPLENDIDA	L417	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2005/405	L. SPLENDIDA	L417	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2008/293	L. SPLENDIDA	L417	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1974/001	L. SPLENDIDA	L030	L. BIFOLIA	L023	NOT SUCCESSFUL				ABNORMAL SEEDS
1976/003	L. SPLENDIDA	L030	L. BIFOLIA	L023	SUCCESSFUL				
1978/016	L. SPLENDIDA	L030	L. BIFOLIA	L175	NOT SUCCESSFUL				NO SEEDSET
1989/006	L. SPLENDIDA	L325	L. BIFOLIA	L390	NOT SUCCESSFUL				ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1991/020	L. SPLENDIDA	L437	L. BIFOLIA	L390	SUCCESSFUL	Y	Y		
1991/021	L. SPLENDIDA	L325	L. BIFOLIA	L390	SUCCESSFUL	Y	Y		
1993/165	L. SPLENDIDA	L419	L. BIFOLIA	T1991/064/014	NOT SUCCESSFUL				NO SEEDSET
1993/166	L. SPLENDIDA	L417	L. BIFOLIA	T1991/064/014	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/536	L. SPLENDIDA	L417	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/541	L. SPLENDIDA	L419	L. BIFOLIA	L389	SUCCESSFUL	FEW	Y	Y	
2004/542	L. SPLENDIDA	L419	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/123	L. SPLENDIDA	L417	L. BIFOLIA	T1991/049/29	NOT SUCCESSFUL				NO SEEDSET
2008/245	L. SPLENDIDA	L417	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2008/271	L. SPLENDIDA	L417	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
1992/097	L. SPLENDIDA	L417	L. CARNOSA	L331	SUCCESSFUL	Y			
1992/101	L. SPLENDIDA	L419	L. CARNOSA	L331	SUCCESSFUL	FEW		Y	
1992/105	L. SPLENDIDA	L419	L. CARNOSA	L393	SUCCESSFUL	Y			
2005/406	L. SPLENDIDA	L417	L. CONTAMINATA	L82	NOT SUCCESSFUL				NO SEEDSET
2008/276	L. SPLENDIDA	L417	L. CONTAMINATA	L082	SUCCESSFUL	FEW		Y	
2001/466	L. SPLENDIDA	L417	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/467	L. SPLENDIDA	L417	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/473	L. SPLENDIDA	L419	L. FLAVA	L124	SUCCESSFUL	FEW	FEW	Y	
2001/474	L. SPLENDIDA	L419	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/246	L. SPLENDIDA	L417	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET
2009/002	L. SPLENDIDA	L419	L. FLAVA	L144	SUCCESSFUL	FEW	Y		
2009/003	L. SPLENDIDA	L419	L. FLAVA	L124	SUCCESSFUL	FEW	Y	Y	
2009/010	L. SPLENDIDA	L417	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1993/168	L. SPLENDIDA	L417	L. FRAMESII	T1992/270/001	SUCCESSFUL	FEW		Y	
1993/169	L. SPLENDIDA	L419	L. FRAMESII	T1992/270/001	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1995/049	L. SPLENDIDA	L417	L. FRAMESII	T1992/270/001	SUCCESSFUL	FEW		Y	
2005/411	L. SPLENDIDA	L417	L. LILIFLORA	L290	SUCCESSFUL	FEW	FEW	Y	
2005/412	L. SPLENDIDA	L417	L. LILIFLORA	T1993/032/004	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2009/011	L. SPLENDIDA	L417	L. LILIFLORA	T1993/032	NOT SUCCESSFUL				NO SEEDSET
2010/015	L. SPLENDIDA	L417	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/539	L. SPLENDIDA	L417	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2008/249	L. SPLENDIDA	L417	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2008/272	L. SPLENDIDA	L417	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2009/009	L. SPLENDIDA	L417	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2004/538	L. SPLENDIDA	L417	L. MUTABILIS	L161	SUCCESSFUL	FEW		Y	
2005/404	L. SPLENDIDA	L417	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2005/415	L. SPLENDIDA	L417	L. MUTABILIS	L161	SUCCESSFUL	FEW	FEW	Y	
2006/124	L. SPLENDIDA	L417	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2008/247	L. SPLENDIDA	L417	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2008/252	L. SPLENDIDA	L417	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
1994/141	L. SPLENDIDA	L417	L. NAMAQUENSIS	L258	SUCCESSFUL	FEW		Y	
1995/048	L. SPLENDIDA	L417	L. NAMAQUENSIS	L258	NOT SUCCESSFUL	FEW	FEW	Y	SEEDLING LETHALITY
1995/050	L. SPLENDIDA	L419	L. NAMAQUENSIS	L258	SUCCESSFUL	FEW	FEW	Y	
1966/033	L. SPLENDIDA		L. ORCHIOIDES		SUCCESSFUL				
2004/537	L. SPLENDIDA	L417	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2005/414	L. SPLENDIDA	L417	L. ORCHIOIDES	T19992/032/006	NOT SUCCESSFUL				NO SEEDSET
2008/274	L. SPLENDIDA	L417	L. ORCHIOIDES	T1992/032/005	NOT SUCCESSFUL				NO SEEDSET
1992/092	L. SPLENDIDA	L417	L. PALLIDA	T1991/056/002	SUCCESSFUL	Y			
1992/099	L. SPLENDIDA	L417	L. PALLIDA	L285	SUCCESSFUL	Y			

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
1992/102	L. SPLENDIDA	L419	L. PALLIDA	L285	SUCCESSFUL	Y			
1992/269	L. SPLENDIDA	L417	L. PALLIDA	L399	SUCCESSFUL	Y			
1993/167	L. SPLENDIDA	L417	L. PALLIDA	L397	SUCCESSFUL	FEW			
1994/142	L. SPLENDIDA	L419	L. PALLIDA	L285	SUCCESSFUL	Y		Y	
2005/407	L. SPLENDIDA	L417	L. PALLIDA	L49/1	NOT SUCCESSFUL				NO SEEDSET
2005/408	L. SPLENDIDA	L417	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2008/275	L. SPLENDIDA	L417	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2008/292	L. SPLENDIDA	L417	L. PALLIDA	L406	SUCCESSFUL	FEW	FEW	Y	
2005/409	L. SPLENDIDA	L417	L. PERRYAE	L53	NOT SUCCESSFUL				NO SEEDSET
1976/006	L. SPLENDIDA	L030	L. PUNCTATA	L174	NOT SUCCESSFUL				ABNORMAL SEEDS
1989/005	L. SPLENDIDA	L325	L. PUNCTATA	L277	SUCCESSFUL	Y	Y		
1992/096	L. SPLENDIDA	L417	L. PUNCTATA	L277	NOT SUCCESSFUL				ABNORMAL SEEDS
1992/104	L. SPLENDIDA	L419	L. PUNCTATA	L277	NOT SUCCESSFUL				SEEDLING LETHALITY
2003/393	L. SPLENDIDA	L417	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEED
2003/394	L. SPLENDIDA	L417	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEED
2003/396	L. SPLENDIDA	L419	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEED
2003/397	L. SPLENDIDA	L419	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND MANY ABNORMAL SEED
2008/273	L. SPLENDIDA	L417	L. PUNCTATA	L277	SUCCESSFUL	FEW	FEW	Y	
2008/277	L. SPLENDIDA	L417	L. PUNCTATA	L381	SUCCESSFUL	FEW	FEW	Y	
1975/062	L. SPLENDIDA	L183	L. QUADRICOLOR	L123	NOT SUCCESSFUL				SEEDLING LETHALITY
2001/464	L. SPLENDIDA	L417	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/465	L. SPLENDIDA	L417	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/468	L. SPLENDIDA	L417	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/469	L. SPLENDIDA	L417	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/471	L. SPLENDIDA	L419	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2001/472	L. SPLENDIDA	L419	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2002/304	L. SPLENDIDA	L419	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2002/305	L. SPLENDIDA	L419	L. QUADRICOLOR	L212	SUCCESSFUL	Y	FEW	Y	
2007/119	L. SPLENDIDA	L417	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED
2007/121	L. SPLENDIDA	L419	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	FEW	Y	
2008/243	L. SPLENDIDA	L419	L. QUADRICOLOR	L122	SUCCESSFUL	FEW	FEW	Y	
2008/244	L. SPLENDIDA	L417	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2008/248	L. SPLENDIDA	L417	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET
2008/251	L. SPLENDIDA	L417	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET
2009/001	L. SPLENDIDA	L419	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2009/004	L. SPLENDIDA	L419	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/470	L. SPLENDIDA	L419	L. SPLENDIDA	L417	SUCCESSFUL	FEW	FEW	Y	
2002/306	L. SPLENDIDA	L417	L. SPLENDIDA	L419	SUCCESSFUL	FEW	FEW	Y	
2004/543	L. SPLENDIDA	L419	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2005/413	L. SPLENDIDA	L417	L. SPLENDIDA	L417	SUCCESSFUL	FEW	FEW	Y	
2007/120	L. SPLENDIDA	L417	L. SPLENDIDA	L417	SUCCESSFUL	FEW		Y	
2009/005	L. SPLENDIDA	L419	L. SPLENDIDA	L419	SUCCESSFUL	FEW		Y	
2009/005	L. SPLENDIDA	L419	L. SPLENDIDA	L419	SUCCESSFUL	FEW		Y	
2010/011	L. SPLENDIDA	L419	L. SPLENDIDA	L419	SUCCESSFUL	FEW		Y	
2010/012	L. SPLENDIDA	L419	L. SPLENDIDA	L417	SUCCESSFUL	Y			
2005/410	L. SPLENDIDA	L417	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2010/005	L. SPLENDIDA	L417	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
1976/007	L. SPLENDIDA	L030	L. VIRIDIFLORA	L119	SUCCESSFUL				
1986/022	L. SPLENDIDA	L305	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				ABNORMAL SEEDS
1987/024	L. SPLENDIDA	L325	L. VIRIDIFLORA	L194	SUCCESSFUL	Y	Y		
2003/395	L. SPLENDIDA	L417	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEED

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2003/398	L. SPLENDIDA	L419	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEEDS
2006/122	L. SPLENDIDA	L417	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2008/250	L. SPLENDIDA	L417	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2001/046	L. THOMASIAE	T1996/085/004	L. LILIFLORA	T1992/342/001	SUCCESSFUL	FEW	FEW	Y	
1975/027	L. UNDULATA	L211	L. ALOIDES	L022	NOT SUCCESSFUL				NO SEEDSET
1975/026	L. UNDULATA	L216	L. ALOIDES	L045	NOT SUCCESSFUL				ABNORMAL SEEDS
1992/043	L. UNDULATA	L269	L. BIFOLIA	T1991/070/013	NOT SUCCESSFUL				NO SEEDSET
1992/044	L. UNDULATA	L269	L. BIFOLIA	T1991/070/015	NOT SUCCESSFUL				NO SEEDSET
1994/028	L. UNDULATA	L342	L. CONCORDIANA	T1992/296/011	SUCCESSFUL	FEW	FEW	Y	
1994/029	L. UNDULATA	L342	L. CONCORDIANA	T1992/296/007	NOT SUCCESSFUL				ABNORMAL SEEDS
1994/027	L. UNDULATA	L269/001	L. ORCHIOIDES	T1990/058/004	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1994/030	L. UNDULATA	L269/001	L. ORCHIOIDES	T1992/032	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
1995/044	L. UNDULATA	L269	L. ORCHIOIDES	T1992/282/008	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1995/043	L. UNDULATA	L269	L. PALLIDA	T1992/284/004	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS AND SEEDLING LETHALITY
1978/002	L. UNDULATA	L216	L. PUNCTATA	L174	NOT SUCCESSFUL				NO SEEDSET
1978/003	L. UNDULATA	L105	L. PUNCTATA	L174	NOT SUCCESSFUL				SEEDLING LETHALITY
1992/041	L. UNDULATA	L342	L. PUNCTATA	T1991/050/009	NOT SUCCESSFUL				ABNORMAL SEEDS
1992/042	L. UNDULATA	L269	L. PUNCTATA	L277	NOT SUCCESSFUL				ABNORMAL SEEDS
2000/237	L. UNIFOLIA	L315	L. ALBA	T1997/001/012	NOT SUCCESSFUL				NO SEEDSET
2004/572	L. UNIFOLIA	L229	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2004/573	L. UNIFOLIA	L229	L. BACHMANII	L127	NOT SUCCESSFUL				NO SEEDSET
2008/309	L. UNIFOLIA	L229	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
2003/450	L. UNIFOLIA	L229	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2003/451	L. UNIFOLIA	L229	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/569	L. UNIFOLIA	L229	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2006/629	L. UNIFOLIA	L229	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET
2006/630	L. UNIFOLIA	L229	L. BIFOLIA	T1991/049/29	NOT SUCCESSFUL				NO SEEDSET
2008/310	L. UNIFOLIA	L229	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET
2004/574	L. UNIFOLIA	L229	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2008/315	L. UNIFOLIA	L229	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2001/536	L. UNIFOLIA	L229	L. FLAVA	L124	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/537	L. UNIFOLIA	L229	L. FLAVA	L144	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2009/014	L. UNIFOLIA	L229	L. FLAVA	L144	SUCCESSFUL	FEW	FEW	Y	
2009/015	L. UNIFOLIA	L229	L. FLAVA	L124	SUCCESSFUL	FEW	FEW	Y	
2004/577	L. UNIFOLIA	L229	L. LILIFLORA	T1993/032/009	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/312	L. UNIFOLIA	L229	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET
2008/321	L. UNIFOLIA	L229	L. LILIFLORA	T1993/032	NOT SUCCESSFUL				NO SEEDSET
2004/571	L. UNIFOLIA	L229	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2004/579	L. UNIFOLIA	L229	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/313	L. UNIFOLIA	L229	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2008/314	L. UNIFOLIA	L229	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2004/515	L. UNIFOLIA	L229	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2004/570	L. UNIFOLIA	L229	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2008/318	L. UNIFOLIA	L229	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2008/320	L. UNIFOLIA	L229	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2003/452	L. UNIFOLIA	L229	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS AND SEEDLING LETHALITY
2004/575	L. UNIFOLIA	L229	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/576	L. UNIFOLIA	L229	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2008/316	L. UNIFOLIA	L229	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2008/322	L. UNIFOLIA	L229	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/524	L. UNIFOLIA	T1993/057/001	L. PERRYAE	L53	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/540	L. UNIFOLIA	L229	L. PERRYAE	L53	SUCCESSFUL	Y	FEW		
1978/001	L. UNIFOLIA	L110	L. PUNCTATA	L174	NOT SUCCESSFUL				SEEDLING LETHALITY
2003/447	L. UNIFOLIA	L229	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET
2003/448	L. UNIFOLIA	L229	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2004/566	L. UNIFOLIA	L229	L. PUNCTATA	L277	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2004/567	L. UNIFOLIA	L229	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET
2009/012	L. UNIFOLIA	L229	L. PUNCTATA	L381	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/041	L. UNIFOLIA	T1996/088/011	L. PUSILLA	L115	NOT SUCCESSFUL				NO SEEDSET
1975/048	L. UNIFOLIA	L110	L. QUADRICOLOR	L100	NOT SUCCESSFUL				NO SEEDSET
2001/534	L. UNIFOLIA	L229	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/535	L. UNIFOLIA	L229	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2001/538	L. UNIFOLIA	L229	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2001/539	L. UNIFOLIA	L229	L. QUADRICOLOR	L212	NOT SUCCESSFUL				NO SEEDSET AND FEW

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
									ABNORMAL SEEDS
2004/564	L. UNIFOLIA	L229	L. QUADRICOLOR	L101	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/565	L. UNIFOLIA	L229	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
2009/013	L. UNIFOLIA	L229	L. QUADRICOLOR	L155	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2009/016	L. UNIFOLIA	L229	L. QUADRICOLOR	L122	SUCCESSFUL	FEW	Y	Y	
2010/016	L. UNIFOLIA	L229	L. QUADRICOLOR	L212	SUCCESSFUL	FEW	FEW	Y	
2004/578	L. UNIFOLIA	L229	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2008/317	L. UNIFOLIA	L229	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2008/319	L. UNIFOLIA	L229	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2004/580	L. UNIFOLIA	L229	L. UNIFOLIA	L229	SUCCESSFUL	FEW	Y	Y	
2004/601	L. UNIFOLIA	L229	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
1982/070	L. UNIFOLIA	L229	L. VANZYLIAE	L228	NOT SUCCESSFUL				NO SEEDSET
2003/449	L. UNIFOLIA	L229	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2004/568	L. UNIFOLIA	L229	L. VIRIDIFLORA	L194	SUCCESSFUL	FEW	Y	Y	
2008/311	L. UNIFOLIA	L229	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1979/036	L. VANZYLIAE	L208	L. ALOIDES	L033	SUCCESSFUL				
1982/073	L. VANZYLIAE	L228	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
1975/059	L. VIOLACEA	L196	L. QUADRICOLOR	L122	NOT SUCCESSFUL				NO SEEDSET
1975/002	L. VIRIDIFLORA	L119	L. ALOIDES	L039	SUCCESSFUL				
1975/012	L. VIRIDIFLORA	L194	L. ALOIDES	L022	SUCCESSFUL				
2005/033	L. VIRIDIFLORA	L194	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2005/056	L. VIRIDIFLORA	L194	L. BACHMANII	L127	SUCCESSFUL	FEW		Y	
2006/029	L. VIRIDIFLORA	L194	L. BACHMANII	L016	NOT SUCCESSFUL				NO SEEDSET
1978/005	L. VIRIDIFLORA	L194	L. BIFOLIA	L078	NOT SUCCESSFUL				SEEDLING LETHALITY
1978/009	L. VIRIDIFLORA	L194	L. BIFOLIA	L175	NOT SUCCESSFUL				ABNORMAL SEEDS
1978/010	L. VIRIDIFLORA	L111	L. BIFOLIA	L175	NOT SUCCESSFUL				ABNORMAL SEEDS
1979/001	L. VIRIDIFLORA	L119	L. BIFOLIA	L175	NOT SUCCESSFUL				ABNORMAL SEEDS
1994/035	L. VIRIDIFLORA	L194	L. BIFOLIA	T1991/059/009	SUCCESSFUL	FEW	Y	Y	
1994/036	L. VIRIDIFLORA	L194	L. BIFOLIA	T1991/059/065	NOT SUCCESSFUL				ABNORMAL SEEDS
2003/177	L. VIRIDIFLORA	L194	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND ONE ABNORMAL SEED
2005/031	L. VIRIDIFLORA	L194	L. BIFOLIA	L389	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2006/027	L. VIRIDIFLORA	L194	L. BIFOLIA	T1991/049/29	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2007/012	L. VIRIDIFLORA	L194	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				NO SEEDSET AND ABNORMAL SEEDS
2008/006	L. VIRIDIFLORA	L194	L. BIFOLIA	T1991/049/029	NOT SUCCESSFUL				MANY ABNORMAL SEEDS
1993/047	L. VIRIDIFLORA	L194	L. COMPTONII	L284	NOT SUCCESSFUL				NO SEEDSET
2005/034	L. VIRIDIFLORA	L194	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
2006/030	L. VIRIDIFLORA	L194	L. CONTAMINATA	L082	NOT SUCCESSFUL				NO SEEDSET
1987/025	L. VIRIDIFLORA	L194	L. ELEGANS	L308	NOT SUCCESSFUL				NO SEEDSET
2001/206	L. VIRIDIFLORA	L194	L. FLAVA	L124	SUCCESSFUL	FEW	FEW		
2002/020	L. VIRIDIFLORA	L194	L. FLAVA	L144	SUCCESSFUL	FEW	FEW	Y	
2005/060	L. VIRIDIFLORA	L194	L. LILIFLORA	L290	SUCCESSFUL	FEW			
2005/061	L. VIRIDIFLORA	L194	L. LILIFLORA	T1993/032/004	SUCCESSFUL	FEW			
2006/033	L. VIRIDIFLORA	L194	L. LILIFLORA	L290	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2007/018	L. VIRIDIFLORA	L194	L. LILIFLORA	T1993/032	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2008/228	L. VIRIDIFLORA	L194	L. LILIFLORA	T1932/032	NOT SUCCESSFUL				NO SEEDSET
1992/061	L. VIRIDIFLORA	L194	L. LONGIBRACTEATA	T1991/060/006	SUCCESSFUL				
2005/032	L. VIRIDIFLORA	L194	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2005/055	L. VIRIDIFLORA	L194	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2007/013	L. VIRIDIFLORA	L194	L. MEDIANA	L418	NOT SUCCESSFUL				NO SEEDSET
2007/014	L. VIRIDIFLORA	L194	L. MEDIANA	L158	NOT SUCCESSFUL				NO SEEDSET
2003/180	L. VIRIDIFLORA	L194	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2003/181	L. VIRIDIFLORA	L194	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2005/053	L. VIRIDIFLORA	L194	L. MUTABILIS	L161	NOT SUCCESSFUL				NO SEEDSET
2005/054	L. VIRIDIFLORA	L194	L. MUTABILIS	L318	NOT SUCCESSFUL				NO SEEDSET
2003/179	L. VIRIDIFLORA	L194	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				MANY ABNORMAL SEEDS
2005/052	L. VIRIDIFLORA	L194	L. ORCHIOIDES	T1992/032/006	NOT SUCCESSFUL				NO SEEDSET
2006/028	L. VIRIDIFLORA	L194	L. ORCHIOIDES	T1992/032/6	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1987/009	L. VIRIDIFLORA	L194	L. ORCHIOIDES	L316	SUCCESSFUL				
1993/043	L. VIRIDIFLORA	L194	L. PALLIDA	L399	NOT SUCCESSFUL				NO SEEDSET
1993/044	L. VIRIDIFLORA	L194	L. PALLIDA	T1991/056/002	NOT SUCCESSFUL				NO SEEDSET
1995/038	L. VIRIDIFLORA	L194	L. PALLIDA	T1991/055/001	SUCCESSFUL	FEW		Y	
2003/182	L. VIRIDIFLORA	L194	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2003/183	L. VIRIDIFLORA	L194	L. PALLIDA	L406	NOT SUCCESSFUL				NO SEEDSET
2005/057	L. VIRIDIFLORA	L194	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET
2005/058	L. VIRIDIFLORA	L194	L. PALLIDA	L406	SUCCESSFUL	FEW		Y	
2006/031	L. VIRIDIFLORA	L194	L. PALLIDA	L049/1	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
2007/015	L. VIRIDIFLORA	L194	L. PALLIDA	L406	SUCCESSFUL	Y	FEW		
2005/035	L. VIRIDIFLORA	L194	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2007/016	L. VIRIDIFLORA	L194	L. PERRYAE	L053	NOT SUCCESSFUL				NO SEEDSET
2003/175	L. VIRIDIFLORA	L194	L. PUNCTATA	L277	SUCCESSFUL	Y	FEW		
2003/176	L. VIRIDIFLORA	L194	L. PUNCTATA	L381	SUCCESSFUL	FEW	BAIE		
2004/001	L. VIRIDIFLORA	L194	L. PUNCTATA	L227	SUCCESSFUL	Y			
2004/002	L. VIRIDIFLORA	L194	L. PUNCTATA	L381	SUCCESSFUL	Y			
2001/207	L. VIRIDIFLORA	L194	L. QUADRICOLOR	L122	SUCCESSFUL	FEW	FEW	Y	
2001/208	L. VIRIDIFLORA	L194	L. QUADRICOLOR	L155	SUCCESSFUL	Y	FEW		
2002/019	L. VIRIDIFLORA	L194	L. QUADRICOLOR	L101	SUCCESSFUL	FEW	FEW	Y	
2002/021	L. VIRIDIFLORA	L194	L. QUADRICOLOR	L212	SUCCESSFUL	Y	FEW	Y	
1980/003	L. VIRIDIFLORA	L194	L. REFLEXA	L181	SUCCESSFUL				
1993/045	L. VIRIDIFLORA	L194	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET AND FEW ABNORMAL SEEDS
1994/034	L. VIRIDIFLORA	L194	L. SPLENDIDA	L419	SUCCESSFUL	FEW	FEW	Y	
2005/062	L. VIRIDIFLORA	L194	L. SPLENDIDA	L417	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
2005/063	L. VIRIDIFLORA	L194	L. SPLENDIDA	L419	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
2006/594	L. VIRIDIFLORA	L194	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2007/019	L. VIRIDIFLORA	L194	L. SPLENDIDA	L417	NOT SUCCESSFUL				NO SEEDSET
2007/020	L. VIRIDIFLORA	L194	L. SPLENDIDA	L419	NOT SUCCESSFUL				NO SEEDSET
2005/059	L. VIRIDIFLORA	L194	L. UNIFOLIA	L229	NOT SUCCESSFUL				FEW ABNORMAL SEEDS
2007/017	L. VIRIDIFLORA	L194	L. UNIFOLIA	L229	NOT SUCCESSFUL				NO SEEDSET
2001/233	L. VIRIDIFLORA	T1993/060/001	L. VIRIDIFLORA	L194	SUCCESSFUL	Y	Y		
2001/234	L. VIRIDIFLORA	L194	L. VIRIDIFLORA	T1993/060/001	SUCCESSFUL	Y	FEW		
2005/064	L. VIRIDIFLORA	L194	L. VIRIDIFLORA	L194	SUCCESSFUL	FEW			
2006/034	L. VIRIDIFLORA	L194	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2007/021	L. VIRIDIFLORA	L194	L. VIRIDIFLORA	L194	NOT SUCCESSFUL				NO SEEDSET
2008/008	L. VIRIDIFLORA	L194	L. VIRIDFLORA	L194	SUCCESSFUL	FEW	FEW	Y	

Unique no	Female parent species	Female parent no	Male parent species	Male parent no	Successful or not	No of normal seed	No of abnormal seed	No set	Unsuccessful result
2005/064	L. VIRIDIFLORA	L194	L. VIRIDIFLORA	L194	SUCCESSFUL	FEW			
1975/049	L. ZEYHERI	L118	L. QUADRICOLOR	L122	NOT SUCCESSFUL				ABNORMAL SEEDS
1976/008	L. ZEYHERI	L118	L. VIRIDIFLORA	L119	NOT SUCCESSFUL				ABNORMAL SEEDS

APPENDIX D: Complete list of crossing combinations with detail results from the 15 *Lachenalia* species crossing diallel

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2001/201	L277	L124	26	23	1	2	345	38	92.31	13.27	15.00	y	13	3.77
2001/203	L277	L155	22	10	9	3	162	233	86.36	7.36	16.20	y	104	64.20
2001/204	L381	L122	17	0	11	6	0	28	64.71	0.00	0.00	n		
2001/206	L194	L124	17	0	14	3	0	50	82.35	0.00	0.00	n		
2001/207	L194	L122	29	17	1	11	83	33	62.07	2.86	4.88	Y	13	15.66
2001/208	L194	L155	31	26	2	3	228	46	90.32	7.35	8.77	Y	66	28.95
2001/229	L277	L381	14	10	3	1	284	90	92.86	20.29	28.40	Y	167	58.80
2001/230	L381	L277	14	5	0	11	94	0	35.71	6.71	18.80	Y	80	85.11
2001/231	L277	L277	35	32	0	3	854	115	91.43	24.40	26.69	Y	821	96.14
2001/232	L381	L381	27	21	0	6	143	4	77.78	5.30	6.81	Y	104	72.73
2001/233	L800	L194	36	31	5	0	861	611	100.00	23.92	27.77	Y	861	100.00
2001/234	L194	L800	49	45	0	4	1384	91	91.84	28.24	30.76	Y	1031	74.49
2001/309	L389	L122	13	0	1	12	0	1	7.69	0.00	0.00	N		
2001/310	L389	L155	6	0	0	6	0	0	0.00	0.00	0.00	N		
2001/311	L389	L124	12	0	0	12	0	0	0.00	0.00	0.00	N		
2001/312	L389	L144	5	0	0	5	0	0	0.00	0.00	0.00	N		
2001/313	L801	L122	17	0	0	17	0	0	0.00	0.00	0.00	N		
2001/314	L802	L155	25	0	6	19	0	7	24.00	0.00	0.00	N		
2001/315	L802	L101	23	0	4	19	0	5	17.39	0.00	0.00	N		
2001/316	L802/1	L124	31	0	0	31	0	0	0.00	0.00	0.00	N		
2001/317	L802/2	L144	26	0	1	25	0	0	3.85	0.00	0.00	N		
2001/318	L802/3	L122	20	0	0	20	0	0	0.00	0.00	0.00	N		
2001/319	L802/1	L212	30	0	1	29	0	1	3.33	0.00	0.00	N		
2001/320	L802/2	L155	26	4	1	21	4	2	19.23	0.15	1.00	Y	2	50.00
2001/321	L802/2	L101	36	2	1	33	2	1	8.33	0.06	1.00	Y	0	50.00
2001/322	L802/2	L124	30	0	0	30	0	0	0.00	0.00	0.00	N		
2001/323	L802/2	L144	25	5	1	19	5	1	24.00	0.20	1.00	Y	1	20.00

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2001/324	L802/2	L122	24	0	4	0	0	5	16.67	0.00	0.00	N		
2001/325	L802/1	L212	33	0	0	33	0	0	0.00	0.00	0.00	N		
2001/326	L101	L277	8	2	5	1	141	166	87.50	17.63	70.50	Y	127	90.07
2001/327	L101	L381	9	4	3	2	58	100	77.78	6.44	14.50	Y	58	100.00
2001/328	L101	L194	12	0	1	11	0	3	8.33	0.00	0.00	N		
2001/329	L101	L389	11	0	8	3	0	152	72.73	0.00	0.00	N		
2001/330	L101	L801	12	0	5	7	0	57	41.67	0.00	0.00	N		
2001/331	L155	L277	21	10	7	4	13	164	80.95	0.62	1.30	Y	10	76.92
2001/332	L155	L381	18	1	12	5	1	124	72.22	0.06	1.00	Y	1	100.00
2001/333	L155	L194	14	0	3	11	0	3	21.43	0.00	0.00	N		
2001/334	L155	L389	17	0	8	9	0	62	47.06	0.00	0.00	N		
2001/335	L155	L801	25	1	6	18	1	28	28.00	0.04	1.00	Y	1	100.00
2001/336	L144	L277	25	7	9	9	27	239	64.00	1.08	3.86	Y	9	33.33
2001/337	L144	L381	20	8	5	7	47	262	65.00	2.35	5.88	Y	1	2.13
2001/338	L144	L194	20	0	6	14	0	29	30.00	0.00	0.00	N		
2001/339	L144	L389	24	0	11	13	0	187	45.83	0.00	0.00	N		
2001/340	L122	L277	13	0	7	6	0	140	53.85	0.00	0.00	N		
2001/341	L122	L381	13	0	10	3	0	223	76.92	0.00	0.00	N		
2001/342	L122	L194	13	0	3	10	0	4	23.08	0.00	0.00	N		
2001/343	L122	L389	14	0	13	1	0	185	92.86	0.00	0.00	N		
2001/344	L122	L801	13	0	11	2	0	53	84.62	0.00	0.00	N		
2001/345	L124	L277	23	10	8	5	47	880	78.26	2.04	4.70	Y	41	87.23
2001/346	L124	L381	22	13	4	5	225	689	77.27	10.23	17.31	Y	63	28.00
2001/347	L212	L277	9	0	7	2	0	263	77.78	0.00	0.00	N		
2001/348	L212	L381	8	0	7	1	0	200	87.50	0.00	0.00	N		
2001/349	L212	L194	9	0	4	5	0	17	44.44	0.00	0.00	N		
2001/350	L212	L389	6	0	2	4	0	18	33.33	0.00	0.00	N		
2001/351	L212	L801	3	0	2	1	0	3	66.67	0.00	0.00	N		
2001/352	L389	L101	25	0	0	25	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2001/353	L389	L212	13	0	0	13	0	0	0.00	0.00	0.00	N		
2001/354	L101	L802	13	0	0	13	0	0	0.00	0.00	0.00	N		
2001/355	L389	L801	22	9	3	10	156	89	54.55	7.09	17.33	Y	141	90.38
2001/356	L801/1	L389	11	8	2	1	178	22	90.91	16.18	22.25	Y	178	100.00
2001/357	L801/1	L101	11	0	0	11	0	0	0.00	0.00	0.00	N		
2001/358	L801/2	L124	3	0	0	3	0	0	0.00	0.00	0.00	N		
2001/359	L801/2	L144	13	0	1	12	0	1	7.69	0.00	0.00	N		
2001/360	L801/2	L155	15	0	0	15	0	0	0.00	0.00	0.00	N		
2001/361	L801/2	L212	13	0	1	12	0	1	7.69	0.00	0.00	N		
2001/362	L101	L122	8	7	1	0	107	5	100.00	13.38	15.29	Y	98	91.59
2001/383	L155	L101	5	4	0	1	35	11	80.00	7.00	8.75	Y	35	100.00
2001/384	L144	L101	23	0	3	20	0	13	13.04	0.00	0.00	N		
2001/385	L144	L122	14	0	0	14	0	0	0.00	0.00	0.00	N		
2001/386	L144	L124	20	1	1	18	1	7	10.00	0.05	1.00	Y	1	100.00
2001/387	L144	L155	19	0	1	18	0	4	5.26	0.00	0.00	N		
2001/388	L144	L212	18	0	0	18	0	0	0.00	0.00	0.00	N		
2001/390	L418	L101	68	0	30	38	0	242	44.12	0.00	0.00	N		
2001/391	L418	L122	59	0	32	27	0	183	54.24	0.00	0.00	N		
2001/393	L318	L122	31	0	1	30	0	1	3.23	0.00	0.00	N		
2001/394	L318	L124	51	0	0	51	0	0	0.00	0.00	0.00	N		
2001/395	L318	L144	44	0	0	44	0	0	0.00	0.00	0.00	N		
2001/396	L318	L155	36	0	2	34	0	2	5.56	0.00	0.00	N		
2001/397	L318	L212	63	0	3	30	0	3	4.76	0.00	0.00	N		
2001/398	L016	L101	49	0	22	27	0	66	44.90	0.00	0.00	N		
2001/399	L016	L122	37	0	15	22	0	46	40.54	0.00	0.00	N		
2001/410	L418	L124	81	0	11	70	0	15	13.58	0.00	0.00	N		
2001/411	L418	L144	59	0	29	30	0	155	49.15	0.00	0.00	N		
2001/412	L418	L155	25	0	11	14	0	39	44.00	0.00	0.00	N		
2001/413	L161	L101	47	29	4	14	71	16	70.21	1.51	2.45	Y	59	83.10

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2001/414	L161	L122	95	16	6	73	19	10	23.16	0.20	1.19	Y	5	26.32
2001/415	L802/2	L802	41	16	12	13	250	170	68.29	6.10	15.63	Y	182	72.80
2001/416	L802/2	L802/1	42	30	1	11	238	130	73.81	5.67	7.93	Y	200	84.03
2001/417	L122	L802	22	0	0	22	0	0	0.00	0.00	0.00	N		
2001/418	L122	L161	11	0	0	11	0	0	0.00	0.00	0.00	N		
2001/419	L122	L418	16	0	0	16	0	0	0.00	0.00	0.00	N		
2001/420	L122	L101	19	2	9	8	3	155	57.89	0.16	1.50	Y	3	100.00
2001/421	L122	L124	13	1	5	7	2	80	46.15	0.15	2.00	Y	0	50.00
2001/422	L122	L155	13	0	5	8	0	50	38.46	0.00	0.00	N		
2001/423	L122	L212	18	0	1	17	0	1	5.56	0.00	0.00	N		
2001/424	L144	L161	13	0	0	13	0	0	0.00	0.00	0.00	N		
2001/425	L144	L418	19	0	0	19	0	0	0.00	0.00	0.00	N		
2001/426	L212	L161	19	0	0	19	0	0	0.00	0.00	0.00	N		
2001/427	L212	L418	18	0	0	18	0	0	0.00	0.00	0.00	N		
2001/428	L212	L101	13	0	0	13	0	0	0.00	0.00	0.00	N		
2001/429	L212	L122	13	0	0	13	0	0	0.00	0.00	0.00	N		
2001/430	L212	L124	17	0	13	4	0	328	76.47	0.00	0.00	N		
2001/431	L202	L144	12	0	9	3	0	119	75.00	0.00	0.00	N		
2001/432	L212	L155	11	0	3	9	0	39	27.27	0.00	0.00	N		
2001/433	L161	L124	43	4	2	37	4	3	13.95	0.09	1.00	Y	2	50.00
2001/434	L161	L144	40	6	0	34	8	1	15.00	0.20	1.33	Y	6	75.00
2001/435	L161	L155	38	9	2	27	18	7	28.95	0.47	2.00	Y	8	44.44
2001/436	L161	L212	51	3	0	48	4	0	5.88	0.08	1.33	Y	2	50.00
2001/437	L016	L124	17	0	0	17	0	0	0.00	0.00	0.00	N		
2001/438	L016	L144	29	0	0	29	0	0	0.00	0.00	0.00	N		
2001/439	L016	L155	17	0	1	16	0	2	5.88	0.00	0.00	N		
2001/440	L016	L212	16	0	1	15	0	1	6.25	0.00	0.00	N		
2001/441	L418	L212	49	0	12	37	1	19	24.49	0.02	0.00	N	0	0.00
2001/442	L122	L381	13	0	0	13	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2001/443	L122	L016	16	0	0	16	0	0	0.00	0.00	0.00	N		
2001/445	L122	L417	15	0	0	15	0	0	0.00	0.00	0.00	N		
2001/446	L122	L144	12	5	0	7	23	47	41.67	1.92	4.60	Y	11	47.83
2001/447	L124	L194	12	0	0	12	0	0	0.00	0.00	0.00	N		
2001/448	L124	L389	16	0	0	16	0	0	0.00	0.00	0.00	N		
2001/449	L124	L801	13	0	2	11	0	13	15.38	0.00	0.00	N		
2001/450	L124	L802	11	0	0	11	0	0	0.00	0.00	0.00	N		
2001/451	L124	L161	5	0	0	5	0	0	0.00	0.00	0.00	N		
2001/452	L144	L801	13	0	0	13	0	0	0.00	0.00	0.00	N		
2001/453	L144	L802	15	0	0	15	0	0	0.00	0.00	0.00	N		
2001/454	L144	L318	17	0	0	17	0	0	0.00	0.00	0.00	N		
2001/455	L144	L016	16	0	0	16	0	0	0.00	0.00	0.00	N		
2001/457	L212	L802	11	0	0	11	0	0	0.00	0.00	0.00	N		
2001/458	L212	L318	9	0	0	9	0	0	0.00	0.00	0.00	N		
2001/459	L212	L016	15	0	0	15	0	0	0.00	0.00	0.00	N		
2001/461	L212	L417	13	0	0	13	0	0	0.00	0.00	0.00	N		
2001/462	L161	L318	29	19	0	10	158	25	65.52	5.45	8.32	Y	158	100.00
2001/464	L417	L101	27	0	6	21	0	20	22.22	0.00	0.00	N		
2001/465	L417	L122	22	0	2	20	0	10	9.09	0.00	0.00	N		
2001/466	L417	L124	23	0	2	21	0	6	8.70	0.00	0.00	N		
2001/467	L417	L144	25	0	2	23	0	3	8.00	0.00	0.00	N		
2001/468	L417	L155	28	0	5	23	0	25	17.86	0.00	0.00	N		
2001/469	L417	L212	19	0	1	18	0	1	5.26	0.00	0.00	N		
2001/470	L419	L417	34	9	2	23	22	4	32.35	0.65	2.44	Y	17	77.27
2001/471	L419	L101	25	0	3	22	0	9	12.00	0.00	0.00	N		
2001/472	L419	L122	25	0	8	17	0	40	32.00	0.00	0.00	N		
2001/473	L419	L124	30	3	17	10	10	74	66.67	0.33	3.33	Y	1	10.00
2001/474	L419	L124	25	0	5	20	0	12	20.00	0.00	0.00	N		
2001/475	L419	L144	11	0	1	10	0	1	9.09	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2001/476	L803	L802	20	5	6	9	9	35	55.00	0.45	1.80	Y	2	22.22
2001/477	L803	L802/1	12	0	2	10	0	2	16.67	0.00	0.00	N		
2001/482	L406	L101	86	45	18	24	188	208	73.26	2.19	4.18	Y	142	75.53
2001/485	L406	L144	85	8	15	62	16	135	27.06	0.19	2.00	Y	0	6.25
2001/486	L082	L101	58	0	9	49	0	25	15.52	0.00	0.00	N		
2001/488	L082	L124	26	0	10	16	0	28	38.46	0.00	0.00	N		
2001/491	L049/1	L122	20	0	0	20	0	0	0.00	0.00	0.00	N		
2001/492	L049/1	L124	48	0	2	46	0	6	4.17	0.00	0.00	N		
2001/494	L053	L101	34	0	24	10	0	217	70.59	0.00	0.00	N		
2001/495	L158	L101	42	0	7	35	0	49	16.67	0.00	0.00	N		
2001/496	L158	L122	37	0	10	27	0	52	27.03	0.00	0.00	N		
2001/497	L804	L101	50	0	19	31	0	69	38.00	0.00	0.00	N		
2001/498	L804/1	L122	50	0	0	50	0	0	0.00	0.00	0.00	N		
2001/499	L804/1	L124	64	0	2	62	0	2	3.13	0.00	0.00	N		
2001/500	L804/1	L144	45	0	0	45	0	0	0.00	0.00	0.00	N		
2001/501	L804/1	L144	35	0	0	35	0	0	0.00	0.00	0.00	N		
2001/502	L804/1	L155	22	0	0	22	0	0	0.00	0.00	0.00	N		
2001/503	L804	L155	51	0	1	50	0	1	1.96	0.00	0.00	N		
2001/504	L804	L212	36	0	7	29	0	14	19.44	0.00	0.00	N		
2001/505	L082	L144	47	0	13	34	0	33	27.66	0.00	0.00	N		
2001/506	L082	L155	93	0	33	60	0	198	35.48	0.00	0.00	N		
2001/508	L082	L207	51	24	6	21	147	86	58.82	2.88	6.13	Y	147	100.00
2001/509	L805	L082	37	0	9	28	0	28	24.32	0.00	0.00	N		
2001/516	L049/1	L155	42	0	4	38	0	15	9.52	0.00	0.00	N		
2001/518	L049/1	L406	27	13	3	11	91	115	59.26	3.37	7.00	Y	77	84.62
2001/519	L406	L155	70	1	23	46	1	125	34.29	0.01	1.00	Y	1	100.00
2001/520	L406	L212	52	3	10	39	8	49	25.00	0.15	2.67	Y	8	100.00
2001/521	L406	L049/1	66	45	0	21	393	20	68.18	5.95	8.73	Y	375	95.42
2001/524	L806	L053	26	0	9	17	0	79	34.62	0.00	0.00	N		
2001/525	L290	L101	60	0	17	43	0	56	28.33	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2001/526	L290	L122	41	0	8	33	0	17	19.51	0.00	0.00	N		
2001/527	L290	L124	51	0	19	32	0	32	37.25	0.00	0.00	N		
2001/528	L290	L144	63	1	13	39	1	41	22.22	0.02	1.00	Y	1	100.00
2001/529	L158	L124	41	0	23	18	0	139	56.10	0.00	0.00	N		
2001/530	L158	L144	30	0	17	23	0	88	56.67	0.00	0.00	N		
2001/531	L158	L155	44	0	12	32	0	35	27.27	0.00	0.00	N		
2001/532	L158	L212	34	0	7	27	0	31	20.59	0.00	0.00	N		
2001/533	L158	L418	18	4	7	5	19	89	61.11	1.06	4.75	Y	17	89.47
2001/534	L229	L101	23	0	3	20	0	14	13.04	0.00	0.00	N		
2001/535	L229	L122	22	0	9	13	0	19	40.91	0.00	0.00	N		
2001/536	L229	L124	32	0	23	11	0	121	71.88	0.00	0.00	N		
2001/537	L229	L144	23	0	22	1	0	206	95.65	0.00	0.00	N		
2001/538	L229	L155	26	0	23	3	0	263	88.46	0.00	0.00	N		
2001/539	L229	L212	36	0	24	12	0	104	66.67	0.00	0.00	N		
2001/540	L229	L053	22	22	0	0	478	57	100.00	21.73	21.73	Y	426	89.12
2001/541	L290	L155	64	3	21	40	1	187	37.50	0.02	0.33	Y	1	100.00
2001/542	L290	L212	86	0	37	49	0	286	43.02	0.00	0.00	N		
2001/543	L290	L804/1	41	27	0	14	163	59	65.85	3.98	6.04	Y	103	63.19
2001/544	L804/2	L290	42	26	2	14	54	21	66.67	1.29	2.08	Y	54	100.00
2002/010	L277	L101	17	13	0	4	54	21	76.47	3.18	4.15	Y	1	1.85
2002/011	L277	L122	21	0	13	8	0	44	61.90	0.00	0.00	N		
2002/012	L277	L144	22	18	0	4	365	8	81.82	16.59	20.28	Y	1	0.27
2002/013	L277	L212	31	0	27	4	0	277	87.10	0.00	0.00	N		
2002/014	L381	L101	23	0	17	6	0	293	73.91	0.00	0.00	N		
2002/015	L381	L124	16	8	1	7	73	33	56.25	4.56	9.13	Y	1	1.37
2002/016	L381	L144	32	8	6	18	28	99	43.75	0.88	3.50	Y	1	3.57
2002/017	L381	L155	25	0	25	0	0	514	100.00	0.00	0.00	N		
2002/018	L381	L212	19	2	11	6	24	69	68.42	1.26	12.00	Y	22	91.67
2002/019	L194	L101	44	30	1	13	129	81	70.45	2.93	4.30	Y	129	100.00

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2002/020	L194	L144	46	22	2	22	85	64	52.17	1.85	3.86	Y	62	72.94
2002/021	L194	L212	38	31	3	4	243	89	89.47	6.39	7.84	Y	160	65.84
2002/022	L389	L144	30	0	1	29	0	1	3.33	0.00	0.00	N		
2002/023	L389	L155	16	0	0	16	0	0	0.00	0.00	0.00	N		
2002/024	L801/2	L124	15	0	0	15	0	0	0.00	0.00	0.00	N		
2002/081	L101	L277	6	5	1	0	64	98	100.00	10.67	12.80	Y	41	64.06
2002/082	L101	L381	5	3	0	2	81	163	60.00	16.20	27.00	Y	81	100.00
2002/083	L101	L161	8	0	0	8	0	0	0.00	0.00	0.00	N		
2002/084	L101	L318	8	0	0	8	0	0	0.00	0.00	0.00	N		
2002/085	L101	L082	2	0	0	2	0	0	0.00	0.00	0.00	N		
2002/086	L101	L016	2	0	0	2	0	0	0.00	0.00	0.00	N		
2002/087	L101	L122	6	4	0	2	11	4	66.67	1.83	2.75	Y	10	90.91
2002/088	L155	L161	6	0	0	6	0	0	0.00	0.00	0.00	N		
2002/089	L155	L318	4	0	0	4	0	0	0.00	0.00	0.00	N		
2002/126	L101	L049/1	3	0	0	3	0	0	0.00	0.00	0.00	N		
2002/127	L101	L406	5	0	0	5	0	0	0.00	0.00	0.00	N		
2002/128	L101	L418	5	0	0	5	0	0	0.00	0.00	0.00	N		
2002/129	L101	L158	4	0	0	4	0	0	0.00	0.00	0.00	N		
2002/130	L101	L804/2	2	0	0	2	0	0	0.00	0.00	0.00	N		
2002/131	L101	L290	2	0	0	2	0	0	0.00	0.00	0.00	N		
2002/132	L101	L417	2	0	0	2	0	0	0.00	0.00	0.00	N		
2002/134	L101	L053	4	0	0	4	0	0	0.00	0.00	0.00	N		
2002/135	L101	L229	3	0	0	3	0	0	0.00	0.00	0.00	N		
2002/136	L101	L101	2	0	0	2	0	0	0.00	0.00	0.00	N		
2002/138	L101	L144	6	2	1	3	48	17	50.00	8.00	24.00	Y	44	91.67
2002/139	L101	L155	6	0	0	6	0	0	0.00	0.00	0.00	N		
2002/140	L101	L212	6	4	0	2	72	8	66.67	12.00	18.00	Y	61	84.72
2002/141	L122	L082	14	0	0	4	0	0	0.00	0.00	0.00	N		
2002/142	L144	L082	11	0	0	11	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2002/143	L144	L049/1	13	0	0	13	0	0	0.00	0.00	0.00	N		
2002/144	L144	L406	22	0	0	22	0	0	0.00	0.00	0.00	N		
2002/145	L144	L158	19	0	0	19	0	0	0.00	0.00	0.00	N		
2002/146	L155	L082	26	0	0	26	0	0	0.00	0.00	0.00	N		
2002/147	L155	L016	9	0	0	9	0	0	0.00	0.00	0.00	N		
2002/150	L155	L049/1	8	0	0	8	0	0	0.00	0.00	0.00	N		
2002/151	L155	L406	4	0	0	4	0	0	0.00	0.00	0.00	N		
2002/152	L155	L418	4	0	0	4	0	0	0.00	0.00	0.00	N		
2002/153	L212	L277	6	0	5	1	0	153	83.33	0.00	0.00	N		
2002/154	L418	L158	22	10	0	12	39	15	45.45	1.77	3.90	Y	11	28.21
2002/245	L122	L049/1	5	0	0	5	0	0	0.00	0.00	0.00	N		
2002/246	L122	L406	9	0	0	9	0	0	0.00	0.00	0.00	N		
2002/247	L122	L158	13	0	0	13	0	0	0.00	0.00	0.00	N		
2002/248	L122	L804/2	10	0	0	10	0	0	0.00	0.00	0.00	N		
2002/249	L122	L290	12	0	0	12	0	0	0.00	0.00	0.00	N		
2002/250	L122	L417	11	0	0	11	0	0	0.00	0.00	0.00	N		
2002/251	L122	L419	7	0	0	7	0	0	0.00	0.00	0.00	N		
2002/253	L122	L229	8	0	0	8	0	0	0.00	0.00	0.00	N		
2002/254	L122	L101	7	5	0	2	75	45	71.43	10.71	15.00	Y	21	28.00
2002/255	L122	L122	3	0	0	3	0	0	0.00	0.00	0.00	N		
2002/256	L122	L155	5	1	1	3	1	1	40.00	0.20	1.00	Y	1	100.00
2002/257	L124	L318	5	0	0	5	0	0	0.00	0.00	0.00	N		
2002/258	L124	L082	5	0	0	5	0	0	0.00	0.00	0.00	N		
2002/259	L124	L016	6	0	0	6	0	0	0.00	0.00	0.00	N		
2002/261	L144	L804/2	25	0	0	25	0	0	0.00	0.00	0.00	N		
2002/262	L144	L290	21	0	0	21	0	0	0.00	0.00	0.00	N		
2002/263	L144	L417	21	0	0	21	0	0	0.00	0.00	0.00	N		
2002/264	L144	L419	39	0	0	39	0	0	0.00	0.00	0.00	N		
2002/265	L144	L053	18	0	0	18	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2002/266	L144	L229	21	0	0	21	0	0	0.00	0.00	0.00	N		
2002/267	L144	L124	18	1	1	16	1	1	11.11	0.06	1.00	Y	1	100.00
2002/268	L144	L144	14	0	1	13	0	1	7.14	0.00	0.00	N		
2002/269	L155	L158	5	0	0	5	0	0	0.00	0.00	0.00	N		
2002/270	L155	L804/2	5	0	0	5	0	0	0.00	0.00	0.00	N		
2002/271	L155	L290	10	0	0	10	0	0	0.00	0.00	0.00	N		
2002/272	L155	L417	2	0	0	2	0	0	0.00	0.00	0.00	N		
2002/273	L155	L419	4	0	0	4	0	0	0.00	0.00	0.00	N		
2002/274	L155	L053	5	0	0	5	0	0	0.00	0.00	0.00	N		
2002/275	L155	L229	3	0	0	3	0	0	0.00	0.00	0.00	N		
2002/276	L155	L101	5	1	0	4	8	2	20.00	1.60	8.00	Y	1	12.50
2002/277	L155	L122	4	0	0	4	0	0	0.00	0.00	0.00	N		
2002/278	L155	L124	5	0	1	4	0	4	20.00	0.00	0.00	N		
2002/279	L155	L144	6	1	1	4	7	3	33.33	1.17	7.00	Y	7	100.00
2002/280	L155	L155	4	0	0	4	0	0	0.00	0.00	0.00	N		
2002/281	L155	L212	4	2	0	2	4	0	50.00	1.00	2.00	Y	4	100.00
2002/282	L212	L381	6	0	3	3	0	75	50.00	0.00	0.00	N		
2002/283	L212	L194	8	0	1	7	0	3	12.50	0.00	0.00	N		
2002/284	L212	L389	4	0	3	1	0	9	75.00	0.00	0.00	N		
2002/285	L212	L801/2	10	0	0	10	0	0	0.00	0.00	0.00	N		
2002/286	L212	L082	7	0	0	7	0	0	0.00	0.00	0.00	N		
2002/288	L212	L049/1	8	0	0	8	0	0	0.00	0.00	0.00	N		
2002/289	L212	L406	8	0	0	8	0	0	0.00	0.00	0.00	N		
2002/290	L212	L158	7	0	0	7	0	0	0.00	0.00	0.00	N		
2002/291	L212	L804/2	7	0	0	7	0	0	0.00	0.00	0.00	N		
2002/292	L212	L290	6	0	0	6	0	0	0.00	0.00	0.00	N		
2002/293	L212	L419	11	0	0	11	0	0	0.00	0.00	0.00	N		
2002/294	L212	L053	11	0	0	11	0	0	0.00	0.00	0.00	N		
2002/295	L212	L229	6	0	0	6	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2002/296	L212	L101	7	0	1	6	0	7	14.29	0.00	0.00	N		
2002/297	L212	L155	9	8	0	1	89	58	88.89	9.89	11.13	Y	45	50.56
2002/298	L212	L212	8	0	0	8	0	0	0.00	0.00	0.00	N		
2002/304	L419	L155	34	0	4	30	0	8	11.76	0.00	0.00	N		
2002/305	L419	L212	35	24	0	11	325	116	68.57	9.29	13.54	Y	1	0.31
2002/306	L417	L419	34	17	0	17	131	5	50.00	3.85	7.71	Y	73	55.73
2002/313	L124	L049/1	11	0	0	11	0	0	0.00	0.00	0.00	N		
2002/315	L124	L418	6	0	0	6	0	0	0.00	0.00	0.00	N		
2002/316	L124	L158	4	0	0	4	0	0	0.00	0.00	0.00	N		
2002/317	L124	L804/2	4	0	0	4	0	0	0.00	0.00	0.00	N		
2003/042	L381	L122	14	0	12	2	0	105	85.71	0.00	0.00	N		
2003/043	L101	L101	5	1	0	4	1	0	20.00	0.20	1.00	N		
2003/044	L101	L124	13	6	0	7	407	1	46.15	31.31	67.83	Y	46	11.30
2003/114	L101	L417	13	2	0	11	2	0	15.38	0.15	1.00	Y	1	50.00
2003/115	L122	L053	10	0	0	10	0	0	0.00	0.00	0.00	N		
2003/116	L122	L229	7	0	0	7	0	0	0.00	0.00	0.00	N		
2003/117	L122	L122	15	3	1	11	4	11	26.67	0.27	1.33	N		
2003/118	L155	L122	9	5	0	4	57	7	55.56	6.33	11.40	Y	48	84.21
2003/119	L155	L124	6	6	0	0	43	82	100.00	7.17	7.17	Y	34	79.07
2003/164	L101	L419	3	0	0	3	0	0	0.00	0.00	0.00	N		
2003/165	L124	L417	7	0	0	7	0	0	0.00	0.00	0.00	N		
2003/166	L124	L419	4	0	0	4	0	0	0.00	0.00	0.00	N		
2003/168	L155	L406	9	0	0	9	0	0	0.00	0.00	0.00	N		
2003/169	L155	L158	7	0	0	7	0	0	0.00	0.00	0.00	N		
2003/170	L155	L408/1	7	0	0	7	0	0	0.00	0.00	0.00	N		
2003/171	L389	L277	10	0	0	10	0	0	0.00	0.00	0.00	N		
2003/172	L389	L381	13	0	0	13	0	0	0.00	0.00	0.00	N		
2003/173	L389	L194	17	0	0	17	0	0	0.00	0.00	0.00	N		
2003/174	L389	L802	12	0	0	12	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2003/175	L194	L277	8	8	0	0	214	20	100.00	26.75	26.75	Y	100	46.73
2003/176	L194	L381	7	6	0	1	135	2	85.71	19.29	22.50	Y	21	15.56
2003/177	L194	L389	1	0	1	1	0	1	100.00	0.00	0.00	N		
2003/178	L381	L194	3	0	0	3	0	0	0.00	0.00	0.00	N		
2003/179	L194	L802	6	0	6	0	0	52	100.00	0.00	0.00	N		
2003/180	L194	L161	4	0	0	4	0	0	0.00	0.00	0.00	N		
2003/181	L194	L318	5	0	0	5	0	0	0.00	0.00	0.00	N		
2003/182	L194	L049/1	4	0	0	4	0	0	0.00	0.00	0.00	N		
2003/183	L194	L406	5	0	0	5	0	0	0.00	0.00	0.00	N		
2003/184	L802/1	L277	31	0	3	28	0	4	9.68	0.00	0.00	N		
2003/185	L389	L161	8	0	0	8	0	0	0.00	0.00	0.00	N		
2003/186	L389	L318	10	0	0	10	0	0	0.00	0.00	0.00	N		
2003/187	L389	L418	11	1	0	10	1	0	9.09	0.09	1.00	N	0	0.00
2003/188	L389	L158	10	0	0	10	0	0	0.00	0.00	0.00	N		
2003/189	L389	L417	8	0	0	8	0	0	0.00	0.00	0.00	N		
2003/190	L389	L419	8	0	0	8	0	0	0.00	0.00	0.00	N		
2003/191	L389	L049/1	23	0	0	23	0	0	0.00	0.00	0.00	N		
2003/192	L016	L277	17	16	0	1	105	3	94.12	6.18	6.56	N	0	0.00
2003/193	L389	L406	9	0	0	9	0	0	0.00	0.00	0.00	N		
2003/194	L389	L016	14	0	0	14	0	0	0.00	0.00	0.00	N		
2003/196	L389	L082	8	0	0	8	0	0	0.00	0.00	0.00	N		
2003/198	L389	L053	6	0	0	6	0	0	0.00	0.00	0.00	N		
2003/199	L389	L229	7	1	0	6	1	0	14.29	0.14	1.00	N	0	0.00
2003/200	L802/1	L381	16	0	0	16	0	0	0.00	0.00	0.00	N		
2003/201	L801/2	L277	13	0	3	10	0	3	23.08	0.00	0.00	N		
2003/202	L016	L381	19	14	0	5	31	7	73.68	1.63	2.21	N	0	0.00
2003/203	L016	L389	20	3	3	14	3	5	30.00	0.15	1.00	N	0	0.00
2003/207	L101	L804/1	6	0	0	6	0	0	0.00	0.00	0.00	N		
2003/209	L101	L053	7	0	0	7	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2003/210	L101	L229	7	0	0	7	0	0	0.00	0.00	0.00	N		
2003/211	L124	L053	2	0	0	2	0	0	0.00	0.00	0.00	N		
2003/212	L124	L229	2	0	0	2	0	0	0.00	0.00	0.00	N		
2003/213	L124	L101	5	0	0	5	0	0	0.00	0.00	0.00	N		
2003/214	L124	L122	4	3	0	1	10	13	75.00	2.50	3.33	Y	8	80.00
2003/215	L155	L290	6	0	0	6	0	0	0.00	0.00	0.00	N		
2003/216	L318	L101	17	0	1	16	0	1	5.88	0.00	0.00	N		
2003/217	L389	L290	11	0	0	11	0	0	0.00	0.00	0.00	N		
2003/218	L389	L804/1	4	0	0	4	0	0	0.00	0.00	0.00	N		
2003/219	L801/2	L381	11	0	0	11	0	0	0.00	0.00	0.00	N		
2003/220	L801/2	L194	6	0	0	6	0	0	0.00	0.00	0.00	N		
2003/221	L802/2	L194	43	0	0	43	0	0	0.00	0.00	0.00	N		
2003/222	L802/2	L389	35	0	6	29	0	8	17.14	0.00	0.00	N		
2003/223	L802/2	L801/2	37	1	3	33	2	4	10.81	0.05	2.00	Y	1	50.00
2003/224	L802/2	L161	33	0	0	33	0	0	0.00	0.00	0.00	N		
2003/225	L802/2	L318	33	0	1	32	0	1	3.03	0.00	0.00	N		
2003/226	L802/1	L418	34	0	1	33	0	2	2.94	0.00	0.00	N		
2003/227	L802/1	L158	28	0	0	28	0	0	0.00	0.00	0.00	N		
2003/228	L802/1	L016	44	0	0	44	0	0	0.00	0.00	0.00	N		
2003/230	L802/2	L082	38	0	0	38	0	0	0.00	0.00	0.00	N		
2003/231	L802/2	L049/1	29	0	4	25	0	7	13.79	0.00	0.00	N		
2003/232	L802/2	L406	29	0	7	22	0	12	24.14	0.00	0.00	N		
2003/234	L802/2	L053	34	0	0	34	0	0	0.00	0.00	0.00	N		
2003/235	L802/2	L229	24	0		24	0	0	0.00	0.00	0.00	N		
2003/236	L802/2	L290	27	0	1	26	0	2	3.70	0.00	0.00	N		
2003/237	L802/2	L804/1	28	0	13	15	0	23	46.43	0.00	0.00	N		
2003/238	L802/2	L417	38	0	0	38	0	0	0.00	0.00	0.00	N		
2003/239	L802/2	L419	26	0	0	26	0	0	0.00	0.00	0.00	N		
2003/240	L161	L277	21	1	0	20	1	0	4.76	0.05	1.00	Y	1	100.00

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2003/241	L161	L381	15	0	0	15	0	0	0.00	0.00	0.00	N		
2003/242	L161	L194	13	0	0	13	0	0	0.00	0.00	0.00	N		
2003/243	L418	L277	42	0	21	21	0	143	50.00	0.00	0.00	N		
2003/244	L418	L381	26	0	14	11	0	57	53.85	0.00	0.00	N		
2003/245	L418	L194	34	0	19	15	0	58	55.88	0.00	0.00	N		
2003/278	L122	L418	8	0	0	8	0	0	0.00	0.00	0.00	N		
2003/279	L124	L161	6	0	0	6	0	0	0.00	0.00	0.00	N		
2003/280	L124	L124	6	5	0	1	11	4	83.33	1.83	2.20	Y	3	27.27
2003/281	L124	L144	4	4	0	0	205	6	100.00	51.25	51.25	Y	184	89.76
2003/282	L124	L155	7	7	0	0	355	4	100.00	50.71	50.71	Y	278	78.31
2003/283	L124	L212	5	0	3	2	0	16	60.00	0.00	0.00	N		
2003/284	L155	L417	12	0	2	10	0	2	16.67	0.00	0.00	N		
2003/285	L155	L419	10	0	0	10	0	0	0.00	0.00	0.00	N		
2003/286	L155	L053	7	0	0	7	0	0	0.00	0.00	0.00	N		
2003/287	L155	L229	9	0	0	9	0	0	0.00	0.00	0.00	N		
2003/288	L155	L144	8	6	0	2	93	14	75.00	11.63	15.50	Y	87	93.55
2003/289	L155	L155	7	0	0	7	0	0	0.00	0.00	0.00	N		
2003/290	L155	L212	8	7	0	1	102	10	87.50	12.75	14.57	Y	46	45.10
2003/291	L082	L212	53	0	0	53	0	0	0.00	0.00	0.00	N		
2003/292	L053	L122	3	0	2	1	0	5	66.67	0.00	0.00	N		
2003/293	L802/3	L101	38	0	2	36	0	3	5.26	0.00	0.00	N		
2003/294	L802/3	L122	33	0	8	25	0	9	24.24	0.00	0.00	N		
2003/295	L802/3	L124	20	0	0	20	0	0	0.00	0.00	0.00	N		
2003/296	L802/3	L144	11	0	0	11	0	0	0.00	0.00	0.00	N		
2003/297	L802/3	L212	23	0	0	23	0	0	0.00	0.00	0.00	N		
2003/298	L804/3	L277	14	0	0	14	0	0	0.00	0.00	0.00	N		
2003/299	L804/3	L381	29	0	1	28	0	1	3.45	0.00	0.00	N		
2003/300	L161	L389	11	0	0	11	0	0	0.00	0.00	0.00	N		
2003/301	L161	L801/2	20	0	0	20	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2003/302	L161	L802	8	0	4	4	0	6	50.00	0.00	0.00	N		
2003/303	L318	L277	31	0	0	31	0	0	0.00	0.00	0.00	N		
2003/304	L318	L381	28	0	0	28	0	0	0.00	0.00	0.00	N		
2003/305	L318	L194	25	0	0	25	0	0	0.00	0.00	0.00	N		
2003/306	L318	L389	20	0	0	20	0	0	0.00	0.00	0.00	N		
2003/307	L318	L801/2	14	0	0	14	0	0	0.00	0.00	0.00	N		
2003/308	L318	L802	19	0	6	13	0	8	31.58	0.00	0.00	N		
2003/309	L318	L418	28	0	0	28	0	0	0.00	0.00	0.00	N		
2003/310	L318	L158	32	0	1	31	0	1	3.13	0.00	0.00	N		
2003/311	L318	L016	24	0	3	21	0	3	12.50	0.00	0.00	N		
2003/312	L418	L389	45	0	3	42	0	4	6.67	0.00	0.00	N		
2003/313	L418	L801/2	14	0	0	14	0	0	0.00	0.00	0.00	N		
2003/314	L418	L802	35	0	17	18	0	48	48.57	0.00	0.00	N		
2003/315	L418	L161	33	0	3	30	0	3	9.09	0.00	0.00	N		
2003/316	L418	L318	33	0	2	31	0	3	6.06	0.00	0.00	N		
2003/317	L418	L016	45	1	19	25	1	49	44.44	0.02	1.00	Y	1	100.00
2003/319	L418	L082	44	1	10	33	1	44	25.00	0.02	1.00	Y	1	100.00
2003/320	L418	L049/1	23	0	0	23	0	0	0.00	0.00	0.00	N		
2003/321	L418	L406	16	0	1	15	0	1	6.25	0.00	0.00	N		
2003/323	L418	L053	23	0	0	23	0	0	0.00	0.00	0.00	N		
2003/324	L418	L229	13	0	1	12	0	1	7.69	0.00	0.00	N		
2003/325	L418	L290	15	0	1	14	0	2	6.67	0.00	0.00	N		
2003/326	L418	L804/1	14	0	4	10	0	11	28.57	0.00	0.00	N		
2003/327	L418	L417	26	0	0	26	0	0	0.00	0.00	0.00	N		
2003/329	L158	L277	11	0	3	8	0	15	27.27	0.00	0.00	N		
2003/330	L158	L381	12	3	0	9	0	20	25.00	0.00	0.00	N		
2003/331	L016	L194	19	12	0	7	31	3	63.16	1.63	2.58	N	0	0.00
2003/332	L016	L801/2	11	0	0	11	0	0	0.00	0.00	0.00	N		
2003/333	L016	L802	15	0	5	10	0	8	33.33	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2003/334	L016	L161	18	0	6	12	0	26	33.33	0.00	0.00	N		
2003/335	L016	L318	19	0	2	17	0	3	10.53	0.00	0.00	N		
2003/336	L016	L418	17	0	7	10	0	14	41.18	0.00	0.00	N		
2003/337	L016	L158	14	0	0	14	0	0	0.00	0.00	0.00	N		
2003/338	L016	L082	17	10	2	5	17	16	70.59	1.00	1.70	Y	15	88.24
2003/339	L016	L049/1	14	0	0	14	0	0	0.00	0.00	0.00	N		
2003/340	L016	L406	15	2	1	12	2	1	20.00	0.13	1.00	Y	1	50.00
2003/342	L016	L053	10	0	0	10	0	0	0.00	0.00	0.00	N		
2003/343	L016	L229	8	0	0	8	0	0	0.00	0.00	0.00	N		
2003/344	L082	L277	47	0	1	46	0	1	2.13	0.00	0.00	N		
2003/345	L082	L381	50	0	1	49	0	3	2.00	0.00	0.00	N		
2003/346	L082	L194	56	0	8	48	0	18	14.29	0.00	0.00	N		
2003/347	L082	L389	70	0	2	68	0	2	2.86	0.00	0.00	N		
2003/348	L082	L801/2	52	0	2	50	0	2	3.85	0.00	0.00	N		
2003/349	L082	L802	42	2	9	31	6	11	26.19	0.14	3.00	N	0	0.00
2003/350	L082	L161	53	0	12	41	0	28	22.64	0.00	0.00	N		
2003/351	L082	L318	46	0	3	43	0	4	6.52	0.00	0.00	N		
2003/352	L082	L418	40	0	0	40	0	0	0.00	0.00	0.00	N		
2003/353	L082	L158	63	0	1	62	0	1	1.59	0.00	0.00	N		
2003/354	L082	L016	39	6	1	32	18	6	17.95	0.46	3.00	Y	1	5.56
2003/356	L082	L049/1	39	1	1	37	1	1	5.13	0.03	1.00	N	0	0.00
2003/357	L082	L406	24	2	7	15	2	23	37.50	0.08	1.00	Y	1	50.00
2003/359	L082	L053	28	0	0	28	0	0	0.00	0.00	0.00	N		
2003/360	L082	L229	21	0	0	21	0	0	0.00	0.00	0.00	N		
2003/361	L082	L290	12	0	2	10	0	3	16.67	0.00	0.00	N		
2003/362	L082	L804/1	11	0	6	5	0	20	54.55	0.00	0.00	N		
2003/363	L082	L417	28	1	2	25	1	2	10.71	0.04	1.00	Y	2	200.00
2003/364	L082	L419	41	2	1	38	3	1	7.32	0.07	1.50	N	0	0.00
2003/365	L406	L277	23	0	8	14	0	24	34.78	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2003/366	L406	L381	67	5	11	51	24	30	23.88	0.36	4.80	Y	1	4.17
2003/367	L406	L194	24	3	0	21	6	4	12.50	0.25	2.00	Y	1	16.67
2003/368	L406	L389	48	0	1	47	0	1	2.08	0.00	0.00	N		
2003/369	L406	L801/2	30	0	0	30	0	0	0.00	0.00	0.00	N		
2003/370	L406	L802	71	0	11	60	0	27	15.49	0.00	0.00	N		
2003/371	L406	L161	76	6	0	70	7	0	7.89	0.09	1.17	Y	1	14.29
2003/372	L406	L318	70	6	1	63	8	2	10.00	0.11	1.33	N		0.00
2003/373	L804/1	L277	32	0	0	32	0	0	0.00	0.00	0.00	N		
2003/374	L804	L381	76	20	13	43	43	74	43.42	0.57	2.15	Y	4	9.30
2003/375	L804	L194	26	3	5	19	4	9	30.77	0.15	1.33	Y	1	25.00
2003/376	L804	L389	17	0	0	17	0	0	0.00	0.00	0.00	N		
2003/377	L804	L801/2	26	0	3	23	0	4	11.54	0.00	0.00	N		
2003/378	L804	L802	27	0	0	27	0	0	0.00	0.00	0.00	N		
2003/379	L804	L161	24	0	0	24	0	0	0.00	0.00	0.00	N		
2003/380	L804	L318	27	0	0	27	0	0	0.00	0.00	0.00	N		
2003/381	L804	L418	38	0	0	38	0	0	0.00	0.00	0.00	N		
2003/382	L804	L158	43	0	0	43	0	0	0.00	0.00	0.00	N		
2003/383	L804	L016	48	0	0	48	0	0	0.00	0.00	0.00	N		
2003/385	L804/1	L082	8	0	0	8	0	0	0.00	0.00	0.00	N		
2003/387	L804/1	L406	10	0	0	10	0	0	0.00	0.00	0.00	N		
2003/389	L804/1	L053	29	0	0	29	0	0	0.00	0.00	0.00	N		
2003/390	L804/1	L229	12	0	0	12	0	0	0.00	0.00	0.00	N		
2003/391	L804	L417	55	0	3	52	0	6	5.45	0.00	0.00	N		
2003/392	L804/1	L419	19	0	1	18	0	1	5.26	0.00	0.00	N		
2003/393	L417	L277	19	0	12	7	0	107	63.16	0.00	0.00	N		
2003/394	L417	L381	13	0	8	5	0	70	61.54	0.00	0.00	N		
2003/395	L417	L194	6	0	1	5	0	6	16.67	0.00	0.00	N		
2003/396	L419	L277	10	0	4	6	0	57	40.00	0.00	0.00	N		
2003/397	L419	L381	15	0	10	5	0	128	66.67	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2003/398	L419	L194	13	0	1	14	0	1	7.69	0.00	0.00	N		
2003/404	L049/1	L124	41	0	7	34	0	10	17.07	0.00	0.00	N		
2003/405	L049/1	L144	43	0	11	32	0	20	25.58	0.00	0.00	N		
2003/407	L318	L082	25	0	2	23	0	2	8.00	0.00	0.00	N		
2003/408	L318	L049/1	23	0	2	21	0	2	8.70	0.00	0.00	N		
2003/409	L318	L406	35	0	3	28	0	14	8.57	0.00	0.00	N		
2003/411	L318	L053	24	0	0	24	0	0	0.00	0.00	0.00	N		
2003/412	L318	L229	27	0	0	27	0	0	0.00	0.00	0.00	N		
2003/413	L318	L290	25	0	3	22	0	4	12.00	0.00	0.00	N		
2003/414	L318	L804/1	25	8	1	16	14	3	36.00	0.56	1.75	Y	1	7.14
2003/415	L318	L417	20	0	4	16	0	4	20.00	0.00	0.00	N		
2003/416	L318	L419	15	0	0	15	0	0	0.00	0.00	0.00	N		
2003/420	L049/1	L277	24	0	0	24	0	0	0.00	0.00	0.00	N		
2003/421	L049/1	L381	29	0	6	23	0	14	20.69	0.00	0.00	N		
2003/422	L049/1	L194	31	0	0	31	0	0	0.00	0.00	0.00	N		
2003/423	L049/1	L389	35	0	3	32	0	5	8.57	0.00	0.00	N		
2003/424	L049/1	L801/2	67	0	4	63	0	8	5.97	0.00	0.00	N		
2003/425	L049/1	L802	33	0	4	29	0	7	12.12	0.00	0.00	N		
2003/426	L049/1	L161	22	0	0	22	0	0	0.00	0.00	0.00	N		
2003/427	L049/1	L318	42	0	0	42	0	0	0.00	0.00	0.00	N		
2003/428	L049/1	L418	25	0	0	25	0	0	0.00	0.00	0.00	N		
2003/429	L406	L418	49	0	0	49	0	0	0.00	0.00	0.00	N		
2003/430	L406	L158	55	0	0	55	0	0	0.00	0.00	0.00	N		
2003/431	L406	L016	54	0	0	54	0	0	0.00	0.00	0.00	N		
2003/433	L406	L082	24	3	1	20	4	1	16.67	0.17	1.33	N		
2003/435	L406	L053	53	3	0	50	7	0	5.66	0.13	2.33	Y	2	28.57
2003/436	L406	L229	55	3	0	52	3	0	5.45	0.05	1.00	N	0	0.00
2003/437	L406	L290	52	38	0	14	142	1	73.08	2.73	3.74	Y	72	50.70
2003/438	L406	L804/1	64	47	0	17	386	2	73.44	6.03	8.21	Y	239	61.92

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2003/439	L406	L417	67	5	0	62	7	0	7.46	0.10	1.40	Y	3	42.86
2003/440	L406	L419	54	18	0	36	157	6	33.33	2.91	8.72	Y	85	54.14
2003/441	L158	L194	12	2	2	8	3	10	33.33	0.25	1.50	Y	1	33.33
2003/442	L158	L389	10	0	0	10	0	0	0.00	0.00	0.00	N		
2003/443	L158	L801/2	14	0	0	14	0	0	0.00	0.00	0.00	N		
2003/447	L229	L277	5	0	0	5	0	0	0.00	0.00	0.00	N		
2003/448	L229	L381	5	0	0	5	0	0	0.00	0.00	0.00	N		
2003/449	L229	L194	6	0	2	4	0	2	33.33	0.00	0.00	N		
2003/450	L229	L389	5	0	2	3	0	7	40.00	0.00	0.00	N		
2003/451	L229	L801/2	7	0	4	3	0	8	57.14	0.00	0.00	N		
2003/452	L229	L802	7	3	2	2	9	24	71.43	1.29	3.00	Y	1	11.11
2003/453	L053	l158	18	0	11	7	0	62	61.11	0.00	0.00	N		
2003/454	L053	L016	10	0	8	2	0	45	80.00	0.00	0.00	N		
2003/455	L158	L802	16	0	1	15	0	1	6.25	0.00	0.00	N		
2003/456	L158	L161	14	0	0	14	0	0	0.00	0.00	0.00	N		
2003/457	L158	L318	20	0	0	20	0	0	0.00	0.00	0.00	N		
2003/458	L158	L016	17	0	6	11	0	31	35.29	0.00	0.00	N		
2003/460	L158	L082	12	0	0	12	0	0	0.00	0.00	0.00	N		
2003/461	L158	L049/1	15	0	0	15	0	0	0.00	0.00	0.00	N		
2003/462	L158	L406	8	0	0	8	0	0	0.00	0.00	0.00	N		
2004/001	L194	L277	21	19	0	1	240	481	90.48	11.43	12.63	y	240	100.00
2004/002	L194	L381	14	11	1	2	152	208	85.71	10.86	13.82	y	152	100.00
2004/003	L389	L277	3	0	1	2	0	1	33.33	0.00	0.00	N		
2004/004	L389	L381	20	1	7	12	4	26	40.00	0.20	4.00	y	1	25.00
2004/005	L389	L194	30	0	1	29	0	1	3.33	0.00	0.00	n		
2004/006	L389	L389	23	23	0	0	197	92	100.00	8.57	8.57	y	126	63.96
2004/007	L389	L101	10	0	3	7	0	4	30.00	0.00	0.00	N		
2004/008	L389	L122	7	0	2	8	0	3	28.57	0.00	0.00	N		
2004/009	L389	L1961	7	0	0	7	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2004/010	L801/3	L801/3	18	12	2	4	69	17	77.78	3.83	5.75	y	3	4.35
2004/011	L801/2	L101	13	4	0	9	6	0	30.77	0.46	1.50	y	2	33.33
2004/012	L801/2	L277	8	1	1	6	4	3	25.00	0.50	4.00	y	4	100.00
2004/013	L801/5	L381	7	0	0	7	0	0	0.00	0.00	0.00	N		
2004/014	L801/4	L381	14	2	2	10	2	3	28.57	0.14	1.00	y	1	50.00
2004/015	L801/5	L194	11	0	0	11	0	0	0.00	0.00	0.00	N		
2004/016	L801/4	L194	12	0	0	12	0	0	0.00	0.00	0.00	N		
2004/017	L801/3	L161	17	1	0	16	3	1	5.88	0.18	3.00	y	1	33.33
2004/018	L802/1	L101	23	0	0	23	0	0	0.00	0.00	0.00	N		
2004/019	L802/2	L101	24	0	0	24	0	0	0.00	0.00	0.00	N		
2004/020	L802/4	L155	23	0	0	23	0	0	0.00	0.00	0.00	N		
2004/021	L802/2	L155	23	0	0	23	0	0	0.00	0.00	0.00	N		
2004/022	L802/1	L194	25	0	0	25	0	0	0.00	0.00	0.00	N		
2004/023	L802/2	L194	20	3	4	13	5	8	35.00	0.25	1.67	y	1	20.00
2004/024	L802/2	L161	38	0	0	38	0	0	0.00	0.00	0.00	N		
2004/025	L101	L194	3	1	0	2	19	3	33.33	6.33	19.00	y	11	57.89
2004/026	L101	L389	17	2	12	3	2	304	82.35	0.12	1.00	y	1	50.00
2004/027	L101	L801/2	11	0	6	5	0	77	54.55	0.00	0.00	N		
2004/028	L101	L802/2	9	0	4	5	0	35	44.44	0.00	0.00	N		
2004/029	L101	L161	8	0	0	8	0	0	0.00	0.00	0.00	N		
2004/030	L101	L318	9	0	0	9	0	0	0.00	0.00	0.00	N		
2004/031	L101	L418	6	0	0	6	0	0	0.00	0.00	0.00	N		
2004/032	L101	L144	17	11	3	3	372	19	82.35	21.88	33.82	y	48	12.90
2004/033	L101	L101	14	8	0	6	364	2	57.14	26.00	45.50	y	10	2.75
2004/034	L122	L277	8	0	8	0	0	173	100.00	0.00	0.00	N		
2004/035	L122	L381	10	0	10	0	0	221	100.00	0.00	0.00	n		
2004/036	L122	L194	8	0	3	5	0	4	37.50	0.00	0.00	N		
2004/037	L122	L389	7	0	5	2	0	23	71.43	0.00	0.00	n		
2004/038	L122	L801/2	9	0	7	2	0	20	77.78	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2004/039	L122	L802/2	9	0	0	9	0	0	0.00	0.00	0.00	N		
2004/040	L122	L161	12	0	0	12	0	0	0.00	0.00	0.00	N		
2004/041	L122	L318	11	0	0	11	0	0	0.00	0.00	0.00	N		
2004/042	L122	L212	11	0	3	8	0	5	27.27	0.00	0.00	n		
2004/043	L144	L194	16	0	1	15	0	2	6.25	0.00	0.00	N		
2004/044	L144	L389	15	6	3	6	45	162	60.00	3.00	7.50	y	15	33.33
2004/045	L144	L801/2	16	0	2	14	0	2	12.50	0.00	0.00	n		
2004/046	L144	L802/2	15	0	0	15	0	0	0.00	0.00	0.00	N		
2004/047	L144	L161	7	0	0	7	0	0	0.00	0.00	0.00	N		
2004/048	L144	L318	9	0	0	9	0	0	0.00	0.00	0.00	N		
2004/049	L144	L418	32	0	0	32	0	0	0.00	0.00	0.00	N		
2004/050	L144	L101	19	3	1	15	24	3	21.05	1.26	8.00	y	14	58.33
2004/051	L144	L122	14	2	0	12	3	0	14.29	0.21	1.50	y	3	100.00
2004/052	L144	L144	14	0	0	14	0	0	0.00	0.00	0.00	N		
2004/053	L144	L155	12	4	0	8	4	0	33.33	0.33	1.00	y	3	75.00
2004/054	L144	L212	17	0	2	15	0	24	11.76	0.00	0.00	N		
2004/055	L155	L194	9	4	0	5	10	18	44.44	1.11	2.50	y	7	70.00
2004/056	L155	L389	8	0	4	4	0	21	50.00	0.00	0.00	N		
2004/057	L155	L802/2	14	0	2	12	0	6	14.29	0.00	0.00	n		
2004/058	L155	L161	3	0	0	3	0	0	0.00	0.00	0.00	N		
2004/059	L155	L318	4	0	0	4	0	0	0.00	0.00	0.00	N		
2004/060	L155	L418	4	0	0	4	0	0	0.00	0.00	0.00	N		
2004/061	L155	L122	7	0	0	7	0	0	0.00	0.00	0.00	N		
2004/062	L212	L802/2	13	0	2	11	0	18	15.38	0.00	0.00	N		
2004/063	L212	L318	13	0	0	13	0	0	0.00	0.00	0.00	N		
2004/064	L212	L122	15	3	6	6	6	16	60.00	0.40	2.00	y	8	133.33
2004/065	L212	L144	10	7	0	3	104	83	70.00	10.40	14.86	y	22	21.15
2004/066	L212	L155	7	4	0	3	78	6	57.14	11.14	19.50	n	0	0.00
2004/067	L318	L801/2	13	0	0	13	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2004/068	L161	L277	25	7	2	16	12	2	36.00	0.48	1.71	y	10	83.33
2004/069	L161	L381	13	0	6	7	0	7	46.15	0.00	0.00	n		
2004/070	L161	L194	30	0	0	30	0	0	0.00	0.00	0.00	N		
2004/071	L161	L389	37	0	5	32	0	7	13.51	0.00	0.00	N		
2004/072	L161	L801/2	12	0	0	12	0	0	0.00	0.00	0.00	N		
2004/073	L161	L802/2	17	1	0	16	2	0	5.88	0.12	2.00	n	0	0.00
2004/074	L161	L418	50	0	0	50	0	0	0.00	0.00	0.00	N		
2004/075	L418	L101	41	0	32	9	0	182	78.05	0.00	0.00	n		
2004/299	L122	L418	7	0	0	7	0	0	0.00	0.00	0.00	N		
2004/300	L318	L277	8	0	2	6	0	2	25.00	0.00	0.00	N		
2004/414	L802	L016	25	0	0	25	0	0	0.00	0.00	0.00	N		
2004/415	L101	L016	7	0	0	7	0	0	0.00	0.00	0.00	N		
2004/416	L122	L016	10	0	0	10	0	0	0.00	0.00	0.00	N		
2004/417	L122	L124	20	11	6	3	17	161	85.00	0.85	1.55	y	1	5.88
2004/418	L124	L194	4	0	0	4	0	0	0.00	0.00	0.00	N		
2004/419	L124	L389	8	4	3	1	4	462	87.50	0.50	1.00	y	1	25.00
2004/420	L124	L801/2	9	0	5	4	0	237	55.56	0.00	0.00	N		
2004/421	L124	L802/2	8	0	2	6	0	2	25.00	0.00	0.00	N		
2004/422	L124	L318	12	0	0	12	0	0	0.00	0.00	0.00	N		
2004/423	L124	L418	13	0	0	13	0	0	0.00	0.00	0.00	N		
2004/424	L124	L101	14	7	1	6	13	63	57.14	0.93	1.86	y	6	46.15
2004/425	L124	L016	19	0	0	19	0	0	0.00	0.00	0.00	N		
2004/426	L144	L016	15	0	0	15	0	0	0.00	0.00	0.00	N		
2004/427	L155	L124	5	4	0	1	26	47	80.00	5.20	6.50	y	8	30.77
2004/428	L155	L016	16	0	0	16	0	0	0.00	0.00	0.00	N		
2004/429	L212	L124	14	0	12	2	0	408	85.71	0.00	0.00	n		
2004/430	L212	L122	19	0	0	19	0	0	0.00	0.00	0.00	N		
2004/431	L318	L144	15	0	0	15	0	0	0.00	0.00	0.00	N		
2004/432	L318	L155	38	0	3	35	0	17	7.89	0.00	0.00	n		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2004/433	L318	L381	22	0	3	19	0	4	13.64	0.00	0.00	N		
2004/434	L318	L194	11	0	2	9	0	2	18.18	0.00	0.00	N		
2004/435	L318	L802/2	23	0	2	21	0	4	8.70	0.00	0.00	N		
2004/436	L318	L418	34	0	0	34	0	0	0.00	0.00	0.00	N		
2004/437	L318	L318	14	1	2	11	1	2	21.43	0.07	1.00	y	1	100.00
2004/438	L161	L016	30	13	1	16	44	5	46.67	1.47	3.38	y	1	2.27
2004/439	L161	L161	49	0	0	49	0	0	0.00	0.00	0.00	N		
2004/440	L016	L124	29	0	3	26	0	8	10.34	0.00	0.00	N		
2004/441	L016	L212	35	0	1	34	0	1	2.86	0.00	0.00	N		
2004/442	L016	L277	20	0	13	7	0	38	65.00	0.00	0.00	n		
2004/443	L016	L381	19	0	5	14	0	8	26.32	0.00	0.00	n		
2004/444	L016	L194	21	0	4	17	0	6	19.05	0.00	0.00	n		
2004/445	L016	L389	12	0	4	8	0	5	33.33	0.00	0.00	N		
2004/446	L016	L801/2	34	0	1	33	0	1	2.94	0.00	0.00	N		
2004/447	L016	L802/2	15	0	1	14	0	1	6.67	0.00	0.00	N		
2004/448	L016	L161	25	0	15	10	0	59	60.00	0.00	0.00	n		
2004/449	L016	L318	15	0	10	5	0	37	66.67	0.00	0.00	N		
2004/450	L016	L418	14	0	0	14	0	0	0.00	0.00	0.00	N		
2004/451	L016	L016	41	0	0	41	0	0	0.00	0.00	0.00	N		
2004/452	L418	L122	33	0	6	27	0	22	18.18	0.00	0.00	N		
2004/453	L418	L144	46	0	23	23	0	82	50.00	0.00	0.00	N		
2004/454	L418	L155	19	0	3	16	0	7	15.79	0.00	0.00	n		
2004/455	L418	L212	35	0	8	27	0	44	22.86	0.00	0.00	N		
2004/456	L418	L389	38	0	4	34	0	5	10.53	0.00	0.00	n		
2004/458	L418	L802/2	20	0	3	17	0	4	15.00	0.00	0.00	N		
2004/459	L418	L161	32	0	3	29	0	3	9.38	0.00	0.00	N		
2004/460	L418	L418	32	0	9	23	0	23	28.13	0.00	0.00	n		
2004/461	L122	L419	8	0	0	8	0	0	0.00	0.00	0.00	N		
2004/462	L212	L419	13	0	0	13	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2004/463	L212	L212	9	0	4	5	0	8	44.44	0.00	0.00	N		
2004/466	L802/2	L155	20	0	0	20	0	0	0.00	0.00	0.00	N		
2004/467	L318	L161	21	0	0	21	0	0	0.00	0.00	0.00	N		
2004/468	L082	L101	102	0	16	86	0	21	15.69	0.00	0.00	n		
2004/469	L082	L122	31	0	0	31	0	0	0.00	0.00	0.00	N		
2004/470	L082	L124	33	0	0	33	0	0	0.00	0.00	0.00	N		
2004/471	L082	L144	53	0	5	48	0	8	9.43	0.00	0.00	n		
2004/472	L082	L212	59	0	1	58	0	1	1.69	0.00	0.00	N		
2004/474	L082	L049/1	28	0	8	20	0	44	28.57	0.00	0.00	n		
2004/475	L082	L406	43	0	6	37	0	20	13.95	0.00	0.00	N		
2004/476	L082	L053	47	0	0	47	0	0	0.00	0.00	0.00	N		
2004/477	L082	L804/1	33	0	13	20	0	53	39.39	0.00	0.00	n		
2004/478	L082	L417	40	0	6	34	0	10	15.00	0.00	0.00	N		
2004/479	L082	L082	69	7	0	62	11	1	10.14	0.16	1.57	y	7	63.64
2004/485	L016	L419	36	0	5	31	0	7	13.89	0.00	0.00	N		
2004/486	L049/1	L122	34	0	3	31	0	3	8.82	0.00	0.00	n		
2004/487	L049/1	L124	26	0	5	21	0	31	19.23	0.00	0.00	n		
2004/488	L049/1	L155	45	0	2	43	0	2	4.44	0.00	0.00	N		
2004/489	L049/1	L277	26	1	13	12	1	36	53.85	0.04	1.00	y	1	100.00
2004/490	L049/1	L381	19	0	8	11	0	30	42.11	0.00	0.00	n		
2004/491	L049/1	L194	12	0	1	11	0	2	8.33	0.00	0.00	n		
2004/492	L049/1	L389	7	0	0	7	0	0	0.00	0.00	0.00	N		
2004/493	L049/1	L801/6	5	0	0	5	0	0	0.00	0.00	0.00	N		
2004/494	L049/1	L802/2	29	0	4	25	0	8	13.79	0.00	0.00	N		
2004/495	L049/1	L161	11	0	0	11	0	0	0.00	0.00	0.00	N		
2004/496	L049/1	L318	28	0	0	28	0	0	0.00	0.00	0.00	N		
2004/497	L049/1	L016	33	2	0	31	2	1	6.06	0.06	1.00	y	2	100.00
2004/498	L049/1	L082	29	1	0	28	1	0	3.45	0.03	1.00	n	0	0.00
2004/499	L049/1	L053	24	0	0	24	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2004/500	L049/1	L417	25	6	0	19	8	10	24.00	0.32	1.33	y	1	12.50
2004/501	L049/1	L419	28	7	2	19	23	8	32.14	0.82	3.29	y	20	86.96
2004/502	L049/1	L049/1	25	2	0	23	2	0	8.00	0.08	1.00	n	0	0.00
2004/503	L406	L389	57	0	0	57	0	0	0.00	0.00	0.00	N		
2004/505	L406	L406	69	1	0	68	1	0	1.45	0.01	1.00	y	1	100.00
2004/506	L053	L155	17	0	10	7	0	69	58.82	0.00	0.00	N		
2004/507	L053	L212	30	0	17	13	0	61	56.67	0.00	0.00	n		
2004/508	L053	L277	38	0	28	10	0	235	73.68	0.00	0.00	n		
2004/509	L053	L381	23	0	15	8	0	76	65.22	0.00	0.00	n		
2004/510	L053	L194	30	0	20	10	0	97	66.67	0.00	0.00	n		
2004/511	L053	L389	33	0	17	16	0	47	51.52	0.00	0.00	N		
2004/512	L053	L801/2	6	0	4	2	0	8	66.67	0.00	0.00	N		
2004/513	L053	L802/2	28	0	26	2	0	254	92.86	0.00	0.00	n		
2004/514	L053	L161	29	0	2	27	0	5	6.90	0.00	0.00	N		
2004/515	L229	L161	6	0	0	6	0	0	0.00	0.00	0.00	N		
2004/517	L804	L101	31	26	1	4	136	14	87.10	4.39	5.23	y	13	9.56
2004/518	L804	L122	39	11	13	15	54	43	61.54	1.38	4.91	y	6	11.11
2004/519	L804	L277	72	28	5	39	63	44	45.83	0.88	2.25	y	9	14.29
2004/520	L804	L194	36	8	0	28	11	10	22.22	0.31	1.38	y	2	18.18
2004/521	L804	L389	24	1	5	18	1	8	25.00	0.04	1.00	y	1	100.00
2004/522	L804	L801/2	94	0	15	79	0	25	15.96	0.00	0.00	N		
2004/523	L804	L802/2	11	6	0	5	20	10	54.55	1.82	3.33	y	1	5.00
2004/524	L804	L161	30	0	0	30	0	0	0.00	0.00	0.00	N		
2004/525	L804	L318	40	0	0	40	0	0	0.00	0.00	0.00	N		
2004/526	L804	L418	25	2	0	23	2	0	8.00	0.08	1.00	y	2	100.00
2004/527	L804/1	L016	46	0	0	46	0	0	0.00	0.00	0.00	N		
2004/529	L804/1	L082	31	0	0	31	0	0	0.00	0.00	0.00	N		
2004/530	L804/1	L049/1	35	0	6	29	0	11	17.14	0.00	0.00	n		
2004/531	L804/1	L406	25	0	3	22	0	7	12.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2004/532	L804/1	L053	42	0	0	42	0	0	0.00	0.00	0.00	N		
2004/533	L804/1	L419	36	0	0	36	0	0	0.00	0.00	0.00	N		
2004/534	L804/1	L804/1	45	1	0	44	1	0	2.22	0.02	1.00	y	1	100.00
2004/535	L418	L419	39	0	4	35	0	7	10.26	0.00	0.00	N		
2004/536	L417	L389	8	0	3	5	0	3	37.50	0.00	0.00	N		
2004/537	L417	L802/2	6	0	1	5	0	1	16.67	0.00	0.00	N		
2004/538	L417	L161	21	1	0	20	1	0	4.76	0.05	1.00	y	1	100.00
2004/539	L417	L418	26	0	0	26	0	0	0.00	0.00	0.00	N		
2004/540	L417	L016	8	0	0	8	0	0	0.00	0.00	0.00	N		
2004/541	L419	L389	26	2	15	9	3	195	65.38	0.12	1.50	y	1	33.33
2004/542	L419	L801/2	14	0	6	8	0	30	42.86	0.00	0.00	N		
2004/543	L419	L419	41	26	0	15	96	31	63.41	2.34	3.69	y	47	48.96
2004/544	L318	L389	19	0	2	17	0	4	10.53	0.00	0.00	N		
2004/546	L318	L419	16	0	2	14	0	2	12.50	0.00	0.00	N		
2004/547	L158	L101	20	0	5	15	0	9	25.00	0.00	0.00	N		
2004/548	L158	L122	18	0	4	14	0	6	22.22	0.00	0.00	N		
2004/549	L158	L124	14	0	0	14	0	0	0.00	0.00	0.00	N		
2004/550	L158	L144	18	0	0	18	0	0	0.00	0.00	0.00	N		
2004/551	L158	L155	12	0	1	11	0	1	8.33	0.00	0.00	N		
2004/552	L158	L212	13	0	1	12	0	1	7.69	0.00	0.00	N		
2004/553	L158	L277	15	0	4	11	0	14	26.67	0.00	0.00	N		
2004/554	L158	L194	14	0	0	14	0	0	0.00	0.00	0.00	N		
2004/555	L158	L389	19	0	1	18	0	1	5.26	0.00	0.00	N		
2004/556	L158	L802/2	22	0	11	11	0	22	50.00	0.00	0.00	N		
2004/557	L158	L161	18	0	0	18	0	0	0.00	0.00	0.00	N		
2004/558	L158	L016	10	0	3	7	0	3	30.00	0.00	0.00	N		
2004/559	L158	L053	16	0	4	12	0	5	25.00	0.00	0.00	N		
2004/560	L158	L229	16	0	0	16	0	0	0.00	0.00	0.00	N		
2004/561	L158	L804/1	24	0	4	20	0	3	16.67	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2004/562	L158	L417	18	0	5	13	0	6	27.78	0.00	0.00	N		
2004/563	L158	L419	22	0	2	20	0	2	9.09	0.00	0.00	N		
2004/564	L229	L101	9	0	3	6	0	16	33.33	0.00	0.00	n		
2004/565	L229	L122	8	0	0	8	0	0	0.00	0.00	0.00	N		
2004/566	L229	L277	10	0	1	9	0	1	10.00	0.00	0.00	N		
2004/567	L229	L381	6	0	0	6	0	0	0.00	0.00	0.00	N		
2004/568	L229	L194	8	1	1	6	2	1	25.00	0.25	2.00	y	1	50.00
2004/569	L229	L389	5	0	0	5	0	0	0.00	0.00	0.00	N		
2004/570	L229	L318	10	0	0	10	0	0	0.00	0.00	0.00	N		
2004/571	L229	L158	9	0	0	9	0	0	0.00	0.00	0.00	N		
2004/572	L229	L016	8	0	0	8	0	0	0.00	0.00	0.00	N		
2004/574	L229	L082	10	0	0	10	0	0	0.00	0.00	0.00	N		
2004/575	L229	L049/1	8	0	7	1	0	36	87.50	0.00	0.00	N		
2004/576	L229	L406	10	0	3	7	0	4	30.00	0.00	0.00	N		
2004/577	L229	L408/1	15	0	3	12	0	4	20.00	0.00	0.00	N		
2004/578	L229	L417	8	0	1	7	0	1	12.50	0.00	0.00	N		
2004/579	L229	L418	7	0	4	3	0	25	57.14	0.00	0.00	N		
2004/580	L229	L229	30	11	1	18	14	1	40.00	0.47	1.27	y	7	50.00
2004/582	L290	L277	30	0	9	21	0	26	30.00	0.00	0.00	N		
2004/583	L290	L381	31	0	12	19	0	48	38.71	0.00	0.00	N		
2004/584	L290	L194	26	0	1	25	0	2	3.85	0.00	0.00	N		
2004/585	L290	L389	20	1	5	14	1	8	30.00	0.05	1.00	y	1	100.00
2004/586	L290	L801/2	38	0	5	33	0	9	13.16	0.00	0.00	N		
2004/587	L290	L802L2	31	0	8	23	0	20	25.81	0.00	0.00	N		
2004/588	L290	L161	15	0	0	15	0	0	0.00	0.00	0.00	N		
2004/589	L290	L318	23	0	0	23	0	0	0.00	0.00	0.00	N		
2004/590	L290	L418	36	0	0	36	0	0	0.00	0.00	0.00	N		
2004/591	L290	L158	36	0	0	36	0	0	0.00	0.00	0.00	N		
2004/592	L290	L016	31	0	0	31	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2004/594	L290	L082	35	0	6	29	0	10	17.14	0.00	0.00	N		
2004/595	L290	L049/1	20	17	0	3	66	41	85.00	3.30	3.88	y	52	78.79
2004/596	L290	L406	26	10	0	16	33	16	38.46	1.27	3.30	y	29	87.88
2004/597	L290	L053	18	0	0	18	0	0	0.00	0.00	0.00	N		
2004/598	L290	L229	21	0	0	21	0	0	0.00	0.00	0.00	N		
2004/599	L290	L417	15	4	3	8	4	9	46.67	0.27	1.00	y	3	75.00
2004/600	L290	L419	5	0	0	5	0	0	0.00	0.00	0.00	N		
2004/601	L229	L229	2	0	0	2	0	0	0.00	0.00	0.00	N		
2004/602	L804/2	L229	30	0	1	29	0	1	3.33	0.00	0.00	N		
2004/603	L804/2	L158	28	0	1	27	0	1	3.57	0.00	0.00	N		
2005/001	L277	L194	15	4	0	11	7	0	26.67	0.47	1.75	n	0	0.00
2005/002	L277	L389	12	1	8	3	1	134	75.00	0.08	1.00	y	1	100.00
2005/003	L277	L801/2	12	0	9	3	0	97	75.00	0.00	0.00	N		
2005/004	L277	L802	7	0	0	7	0	0	0.00	0.00	0.00	N		
2005/005	L277	L161	6	0	0	6	0	0	0.00	0.00	0.00	N		
2005/006	L277	L318	18	0	0	18	0	0	0.00	0.00	0.00	N		
2005/007	L277	L418	20	0	0	20	0	0	0.00	0.00	0.00	N		
2005/008	L277	L158	12	0	0	12	0	0	0.00	0.00	0.00	N		
2005/009	L277	L016	35	0	0	35	0	0	0.00	0.00	0.00	N		
2005/011	L277	L082	15	0	0	15	0	0	0.00	0.00	0.00	N		
2005/012	L277	L049/1	22	0	0	22	0	0	0.00	0.00	0.00	N		
2005/013	L277	L406	14	0	0	14	0	0	0.00	0.00	0.00	N		
2005/014	L277	L053	12	0	0	12	0	0	0.00	0.00	0.00	N		
2005/015	L277	L229	5	0	0	5	0	0	0.00	0.00	0.00	N		
2005/016	L277	L290	24	1	0	23	7	0	4.17	0.29	7.00	y	3	42.86
2005/017	L277	L802/1	19	0	0	19	0	0	0.00	0.00	0.00	N		
2005/018	L277	L417	17	0	0	17	0	0	0.00	0.00	0.00	N		
2005/019	L277	L419	27	0	0	27	0	0	0.00	0.00	0.00	N		
2005/020	L277	L122	4	4	0	0	103	6	100.00	25.75	25.75	n	0	0.00

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2005/021	L277	L212	9	0	6	3	0	54	66.67	0.00	0.00	n		
2005/022	L381	L389	2	0	2	0	0	31	100.00	0.00	0.00	N		
2005/023	L381	L401/2	12	0	8	4	0	151	66.67	0.00	0.00	N		
2005/024	L381	L402	5	0	0	5	0	0	0.00	0.00	0.00	N		
2005/025	L381	L161	10	0	0	10	0	0	0.00	0.00	0.00	N		
2005/026	L381	L418	4	0	0	4	0	0	0.00	0.00	0.00	N		
2005/028	L381	L082	7	0	0	7	0	0	0.00	0.00	0.00	N		
2005/029	L381	L049/1	2	1	0	1	1	0	50.00	0.50	1.00	y	1	100.00
2005/030	L277	L381	12	7	0	5	170	21	58.33	14.17	24.29	y	81	47.65
2005/031	L194	L389	21	0	9	12	0	44	42.86	0.00	0.00	N		
2005/032	L194	L418	25	0	0	25	0	0	0.00	0.00	0.00	N		
2005/033	L194	L016	18	0	0	18	0	0	0.00	0.00	0.00	N		
2005/034	L194	L082	25	0	0	25	0	0	0.00	0.00	0.00	N		
2005/035	L194	L0853	13	0	0	13	0	0	0.00	0.00	0.00	N		
2005/036	L389	L212	8	0	0	8	0	0	0.00	0.00	0.00	N		
2005/037	L389	L802	23	0	2	21	0	25	8.70	0.00	0.00	N		
2005/038	L389	L318	18	0	1	17	0	1	5.56	0.00	0.00	N		
2005/039	L389	L418	16	0	0	16	0	0	0.00	0.00	0.00	N		
2005/040	L389	L158	11	0	0	11	0	0	0.00	0.00	0.00	N		
2005/041	L389	L016	10	0	0	10	0	0	0.00	0.00	0.00	N		
2005/042	L389	L127	16	0	0	16	0	0	0.00	0.00	0.00	N		
2005/043	L389	L049/1	16	0	0	16	0	0	0.00	0.00	0.00	N		
2005/044	L389	L406	3	0	0	3	0	0	0.00	0.00	0.00	N		
2005/045	L389	L053	34	0	1	33	0	9	2.94	0.00	0.00	N		
2005/046	L389	L229	31	0	0	30	0	1	0.00	0.00	0.00	N		
2005/047	L389	L290	15	0	1	14	0	1	6.67	0.00	0.00	N		
2005/048	L389	L801/2	14	0	0	14	0	0	0.00	0.00	0.00	N		
2005/049	L389	L417	8	0	0	8	0	0	0.00	0.00	0.00	N		
2005/050	L389	L417	4	0	0	4	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2005/052	L194	L802	9	0	0	9	0	0	0.00	0.00	0.00	N		
2005/053	L194	L161	25	0	0	25	0	0	0.00	0.00	0.00	N		
2005/054	L194	L318	17	0	0	17	0	0	0.00	0.00	0.00	N		
2005/055	L194	L158	33	0	0	33	0	0	0.00	0.00	0.00	N		
2005/057	L194	L049/1	6	0	0	6	0	0	0.00	0.00	0.00	N		
2005/058	L194	L406	6	1	0	5	1	0	16.67	0.17	1.00	y	1	100.00
2005/059	L194	L229	27	2	0	25	2	0	7.41	0.07	1.00	n	0	0.00
2005/060	L194	L290	28	1	0	27	1	0	3.57	0.04	1.00	y	1	100.00
2005/061	L194	L804/2	29	2	0	27	3	0	6.90	0.10	1.50	y	1	33.33
2005/062	L194	L417	44	1	0	43	2	1	2.27	0.05	2.00	n	0	0.00
2005/063	L194	L419	37	2	0	35	2	0	5.41	0.05	1.00	n	0	0.00
2005/064	L194	L194	35	2	0	33	2	0	5.71	0.06	1.00	y	2	100.00
2005/065	L389	L124	12	0	0	12	0	0	0.00	0.00	0.00	N		
2005/066	L389	L082	8	0	0	8	0	0	0.00	0.00	0.00	N		
2005/067	L801/2	L101	8	0	0	8	0	0	0.00	0.00	0.00	N		
2005/068	L801/3	L122	12	0	0	12	0	0	0.00	0.00	0.00	N		
2005/069	L801/4	L318	21	0	0	21	0	0	0.00	0.00	0.00	N		
2005/070	L801/4	L418	14	0	0	14	0	0	0.00	0.00	0.00	N		
2005/071	L801/4	L016	22	0	0	22	0	0	0.00	0.00	0.00	N		
2005/072	L801/5	L082	40	0	0	40	0	0	0.00	0.00	0.00	N		
2005/073	L801/2	L049/1	13	0	0	13	0	0	0.00	0.00	0.00	N		
2005/074	L801/2	L053	17	0	0	17	0	0	0.00	0.00	0.00	N		
2005/075	L801/2	L290	14	0	0	14	0	0	0.00	0.00	0.00	N		
2005/076	L802/1	L194	20	0	0	20	0	0	0.00	0.00	0.00	N		
2005/080	L802/1	L049/1	29	0	2	27	0	4	6.90	0.00	0.00	N		
2005/081	L802/1	L406	16	0	0	16	0	0	0.00	0.00	0.00	N		
2005/082	L802/2	L053	23	0	0	23	0	0	0.00	0.00	0.00	N		
2005/083	L101	L082	4	0	0	4	0	0	0.00	0.00	0.00	N		
2005/085	L101	L049/1	12	0	0	12	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2005/086	L101	L406	6	0	0	6	0	0	0.00	0.00	0.00	N		
2005/087	L101	L158	3	0	0	3	0	0	0.00	0.00	0.00	N		
2005/088	L101	L419	2	0	0	2	0	0	0.00	0.00	0.00	N		
2005/090	L155	L194	14	3	0	11	3	1	21.43	0.21	1.00	y	2	66.67
2005/091	L155	L049/1	7	0	0	7	0	0	0.00	0.00	0.00	N		
2005/092	L155	L122	9	1	0	8	3	0	11.11	0.33	3.00	y	1	33.33
2005/272	L381	L290	4	0	0	4	0	0	0.00	0.00	0.00	N		
2005/273	L381	L417	3	0	0	3	0	0	0.00	0.00	0.00	N		
2005/274	L801/2	L158	21	0	0	21	0	0	0.00	0.00	0.00	N		
2005/276	L801/2	L406	15	0	1	14	0	2	6.67	0.00	0.00	N		
2005/277	L801/3	L229	7	0	0	7	0	0	0.00	0.00	0.00	N		
2005/279	L801/2	L417	5	0	0	5	0	0	0.00	0.00	0.00	N		
2005/280	L802	L229	23	0	0	23	0	0	0.00	0.00	0.00	N		
2005/282	L802	L804/2	27	0	1	26	0	7	3.70	0.00	0.00	N		
2005/286	L122	L049/1	9	0	0	9	0	0	0.00	0.00	0.00	N		
2005/287	L122	L406	7	0	0	7	0	0	0.00	0.00	0.00	N		
2005/289	L122	L804/2	5	0	0	5	0	0	0.00	0.00	0.00	N		
2005/290	L122	L290	4	0	0	4	0	0	0.00	0.00	0.00	N		
2005/291	L122	L417	8	0	0	8	0	0	0.00	0.00	0.00	N		
2005/292	L122	L053	7	0	0	7	0	0	0.00	0.00	0.00	N		
2005/293	L122	L229	5	0	0	5	0	0	0.00	0.00	0.00	N		
2005/294	L122	L124	5	0	3	2	0	19	60.00	0.00	0.00	N		
2005/295	L122	L212	9	0	0	9	0	0	0.00	0.00	0.00	N		
2005/296	L144	L389	21	0	11	10	0	140	52.38	0.00	0.00	N		
2005/297	L144	L801/2	12	0	0	12	0	0	0.00	0.00	0.00	N		
2005/298	L144	L082	11	0	0	11	0	0	0.00	0.00	0.00	N		
2005/300	L144	L049/1	20	0	0	20	0	0	0.00	0.00	0.00	N		
2005/301	L144	L406	5	0	0	5	0	0	0.00	0.00	0.00	N		
2005/302	L144	L158	2	0	0	2	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2005/303	L144	L290	13	0	0	13	0	0	0.00	0.00	0.00	N		
2005/304	L144	L417	16	0	0	16	0	0	0.00	0.00	0.00	N		
2005/305	L144	L053	6	0	0	6	0	0	0.00	0.00	0.00	N		
2005/308	L144	L155	7	0	0	7	0	0	0.00	0.00	0.00	N		
2005/309	L144	L389	10	0	2	8	0	6	20.00	0.00	0.00	N		
2005/310	L144	L802	14	0	0	14	0	0	0.00	0.00	0.00	N		
2005/337	L381	L318	3	0	0	3	0	0	0.00	0.00	0.00	N		
2005/338	L124	L290	8	0	0	8	0	0	0.00	0.00	0.00	N		
2005/339	L212	L082	5	0	0	5	0	0	0.00	0.00	0.00	N		
2005/340	L212	L049/1	3	0	0	3	0	0	0.00	0.00	0.00	N		
2005/342	L212	L158	3	0	0	3	0	0	0.00	0.00	0.00	N		
2005/343	L212	L804/2	4	0	0	4	0	0	0.00	0.00	0.00	N		
2005/345	L212	L053	4	0	0	4	0	0	0.00	0.00	0.00	N		
2005/347	L212	L122	2	0	0	2	0	0	0.00	0.00	0.00	N		
2005/348	L318	L155	12	0	0	12	0	0	0.00	0.00	0.00	N		
2005/349	L318	L277	13	0	0	13	0	0	0.00	0.00	0.00	N		
2005/350	L318	L381	13	0	0	13	0	0	0.00	0.00	0.00	N		
2005/351	L318	L194	20	14	1	5	24	2	75.00	1.20	1.71	y	26	108.33
2005/353	L318	L053	16	0	3	13	0	4	18.75	0.00	0.00	N		
2005/354	L318	L229	16	1	0	15	1	0	6.25	0.06	1.00	y	0	0.00
2005/355	L318	L290	12	0	12	0	0	44	100.00	0.00	0.00	N		
2005/356	L318	L417	10	0	9	1	0	23	90.00	0.00	0.00	N		
2005/357	L318	L419	17	3	3	11	4	4	35.29	0.24	1.33	y	0	0.00
2005/358	L318	L318	8	0	0	8	0	0	0.00	0.00	0.00	N		
2005/359	L161	L158	11	0	0	11	0	0	0.00	0.00	0.00	N		
2005/361	L161	L082	40	0	0	40	0	0	0.00	0.00	0.00	N		
2005/362	L161	L049/1	15	2	0	13	2	3	13.33	0.13	1.00	y	2	100.00
2005/363	L161	L406	19	0	0	19	0	0	0.00	0.00	0.00	N		
2005/365	L161	L229	8	0	0	8	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2005/366	L161	L290	14	0	2	12	0	8	14.29	0.00	0.00	N		
2005/367	L161	L804/2	24	0	0	24	0	0	0.00	0.00	0.00	N		
2005/369	L161	L419	14	0	0	14	0	0	0.00	0.00	0.00	N		
2005/370	L016	L389	10	0	0	10	0	0	0.00	0.00	0.00	N		
2005/371	L016	L161	8	0	3	5	0	14	37.50	0.00	0.00	N		
2005/372	L016	L418	10	0	3	7	0	8	30.00	0.00	0.00	N		
2005/373	L016	L158	6	0	0	6	0	0	0.00	0.00	0.00	N		
2005/374	L016	L082	22	12	1	9	35	22	59.09	1.59	2.92	y	35	100.00
2005/375	L016	L049/1	8	0	0	8	0	0	0.00	0.00	0.00	N		
2005/376	L016	L406	10	0	0	10	0	0	0.00	0.00	0.00	N		
2005/377	L016	L053	2	0	0	2	0	0	0.00	0.00	0.00	N		
2005/378	L016	L229	8	0	0	8	0	0	0.00	0.00	0.00	N		
2005/379	L016	L290	10	3	0	7	20	7	30.00	2.00	6.67	y	7	35.00
2005/380	L016	L804/2	29	0	1	28	0	1	3.45	0.00	0.00	N		
2005/381	L016	L417	4	0	0	4	0	0	0.00	0.00	0.00	N		
2005/383	L016	L016	13	0	0	13	0	0	0.00	0.00	0.00	N		
2005/385	L406	L406	32	6	0	26	13	0	18.75	0.41	2.17	y	11	84.62
2005/388	L804	L802/2	31	7	15	9	9	73	70.97	0.29	1.29	y		
2005/390	L418	L124	30	0	3	27	0	7	10.00	0.00	0.00	N		
2005/391	L418	L801/2	28	0	1	27	0	1	3.57	0.00	0.00	N		
2005/392	L418	L127	13	0	0	13	0	0	0.00	0.00	0.00	N		
2005/393	L418	L049/1	29	0	3	26	0	9	10.34	0.00	0.00	N		
2005/394	L418	L406	25	0	2	23	0	4	8.00	0.00	0.00	N		
2005/395	L418	L053	30	0	0	30	0	0	0.00	0.00	0.00	N		
2005/396	L418	L229	24	0	0	24	0	0	0.00	0.00	0.00	N		
2005/397	L418	L290	16	0	10	6	0	52	62.50	0.00	0.00	N		
2005/398	L418	L802/2	11	0	0	11	0	0	0.00	0.00	0.00	N		
2005/399	L418	L417	12	0	0	12	0	0	0.00	0.00	0.00	N		
2005/400	L418	L419	21	0	16	5	0	82	76.19	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2005/402	L418	L158	12	7	3	2	25	12	83.33	2.08	3.57	y	29	116.00
2005/404	L417	L318	11	0	0	11	0	0	0.00	0.00	0.00	N		
2005/406	L417	L082	13	0	0	13	0	0	0.00	0.00	0.00	N		
2005/407	L417	L049/1	11	0	0	11	0	0	0.00	0.00	0.00	N		
2005/408	L417	L406	14	0	0	14	0	0	0.00	0.00	0.00	N		
2005/409	L417	L053	5	0	0	5	0	0	0.00	0.00	0.00	N		
2005/410	L417	L229	19	0	0	19	0	0	0.00	0.00	0.00	N		
2005/411	L417	L290	18	9	1	8	38	57	55.56	2.11	4.22	y	31	81.58
2005/412	L417	L804	27	0	1	26	0	6	3.70	0.00	0.00	N		
2005/413	L417	L417	18	7	2	9	10	6	50.00	0.56	1.43	y	9	90.00
2005/414	L417	L802	12	0	0	12	0	0	0.00	0.00	0.00	N		
2005/415	L417	L161	8	6	0	2	32	15	75.00	4.00	5.33	y	30	93.75
2005/419	L053	L318	29	4	7	18	5	59	37.93	0.17	1.25	y	1	20.00
2005/420	L053	L418	32	0	24	8	0	308	75.00	0.00	0.00	n		
2005/421	L053	L158	28	0	7	21	0	27	25.00	0.00	0.00	N		
2005/422	L053	L016	28	0	22	6	0	109	78.57	0.00	0.00	N		
2005/424	L053	L082	25	0	15	10	0	41	60.00	0.00	0.00	N		
2005/425	L053	L049/1	24	0	0	24	0	0	0.00	0.00	0.00	N		
2005/426	L053	L406	26	0	11	15	0	100	42.31	0.00	0.00	N		
2005/427	L053	L290	23	0	11	12	0	20	47.83	0.00	0.00	N		
2005/428	L053	L804/2	46	0	0	46	0	0	0.00	0.00	0.00	N		
2005/429	L053	L417	25	0	15	10	0	101	60.00	0.00	0.00	N		
2005/430	L053	L419	23	0	16	7	0	123	69.57	0.00	0.00	N		
2006/001	L277	L122	2	0	0	2	0	0	0.00	0.00	0.00	N		
2006/002	L277	L389	7	0	7	0	0	105	100.00	0.00	0.00	N		
2006/003	L277	L802	2	0	0	2	0	0	0.00	0.00	0.00	N		
2006/004	L277	L082	5	0	0	5	0	0	0.00	0.00	0.00	N		
2006/005	L277	L290	6	0	0	6	0	0	0.00	0.00	0.00	N		
2006/006	L381	L101	4	0	3	1	0	0	75.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2006/007	L381	L122	5	0	0	5	0	0	0.00	0.00	0.00	N		
2006/008	L381	L155	3	0	3	0	0	17	100.00	0.00	0.00	N		
2006/009	L381	L212	3	0	3	0	0	14	100.00	0.00	0.00	N		
2006/010	L381	L194	4	0	0	4	0	0	0.00	0.00	0.00	N		
2006/011	L381	L389	1	0	1	0	0	24	100.00	0.00	0.00	N		
2006/012	L381	L801/2	4	0	4	0	0	69	100.00	0.00	0.00	N		
2006/013	L381	L802	2	0	0	2	0	0	0.00	0.00	0.00	N		
2006/014	L381	L161	17	0	0	17	0	0	0.00	0.00	0.00	N		
2006/015	L381	L318	3	0	0	3	0	0	0.00	0.00	0.00	N		
2006/018	L381	L016	16	0	0	16	0	0	0.00	0.00	0.00	N		
2006/019	L381	L082	7	0	0	7	0	0	0.00	0.00	0.00	N		
2006/020	L381	L049/1	6	0	0	6	0	0	0.00	0.00	0.00	N		
2006/022	L381	L053	10	0	0	10	0	0	0.00	0.00	0.00	N		
2006/024	L381	L290	4	0	0	4	0	0	0.00	0.00	0.00	N		
2006/025	L381	L417	6	0	0	6	0	0	0.00	0.00	0.00	N		
2006/027	L194	L801/2	12	0	4	6	0	7	33.33	0.00	0.00	N		
2006/028	L194	L802	12	0	10	2	0	39	83.33	0.00	0.00	N		
2006/029	L194	L016	9	0	0	9	0	0	0.00	0.00	0.00	N		
2006/030	L194	L082	7	0	0	7	0	0	0.00	0.00	0.00	N		
2006/031	L194	L049/1	12	0	1	11	0	1	8.33	0.00	0.00	N		
2006/033	L194	L290	17	0	1	16	0	2	5.88	0.00	0.00	n		
2006/034	L194	L194	11	0	3	8	0	6	27.27	0.00	0.00	N		
2006/035	L389	L101	17	0	4	13	0	4	23.53	0.00	0.00	N		
2006/036	L389	L381	9	0	4	5	0	22	44.44	0.00	0.00	N		
2006/037	L389	L802	12	0	0	12	0	0	0.00	0.00	0.00	N		
2006/038	L389	L418	9	0	0	9	0	0	0.00	0.00	0.00	N		
2006/039	L801/6	L101	29	0	0	29	0	0	0.00	0.00	0.00	N		
2006/040	L801/6	L144	40	0	0	40	0	0	0.00	0.00	0.00	N		
2006/041	L801/7	L155	12	0	0	12	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2006/042	L801/7	L277	21	0	0	21	0	0	0.00	0.00	0.00	N		
2006/044	L801/2	L802	24	0	0	24	0	0	0.00	0.00	0.00	N		
2006/045	L801/2	L161	10	0	0	10	0	0	0.00	0.00	0.00	N		
2006/046	L801/2	L318	11	0	0	11	0	0	0.00	0.00	0.00	N		
2006/047	L801/2	L418	11	0	0	11	0	0	0.00	0.00	0.00	N		
2006/048	L801/2	L016	10	0	0	10	0	0	0.00	0.00	0.00	N		
2006/051	L801/1	L053	9	0	0	9	0	0	0.00	0.00	0.00	N		
2006/052	L801/1	L290	26	0	0	26	0	0	0.00	0.00	0.00	N		
2006/053	L801/1	L417	7	0	0	7	0	0	0.00	0.00	0.00	N		
2006/054	L802/1	L101	12	0	0	12	0	0	0.00	0.00	0.00	N		
2006/055	L802/1	L144	19	0	1	18	0	1	5.26	0.00	0.00	N		
2006/056	L802/1	L155	6	0	0	6	0	0	0.00	0.00	0.00	N		
2006/057	L802/1	L318	6	0	0	6	0	0	0.00	0.00	0.00	N		
2006/059	L802/4	L290	22	0	0	22	0	0	0.00	0.00	0.00	N		
2006/060	L802/2	L417	24	0	0	24	0	0	0.00	0.00	0.00	N		
2006/061	L101	L194	14	10	1	4	333	73	78.57	23.79	33.30	y	100	30.03
2006/062	L101	L389	12	0	9	3	0	246	75.00	0.00	0.00	N		
2006/063	L101	L802	17	0	0	17	0	0	0.00	0.00	0.00	N		
2006/064	L101	L082	10	0	0	10	0	0	0.00	0.00	0.00	N		
2006/065	L101	L016	15	0	0	15	0	0	0.00	0.00	0.00	N		
2006/066	L101	L049/1	5	0	0	5	0	0	0.00	0.00	0.00	N		
2006/067	L101	L418	6	0	0	6	0	0	0.00	0.00	0.00	N		
2006/068	L101	L290	12	0	0	12	0	0	0.00	0.00	0.00	N		
2006/069	L101	L053	6	0	0	6	0	0	0.00	0.00	0.00	N		
2006/070	L101	L101	9	9	0	0	480	38	100.00	53.33	53.33	y	43	8.96
2006/071	L122	L082	3	0	0	3	0	0	0.00	0.00	0.00	N		
2006/072	L122	L049/1	8	0	0	8	0	0	0.00	0.00	0.00	N		
2006/073	L122	L418	3	0	0	3	0	0	0.00	0.00	0.00	N		
2006/074	L122	L290	14	0	0	14	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2006/075	L122	L417	14	0	0	14	0	0	0.00	0.00	0.00	N		
2006/076	L122	L053	3	0	0	3	0	0	0.00	0.00	0.00	N		
2006/077	L144	L101	11	7	0	4	77	8	63.64	7.00	11.00	y	49	63.64
2006/081	L155	L161	9	0	0	9	0	0	0.00	0.00	0.00	N		
2006/083	L155	L049/1	6	0	0	6	0	0	0.00	0.00	0.00	N		
2006/084	L155	L406	4	0	0	4	0	0	0.00	0.00	0.00	N		
2006/085	L155	L418	9	0	0	9	0	0	0.00	0.00	0.00	N		
2006/086	L155	L053	13	0	0	13	0	0	0.00	0.00	0.00	N		
2006/096	L161	L381	14	0	0	14	0	0	0.00	0.00	0.00	N		
2006/098	L161	L049/1	21	0	0	21	0	0	0.00	0.00	0.00	N		
2006/100	L161	L290	20	0	0	20	0	0	0.00	0.00	0.00	N		
2006/101	L161	L417	10	0	0	10	0	0	0.00	0.00	0.00	N		
2006/103	L016	L122	16	0	0	16	0	0	0.00	0.00	0.00	N		
2006/104	L016	L124	21	0	0	21	0	0	0.00	0.00	0.00	N		
2006/105	L016	L144	17	0	0	17	0	0	0.00	0.00	0.00	N		
2006/107	L016	L277	3	0	0	3	0	0	0.00	0.00	0.00	N		
2006/108	L016	L381	12	0	0	12	0	0	0.00	0.00	0.00	N		
2006/111	L016	L053	3	0	0	3	0	0	0.00	0.00	0.00	N		
2006/112	L016	L229	3	0	0	3	0	0	0.00	0.00	0.00	N		
2006/113	L016	L290	21	0	0	21	0	0	0.00	0.00	0.00	N		
2006/114	L016	L417	12	0	0	12	0	0	0.00	0.00	0.00	N		
2006/121	L418	L418	40	5	0	35	6	0	12.50	0.15	1.20	n	0	0.00
2006/122	L417	L194	24	0	0	24	0	0	0.00	0.00	0.00	N		
2006/123	L417	L801/2	18	0	0	18	0	0	0.00	0.00	0.00	N		
2006/124	L417	L161	10	0	0	10	0	0	0.00	0.00	0.00	N		
2006/594	L194	L417	9	0	0	9	0	0	0.00	0.00	0.00	N		
2006/595	L392	L417	30	0	0	30	0	0	0.00	0.00	0.00	N		
2006/596	L082	L122	14	0	0	14	0	0	0.00	0.00	0.00	N		
2006/598	L082	L155	15	0	0	15	0	0	0.00	0.00	0.00	N		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2006/599	L082	L277	10	0	0	10	0	0	0.00	0.00	0.00	N		
2006/600	L082	L381	12	0	0	12	0	0	0.00	0.00	0.00	N		
2006/601	L082	L389	3	0	0	3	0	0	0.00	0.00	0.00	N		
2006/602	L082	L801/2	7	0	0	7	0	0	0.00	0.00	0.00	N		
2006/603	L082	L318	14	0	0	14	0	0	0.00	0.00	0.00	N		
2006/609	L049/1	L122	26	0	1	25	0	1	3.85	0.00	0.00	N		
2006/610	L049/1	L144	15	0	1	14	0	1	6.67	0.00	0.00	N		
2006/612	L049/1	L194	24	1	5	18	2	22	25.00	0.08	2.00	y	1	50.00
2006/619	L049/1	L389	24	0	0	24	0	0	0.00	0.00	0.00	N		
2006/621	L049/1	L8012	28	0	0	28	0	0	0.00	0.00	0.00	N		
2006/622	L049/1	L418	9	0	0	9	0	0	0.00	0.00	0.00	N		
2006/623	L049/1	L016	16	0	0	16	0	0	0.00	0.00	0.00	N		
2006/624	L053	L101	17	0	0	17	0	0	0.00	0.00	0.00	N		
2006/627	L053	L144	25	0	3	22	0	5	12.00	0.00	0.00	N		
2006/629	L229	L389	4	0	0	4	0	0	0.00	0.00	0.00	N		
2006/630	L229	L801/2	3	0	0	3	0	0	0.00	0.00	0.00	N		
2006/633	L158	L144	7	0	0	7	0	0	0.00	0.00	0.00	N		
2006/634	L158	L381	12	0	0	12	0	0	0.00	0.00	0.00	N		
2006/635	L144	L212	14	2	0	12	2	0	14.29	0.14	1.00	y	1	50.00
2006/636	L406	L406	26	0	0	26	0	0	0.00	0.00	0.00	N		
2006/641	L158	L194	15	0	0	15	0	0	0.00	0.00	0.00	N		
2006/642	L290	L212	24	0	0	24	0	0	0.00	0.00	0.00	N		
2006/643	L290	L417	8	0	0	8	0	0	0.00	0.00	0.00	n		
2006/644	L290	L277	10	0	0	10	0	0	0.00	0.00	0.00	n		
2006/645	L290	L381	10	0	0	10	0	0	0.00	0.00	0.00	n		
2007/001	L277	L801/2	7	0	0	7	0	0	0.00	0.00	0.00	n		
2007/002	L389	L381	20	0	0	20	0	0	0.00	0.00	0.00	n		
2007/003	L277	L161	6	1	0	5	5	2	16.67	0.83	5.00	n	0	0.00
2007/004	L277	L318	11	0	0	11	0	0	0.00	0.00	0.00	n		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2007/005	L277	L418	3	0	0	3	0	0	0.00	0.00	0.00	n		
2007/006	L277	L158	11	1	0	10	3	0	9.09	0.27	3.00	y	3	100.00
2007/007	L277	L406	9	0	0	9	0	0	0.00	0.00	0.00	n		
2007/008	L277	L053	8	0	0	8	0	0	0.00	0.00	0.00	n		
2007/009	L277	L229	8	0	0	8	0	0	0.00	0.00	0.00	n		
2007/010	L277	L290	9	0	0	9	0	0	0.00	0.00	0.00	n		
2007/011	L277	L804	9	0	0	9	0	0	0.00	0.00	0.00	n		
2007/012	L194	L801/2	8	0	3	5	0	40	37.50	0.00	0.00	n		
2007/013	L194	L418	9	0	0	9	0	0	0.00	0.00	0.00	n		
2007/014	L194	L158	10	0	0	10	0	0	0.00	0.00	0.00	n		
2007/015	L194	L406	5	4	1	0	61	17	100.00	12.20	15.25	y	44	72.13
2007/016	L194	L053	11	0	0	11	0	0	0.00	0.00	0.00	n		
2007/017	L194	L229	4	0	0	4	0	0	0.00	0.00	0.00	n		
2007/018	L194	L804	2	0	0	2	0	0	0.00	0.00	0.00	n		
2007/019	L194	L417	6	0	0	6	0	0	0.00	0.00	0.00	n		
2007/020	L194	L419	8	0	0	8	0	0	0.00	0.00	0.00	n		
2007/021	L194	L194	4	0	0	4	0	0	0.00	0.00	0.00	n		
2007/022	L389	L406	20	0	1	19	0	4	5.00	0.00	0.00	n		
2007/023	L389	L229	28	0	0	28	0	0	0.00	0.00	0.00	n		
2007/024	L801/2	L212	11	0	0	11	0	0	0.00	0.00	0.00	n		
2007/025	L801/2	L277	22	0	0	22	0	0	0.00	0.00	0.00	n		
2007/026	L801/2	L381	7	0	0	7	0	0	0.00	0.00	0.00	n		
2007/027	L801/2	L802	11	0	0	11	0	0	0.00	0.00	0.00	n		
2007/028	L801/2	L158	6	0	0	6	0	0	0.00	0.00	0.00	n		
2007/029	L801/2	L082	12	0	0	12	0	0	0.00	0.00	0.00	n		
2007/030	L801/2	L049/1	10	0	0	10	0	0	0.00	0.00	0.00	n		
2007/031	L801/2	L406	7	0	1	6	0	2	14.29	0.00	0.00	n		
2007/032	L801/2	L229	4	0	0	4	0	0	0.00	0.00	0.00	n		
2007/033	L802	L158	20	0	0	20	0	0	0.00	0.00	0.00	n		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2007/034	L802	L082	18	0	0	18	0	0	0.00	0.00	0.00	n		
2007/035	L802	L419	17	0	0	17	0	0	0.00	0.00	0.00	n		
2007/036	L101	L389	18	0	16	2	0	452	88.89	0.00	0.00	n		
2007/037	L101	L802	13	0	0	13	0	0	0.00	0.00	0.00	n		
2007/038	L101	L406	14	10	0	4	218	179	71.43	15.57	21.80	y	175	80.28
2007/039	L101	L158	16	1	0	15	1	0	6.25	0.06	1.00	y	1	100.00
2007/040	L101	L417	4	0	0	4	0	0	0.00	0.00	0.00	n		
2007/041	L101	L419	2	0	0	2	0	0	0.00	0.00	0.00	n		
2007/042	L101	L229	4	0	0	4	0	0	0.00	0.00	0.00	n		
2007/043	L101	L101	8	5	0	3	150	38	62.50	18.75	30.00	y	56	37.33
2007/044	L122	L406	4	0	3	1	0	7	75.00	0.00	0.00	n		
2007/045	L122	L158	6	0	0	6	0	0	0.00	0.00	0.00	n		
2007/046	L122	L804	8	0	0	8	0	0	0.00	0.00	0.00	n		
2007/047	L122	L290	7	0	0	7	0	0	0.00	0.00	0.00	n		
2007/048	L122	L419	6	0	0	6	0	0	0.00	0.00	0.00	n		
2007/049	L124	L389	9	0	6	3	0	114	66.67	0.00	0.00	n		
2007/050	L124	L802	4	0	0	4	0	0	0.00	0.00	0.00	n		
2007/051	L124	L082	5	0	0	5	0	0	0.00	0.00	0.00	n		
2007/052	L124	L049/1	4	0	0	4	0	0	0.00	0.00	0.00	n		
2007/053	L124	L406	4	0	0	4	0	0	0.00	0.00	0.00	n		
2007/054	L124	L229	8	0	0	8	0	0	0.00	0.00	0.00	n		
2007/055	L124	L101	18	4	0	14	53	36	22.22	2.94	13.25	y	53	100.00
2007/056	L124	L122	11	0	0	11	0	0	0.00	0.00	0.00	n		
2007/057	L124	L155	4	0	0	4	0	0	0.00	0.00	0.00	n		
2007/058	L124	L212	14	1	0	13	2	0	7.14	0.14	2.00	y	2	100.00
2007/059	L124	L389	10	0	8	2	0	9	80.00	0.00	0.00	n		
2007/060	L155	L318	6	0	0	6	0	0	0.00	0.00	0.00	n		
2007/061	L155	L290	4	0	0	4	0	0	0.00	0.00	0.00	n		
2007/062	L155	L419	5	0	0	5	0	0	0.00	0.00	0.00	n		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2007/063	L155	L229	3	0	0	3	0	0	0.00	0.00	0.00	n		
2007/064	L155	L122	4	0	0	4	0	0	0.00	0.00	0.00	n		
2007/065	L212	L381	4	0	2	2	0	49	50.00	0.00	0.00	n		
2007/066	L212	L389	3	0	2	1	0	6	66.67	0.00	0.00	n		
2007/067	L212	L082	2	0	0	2	0	0	0.00	0.00	0.00	n		
2007/068	L212	L158	3	0	0	3	0	0	0.00	0.00	0.00	n		
2007/069	L212	L053	4	0	0	4	0	0	0.00	0.00	0.00	n		
2007/070	L212	L229	2	0	0	2	0	0	0.00	0.00	0.00	n		
2007/071	L212	L122	2	0	0	2	0	0	0.00	0.00	0.00	n		
2007/072	L212	L212	2	0	0	2	0	0	0.00	0.00	0.00	n		
2007/073	L318	L155	17	0	0	17	0	0	0.00	0.00	0.00	n		
2007/074	L318	L212	13	0	0	13	0	0	0.00	0.00	0.00	n		
2007/075	L318	L381	6	0	0	6	0	0	0.00	0.00	0.00	n		
2007/076	L318	L194	4	1	0	3	1	0	25.00	0.25	1.00	y	1	100.00
2007/077	L318	L158	11	0	0	11	0	0	0.00	0.00	0.00	n		
2007/078	L318	L082	12	0	1	11	0	2	8.33	0.00	0.00	n		
2007/079	L318	L049/1	10	0	1	9	0	1	10.00	0.00	0.00	n		
2007/080	L318	L406	9	7	0	2	10	0	77.78	1.11	1.43	y	8	80.00
2007/081	L318	L053	12	0	0	12	0	0	0.00	0.00	0.00	n		
2007/082	L318	L229	9	0	0	9	0	0	0.00	0.00	0.00	n		
2007/083	L318	L318	14	0	0	14	0	0	0.00	0.00	0.00	n		
2007/084	L161	L158	18	0	0	18	0	0	0.00	0.00	0.00	n		
2007/085	L161	L082	33	0	1	32	0	0	3.03	0.00	0.00	n		
2007/086	L161	L049/1	8	0	0	8	0	0	0.00	0.00	0.00	n		
2007/087	L161	L406	16	0	1	15	0	2	6.25	0.00	0.00	n		
2007/088	L161	L053	28	0	0	28	0	0	0.00	0.00	0.00	n		
2007/089	L161	L229	15	0	0	15	0	0	0.00	0.00	0.00	n		
2007/090	L161	L804	14	8	0	6	26	0	57.14	1.86	3.25	y	8	30.77
2007/091	L161	L417	14	0	0	14	0	0	0.00	0.00	0.00	n		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2007/092	L161	L419	9	0	0	9	0	0	0.00	0.00	0.00	n		
2007/093	L016	L101	4	0	0	4	0	0	0.00	0.00	0.00	n		
2007/094	L016	L122	8	0	0	8	0	0	0.00	0.00	0.00	n		
2007/095	L016	L155	3	0	0	3	0	0	0.00	0.00	0.00	n		
2007/096	L016	L194	11	0	0	11	0	0	0.00	0.00	0.00	n		
2007/097	L016	L389	8	0	0	8	0	0	0.00	0.00	0.00	n		
2007/098	L333/1	L333/1	30	10	2	18	14	9	40.00	0.47	1.40	y	2	14.29
2007/099	L049/1	L122	24	10	3	11	26	46	54.17	1.08	2.60	y	5	19.23
2007/100	L049/1	L049/1	33	0	0	33	0	0	0.00	0.00	0.00	n		
2007/101	L406	L801/2	14	0	0	14	0	0	0.00	0.00	0.00	n		
2007/102	L406	L802	24	0	0	24	0	0	0.00	0.00	0.00	n		
2007/103	L406	L406	53	0	0	53	0	0	0.00	0.00	0.00	n		
2007/104	L053	L101	17	0	17	0	0	137	100.00	0.00	0.00	n		
2007/105	L053	L122	13	0	10	3	0	89	76.92	0.00	0.00	n		
2007/106	L053	L124	15	0	9	6	0	51	60.00	0.00	0.00	n		
2007/107	L053	L144	13	0	9	4	0	37	69.23	0.00	0.00	n		
2007/108	L053	L212	13	0	5	8	0	35	38.46	0.00	0.00	n		
2007/109	L053	L277	14	0	13	1	0	81	92.86	0.00	0.00	n		
2007/110	L053	L381	10	0	9	1	0	75	90.00	0.00	0.00	n		
2007/111	L053	L053	9	0	0	9	0	0	0.00	0.00	0.00	n		
2007/112	L418	L101	24	0	1	23	0	1	4.17	0.00	0.00	n		
2007/113	L418	L277	25	0	1	24	0	2	4.00	0.00	0.00	n		
2007/114	L418	L381	31	0	0	31	0	0	0.00	0.00	0.00	n		
2007/115	L418	L184	17	0	3	14	0	13	17.65	0.00	0.00	n		
2007/116	L418	L082	20	0	0	20	0	0	0.00	0.00	0.00	n		
2007/117	L418	L049/1	24	0	11	13	0	23	45.83	0.00	0.00	n		
2007/118	L418	L804	18	0	8	10	0	55	44.44	0.00	0.00	n		
2007/119	L417	L101	22	0	10	0	13	28	45.45	0.59	0.00	n		
2007/120	L417	L417	30	3	0	27	3	0	10.00	0.10	1.00	n	0	0.00

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2007/121	L419	L101	32	8	1	23	23	5	28.13	0.72	2.88	y	3	13.04
2007/429	L161	L290	6	0	0	6	0	0	0.00	0.00	0.00	n		
2007/430	L053	L212	13	0	0	13	0	0	0.00	0.00	0.00	n		
2008/001	L277	L801/2	9	0	2	0	10	1	22.22	1.11	0.00	n		
2008/002	L277	L802	5	0	0	5	0	0	0.00	0.00	0.00	n		
2008/003	L277	L161	5	0	0	5	0	0	0.00	0.00	0.00	n		
2008/004	L277	L122	10	0	0	10	0	0	0.00	0.00	0.00	n		
2008/005	L804/2	L389	16	0	0	16	0	0	0.00	0.00	0.00	n		
2008/006	L194	L801/2	4	0	4	0	0	54	100.00	0.00	0.00	n		
2008/007	L804/2	L049/1	12	6	0	6	44	2	50.00	3.67	7.33	y	18	40.91
2008/008	L194	L194	13	1	0	12	1	1	7.69	0.08	1.00	y	1	100.00
2008/009	L389	L381	13	3	5	6	9	13	61.54	0.69	3.00	y	1	11.11
2008/010	L389	L229	8	1	1	6	2	6	25.00	0.25	2.00	n	0	0.00
2008/011	L801/2	L161	12	0	0	12	0	0	0.00	0.00	0.00	n		
2008/012	L801/2	L804	25	0	0	25	0	0	0.00	0.00	0.00	n		
2008/013	L804/2	L804/2	20	3	1	16	3	1	20.00	0.15	1.00	y	3	100.00
2008/014	L802	L381	30	1	0	29	2	0	3.33	0.07	2.00	n	0	0.00
2008/015	L804/2	L804/2	21	0	0	21	0	0	0.00	0.00	0.00	n		
2008/016	L101	L406	7	0	0	7	0	0	0.00	0.00	0.00	n		
2008/017	L101	L804/1	8	0	0	8	0	0	0.00	0.00	0.00	n		
2008/018	L124	L801/2	6	2	0	4	2	76	33.33	0.33	1.00	y	1	50.00
2008/019	L124	L016	5	0	0	5	0	0	0.00	0.00	0.00	n		
2008/020	L124	L158	6	0	0	6	0	0	0.00	0.00	0.00	n		
2008/021	L124	L804	5	0	0	5	0	0	0.00	0.00	0.00	n		
2008/022	L124	L290	6	0	0	6	0	0	0.00	0.00	0.00	n		
2008/023	L124	L417	5	0	0	5	0	0	0.00	0.00	0.00	n		
2008/024	L124	L804/2	8	0	0	8	0	0	0.00	0.00	0.00	n		
2008/025	L124	L053	6	0	0	6	0	0	0.00	0.00	0.00	n		
2008/026	L124	L229	10	0	0	10	0	0	0.00	0.00	0.00	n		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2008/027	L124	L212	6	4	0	2	10	5	66.67	1.67	2.50	y	10	100.00
2008/028	L155	L124	15	2	0	13	3	0	13.33	0.20	1.50	y	3	100.00
2008/029	L155	L418	5	0	0	5	0	0	0.00	0.00	0.00	n		
2008/030	L155	L804/1	6	0	0	6	0	0	0.00	0.00	0.00	n		
2008/031	L155	L155	7	0	0	7	0	0	0.00	0.00	0.00	n		
2008/032	L212	L277	6	0	1	5	0	1	16.67	0.00	0.00	n		
2008/033	L212	L389	3	0	3	0	0	17	100.00	0.00	0.00	n		
2008/034	L212	L802/2	4	0	0	4	0	0	0.00	0.00	0.00	n		
2008/035	L212	L049/1	3	0	0	3	0	0	0.00	0.00	0.00	n		
2008/036	L212	L406	5	0	0	5	0	0	0.00	0.00	0.00	n		
2008/037	L212	L804	4	0	0	4	0	0	0.00	0.00	0.00	n		
2008/038	L212	L290	4	0	0	4	0	0	0.00	0.00	0.00	n		
2008/039	L212	L417	3	0	0	3	0	0	0.00	0.00	0.00	n		
2008/040	L212	L124	4	2	0	2	25	8	50.00	6.25	12.50	y	23	92.00
2008/041	L212	L144	5	1	0	4	31	4	20.00	6.20	31.00	y	31	100.00
2008/042	L318	L381	21	2	1	18	2	1	14.29	0.10	1.00	y	1	50.00
2008/043	L318	L016	25	5	1	19	6	1	24.00	0.24	1.20	y	1	16.67
2008/044	L318	L804/1	20	2	0	18	3	0	10.00	0.15	1.50	n	0	0.00
2008/045	L161	L804	38	0	0	38	0	0	0.00	0.00	0.00	n		
2008/112	L802/1	L144	26	0	0	26	0	0	0.00	0.00	0.00	n		
2008/113	L802/4	L290	34	0	0	34	0	0	0.00	0.00	0.00	n		
2008/228	L194	L804	7	0	0	7	0	0	0.00	0.00	0.00	n		
2008/229	L418	L318	24	0	0	24	0	0	0.00	0.00	0.00	n		
2008/242	L418	L381	30	0	5	25	0	9	16.67	0.00	0.00	n		
2008/243	L419	L122	24	2	2	20	3	10	16.67	0.13	1.50	y	1	33.33
2008/244	L417	L122	13	0	0	13	0	0	0.00	0.00	0.00	n		
2008/245	L417	L389	30	0	0	30	0	0	0.00	0.00	0.00	n		
2008/246	L417	L144	15	0	0	15	0	0	0.00	0.00	0.00	n		
2008/247	L417	L161	25	0	0	25	0	0	0.00	0.00	0.00	n		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2008/248	L417	L212	10	0	0	10	0	0	0.00	0.00	0.00	n		
2008/249	L417	L158	15	0	0	15	0	0	0.00	0.00	0.00	n		
2008/250	L417	L194	24	0	0	24	0	0	0.00	0.00	0.00	n		
2008/251	L417	L155	11	0	0	11	0	0	0.00	0.00	0.00	n		
2008/252	L417	L318	24	0	0	24	0	0	0.00	0.00	0.00	n		
2008/253	L049/1	L277	6	0	0	6	0	0	0.00	0.00	0.00	n		
2008/262	L418	L158	38	18	3	17	88	74	55.26	2.32	4.89	y	88	100.00
2008/263	L016	L406	22	0	4	18	0	6	18.18	0.00	0.00	n		
2008/264	L016	L290	19	2	0	17	3	0	10.53	0.16	1.50	n	0	0.00
2008/265	L016	L419	21	1	0	20	1	0	4.76	0.05	1.00	n	0	0.00
2008/266	L016	L804	15	4	2	9	8	8	40.00	0.53	2.00	n	0	0.00
2008/267	L053	L229	25	13	1	11	39	2	56.00	1.56	3.00	y	27	69.23
2008/268	L053	L406	18	0	0	18	0	0	0.00	0.00	0.00	n		
2008/269	L053	L419	11	0	7	4	0	52	63.64	0.00	0.00	n		
2008/270	L053	L389	10	0	4	6	0	10	40.00	0.00	0.00	n		
2008/271	L417	L801/2	19	0	0	19	0	0	0.00	0.00	0.00	n		
2008/272	L417	L158	27	0	0	27	0	0	0.00	0.00	0.00	n		
2008/273	L417	L277	19	2	1	16	4	3	15.79	0.21	2.00	y	1	25.00
2008/274	L417	L802/2	14	0	0	14	0	0	0.00	0.00	0.00	n		
2008/275	L417	L049/1	35	0	0	35	0	0	0.00	0.00	0.00	n		
2008/276	L417	L082	36	2	0	34	2	0	5.56	0.06	1.00	y	1	50.00
2008/277	L417	L381	36	1	3	32	1	15	11.11	0.03	1.00	y	1	100.00
2008/278	L049/1	L053	40	0	0	40	0	0	0.00	0.00	0.00	n		
2008/279	L049/1	L419	40	0	0	40	0	0	0.00	0.00	0.00	n		
2008/280	L049/1	L158	32	0	0	32	0	0	0.00	0.00	0.00	n		
2008/281	L049/1	L801/2	17	0	0	17	0	0	0.00	0.00	0.00	n		
2008/282	L049/1	L290	58	0	0	58	0	0	0.00	0.00	0.00	n		
2008/283	L049/1	L016	40	0	0	40	0	0	0.00	0.00	0.00	n		
2008/284	L049/1	L417	32	0	0	32	0	0	0.00	0.00	0.00	n		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2008/285	L049/1	L229	42	0	0	42	0	0	0.00	0.00	0.00	n		
2008/286	L049/1	L144	48	6	5	37	11	16	22.92	0.23	1.83	n	0	0.00
2008/287	L049/1	L277	17	0	2	15	0	2	11.76	0.00	0.00	n		
2008/288	L049/1	L389	34	1	2	31	2	9	8.82	0.06	2.00	n	0	0.00
2008/289	L049/1	L418	27	0	0	27	0	0	0.00	0.00	0.00	n		
2008/290	L049/1	L804	48	1	0	47	1	0	2.08	0.02	1.00	y	1	100.00
2008/291	L049/1	L082	40	0	0	40	0	0	0.00	0.00	0.00	n		
2008/292	L417	L406	13	2	0	11	7	8	15.38	0.54	3.50	y	5	71.43
2008/293	L417	L016	32	1	0	31	1	0	3.13	0.03	1.00	n	0	0.00
2008/294	L053	L804/1	24	1	4	19	1	9	20.83	0.04	1.00	n	0	0.00
2008/295	L053	L082	27	2	1	24	2	1	11.11	0.07	1.00	y	2	100.00
2008/296	L053	L418	16	0	0	16	0	0	0.00	0.00	0.00	n		
2008/297	L053	L016	33	0	13	20	0	39	39.39	0.00	0.00	n		
2008/298	L053	L158	14	0	4	10	0	13	28.57	0.00	0.00	n		
2008/299	L053	L417	15	0	0	15	0	0	0.00	0.00	0.00	n		
2008/300	L053	L302/2	19	0	10	8	0	58	52.63	0.00	0.00	n		
2008/301	L053	L801/2	14	0	3	11	0	9	21.43	0.00	0.00	n		
2008/302	L053	L049/1	10	4	4	2	7	34	80.00	0.70	1.75	n	0	0.00
2008/303	L053	L318	16	0	0	16	0	0	0.00	0.00	0.00	n		
2008/304	L053	L053	25	1	1	23	1	1	8.00	0.04	1.00	n	0	0.00
2008/305	L053	L194	30	0	0	30	0	0	0.00	0.00	0.00	n		
2008/306	L053	L290	19	0	0	19	0	0	0.00	0.00	0.00	n		
2008/307	L053	L161	20	1	1	18	1	1	10.00	0.05	1.00	n	0	0.00
2008/308	L406	L158	30	0	0	30	0	0	0.00	0.00	0.00	n		
2008/309	L229	L016	9	0	0	9	0	0	0.00	0.00	0.00	n		
2008/310	L229	L801/2	12	0	0	12	0	0	0.00	0.00	0.00	n		
2008/311	L229	L194	12	0	0	12	0	0	0.00	0.00	0.00	n		
2008/312	L229	L290	12	0	0	12	0	0	0.00	0.00	0.00	n		
2008/313	L229	L418	5	0	0	5	0	0	0.00	0.00	0.00	n		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2008/314	L229	L158	10	0	0	10	0	0	0.00	0.00	0.00	n		
2008/315	L229	L082	9	0	0	9	0	0	0.00	0.00	0.00	n		
2008/316	L229	L406	10	0	0	10	0	0	0.00	0.00	0.00	n		
2008/317	L229	L419	2	0	0	2	0	0	0.00	0.00	0.00	n		
2008/318	L229	L161	7	0	0	7	0	0	0.00	0.00	0.00	n		
2008/319	L229	L417	9	0	0	9	0	0	0.00	0.00	0.00	n		
2008/320	L229	L318	9	0	0	9	0	0	0.00	0.00	0.00	n		
2008/321	L229	L804	10	0	0	10	0	0	0.00	0.00	0.00	n		
2008/322	L229	L049/1	6	0	4	2	0	12	66.67	0.00	0.00	n		
2008/323	L082	L801/2	24	0	0	24	0	0	0.00	0.00	0.00	n		
2008/324	L082	L406	11	0	0	11	0	0	0.00	0.00	0.00	n		
2008/325	L082	L381	20	0	0	20	0	0	0.00	0.00	0.00	n		
2008/326	L082	L122	25	0	0	25	0	0	0.00	0.00	0.00	n		
2008/327	L082	L124	38	0	0	38	0	0	0.00	0.00	0.00	n		
2008/328	L082	L290	18	0	0	18	0	0	0.00	0.00	0.00	n		
2008/329	L158	L318	23	0	0	23	0	0	0.00	0.00	0.00	n		
2008/330	L158	L158	20	0	0	20	0	0	0.00	0.00	0.00	n		
2008/331	L158	L804	18	0	0	18	0	0	0.00	0.00	0.00	n		
2008/332	L158	L082	18	0	0	18	0	0	0.00	0.00	0.00	n		
2008/333	L158	L124	30	0	4	26	0	11	13.33	0.00	0.00	n		
2008/334	L158	L381	21	0	3	18	0	14	14.29	0.00	0.00	n		
2008/335	L158	L229	17	0	0	17	0	0	0.00	0.00	0.00	n		
2008/336	L158	L406	22	0	0	22	0	0	0.00	0.00	0.00	n		
2008/337	L158	L194	17	0	0	14	0	0	0.00	0.00	0.00	n		
2008/338	L158	L318	21	0	0	21	0	0	0.00	0.00	0.00	n		
2008/339	L158	L290	12	0	0	12	0	0	0.00	0.00	0.00	n		
2008/340	L158	L049/1	18	0	0	18	0	0	0.00	0.00	0.00	n		
2008/341	L158	L801/2	18	0	0	18	0	0	0.00	0.00	0.00	n		
2008/342	L158	L053	30	0	0	30	0	0	0.00	0.00	0.00	n		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2008/343	L290	L122	30	1	1	28	1	1	6.67	0.03	1.00	y	1	100.00
2008/344	L290	L053	34	1	1	32	1	1	5.88	0.03	1.00	n	0	0.00
2008/345	L290	L418	20	0	0	20	0	0	0.00	0.00	0.00	n		
2008/346	L290	L389	25	0	0	25	0	0	0.00	0.00	0.00	n		
2008/347	L290	L161	29	1	1	27	1	1	6.90	0.03	1.00	y	1	100.00
2008/348	L290	L801/2	36	0	7	29	0	11	19.44	0.00	0.00	n		
2008/349	L290	L802/2	34	4	2	28	4	3	17.65	0.12	1.00	y	2	50.00
2008/350	L290	L290	91	10	2	79	11	2	13.19	0.12	1.10	y	3	27.27
2008/351	L290	L318	21	0	1	20	0	3	4.76	0.00	0.00	n		
2008/352	L290	L417	24	1	0	23	1	0	4.17	0.04	1.00	n	0	0.00
2008/353	L290	L158	42	0	0	42	0	0	0.00	0.00	0.00	n		
2008/354	L290	L212	32	0	0	32	0	0	0.00	0.00	0.00	n		
2008/355	L290	L277	28	0	15	13	0	81	53.57	0.00	0.00	n		
2008/356	L290	L124	45	0	12	33	0	25	26.67	0.00	0.00	n		
2008/357	L290	L194	41	0	1	40	0	1	2.44	0.00	0.00	n		
2008/358	L290	L406	38	14	2	22	29	4	42.11	0.76	2.07	y	20	68.97
2008/359	L290	L419	42	2	0	40	3	0	4.76	0.07	1.50	y	1	33.33
2008/360	L290	L229	38	1	1	36	1	1	5.26	0.03	1.00	n	0	0.00
2008/361	L290	L016	30	1	0	29	1	0	3.33	0.03	1.00	n	0	0.00
2008/362	L290	L082	42	0	6	36	0	7	14.29	0.00	0.00	n		
2008/363	L290	L049/1	53	25	0	28	216	2	47.17	4.08	8.64	y	197	91.20
2008/364	L290	L101	33	21	2	10	68	35	69.70	2.06	3.24	n	0	0.00
2008/365	L804/2	L406	26	5	1	20	5	1	23.08	0.19	1.00	y	4	80.00
2009/001	L419	L155	6	0	2	4	0	3	33.33	0.00	0.00	n		
2009/002	L419	L144	5	4	0	1	21	84	80.00	4.20	5.25	y	1	4.76
2009/003	L419	L124	4	2	1	1	24	34	75.00	6.00	12.00	y	2	8.33
2009/004	L419	L212	11	3	1	7	4	5	36.36	0.36	1.33	n	0	0.00
2009/005	L419	L419	5	2	0	3	6	0	40.00	1.20	3.00	y	6	100.00
2009/006	L124	L419	8	0	0	8	0	0	0.00	0.00	0.00	n		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2009/007	L801/2	L419	10	0	0	10	0	0	0.00	0.00	0.00	n		
2009/008	L049/1	L229	30	0	0	30	0	0	0.00	0.00	0.00	n		
2009/009	L417	L418	20	0	0	20	0	0	0.00	0.00	0.00	n		
2009/010	L417	L124	10	0	2	8	0	6	20.00	0.00	0.00	n		
2009/011	L417	L804	8	0	0	8	0	0	0.00	0.00	0.00	n		
2009/012	L229	L381	12	0	2	10	0	7	16.67	0.00	0.00	n		
2009/013	L229	L155	17	0	8	9	0	42	47.06	0.00	0.00	n		
2009/014	L229	L144	14	3	8	3	3	51	78.57	0.21	1.00	y	1	33.33
2009/015	L229	L124	11	2	4	5	2	5	54.55	0.18	1.00	y	1	50.00
2009/016	L229	L122	12	2	4	6	3	47	50.00	0.25	1.50	y	3	100.00
2009/017	L158	L419	31	0	2	29	0	5	6.45	0.00	0.00	n		
2009/018	L158	L290	24	0	4	21	0	10	16.67	0.00	0.00	n		
2009/019	L082	L389	33	0	1	32	0	2	3.03	0.00	0.00	n		
2009/021	L082	L417	29	0	2	27	0	8	6.90	0.00	0.00	n		
2009/022	L082	L418	34	0	1	33	0	1	2.94	0.00	0.00	n		
2009/023	L082	L229	32	0	0	32	0	0	0.00	0.00	0.00	n		
2009/024	L082	L049/1	29	1	11	17	1	22	41.38	0.03	1.00	y	1	100.00
2009/025	L082	L158	36	0	6	24	0	11	16.67	0.00	0.00	n		
2009/026	L290	L290	32	5	0	27	9	0	15.63	0.28	1.80	y	3	33.33
2009/027	L290	L381	53	16	18	19	58	142	64.15	1.09	3.63	y	3	5.17
2009/028	L804/2	L804	43	6	4	33	8	6	23.26	0.19	1.33	y	7	87.50
2009/029	L804/2	L124	32	2	13	14	4	23	46.88	0.13	2.00	y	2	50.00
2010/001	L381	L318	1	0	0	1	0	0	0.00	0.00	0.00	n		
2010/002	L801/2	L419	10	0	1	9	0	2	10.00	0.00	0.00	n		
2010/003	L801/2	L804	7	0	0	7	0	0	0.00	0.00	0.00	n		
2010/004	L381	L389	4	0	3	1	0	60	75.00	0.00	0.00	n		
2010/005	L417	L229	10	0	0	10	0	0	0.00	0.00	0.00	n		
2010/006	L802/2	L144	41	0	0	41	0	0	0.00	0.00	0.00	n		
2010/007	L381	L418	2	0	0	2	0	0	0.00	0.00	0.00	n		

Cross no	Female	Male	No of Flowers	No of flowers with normal seed	No of flowers with ab-normal seeds	No of Flowers With no Seed	No of Nor-mal Seeds	No of Ab-normal Seeds	% Flower Set	Seeds Per Flower Polli-nated	Seed Per Flower Set	Germi-nation	No Seed-lings	% Germi-nation
2010/008	L802/2	L290	30	0	7	23	0	11	23.33	0.00	0.00	n		
2010/009	L802/4	L290	34	0	0	34	0	0	0.00	0.00	0.00	n		
2010/010	L381	L122	1	0	1	0	0	6	100.00	0.00	0.00	n		
2010/011	L419	L419	4	1	0	3	1	0	25.00	0.25	1.00	y	1	100.00
2010/012	L419	L417	6	6	0	0	119	0	100.00	19.83	19.83	y	6	5.04
2010/013	L804/2	L277	20	0	7	13	0	19	35.00	0.00	0.00	n		
2010/014	L290	L381	15	0	10	5	0	36	66.67	0.00	0.00	n		
2010/015	L417	L290	6	0	2	4	0	2	33.33	0.00	0.00	n		
2010/016	L229	L212	5	2	1	2	2	6	60.00	0.40	1.00	y	2	100.00
2010/017	L804/2	L419	15	3	6	6	9	22	60.00	0.60	3.00	y	9	100.00

APPENDIX E: Tables E.1 to E.15 indicating the principle component data contributing towards the cluster analysis of each female male combination. Each table is linked to a specific female parent and indicates the cluster for each combination before and after cross validation of the principle component analysis data

Table E.1: Crosses with *L. bachmanii* (L016) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	Accession	cluster	No of flowers with normal seed	No of flowers with abnormal seed	Percentage flower set	No of normal seed per flower pollinated	No of normal seed per flower set	Germination %
L. bachmanii	L016	1	0.00	0.00	0.00	0.00	0.00	0.00
L. bachmanii	L127	3	36.00	0.00	80.00	4.76	5.94	91.59
L. bifolia	L389	1	0.75	1.75	15.83	0.04	0.25	0.00
L. bifolia	L801	1	0.00	0.50	1.47	0.00	0.00	0.00
L. contaminata	L082	2	11.00	1.50	64.84	1.30	2.31	94.12
L. flava	L124	1	0.00	1.00	3.45	0.00	0.00	0.00
L. flava	L144	1	0.00	0.00	0.00	0.00	0.00	0.00
L. liliflora	L290	1(2)	1.67	0.00	13.51	0.72	2.72	17.50
L. liliflora	L804	1	2.00	1.50	21.72	0.27	1.00	0.00
L. mediana	L158	1	0.00	0.00	0.00	0.00	0.00	0.00
L. mediana	L418	1	0.00	3.33	23.73	0.00	0.00	0.00
L. mutabilis	L161	2	0.00	8.00	43.61	0.00	0.00	0.00
L. mutabilis	L318	2	0.00	6.00	38.60	0.00	0.00	0.00
L. orchioides	L802	1	0.00	3.00	20.00	0.00	0.00	0.00
L. pallida	L049	1	0.00	0.00	0.00	0.00	0.00	0.00
L. pallida	L406	1	0.67	1.67	12.73	0.04	0.33	50.00
L. perryae	L053	1	0.00	0.00	0.00	0.00	0.00	0.00
L. punctata	L277	2	5.33	4.33	53.04	2.06	2.19	0.00
L. punctata	L381	1(2)	4.67	1.67	33.33	0.54	0.74	0.00
L. quadricolor	L101	2	0.00	11.00	22.45	0.00	0.00	0.00
L. quadricolor	L122	2(1)	0.00	5.00	13.51	0.00	0.00	0.00
L. quadricolor	L155	1	0.00	0.50	2.94	0.00	0.00	0.00
L. quadricolor	L212	1	0.00	1.00	4.55	0.00	0.00	0.00
L. splendida	L417	1	0.00	0.00	0.00	0.00	0.00	0.00
L. splendida	L419	1	0.50	2.50	9.33	0.02	0.50	0.00
L. unifolia	L229	1	0.00	0.00	0.00	0.00	0.00	0.00
L. viridiflora	L194	1(2)	4.00	1.33	27.40	0.54	0.86	0.00

[m] Combinations where mechanical barriers (long style x short style) could influence the success rate

Table E.2: Crosses with *L. bifolia* (L389 and L801) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	accession	cluster		No of flowers with normal seed		No of flowers with abnormal seed		Percentage flower set		No of normal seed per flower pollinated		No of normal seed per flower set		Germination %	
		L389	L801	L389	L801	L389	L801	L389	L801	L389	L801	L389	L801	L389	L801
L. bachmanii[m]	L016	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. bifolia	L389	3	3	23.00	4.50	0.00	1.50	100.00	27.27	8.57	3.55	8.57	8.67	63.96	90.38
L. bifolia	L801	3	2(3)	8.00	12.00	2.00	2.00	90.91	77.78	16.18	3.83	22.25	5.75	100.00	4.35
L. contaminata[m]	L082	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. flava	L124	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. flava	L144	1	1	0.00	0.00	0.50	0.50	1.67	3.85	0.00	0.00	0.00	0.00	0.00	0.00
L. liliflora	L290	1	1	0.00	0.00	0.50	0.00	3.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. liliflora	L804	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. mediana	L158	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. mediana	L418	1	1	0.33	0.00	0.00	0.00	3.03	0.00	0.03	0.00	0.33	0.00	0.00	0.00
L. mutabilis[m]	L161	1	1	0.00	0.33	0.00	0.00	0.00	1.96	0.00	0.06	0.00	1.00	0.00	33.33
L. mutabilis[m]	L318	1	1	0.00	0.00	0.50	0.00	2.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. orchioides	L802	1	1	0.00	0.00	0.67	0.00	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. pallida	L049	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. pallida	L406	1	1	0.00	0.00	0.33	1.00	1.67	10.48	0.00	0.00	0.00	0.00	0.00	0.00
L. perryae	L053	1	1	0.00	0.00	0.50	0.00	1.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. punctata	L277	1	1	0.00	0.25	0.50	1.00	16.67	12.02	0.00	0.13	0.00	1.00	0.00	100.00
L. punctata	L381	1	1	0.80	0.50	3.20	0.50	29.20	7.14	0.18	0.04	1.40	0.25	18.06	50.00
L. quadricolor	L101	1	1	0.00	1.00	2.33	0.00	17.84	7.69	0.00	0.12	0.00	0.38	0.00	33.33
L. quadricolor	L122	1	1	0.00	0.00	1.50	0.00	18.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. quadricolor	L155	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. quadricolor	L212	1	1	0.00	0.00	0.00	0.50	0.00	3.85	0.00	0.00	0.00	0.00	0.00	0.00
L. splendida	L417	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. splendida	L419	1	1	0.00	0.00	0.00	0.50	0.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00
L. unifolia	L229	1	1	0.50	0.00	0.25	0.00	9.82	0.00	0.10	0.00	0.75	0.00	0.00	0.00
L. viridiflora	L194	1	1	0.00	0.00	0.50	0.00	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00

[m] Combinations where mechanical barriers (long style x short style) could influence the success rate

Table E.3: Crosses with *L. contaminata* (L082) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	accession	cluster	No of flowers with normal seed	No of flowers with abnormal seed	Percentage flower set	No of normal seed per flower pollinated	No of normal seed per flower set	Germination %
L. bachmanii	L016	1	0.00	0.00	0.00	0.00	0.00	0.00
L. bifolia	L389	1	0.00	1.00	1.96	0.00	0.00	0.00
L. bifolia	L801	1	0.00	0.67	1.28	0.00	0.00	0.00
L. contaminata	L082	2	7.00	0.00	10.14	0.16	1.57	63.64
L. contaminata	L207	3	24.00	6.00	58.82	2.88	6.13	100.00
L. flava	L124	1	0.00	3.33	12.82	0.00	0.00	0.00
L. flava	L144	2	0.00	9.00	18.55	0.00	0.00	0.00
L. liliflora	L290	1	0.00	1.00	8.33	0.00	0.00	0.00
L. liliflora	L804	2	0.00	9.50	46.97	0.00	0.00	0.00
L. mediana	L158	1	0.00	3.50	9.13	0.00	0.00	0.00
L. mediana	L418	1	0.00	0.50	1.47	0.00	0.00	0.00
L. mutabilis	L161	2	0.00	12.00	22.64	0.00	0.00	0.00
L. mutabilis	L318	1	0.00	1.50	3.26	0.00	0.00	0.00
L. orchioides	L802	2	2.00	9.00	26.19	0.14	3.00	0.00
L. pallida	L049	2	0.67	6.67	25.03	0.02	0.67	50.00
L. pallida	L406	1	0.67	4.33	17.15	0.03	0.33	50.00
L. perryae	L053	1	0.00	0.00	0.00	0.00	0.00	0.00
L. punctata	L277	1	0.00	0.50	1.06	0.00	0.00	0.00
L. punctata	L381	1	0.00	0.33	0.67	0.00	0.00	0.00
L. quadricolor	L101	2	0.00	12.50	15.60	0.00	0.00	0.00
L. quadricolor	L122	1	0.00	0.00	0.00	0.00	0.00	0.00
L. quadricolor	L155	2	0.00	16.50	17.74	0.00	0.00	0.00
L. quadricolor	L212	2(1)	0.00	0.50	0.85	0.00	0.00	0.00
L. splendida	L417	1	0.33	3.33	10.87	0.01	0.33	100.00
L. splendida	L419	1	2.00	1.00	7.32	0.07	1.50	0.00
L. unifolia	L229	1	0.00	0.00	0.00	0.00	0.00	0.00
L. viridiflora	L194	2	0.00	8.00	14.29	0.00	0.00	0.00

[m] Combinations where mechanical barriers (long style x short style) could influence the success rate

Table E.4: Crosses with *L. flava* (L124 and L144) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	Accession	cluster		No of flowers with normal seed		No of flowers with abnormal seed		Percentage flower set		No of normal seed per flower pollinated		No of normal seed per flower set		Germination %	
		L124	L144	L124	L144	L124	L144	L124	L144	L124	L144	L124	L144	L124	L144
L. bachmanii[m]	L016	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. bifolia	L389	2	2	1.00	1.50	4.25	6.75	58.54	44.55	0.13	0.75	0.25	1.88	25.00	33.33
L. bifolia	L801	1	1	0.67	0.00	2.33	0.67	34.76	4.17	0.11	0.00	0.33	0.00	50.00	0.00
L. contaminata[m]	L082	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. flava	L124	2(3)	3	5.00	4.00	0.00	0.00	83.33	100.00	1.83	51.25	2.20	51.25	27.27	89.76
L. flava	L144	1	1	1.00	0.00	1.00	0.50	10.56	3.57	0.05	0.00	1.00	0.00	100.00	0.00
L. liliflora	L290	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. liliflora	L804	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. mediana	L158	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. mediana	L418	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. mutabilis[m]	L161	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. mutabilis[m]	L318	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. orchioides	L802	1	1	0.00	0.00	0.67	0.00	8.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. pallida	L049	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. pallida	L406	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. perryae	L053	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. punctata	L277	2	2	10.00	7.00	8.00	9.00	78.26	64.00	2.04	1.08	4.70	3.86	87.23	33.33
L. punctata	L381	3	2(3)	13.00	8.00	4.00	5.00	77.27	65.00	10.23	2.35	17.31	5.88	28.00	2.13
L. quadricolor	L101	1(3)	3	3.67	3.33	0.33	1.33	26.46	32.58	1.29	2.75	5.04	6.33	73.08	60.98
L. quadricolor	L122	1(2)	1	1.50	1.00	0.00	0.00	37.50	7.14	1.25	0.11	1.67	0.75	80.00	100.00
L. quadricolor	L155	3	1	3.50	1.33	0.00	0.33	50.00	12.87	25.36	0.11	25.36	0.33	78.31	75.00
L. quadricolor	L212	1(2)	1	1.67	0.67	1.00	0.67	44.60	8.68	0.60	0.05	1.50	0.33	100.00	50.00
L. splendida	L417	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. splendida	L419	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. unifolia	L229	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. viridiflora	L194	1	1	0.00	0.00	0.00	3.50	0.00	18.13	0.00	0.00	0.00	0.00	0.00	0.00

[m] Combinations where mechanical barriers (long style x short style) could influence the success rate

Table E.5: Crosses with *L. liliflora* (L290 and L804) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	Accession	cluster		No of flowers with normal seed		No of flowers with abnormal seed		Percentage flower set		No of normal seed per flower pollinated		No of normal seed per flower set		Germination %	
		L290	L804	L290	L804	L290	L804	L290	L804	L290	L804	L290	L804	L290	L804
L. bachmanii	L016	1	2(1)	0.50	0.00	0.00	0.00	1.67	0.00	0.02	0.00	0.50	0.00	0.00	0.00
L. bifolia	L389	1	1	0.50	0.33	2.50	1.67	15.00	8.33	0.03	0.01	0.50	0.33	100.00	100.00
L. bifolia	L801	1(2)	2	0.00	0.00	6.00	9.00	16.30	13.75	0.00	0.00	0.00	0.00	0.00	0.00
L. contaminata	L082	1(2)	1	0.00	0.00	6.00	0.00	15.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. flava	L124	2	2	0.00	1.00	15.50	7.50	31.96	25.00	0.00	0.06	0.00	1.00	0.00	50.00
L. flava	L144	2	1	1.00	0.00	13.00	0.00	22.22	0.00	0.02	0.00	1.00	0.00	100.00	0.00
L. liliflora	L290	2	3	7.50	26.00	1.00	2.00	14.41	66.67	0.20	1.29	1.45	2.08	30.30	100.00
L. liliflora	L804	3	1	27.00	2.50	0.00	1.25	65.85	11.37	3.98	0.09	6.04	0.83	63.19	95.83
L. mediana	L158	1	1	0.00	0.00	0.00	0.50	0.00	1.79	0.00	0.00	0.00	0.00	0.00	0.00
L. mediana	L418	1	1	0.00	1.00	0.00	0.00	0.00	4.00	0.00	0.04	0.00	0.50	0.00	100.00
L. mutabilis	L161	1	1	0.50	0.00	0.50	0.00	3.45	0.00	0.02	0.00	0.50	0.00	100.00	0.00
L. mutabilis	L318	1	1	0.00	0.00	0.50	0.00	2.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. orchioides	L802	1(2)	1(2)	2.00	4.33	5.00	5.00	21.73	41.84	0.06	0.70	0.50	1.54	50.00	5.00
L. pallida	L049	3	1(2)	21.00	3.00	0.00	3.00	66.08	33.57	3.69	1.83	6.26	3.67	85.00	40.91
L. pallida	L406	2	1	12.00	1.67	1.00	1.33	40.28	11.69	1.02	0.06	2.69	0.33	78.42	80.00
L. perryae	L053	1	1	0.50	0.00	0.50	0.00	2.94	0.00	0.01	0.00	0.50	0.00	0.00	0.00
L. punctata	L277	2	2	0.00	7.00	8.00	3.00	27.86	20.21	0.00	0.22	0.00	0.56	0.00	14.29
L. punctata	L381	2	2	4.00	10.00	10.00	7.00	42.38	23.43	0.27	0.28	0.91	1.08	5.17	9.30
L. quadricolor	L101	2	2(3)	10.50	13.00	9.50	10.00	49.02	62.55	1.03	2.19	1.62	2.62	0.00	9.56
L. quadricolor	L122	1	2	0.50	5.50	4.50	6.50	13.09	30.77	0.02	0.69	0.50	2.45	100.00	11.11
L. quadricolor	L155	2	1	3.00	0.00	21.00	0.50	37.50	0.98	0.02	0.00	0.33	0.00	100.00	0.00
L. quadricolor	L212	2	1(2)	0.00	0.00	12.33	7.00	14.34	19.44	0.00	0.00	0.00	0.00	0.00	0.00
L. splendida	L417	1	2(1)	1.67	0.00	1.00	3.00	16.94	5.45	0.10	0.00	0.67	0.00	37.50	0.00
L. splendida	L419	1	1	1.00	1.00	0.00	2.33	2.38	21.75	0.04	0.20	0.75	1.00	33.33	100.00
L. unifolia	L229	1	1	0.50	0.00	0.50	0.50	2.63	1.67	0.01	0.00	0.50	0.00	0.00	0.00
L. viridiflora	L194	1	1(2)	0.00	5.50	1.00	2.50	3.14	26.50	0.00	0.23	0.00	1.35	0.00	21.59

[m] Combinations where mechanical barriers (long style x short style) could influence the success rate

Table E.6: Crosses with *L. mediana* (L158 and L418) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	Accession	Cluster		No of flowers with normal seed		No of flowers with abnormal seed		Percentage flower set		No of normal seed per flower pollinated		No of normal seed per flower set		Germination %	
		L158	L418	L158	L418	L158	L418	L158	L418	L158	L418	L158	L418	L158	L418
L. bachmanii	L016	2	2	0.00	1.00	4.50	19.00	32.65	44.44	0.00	0.02	0.00	1.00	0.00	100.00
L. bifolia	L389	1	1	0.00	0.00	0.50	3.50	2.63	8.60	0.00	0.00	0.00	0.00	0.00	0.00
L. bifolia	L801	1	1	0.00	0.00	0.00	0.50	0.00	1.79	0.00	0.00	0.00	0.00	0.00	0.00
L. contaminata	L082	1	1(2)	0.00	0.50	0.00	5.00	0.00	12.50	0.00	0.01	0.00	0.50	0.00	100.00
L. flava	L124	2	2	0.00	0.00	9.00	7.00	23.14	11.79	0.00	0.00	0.00	0.00	0.00	0.00
L. flava	L144	2	2	0.00	0.00	5.67	26.00	18.89	49.58	0.00	0.00	0.00	0.00	0.00	0.00
L. liliflora	L290	1	2	0.00	0.00	2.00	5.50	8.33	34.58	0.00	0.00	0.00	0.00	0.00	0.00
L. liliflora	L804	1	2	0.00	0.00	2.00	6.00	8.33	36.51	0.00	0.00	0.00	0.00	0.00	0.00
L. mediana	L158	1	2	0.00	4.00	0.00	7.00	0.00	61.11	0.00	1.06	0.00	4.75	0.00	89.47
L. mediana	L418	2	1	11.67	2.50	2.00	4.50	61.35	20.31	2.06	0.08	4.12	0.60	81.40	0.00
L. mutabilis	L161	1	1	0.00	0.00	0.00	3.00	0.00	9.23	0.00	0.00	0.00	0.00	0.00	0.00
L. mutabilis	L318	1	1	0.00	0.00	0.00	1.00	0.00	3.03	0.00	0.00	0.00	0.00	0.00	0.00
L. orchioides	L802	2	2	0.00	0.00	6.00	6.67	28.13	21.19	0.00	0.00	0.00	0.00	0.00	0.00
L. pallida	L049	1	1	0.00	0.00	0.00	4.67	0.00	18.73	0.00	0.00	0.00	0.00	0.00	0.00
L. pallida	L406	1	1	0.00	0.00	0.00	1.50	0.00	7.13	0.00	0.00	0.00	0.00	0.00	0.00
L. perryae	L053	1	1	0.00	0.00	2.00	0.00	12.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. punctata	L277	1	2	0.00	0.00	3.50	11.00	26.97	27.00	0.00	0.00	0.00	0.00	0.00	0.00
L. punctata	L381	1	2	1.00	0.00	1.00	6.33	13.10	23.50	0.00	0.00	0.00	0.00	0.00	0.00
L. quadricolor	L101	2	2	0.00	0.00	6.00	21.00	20.83	42.11	0.00	0.00	0.00	0.00	0.00	0.00
L. quadricolor	L122	2	2	0.00	0.00	7.00	19.00	24.62	36.21	0.00	0.00	0.00	0.00	0.00	0.00
L. quadricolor	L155	2	2	0.00	0.00	6.50	7.00	17.80	29.89	0.00	0.00	0.00	0.00	0.00	0.00
L. quadricolor	L212	1	2	0.00	0.00	4.00	10.00	14.14	23.67	0.00	1.00	0.00	0.00	0.00	0.00
L. splendida	L417	2	1	0.00	0.00	5.00	0.00	27.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. splendida	L419	1	2	0.00	0.00	2.00	10.00	7.77	43.22	0.00	0.00	0.00	0.00	0.00	0.00
L. unifolia	L229	1	1	0.00	0.00	0.00	0.50	0.00	3.85	0.00	0.00	0.00	0.00	0.00	0.00
L. viridiflora	L194	1	2	0.50	0.00	0.50	19.00	8.33	55.88	0.60	0.00	0.38	0.00	33.33	0.00

[m] Combinations where mechanical barriers (long style x short style) could influence the success rate

Table E.7: Crosses with *L. mutabilis* (L166 and L318) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	accession	cluster		No of flowers with normal seed		No of flowers with abnormal seed		Percentage flower set		No of normal seed per flower pollinated		No of normal seed per flower set		Germination %	
		L161	L318	L161	L318	L161	L318	L161	L318	L161	L318	L161	L318	L161	L318
L. bachmanii	L016	2	1	13.00	2.50	1.00	2.00	46.67	18.25	1.47	0.12	3.38	0.60	2.27	16.67
L. bifolia	L389	1	1	0.00	0.00	2.50	1.00	6.76	5.26	0.00	0.00	0.00	0.00	0.00	0.00
L. bifolia	L801	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. contaminata	L082	1	1	0.00	0.00	0.50	1.50	1.52	8.17	0.00	0.00	0.00	0.00	0.00	0.00
L. flava	L124	1(2)	2(1)	4.00	0.00	2.00	0.00	13.95	0.00	0.09	0.00	1.00	0.00	50.00	0.00
L. flava	L144	1	1	6.00	0.00	0.00	0.00	15.00	0.00	0.20	0.00	1.33	0.00	75.00	0.00
L. liliflora	L290	1	2	0.00	0.00	0.67	7.50	4.76	56.00	0.00	0.00	0.00	0.00	0.00	0.00
L. liliflora	L804	1	1	2.67	5.00	0.00	0.50	19.05	23.00	0.62	0.36	1.08	1.63	30.77	3.57
L. mediana	L158	1	1	0.00	0.00	0.00	0.50	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00
L. mediana	L418	2(1)	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. mutabilis	L161	2(1)	3	0.00	19.00	0.00	0.00	0.00	65.52	0.00	5.45	0.00	8.32	0.00	100.00
L. mutabilis	L318	1	1	0.00	0.33	0.00	0.67	0.00	7.14	0.00	0.02	0.00	0.33	0.00	100.00
L. orchioides	L802	1	1	0.50	0.00	2.00	4.00	27.94	20.14	0.60	0.00	1.00	0.00	0.00	0.00
L. pallida	L049	1	1	0.67	0.00	0.00	1.50	4.44	9.35	0.04	0.00	0.33	0.00	100.00	0.00
L. pallida	L406	1	1(2)	0.00	3.50	0.50	1.50	3.13	43.17	0.00	0.56	0.00	0.71	0.00	80.00
L. perryae	L053	1	1	0.00	0.00	0.00	1.00	0.00	6.25	0.00	0.00	0.00	0.00	0.00	0.00
L. punctata	L277	1	1	4.00	0.00	1.00	0.67	20.38	8.33	0.26	0.00	1.36	0.00	91.67	0.00
L. punctata	L381	1	1	0.00	0.40	2.00	0.80	15.38	5.58	0.00	0.02	0.00	2.00	0.00	50.00
L. quadricolor	L101	3	1	29.00	0.00	4.00	1.00	70.21	5.88	1.51	0.00	2.45	0.00	83.10	0.00
L. quadricolor	L122	2	1	16.00	0.00	6.00	1.00	23.16	3.23	0.20	0.00	1.19	0.00	26.32	0.00
L. quadricolor	L155	1	1	9.00	0.00	2.00	1.25	28.95	3.36	0.47	0.00	2.00	0.00	44.44	0.00
L. quadricolor	L212	2	1	3.00	0.00	0.00	1.50	5.88	2.38	0.08	0.00	1.33	0.00	50.00	0.00
L. splendida	L417	1	2	0.00	0.00	0.00	6.50	0.00	55.00	0.00	0.00	0.00	0.00	0.00	0.00
L. splendida	L419	1	1	0.00	1.00	0.00	1.67	0.00	15.93	0.00	0.08	0.00	0.44	0.00	0.00
L. unifolia	L229	1	1	0.00	0.33	0.00	0.00	0.00	2.08	0.00	0.02	0.00	0.33	0.00	0.00
L. viridiflora	L194	1	1	0.00	3.75	0.00	0.75	0.00	29.55	0.00	0.36	0.00	0.68	0.00	100.00

[m] Combinations where mechanical barriers (long style x short style) could influence the success rate

Table E.8: Crosses with *L. orchioides* (L802) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	accession	cluster	No of flowers with normal seed	No of flowers with abnormal seed	Percentage flower set	No of normal seed per flower pollinated	No of normal seed per flower set	Germination %
L. bachmanii[m]	L016	1	0.00	0.00	0.00	0.00	0.00	0.00
L. bifolia	L389	1	0.00	6.00	17.14	0.00	0.00	0.00
L. bifolia	L801	1(2)	1.00	3.00	10.81	0.05	2.00	50.00
L. contaminata[m]	L082	1	0.00	0.00	0.00	0.00	0.00	0.00
L. flava	L124	1	0.00	0.00	0.00	0.00	0.00	0.00
L. flava	L144	1	0.83	0.50	5.52	0.03	0.17	20.00
L. liliflora	L290	1	0.00	1.60	5.41	0.00	0.00	0.00
L. liliflora	L804	2	0.00	7.00	25.07	0.00	0.00	0.00
L. mediana	L158	1	0.00	0.00	0.00	0.00	0.00	0.00
L. mediana	L418	1	0.00	1.00	2.94	0.00	0.00	0.00
L. mutabilis[m]	L161	1	0.00	0.00	0.00	0.00	0.00	0.00
L. mutabilis[m]	L318	1	0.00	0.50	1.52	0.00	0.00	0.00
L. orchioides	L802	3	23.00	6.50	71.05	5.88	11.78	78.42
L. pallida	L049	1	0.00	3.00	10.34	0.00	0.00	0.00
L. pallida	L406	1	0.00	3.50	12.07	0.00	0.00	0.00
L. perryae	L053	1	0.00	0.00	0.00	0.00	0.00	0.00
L. punctata	L277	1	0.00	3.00	9.68	0.00	0.00	0.00
L. punctata	L381	1(2)	0.50	0.00	1.67	0.03	1.00	0.00
L. quadricolor	L101	1	0.33	1.17	5.16	0.01	0.17	50.00
L. quadricolor	L122	1(2)	0.00	4.00	13.64	0.00	0.00	0.00
L. quadricolor	L155	1	0.67	1.17	7.21	0.03	0.17	50.00
L. quadricolor	L212	1	0.00	0.33	1.11	0.00	0.00	0.00
L. splendida	L417	1	0.00	0.00	0.00	0.00	0.00	0.00
L. splendida	L419	1	0.00	0.00	0.00	0.00	0.00	0.00
L. unifolia	L229	1	0.00	0.00	0.00	0.00	0.00	0.00
L. viridiflora	L194	1	0.75	1.00	8.75	0.06	0.42	20.00

[m] Combinations where mechanical barriers (long style x short style) could influence the success rate

Table E.9: Crosses with *L. pallida* (L049 and L406) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	accession	cluster		No of flowers with normal seed		No of flowers with abnormal seed		Percentage flower set		No of normal seed per flower pollinated		No of normal seed per flower set		Germination %	
		L049	L406	L049	L406	L049	L406	L049	L406	L049	L406	L049	L406	L049	L406
L. bachmanii	L016	1	2(1)	0.67	0.00	0.00	0.00	2.02	0.00	0.02	0.00	0.33	0.00	100.00	0.00
L. bifolia	L389	1	2(1)	0.25	0.00	1.25	0.50	4.35	1.04	0.01	0.00	0.50	0.00	0.00	0.00
L. bifolia	L801	1	1	0.00	0.00	1.00	0.00	1.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. contamionata	L082	1	1	0.50	3.00	0.00	1.00	1.72	16.67	0.02	0.17	5.00	1.33	0.00	0.00
L. flava	L124	1		0.00		4.67		13.49		0.00		0.00		0.00	
L. flava	L144	1(2)	2	2.00	8.00	5.67	15.00	18.39	27.06	0.08	0.19	0.61	2.00	0.00	6.25
L. liliflora	L290	2(1)	3	0.00	38.00	0.00	0.00	0.00	73.08	0.00	2.73	0.00	3.74	0.00	50.70
L. liliflora	L804	2	3	1.00	47.00	0.00	0.00	2.08	73.44	0.02	6.03	1.00	8.21	100.00	61.92
L. mediana	L158	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. mediana	L418	1	2(1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. mutabilis	L161	1	2	0.00	6.00	0.00	0.00	0.00	7.89	0.00	0.09	0.00	1.17	0.00	14.29
L. mutabilis	L318	1	2	0.00	6.00	0.00	1.00	0.00	10.00	0.00	0.11	0.00	1.33	0.00	0.00
L. orchioides	L802	1	1	0.00	0.00	4.00	5.50	12.96	7.75	0.00	0.00	0.00	0.00	0.00	0.00
L. pallida	L049	1	3	1.00	13.00	0.00	3.00	4.00	59.26	0.04	3.37	0.50	7.00	0.00	84.62
L. pallida	L406	3	1	45.00	1.75	0.00	0.00	68.18	5.05	5.95	0.11	8.73	0.79	95.42	92.31
L. perryae	L053	1	2	0.00	3.00	0.00	0.00	0.00	5.66	0.00	0.13	0.00	2.33	0.00	28.57
L. punctata	L277	1	2	0.25	0.00	3.75	8.00	16.40	34.78	0.01	0.00	0.25	0.00	100.00	0.00
L. punctata	L381	2	2	0.00	5.00	7.00	11.00	31.40	23.88	0.00	0.36	0.00	4.80	0.00	4.17
L. quadricolor	L101		3		45.00		18.00		73.26		2.19		4.18		75.53
L. quadricolor	L122	1		2.50		1.75		16.71		0.27		0.65		19.23	
L. quadricolor	L155	1	2	0.00	1.00	3.00	23.00	6.98	34.29	0.00	0.01	0.00	1.00	0.00	100.00
L. quadricolor	L212		2		3.00		10.00		25.00		0.15		2.67		100.00
L. splendida	L417	1	2	3.00	5.00	0.00	0.00	12.00	7.46	0.16	0.10	0.67	1.40	12.50	42.86
L. splendida	L419	1(2)	3	3.50	18.00	1.00	0.00	16.07	33.33	0.41	2.91	1.64	8.72	86.96	54.14
L. unifolia	L229	1	2	0.00	3.00	0.00	0.00	0.00	5.45	0.00	0.05	0.00	1.00	0.00	0.00
L. viridiflora	L194	1	1	0.33	3.00	2.00	0.00	11.11	12.50	0.03	0.25	67.00	2.00	50.00	16.67

Table E.10: Crosses with *L. perryae* (L053) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	accession	cluster	No of flowers with normal seed	No of flowers with abnormal seed	Percentage flower set	No of normal seed per flower pollinated	No of normal seed per flower set	Germination %
L. bachmanii	L016	2	0.00	17.50	58.98	0.00	0.00	0.00
L. bifolia	L389	2	0.00	10.50	45.76	0.00	0.00	0.00
L. bifolia	L801	1(2)	0.00	3.50	44.05	0.00	0.00	0.00
L. contaminata	L082	2	1.00	8.00	35.56	0.04	0.50	100.00
L. flava	L124	2	0.00	9.00	60.00	0.00	0.00	0.00
L. flava	L144	2	0.00	6.00	40.62	0.00	0.00	0.00
L. liliflora	L290	2(1)	0.00	5.50	23.91	0.00	0.00	0.00
L. liliflora	L804	1	0.50	2.00	10.42	0.02	0.50	0.00
L. mediana	L158	2(1)	0.00	5.50	26.79	0.00	0.00	0.00
L. mediana	L418	2	0.00	12.00	37.50	0.00	0.00	0.00
L. mutabilis	L161	1	0.50	1.50	8.45	0.03	0.50	0.00
L. mutabilis	L318	1	2.00	3.50	18.97	0.09	0.63	20.00
L. orchioides	L802	2	0.00	26.00	92.86	0.00	0.00	0.00
L. pallida	L049	1(2)	2.00	2.00	40.00	0.35	0.88	0.00
L. pallida	L406	2(1)	0.00	5.50	21.15	0.00	0.00	0.00
L. perryae	L053	1	0.50	0.50	4.00	0.02	0.50	0.00
L. punctata	L277	2	0.00	20.50	83.27	0.00	0.00	0.00
L. punctata	L381	2	0.00	12.00	77.61	0.00	0.00	0.00
L. quadricolor	L101	2	0.00	13.67	56.86	0.00	0.00	0.00
L. quadricolor	L122	2	0.00	6.00	71.79	0.00	0.00	0.00
L. quadricolor	L155	2	0.00	10.00	58.82	0.00	0.00	0.00
L. quadricolor	L212	2	0.00	7.33	31.71	0.00	0.00	0.00
L. splendida	L417	2	0.00	7.50	30.00	0.00	0.00	0.00
L. splendida	L419	2	0.00	11.50	66.60	0.00	0.00	0.00
L. unifolia	L229	2	13.00	1.00	56.00	1.56	3.00	69.23
L. viridiflora	L194	2	0.00	10.00	33.33	0.00	0.00	0.00

[m] Combinations where mechanical barriers (long style x short style) could influence the success rate

Table E.11: Crosses with *L. punctata* (L277 and L381) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	accession	cluster		No of flowers with normal seed		No of flowers with abnormal seed		Percentage flower set		No of normal seed per flower pollinated		No of normal seed per flower set		Germination %	
		L277	L381	L277	L381	L277	L381	L277	L381	L277	L381	L277	L381	L277	L381
L. bachmanii[m]	L016	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. bifolia	L389	2	2	0.50	0.00	7.50	2.00	87.50	91.67	0.04	0.00	0.50	0.00	100.00	0.00
L. bifolia	L801	1(2)	2	0.00	0.00	3.67	8.00	32.41	66.67	0.37	0.00	0.00	0.00	0.00	0.00
L. contaminata[m]	L082	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. flava	L124	3	3	23.00	8.00	1.00	1.00	92.31	56.25	13.27	4.56	15.00	9.13	3.77	1.37
L. flava	L144	3	2	18.00	8.00	0.00	6.00	81.82	43.75	16.59	0.88	20.28	3.50	0.27	3.57
L. liliflora	L290	1	1	0.33	0.00	0.00	0.00	1.39	0.00	0.10	0.00	2.33	0.00	42.86	0.00
L. liliflora	L804	1		0.00		0.00		0.00		0.00		0.00		0.00	
L. mediana	L158	1		0.5		0.00		4.55		0.14		1.50		100.00	
L. mediana	L418	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. mutabilis[m]	L161	1	1	0.33	0.00	0.00	0.00	5.56	0.00	0.28	0.00	1.67	0.00	0.00	0.00
L. mutabilis[m]	L318	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. orchioides	L802	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. pallida	L049	1	1	0.00	0.50	0.00	0.00	0.00	25.00	0.00	0.25	0.00	0.50	0.00	100.00
L. pallida	L406	1		0.00		0.00		0.00		0.00		0.00		0.00	
L. perryae	L053	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. punctata	L277	3	3	32.00	8.50	0.00	1.50	91.43	75.60	24.40	17.23	26.69	26.34	96.14	53.22
L. punctata	L381	3	3	5.00	21.00	0.00	0.00	35.71	77.78	6.71	5.30	18.80	6.81	85.11	72.73
L. quadricolor	L101	2(3)	2	13.00	0.00	0.00	10.00	76.47	74.46	3.18	0.00	4.15	0.00	1.85	0.00
L. quadricolor	L122	3	2	1.00	0.00	3.25	6.00	40.48	62.61	6.44	0.00	6.44	0.00	0.00	0.00
L. quadricolor	L155	3	2	10.00	0.00	9.00	14.00	86.36	100.00	7.36	0.00	16.20	0.00	64.20	0.00
L. quadricolor	L212	2	2(3)	0.00	1.00	16.50	7.00	76.88	84.21	0.00	0.63	0.00	6.00	0.00	91.67
L. splendida	L417	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. splendida	L419	1		0.00		0.00		0.00		0.00		0.00		0.00	
L. unifolia	L229	1		0.00		0.00		0.00		0.00		0.00		0.00	
L. viridiflora	L194	1	1	4.00	0.00	0.00	0.00	26.67	0.00	0.47	0.00	1.75	0.00	0.00	0.00

[m] Combinations where mechanical barriers (long style x short style) could influence the success rate

Table E.12: Crosses with *L. quadricolor* (L101, L122, L155 and L212) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	Accession	cluster				No of flowers with normal seed				No of flowers with abnormal seed				Percentage flower set				No of normal seed per flower pollinated				No of normal seed per flower set				Germination %			
		L101	L122	L155	L212	L101	L122	L155	L212	L101	L122	L155	L212	L101	L122	L155	L212	L101	L122	L155	L212	L101	L122	L155	L212	L101	L122	L155	L212
L. bachmanii[m]	L016	1	1	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. bifolia	L389	2	2	2	2	0.50	0.00	0.00	0.00	11.25	9.00	6.00	2.50	79.74	82.14	48.53	68.75	0.03	0.00	0.00	0.00	0.25	0.00	0.00	0.00	50.00	0.00	0.00	0.00
L. bifolia	L801	2	2	2	1(2)	0.00	0.00	1.00	0.00	5.50	9.00	6.00	1.00	48.11	81.20	28.00	33.33	0.00	0.00	0.04	0.00	0.00	0.00	1.00	0.00	0.00	0.00	100.00	0.00
L. contaminata[m]	L082	1	1	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. flava	L124	3	2(3)	3	2(3)	6.00	4.00	3.00	0.67	0.00	4.67	0.25	8.33	46.15	63.72	53.33	70.73	31.31	0.33	3.14	2.08	67.83	1.18	3.79	4.17	11.30	27.94	69.95	92.00
L. flava	L144	3	3	3	3	6.50	5.00	3.50	4.00	2.00	0.00	0.50	0.00	66.18	41.67	54.17	45.00	14.94	1.92	6.40	8.30	28.91	4.6	11.25	22.93	52.28	47.83	96.77	60.58
L. liliflora	L290	1	1	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. liliflora	L804	1	1	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. mediana	L158	1	1	1	1	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.08	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.33	0.00	0.00	0.00	100	0.00	0.00	0.00
L. mediana	L418	1	1	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. mutabilis[m]	L161	1	1	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. mutabilis[m]	L318	1	1	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. orchioides	L802	1	1	1	1	0.00	0.00	0.00	0.00	1.00	0.00	2.00	0.67	11.11	0.00	14.29	5.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. pallida	L049	1	1	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. pallida	L406	3	1	1	1	2.50	0.00	0.00	0.00	0.00	1.00	0.00	0.00	17.86	25.00	0.00	0.00	3.89	0.00	0.00	0.00	5.45	0.00	0.00	0.00	80.28	0.00	0.00	0.00
L. perryae	L053	1	1	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. punctata	L277	3	2	2	2	3.50	0.00	10.00	0.00	3.00	7.50	7.00	4.33	93.75	76.92	80.95	59.26	14.15	0.00	0.62	0.00	41.67	0.00	1.30	0.00	77.07	0.00	76.92	0.00
L. punctata	L381	3	2	2	2	3.50	0.00	1.00	0.00	1.50	6.67	12.00	4.00	68.89	58.97	72.22	62.50	11.32	0.00	0.06	0.00	20.75	0.00	1.00	0.00	100.00	0.00	100.00	0.00
L. quadricolor	L101	3	3	3	1	4.60	3.50	2.50	0.00	0.00	4.50	0.00	0.50	47.93	64.66	50.00	7.14	19.66	5.44	4.30	0.00	25.97	8.25	8.38	0.00	16.35	64.00	56.25	0.00
L. quadricolor	L122	3	1	1(2)	1	5.50	1.50	0.50	0.60	0.50	0.50	3.00	1.20	83.33	13.33	39.23	12.00	7.60	0.13	0.10	0.08	9.02	0.67	0.50	0.40	91.25	0.00	58.77	100.00
L. quadricolor	L155	1	1(2)	1	3	0.00	1.20	0.00	4.00	0.00	0.00	0.00	1.00	0.00	13.33	0.00	57.77	0.00	1.33	0.00	7.01	0.00	2.88	0.00	10.21	0.00	100.0	0.00	25.28
L. quadricolor	L212	3	1	3	1	4.00	0.00	4.50	0.00	0.00	1.33	0.00	1.33	66.67	10.94	68.75	14.81	12.00	0.00	6.88	0.00	18.00	0.00	8.29	0.00	84.72	0.00	72.55	0.00
L. splendida	L417	1	1	1	1	0.67	0.00	0.00	0.00	0.00	0.00	1.00	0.00	5.13	0.00	8.33	0.00	0.05	0.00	0.00	0.00	0.33	0.00	0.00	0.00	50.00	0.00	0.00	0.00
L. splendida	L419	1	1	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. unifolia	L229	1	1	1	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L. viridiflora	L194	3	1	1	1	3.67	0.00	2.33	0.00	0.67	3.00	1.00	2.50	40.08	30.29	29.1	28.47	10.04	0.00	0.44	0.00	17.43	0.00	1.17	0.00	43.96	0.00	68.33	0.00

[m] Combinations where mechanical barriers (long style x short style) could influence the success rate

Table E.13: Crosses with *L. splendida* (L417 and L419) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	accession	cluster		No of flowers with normal seed		No of flowers with abnormal seed		Percentage flower set		No of normal seed per flower pollinated		No of normal seed per flower set		Germination %	
		L417	L419	L417	L419	L417	L419	L417	L419	L417	L419	L417	L419	L417	L419
L. bachmanii	L016	1		0.50		0.00		1.56		0.02		0.50		0.00	
L. bifolia	L389	1	2	0.00	2.00	1.50	15.00	18.75	65.38	0.00	0.12	0.00	1.50	0.00	33.33
L. bifolia	L801	1	2	0.00	0.00	0.00	6.00	0.00	42.86	0.00	0.00	0.00	0.00	0.00	0.00
L. contaminata	L082	1		1.00		0.00		2.78		0.03		0.50		50.00	
L. flava	L124	1	2(3)	0.00	1.37	2.00	7.67	14.35	53.89	0.00	2.11	0.00	5.11	0.00	9.17
L. flava	L144	1	1(3)	0.00	2.00	1.00	0.50	4.00	44.55	0.00	2.10	0.00	2.63	0.00	4.76
L. liliflora	L290	1(2)		4.50		1.50		44.44		1.06		2.11		81.58	
L. liliflora	L804	1		0.00		1.00		3.70		0.00		0.00		0.00	
L. mediana	L158	1		0.00		0.00		0.00		0.00		0.00		0.00	
L. mediana	L418	1		0.00		0.00		0.00		0.00		0.00		0.00	
L. mutabilis	L161	1(2)		1.75		0.00		19.94		1.01		1.58		96.88	
L. mutabilis	L318	1		0.00		0.00		0.00		0.00		0.00		0.00	
L. orchioides	L802	1		0.00		0.33		5.53		0.00		0.00		0.00	
L. pallida	L049	1		0.00		0.00		0.00		0.00		0.00		0.00	
L. pallida	L406	1		1.00		0.00		7.69		0.27		1.75		71.43	
L. perryae	L053	1		0.00		0.00		0.00		0.00		0.00		0.00	
L. punctata	L277	2	1	1.00	0.00	6.50	4.00	39.47	40.00	0.11	0.00	1.00	0.00	25.00	0.00
L. punctata	L381	2	2	0.50	0.00	5.50	10.00	36.32	66.67	0.01	0.00	0.50	0.00	100.00	0.00
L. quadricolor	L101	2	1(2)	0.00	4.00	8.00	2.00	33.84	20.06	0.30	0.36	0.00	1.44	0.00	13.04
L. quadricolor	L122	1	2	0.00	1.00	1.00	5.00	4.55	24.33	0.00	0.06	0.00	0.75	0.00	33.33
L. quadricolor	L155	1	1	0.00	0.00	2.50	3.00	8.93	22.55	0.00	0.00	0.00	0.00	0.00	0.00
L. quadricolor	L212	1(2)	3	0.00	13.50	0.50	0.50	2.63	52.47	0.00	4.82	0.00	7.44	0.00	0.15
L. splendida	L417	1	3	5.00	17.00	1.00	0.00	30.00	50.00	0.33	3.85	1.21	7.71	45.00	55.73
L. splendida	L419	3	2	7.50	9.67	1.00	0.00	66.18	42.80	10.24	1.26	11.14	2.56	41.16	82.99
L. unifolia	L229	1		0.00		0.00		0.00		0.00		0.00		0.00	
L. viridiflora	L194	1	1	0	0.00	0.33	1.00	5.56	7.69	0.00	0.00	0.00	0.00	0.00	0.00

[m] Combinations where mechanical barriers (long style x short style) could influence the success rate

Table E.14: Crosses with *L. unifolia* (L229) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	accession	cluster	No of flowers with normal seed	No of flowers with abnormal seed	Percentage flower set	No of normal seed per flower pollinated	No of normal seed per flower set	Germination %
L. bachmanii[m]	L016	1	0.00	0.00	0.00	0.00	0.00	0.00
L. bifolia	L389	1	0.00	0.67	13.33	0.00	0.00	0.00
L. bifolia	L801	1	0.00	1.33	19.05	0.00	0.00	0.00
L. contaminata[m]	L082	1	0.00	0.00	0.00	0.00	0.00	0.00
L. flava	L124	2	2.00	4.00	54.55	0.18	1.00	50.00
L. flava	L144	2	3.00	8.00	78.57	0.21	1.00	33.33
L. liliflora	L290	1	0.00	0.00	0.00	0.00	0.00	0.00
L. liliflora	L804	1	0.00	3.00	20.00	0.00	0.00	0.00
L. mediana	L158	1	0.00	0.00	0.00	0.00	0.00	0.00
L. mediana	L418	1	0.00	2.00	28.57	0.00	0.00	0.00
L. mutabilis[m]	L161	1	0.00	0.00	0.00	0.00	0.00	0.00
L. mutabilis[m]	L318	1	0.00	0.00	0.00	0.00	0.00	0.00
L. orchioides	L802	2	3.00	2.00	71.43	1.29	3.00	11.11
L. pallida	L049	2	0.00	5.50	77.08	0.00	0.00	0.00
L. pallida	L406	1	0.00	1.50	15.00	0.00	0.00	0.00
L. perryae	L053	3	22.00	0.00	100.00	21.73	21.73	89.12
L. punctata	L277	1	0.00	0.50	5.00	0.00	0.00	0.00
L. punctata	L381	1	0.00	0.67	5.56	0.00	0.00	0.00
L. quadricolor	L101	1	0.00	3.00	33.33	0.00	0.00	0.00
L. quadricolor	L122	1	1.00	2.00	25.00	0.13	0.75	100.00
L. quadricolor	L155	2	0.00	23.00	88.46	0.00	0.00	0.00
L. quadricolor	L212	2	2.00	1.00	60.00	0.40	1.00	100.00
L. splendida	L417	1	0.00	0.50	6.25	0.00	0.00	0.00
L. splendida	L419	1	0.00	0.00	0.00	0.00	0.00	0.00
L. unifolia	L229	1(2)	5.50	0.50	20.00	0.23	0.64	50.00
L. viridiflora	L194	1	0.33	1.00	19.44	0.08	0.67	50.00

[m] Combinations where mechanical barriers (long style x short style) could influence the success rate

Table E.15: Crosses with *L. viridiflora* (L194) as female parent in combination with the 14 other species and including self-pollination and intra-species pollination results

Species	accession	cluster	No of flowers with normal seed	No of flowers with abnormal seed	Percentage flower set	No of normal seed per flower pollinated	No of normal seed per flower set	Germination %
L. bachmanii[m]	L016	1	0.00	0.00	0.00	0.00	0.00	0.00
L. bifolia	L389	2	0.00	5.00	71.43	0.00	0.00	0.00
L. bifolia	L801	2	0.00	3.67	56.94	0.00	0.00	0.00
L. contaminata[m]	L082	1	0.00	0.00	0.00	0.00	0.00	0.00
L. flava	L124	2	0.00	14.00	82.35	0.00	0.00	0.00
L. flava	L144	3	22.00	2.00	52.17	1.85	3.86	72.94
L. liliflora	L290	1	0.50	0.50	4.75	0.02	0.50	100.00
L. liliflora	L804	1	0.67	0.00	2.30	0.03	0.50	33.33
L. mediana	L158	1	0.00	0.00	0.00	0.00	0.00	0.00
L. mediana	L418	1	0.00	0.00	0.00	0.00	0.00	0.00
L. mutabilis[m]	L161	1	0.00	0.00	0.00	0.00	0.00	0.00
L. mutabilis[m]	L318	1	0.00	0.00	0.00	0.00	0.00	0.00
L. orchioides	L802	2	0.00	5.33	61.11	0.00	0.00	0.00
L. pallida	L049	1	0.00	0.33	2.78	0.00	0.00	0.00
L. pallida	L406	3	1.67	0.33	38.89	4.12	5.42	86.07
L. perryae	L053	1	0.00	0.00	0.00	0.00	0.00	0.00
L. punctata	L277	3	13.50	0.00	95.24	19.09	19.69	73.36
L. punctata	L381	3	8.50	0.50	85.71	15.07	18.16	57.78
L. quadricolor	L101	3	30.00	1.00	70.45	2.93	4.30	100.00
L. quadricolor	L122	3	17.00	1.00	62.07	2.86	4.88	15.66
L. quadricolor	L155	3	26.00	2.00	90.32	7.35	8.77	28.95
L. quadricolor	L212	3	31.00	3.00	89.47	6.39	7.84	65.84
L. splendida	L417	1	0.33	0.00	0.76	0.02	0.67	0.00
L. splendida	L419	1	1.00	0.00	2.70	0.03	0.50	0.00
L. unifolia	L229	1	1.00	0.00	3.70	0.04	0.50	0.00
L. viridiflora	L194	1	0.75	0.75	10.17	0.30	0.50	100.00

[m] Combinations where mechanical barriers (long style x short style) could influence the