The World Litchi Cultivars

Awtar Singh
S.D. Pandey
Vishal Nath

भाकृअनुप
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National Research Centre for Litchi
(Indian Council of Agricultural Research)
Mushahari, Muzaffarpur – 842 002, Bihar, India

NRC FOR LITCHI

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Awtar Singh
Principal Scientist (Plant Breeding)
National Research Centre for Litchi,
Mushahari, Muzaffarpur, (Bihar)-842 002 (India)

S.D. Pandey
Principal Scientist (Horticulture)
National Research Centre for Litchi,
Mushahari, Muzaffarpur, (Bihar)-842 002 (India)

Vishal Nath
Director
National Research Centre for Litchi,
Mushahari, Muzaffarpur, (Bihar)-842002 (India)

National Research Centre for Litchi
(Indian Council of Agricultural Research)
Mushahari Farm, Mushahari, Muzaffarpur – 842 002,
Bihar, India

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Foreword

Litchi or lychee is native of Southern China and is presently cultivated in different countries lying within sub-tropical climates. The major litchi producing countries of the world are China, India, Vietnam, Thailand, Bangladesh, South Africa and Nepal. It is also grown on a sizeable area in Australia, United States of America, Philippines and Indonesia. The Asia-Pacific region is responsible for producing more than ninety-five per cent of the total world litchi production. The crop is very popular in the domestic markets, and the demand for export is increasing particularly for fresh, canned and dried litchi fruits.

The litchi crop is highly profitable and therefore, the area under litchi plantation is increasing in the countries like China, Vietnam, India and in some other countries where it has been introduced in the recent past. The major concern in litchi orcharding is the low average productivity, which is around five tonnes per hectare, which can be increased manifold by timely application of inputs and adoption of improved varieties and technologies.

Litchi is having a long history of cultivation, but its genetic base is quite narrow and most of the present day cultivated varieties are the result of clonal selection or seedling selection. Very limited efforts have been made in the varietal improvement through hybridization and employing mordern breeding tools. The yield of litchi cultivars varies significantly from region to region, indicating the need for region-based varietal evaluation and evolution.

A large gap exists between the actual and potential yields in litchi throughout the world, which requires to be minimized by raising the average productivity through vertical increase in yield potential. The vertical increase in the production can be achieved through the use of improved cultivars and appropriate technologies for water, nutrient and plant canopy achitecture management along with appropriate and integrated disease, insect and pest management.

The selection of proper cultivar is crucial for the successful cultivation of litchi and improvement of fruit quality. Therefore, it is desirable to know the fruit quality traits of the litchi cultivars, being grown throughout the world, so that the particular cultivars can be selected for a particular region with desirable quality characters. In light of these factors, the attempts have been made to compile all the available information on litchi cultivars and the breeding lines /germplasm for particular traits by the scientists. It is a timely and useful publication for scientists, students, extension workers, growers and entrepreneurs working on various aspects of litchi.

March, 2012
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Vishal Nath
Director

Preface

Among fruits, the litchi (*Litchi chinensis* Sonn.) occupies an important place and is being cultivated in many countries viz., China, India, Vietnam, Thailand, Bangladesh, South Africa and Nepal. It is also cultivated on a sizeable scale in Australia, United States of America, Philippines and Indonesia. Major concentration of litchi cultivation lies within the Asia-Pacific region. The productivity and quality of litchi continued to remain below the potential level, owing to lack of quality and genuine planting material, lack of genetic diversity, poor management of litchi orchards, low fruit set and excessive fruit drop, susceptibility to many biotic and abiotic stresses, short shelf-life of fruits, etc. The major constraints in litchi production are longer juvenility, irregular bearing in some cultivars, short harvesting period and poor quality of fruits.

The productivity and quality of litchi are mainly governed by the cultivars being grown in a particular location. Therefore, there should be enough knowledge and information on different litchi cultivars available and cultivated in different regions, so that right selection of the cultivars can be done on comparative basis. This information will be important for increasing the production and productivity; extending the harvesting season and improving the fruit quality. By planting different cultivars, the genetic base of litchi will be expanded and it will offer a choice to both the litchi producers and the consumers.

Keeping this in view, the literature on litchi cultivars has been searched and the information on different litchi varieties, being grown all over the world, has been compiled. Attempts were also made to compile the characteristics of litchi cultivars/germplasm, so that the desired cultivars can be planted or utilized in future breeding programmes.

We have tried to compile up to date literature on litchi cultivars of the world, and therefore duly acknowledging the contribution of all the workers in this line. Omission of the references, individual is not intentional and few of them has been listed at last. We are thankful to Director General, ICAR, New Delhi, Deputy Director General (Hort.), ICAR, New Delhi, and ADG (IPM) Assistant Director General (Hort.), ICAR, New Delhi, for their encouragement in the compilation of this literature and to bring it in the form of a technical bulletin.

Authors

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Litchi Cultivars of The World

Litchi (*Litchi chinensis* Sonn.) is a delicious subtropical fruit tree of commercial importance of the *Sapindaceae* family, indigenous to parts of Southern China. The fruit is small, conical, heart-shaped or spherical in shape and bright red in colour. The edible portion of litchi fruit is a white to cream-coloured, translucent pulp that surrounds a glossy and brown seed. The pulp is grape-like in texture, very succulent and aromatic, and is characterized by a sweet, acid, juicy, soft but crisp (turgid) taste. Thus, litchi fruit is highly prized in its fresh form. The important litchi growing countries are China, India, Malaysia, Thailand, Brazil, Vietnam, Myanmar, Mauritius, South Africa, Australia, New Zealand, Madagascar and Taiwan. With the increasing popularity of exotic fruits on the world market, litchi production has steadily increased in the past decades. In 2004-05, world litchi production was about 20,00,000 tons, from an area of 7,23,000 ha, most of which are produced in China, India and Thailand. Furthermore, new plantings have been made, which ensures a continuous growth of litchi fruit in world production senario. In India, at present nearly 73,000 ha area has been under this crop with a total production of 4,48,000 tonnes. India and China account for 91 per cent of the world's litchi production.

Origin and distribution of litchi

Litchi is indigenous to southern China, particularly provinces of Kwangdung and Fukien. The litchi reached West Indies in 1775, South Africa in 1869, the Hawaii Islands by 1873 and Florida in 1883. Other countries, where it reached include Vietnam, Indonesia, Japan, Formosa, Australia, New Zealand, Brazil, etc. Litchi reached India through Burma and was first introduced in Bengal during the end of the 17th century and then spread to other parts of the country.

Lychee, which was introduced in the country in the 18th Century has adapted well to the climate in Eastern India, i.e. Bihar, Jharkhand, West Bengal, Tripura, Uttar Pradesh, Uttarakhand, Chhattisgarh, Punjab and Himachal Pradesh. Due to its increasing demand, the area under cultivation has increased manifold. However, there is need for improving productivity and also widening the genetic base. Concerted research efforts and effective linkages are essential. Suitable cultivars are needed for various climatic

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conditions. It is also essential to develop promising lines/hybrids, which have larger fruit size, small/chicken-tongued seeds, tolerance to fruit cracking, and having various maturity groupings.

Species and varieties

Litchi belongs to the family Sapindaceae and sub-family Nepheleae, which has about 125 genera and more than 1000 species. Other members of the sub-family are longan, anshphal, which grows mostly in Western Ghat, Bengal and Assam at elevations of up to 1600 meters, bears inferior fruits of smaller size, suitable for canned products and Rambutan (*Nephelium lappaceum*) bears fruits of good quality, which are considered even superior to those of litchi by some people.

Litchi has two species, *Litchi philippinensis* and *Litchi chinensis* (*Nephelium litchi* Camb). The former is a wild plant grown in the Philippines. It is being used as a rootstock. It is now considered that there are three clearly defined subspecies of *Litchi chinensis* based mainly on twig thickness, flower arrangement, stamen number and fruit characters (Menzel, 1991). *Litchi chinensis* has slender twigs, flowers in lax cymules, stamens usually six and fruits smooth or with pyramidal warts up to 1mm high. The subspecies is widely grown in China and grows wild in northern Vietnam and Cambodia. *Litchi chinensis* ssp. *philippinensis* has slender twigs, flowers in lax cymules, stamens six to seven and fruit with pyramidal warts up to 3mm high. This subspecies is known only in the Philippines, where it is widely distributed, but rarely cultivated. *Litchi chinensis* ssp. *javenensis* Leenh has thick twigs, flowers in sessile clusters, stamens seven to eleven and fruits smooth or with pyramidal warts up to 1mm high. This subspecies is known and in cultivation only in West Java and southern Indo-China. According to Berg (1978), subspecies *philippinensis,* having the smallest pollen, is the most primitive (Ray, 1990).

Litchi trees are medium to large, much branched, round-topped, handsome evergreen, reaching up to 11 meters or more in height. The compound leaves consists of 4-7 leaflets, about 7-10 cm in length, glossy dark green above and grayish green beneath. The bark is grayish brown and rough. The inflorescence is compound raceme developing from both terminal and axillary buds. Flowers are unisexual, bisexual or intermediate. The flowers of the different sexes on the panicles do not open simultaneously.

They open in different flushes. The sex of flowers varies in different flushes. Usually the first flush produces male flowers. The anthers in the hermaphrodite flowers do not dehisce. Seedless varieties seem to be self or cross sterile. Pollination is carried out mainly by *Apis* and *Melipona* (Apoidea) species, which comprise 98-99 per cent of all the insects visiting litchi flowers (Pandey and Yadava, 1970).

The mature fruits are one-seeded nuts and usually develop in bunches and vary in shape and size depending on the cultivar. Fruits are 2.5 to 3.5 cm in diameter and are usually oval in shape. The pericarp is papillate like straw berry and turns pinkish red when fruit is ripe. The edible portion (aril) separates easily and lies under pericarp and completely surrounds the seeds. It is fleshy, succulent, translucent, pearly white and soft in texture. The blend of sugars and acids in the aril makes it one of the most delicious fruits.

Immediately beneath the skin of some varieties is a small amount of clear, delicious juice. The glossy, succulent, thick, translucent-white to grayish or pinkish fleshy aril, usually separates readily from the seeds. The flavor of the flesh is sub-acid and distinctive. There is much variation in the size and form of the seed. Normally, it is oblong, up to 20 mm long, hard, with a shiny, dark-brown coat and is white internally. Due to some faulty pollination, many fruits have shriveled/partially developed seeds, called "chicken tongue". Fruits that have aborted seeds are termed as "chicken tongue" and are preferred (Lake, 1988), since these fruits have a high flesh to seed ratio (Anonymous, 1991).

After natural dehydration for a few days, the fruit skin turns brown and brittle and the flesh becomes dry, shriveled, dark-brown and raisin-like. Because of the firmness of the shell of the dried fruits, they came to be nicknamed as litchi nuts, and this erroneous name has led to much misunderstanding as the nature of this highly desirable fruit, it is definitely not a nut, because the seed is inedible and fruit is drupe.

The Chinese claim that the lychee is highly variable under different cultural and soil conditions. Professor Groff concluded that one could catalogue 40 or 50 varieties as recognized in Kwangtung, but there were only 15 distinct, widely known and commercial cultivars grown in that province, half of them marketed in season in the City of Canton. Some of

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these are classed as mountain types; the majority is water types. There is a special distinction between the kinds of lychee that leak juice when the skin is broken and those that retain the juice within the flesh. The latter are called dry and clean and are highly prized. There is much variation in form (round, egg-shaped or heart-shaped), skin colour and texture, the fragrance and flavour and even the colour of the flesh and the amount of rag in the seed cavity. Among them, the characters of primary importance, the size and form of the seed.

Breeding objectives

There are many varieties in litchi under cultivation, but none of the varieties is having all the desired characteristics and therefore, there is a need for improvement in one or several characteristics. The major objectives for breeding new cultivars of litchi are as under:

1. High and regular yields and avoidance of biennial bearing.
2. Large fruit size (individual fruit weighing over 20 g) and high number of fruits per panicle.
3. Small seed size, higher aril percentage and or/higher percentage of aborted seeds.
4. Bright red peel colour.
5. Good fruit quality (i.e. high sugar content and good flavour).
6. High keeping quality.
7. Resistance to physiological disorders (less prone to fruit cracking at maturity)/or pests like fruit borer.
8. Wider adaptability to ecological conditions.
9. Desirable tree characteristics, such as dwarfness, sterio fruiting behavior.

Constraints in litchi production

Despite the fact that the lychee is one of the finest fruits and has a growing demand in national and international markets, productivity continues to be low and a gap exists between potential and existing yield.

The ratio in yield between the best-managed orchards and national productivity ranges between 2 to 4 times at different locations. The probable reasons for low yield are the narrow genetic base of the crop, non-availability of suitable superior cultivars, traditional production systems, poor technological support and incidence of insect pests coupled with poor post-harvest management. The shortage of genuine planting material vis-a-vis long juvenile period of lychee plants can also be considered as constraint. The low female/male flower ratio, premature fruit drop and fruit cracking due to non scientific water and nutrient management also add to low productivity and production of poor quality fruits.

The lychee tree has luxuriant vegetative growth, which causes problems in harvesting. Thus, canopy management to achieve the required plant architecture is essential. Lack of scientific information on critical stages for flower bud differentiation, and requirements of water and nutrients also significantly reduces the yield. The lychee has a short shelf-life. Practices that can enhance post-harvest life of fruits would be useful to achieve higher productivity (Singh and Babita, 2001).

Lychee has a very narrow genetic base, which needs to be widened through selection of genotypes from the existing population. There is a need for identification and evaluation of local clones and introduced cultivars, which are regular, early bearers and which produce fruits with small seeds (Ramburn and Seebaluck, 1998). Target oriented programmes must be launched so that germplasm is conserved and used. A systematic approach for the description of cultivars is needed (Singh and Babita, 2001).

The genetic improvement of litchi across the world has been carried out by means of selection of open-pollinated seedling trees of known cultivars. At present there is a demand for high quality early and late season cultivars (Froneman and Oosthuizen, 1994). Despite an enormous wealth of litchi cultivars, an ideal litchi cultivar for modern conditions is lacking. The existing old cultivars appear to have been selected for characters like fruit size, quality and period of maturity. However, the qualitative fruit characters, precocity, dwarfness and regularity of bearing, wider adaptability and resistance to physiological disorders in fruits are of vital importance and must be utilized for development of cultivars for improving the productivity per unit area.

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As the fruit characters are of great interest to the fruit growers, the nature of the attachment of the flesh to the seed, the size and maturity of seed and prickly or smooth surface of the skin, as well as colour of fruit are of major importance. A highly valued character of litchi under intensive culture is the immaturity of seed, which results in seedless fruits. The Chinese refer to these as chicken tongue seeds. This character is present only in few cultivars e.g. Early Seedless and Late Seedless of Indian origin, No Mai Tsz and Kwei Sei of the Chinese origin and Brewster, a seedling selection of Chen Family Purple of Fukien at Florida, USA. Similarly, attractive highly coloured pearl and fleshy aromatic aril characters are also limited to few cultivars e.g. Rose Scented, Kwai Mi and Heung Lai.

Practically, no breeding work has been taken up for the varietal improvement and to evolve an ideal cultivar. However, breeding programmes seem to have been initiated outside China, at Miami, Florida (Knight, 1963), Queensland (Cull, 1977), Saharanpur (Lal and Nirwan, 1980), and Sabour (Thakur and Sharma, 1994) in India. Hybridization work is going on at Sabour where parents with desired characters are crossed to get a hybrid with maximum possible good characters. In the Horticultural Garden of Bihar Agricultural College, Sabour, litchi cultivars like Deshi, Dehra Rose, Ajhauli, Purbi, Early Bedana, Bedana, Shahi, Kasba, China and Mandrazi are used in hybridization work and altogether 125 hybrid plants of different age groups are under screening. In the year 1991, for the first time 14 years old hybrid plants i.e. Hybrids No. 72, 73 (Purbi x Bedana), Hybrid No. 98 (Purbi x Early Bedana) and Hybrid No, 140 (China x Bedana) produced fruits (Kumar and Sharma, 1995). For the development of litchi as a major horticultural crop in the tropics and sub-tropics, evolution of ideal cultivars through breeding is essential (Chauhan, 2001).

Lychee has been cultivated and undergone intensive selection for thousands of years in Asia. The main cultivars in China include Fay Zee Siu, Bah Lup, Lanzhu, Baitang-ying, Haak Yip, Kwai May (Red), No May Chee and Wai Chee. The litchi industry in many other countries is mainly based on cultivars that have originated in China, e.g. Tai So and Wai Chee in Thailand, Tai So, Kwai May Pink and Wai Chee in Australia. Local seedling selections of Chinese cultivars are used in Vietnam, India, Nepal, Bangladesh and southern Thailand. Cultivars developed in the last 50-60 years that are becoming popular are Donguan Seedless, Hexiachuan and

Maguili (in Guangdong, China), Sah Keng (Taiwan, China), Kom and Chacapat (Thailand), UPLB Red (The Philippines) and Salathiel (Australia). Opportunities exist for improving productivity in the region by breeding new selections, with the emphasis on traditional breeding rather than on biotechnology (Bose, *et al.,* 2001).

The Chinese claim that lychee has more cultivars than of any other fruit (Bose, *et al.,* 2001). The most important cultivars in Guangdong are Bah Lup, Baitang-ying, Hak Yip, Fay Zee Siu, Kwai May, No Mai Chee and Wai Chee (Bose, *et al.,* 2001). Wai Chee accounts for over 80 per cent of plantings in Guangxi and bears consistently, because it flowers late and avoids cool weather in spring (Bose, *et al.,* 2001). In Fujian, Lanzhu dominates litchi plantings (Bose, *et al.,* 2001). Some new cultivars have been developed recently including Donguan Seedless and Hexiachuan, that produce seedless/small seeded fruits and Maguili that crops late in the season (Bose, *et al.,* 2001). No Mai Chee and Kwai May have excellent eating quality and a high proportion of chicken-tongue or aborted seeds (Bose, *et al.,* 2001). Fay Zee Siu is also popular because of its excellent eating quality and fruit size (24-32 g) (Bose, *et al.,* 2001). Haak Yip is the most popular cultivar in Taiwan Province of China and accounts for over 50 per cent of the litchi plantings. Other important cultivars include Sum Yee Hong, Chong Yun Hong, No Mai Chee and Sah Keng (Bose, *et al.,* 2001).

In Vietnam, 80 per cent of the litchi plantings are under a single cultivar, Vaithieu (Bose, *et al.,* 2001). The main cultivars in northern Thailand are Tai So (Hong Huay) and to a lesser degree Wai Chee, O-Hia (Baidum) and Chacapat (Chakrapad). A different set of ecotypes has been developed for the areas around Bangkok, including Kom, Luk Lai, Sampao Kaow, Kalake Bai Yaow and Red China. The quality of these selections has been reported not good (Bose, *et al.,* 2001).

Most of the cultivars in India have been selected from seedlings or clones received from China, although a few cultivars appear to be renamed Chinese cultivars, as in Thailand and Australia. Selections have been developed, which can crop in hot and dry conditions. Of the 30 or more cultivars grown in India only six are commercially important. These are Shahi (Muzaffarpur), China, Calcuttia, Bedana, Late Bedana and Longia. These generally have large fruits and excellent fruit quality. In West Bengal, Bomabai, Shahi and Rose Scented can produce 40 kg/tree compared to 15-25 kg/tree in many other cultivars (Bose, *et al.,* 2001).

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In the hilly areas of Nepal, commercial production is based on various seedlings, whereas there are established cultivars in the plains (Majfpuri, Raja Saheb, Dehraduni, China and Calcuttia). Most of these cultivars probably came from India (Bose, *et al.*, 2001). The most important cultivars in Bangladesh are Bombai, Muzaffarpuri, Bedana and China Number Three. Bombai is the oldest cultivar. Bedana has the best quality fruit, but is low yielding (Bose, *et al.*, 2001). Mauritius and a local selection from China, Sinco dominate production in the hilly areas of Philippines, while an introduction from Thailand, UPLB Red is planted in the low lands (Bose, *et al.*, 2001). In Australia, Kwai May Pink accounts for more than 50 per cent of plantings, while Tai So, Souey Tung, Fay Zee Siu, Salathiel and Wai Chee, are the other main cultivars (Bose, *et al.*, 2001).

Methodologies adopted for the improvement of litchi varieties

1. Germplasm evaluation and clonal selection

Since many of the existing cultivars have originated from a relatively limited ancestral stock, the introduction of new germplasm from wild forms and varieties into genetic composition of existing cultivars appears to be very necessary to achieve the breeding objectives. Also, hybrid rootstocks should be developed as the use of dwarfing rootstocks would promote high-density plantings. Many important genetic resources have been identified for different characteristics that can be utilized in future breeding programmes (Table 1).

Table 1. Special characteristics of some of the litchi cultivars

Special Characteristics	Cultivar/Germplasm
Small Seed	Nuomici (No Mai Tzi, Glutinous Rice), Lingshan Xiangli (Lingshan Fragrant Litchi), Hainan Xiaodingxiang (Hainan's Small Clove), Guangxi Zhangluoli (Guangxi Zhengluo Litchi), Bedana
Crisp and sweet flavour with less tannin	Lingshan Xiangxi
Early Maturity	Shanyuedong Red, Early Bedana, Dehra Rose, Shahi
Giant fruit	Edanli, (60-70g)
Sustained higher yields	Heiye (Black Leaf), Baitangying (White Super Poppy)
Ability for flower bud differentiation at higher temperature	Shanyehong, (better flower bud differentiation at 20^0C as compared to 12^0C to common varieties)

Good Canning ability	Heiye, Xuangxi
Drought and infertility tolerance, good adaptability	Tianyan (Sweet Stone), excellent performance in yield and fruit quality, high seed germination rate, fast growth, good for rootstock
Good on tree preservation	Huaizhi, (fully ripe fruits can be left on trees for fresh picking)
Late maturity	Xuehuazi, (ripening during early/mid July, with high yielding characteristics), Fijian Xiafanli (Fujian Xiafan litchi maturing during the late July or early August, enabling extended supply period in combination with early and intermediate maturity types), Longia, Kaselia, Late Bedana

Almost all of these cultivars have arisen as the result of clonal propagation of high-performing parents. No genetic characteristic has been observed to be controlled by segregation and no experiment appears to have been conducted on the heritability of desirable and undesirable characteristics (Galan Sauco, 1989). Wild forms or types of the three known litchi subspecies have been widely collected for integration in breeding programmes, but collections of commercial cultivars have been established at various research institutes in different countries.

High heritability and high genetic advance were recorded for fresh seed weight, fruit weight, fruit volume and fresh and dry pulp weight. Singh *et al.* (1987) observed fruit and seed weight had strong positive correlations with total sugar, ascorbic acid, protein and tryptophan contents, but a significant negative correlation with acidity and phenol content. Thus, selection for two characters (fruit and seed weight) can produce nutritionally superior genotypes. A negative partial correlation between embryo and aril and a direct repressive effect of the former on the later were confirmed. This may be taken into account while breeding varieties less prone to cracking. In nature, the extent of out-crossing in litchi varies from 65-87 per cent depending on the nearness to the pollen source. There is clear exhibition of inbreeding depression with respect to fruit and seed weight, if selfing takes place (Stern *et al.*, 1993).

2. Intervarietal crosses

Selection of high-yielding, better quality litchi has taken place over a long period, but the breeding of new hybrids has not been undertaken to any appreciable extent. Very recently two hybrids, namely Sabour Madhu

(Sabour Bedana) (Fig. 1) and Sabour Priya have been recorded. They are the products of a breeding programme carried out at Sabour (India) involving ten cultivars, namely, Deshi, Early Bedana, Ajhauli, Dehra Rose, Purbi, Shahi, China, Kasba and Late Bedana. The hybrid seedlings grew

Fig. 1. Litchi Litchi cv. Sabour Madhu

slowly and only 4 per cent of the total population flower for the first time at the age of 14 years (Thakur, 1997). Thus, in addition to short period of seed viability, the late bearing habit of the seedlings poses serious problems for hybridization work. Also, the erratic flowering of the seedlings make it difficult to obtain the appropriate type of pollen at the required time for further crossing, if the breeding programme continues further. Thus, the improvement of litchi appears to be confined mainly to selections of improved chance seedlings or genotypes (Table - 2).

3. Intergeneric hybridization

Hybridization was also attempted between litchi and other related genera. Between the hybridization of litchi and longan, no improved hybrid was obtained. Seedling progeny were quite variable with small fruit size, which appeared to be dominant characteristic. Longan cultivars have a strong biennial bearing tendency, and thus, incorporation of this character into the hybrids may cause more erratic fruiting.

Among the diallel crosses between *Nephelium lappaceum, N. rambutan akee, Dimocarpus longan* and *Litchi chinensis,* only intergeneric crosses between longan and litchi were successful. A variable progeny was produced when litchi was the female parent and longan the male, but this

Table 2. Litchi cultivars developed through selection or hybridization

S. No.	Cultivar	Major Characteristics
1.	Groff	It is a seedling selection from the Hak Ip variety. The fruit quality is superior to Hak Ip, a Chinese variety.
2.	Brewster	It is quite similar to Chinese cultivar Chenzi (Chen Family Purple). It requires a relatively severe winter (Maximum temperature < 7^0C) to initiate flowering. Fruits are medium in size (20-22 g), slightly fragrant and sweet. Seeds are small to medium-sized. Flesh recovery is 65 to 75 per cent.
3.	Saharanpur Selection	This is a chance seedling selection. It is late maturing. Fruits ripen in the third week of June. Fruit TSS is around 19.8 per cent. Average fruit weight is 17.6 g. It has a very low percentage of fruit cracking (2% only) compared to other cultivars.
4.	Swarna Roopa	This is the outcome of the selection made at Ranchi from different collections of litchi cultivars. It has attractive deep-pink fruit colour, small seed and high TSS/acid ratio. Fruits are highly resistant to cracking. Fruits mature a week later than the late cultivar China.
5.	Sabour Madhu (H-105)	This hybrid resulted from Purbi x Bedana. It has higher number of fruits (24) per panicle and ripens 8 days later than another late maturing cultivar, Kasba. It has higher TSS and aril percentage than Purbi. Fruit shape resembles Purbi.
6.	Sabour Priya (H-73)	This is a product of Purbi x Bedana. It has better fruit quality than Purbi in terms of higher aril percentage and TSS content. The fruit shape has combination of both the parents. The fruit weight is higher than the better parent (Purbi).

only occurred approximately once in one thousand controlled pollinations and then only in specific combinations. The pollen of both litchi and longan germinated on stigma of rambutan but was arrested in the embryo sac. However, there appears to be no breeding barrier between cultivars or species within a genus except when seedless fruits are commonly produced.

McConchie *et al.* (1994) attempted reciprocal crosses between commercial cultivars of litchi (Bengal and Kwai May Pink) and longan (McLeans Ridges and Duan Yu) and found that hybrid progeny could develop only when litchi was used as female parent. Morphologically the hybrid plants were similar to litchi (the maternal parent), but leaves were smaller. Three types of seeds developed in litchi following pollination with longan pollen: (1) normal seeds with a developed testa and embryo; (2) seeds with aborted embryo but normal testa development; and (3) seedless, where the ovule remained the same size as at anthesis without further development of embryo or testa.

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Wild species of *N. philippinensis* (syn. *N. intermedium*) can provide an important gene for breeding work. Some seedless varieties are occasionally found in the wild, and these could have a potential for fruit production for the canning industry. It could also be possible to explore the potential of hybrids of *N. mutabile* and other wild species with rambutan for use as rootstock material, which could be more resistant to root diseases than rambutan.

Classification of major litchi cultivars

When distinguishing the cultivars, the shape of fruit skin segments and protuberances are reliable and stable genetic characteristics. Fruit size, shape and taste are also variables but are influenced by other than genetic factors. The litchi cultivars vary greatly in vegetative flushing patterns, flush colour and flowering ability.

The leaf of the Rose Scented is boat-shaped while China has a distinctive twist along the length curved upward from the midrib and down along its length. Small leaflets in Bedana are oval-shaped. The fruit shape of litchi is very distinguishing. The round shape of Bedana is distinguished from oblong shape of China or Shahi. The fruit is smooth and pulp is even or uneven. The apex of fruit can be round, obtuse, blunt as in Shahi, or pointed as in China.

The varieties can also be distinguished depending on the colour of new flush and season of flowering. Shahi produces very light coloured flush while China has pinkish flush. Bedana produces bright red or copper coloured flush and short compact panicles. The fruit colour varies in different varieties and is also influenced by growing conditions.

Skin thickness depends on cultivars. Bedana and China have very thick skin, whereas Rose Scented and Shahi have thin skin. Skin surface at maturity also varies-being smooth, swelling and sharp pointed. Protuberances of pericarp (skin) can be smooth as in Bedana or sharply pointed as in China. The presence and absence of seed as well as structure and size of seeds also vary from cultivar to cultivar, but it is also influenced by the environmental conditions. In Rose Scented and Bedana, a high proportion of chicken-tongued seeds are observed, while China has bold seeds.

Due to the production of litchi in India under varying agro-climatic conditions, maturity, fruit colour, shape and size are reported to be varying. Thus, there has been much confusion in the names of cultivars and as a result the same variety is called by different names at different locations.

A large number of cultivars are grown around the world, although the same cultivar may be known under several different names in different places or even within a given country. This has led to confusion amongst researchers, advisors, growers and nurserymen. Chinese researchers report that the shape of the skin segments and protuberances can be used to identify cultivars. These characteristics are more reliable than fruit size, shape or taste. The major characteristics used for the identification and characterization of litchi cultivars have been enumerated.

Harvest season: The harvest season lasts five to ten weeks for a range of cultivars in any one location. Cultivars can be broadly classified as early, mid or late maturing (Table 3), although the order varies from year to year, depending on seasonal conditions. There is some variation in the region, presumably due to differences in environment and culture.

Table 3. Classification of litchi cultivars on the basis of period of maturity

Season of maturity	Cultivars
Early (< 1400 Degree Heat Unit Submission)	Sanyuehong, Baitangying, Baila, Feizixiao, Muzaffarpur, Rose Scented, Shahi, Swarna Roopa, Early Bedana, Dehra Rose
Mid-season (1400-1600 Degree HUS)	Feizixiao, Heiye, China, Purbi, Calcuttia, Bombai, Bedana, Dehra Dun
Late (< 1600 Degree HUS)	Guiwei, Nuomici, Huaizhi, Shuangjianyuhebao, Late Bedana, Longia, CHES-2, Gulabi

Tree: The varieties can be identified by using tree characteristics; however, they change with weather, soil and culture. Differences in the tree size and shape, and length and spread of branches are commonly used, e.g. Brewster is vigorous and erect, with very wide strong crotch angles; Tai So is vigorous, with a spreading habit and sharp crotch angles; while Wai Chee is slow, compact and dome-shaped.

NRC Litchi, Muzaffarpur

Leaves: The leaf characteristics include leaf size, shape and colour, e.g. Tai So has large, glossy, dark green leaflets that have an upward curl from the midrib to be almost canoe-shaped. Bengal has large leaflets, mid-green in colour with a distinctive twist along their length. Hak Yip has dark, glossy green leaflets that are long, narrow-pointed and slightly curled at the tip. Wai Chee leaflets are small, oval-shaped and curve upwards from the midrib and down along their length. The new flush of growth is red in Wai Chee and Kwai May Pink and green-bronze in Tai So.

Fruit: The fruit shape of some cultivars is very distinctive. The round fruit of Kwai May Pink distinguishes it from the egg shape of Tai So or the heart shape of Haak Yip. The shoulders of the fruit can be smooth or flat as in Wai Chee and Kwai May Pink, or uneven as in Souey Tung and Bengal. The apex or tip of the fruit can be round as in Kwai May Pink and Wai Chee, obtuse or blunt as in Souey Tung and Brewster, or pointed as in Bengal. The fruit colours are bright red (Bengal), dull red (Wai Chee), purple-red (Haak Yip) or pink-red (Brewster). The skin can be thick as in Wai Chee, Bengal and Kwai May Pink, or thin as in Haak Yip and Souey Tung. Skin segments at full maturity can be smooth (Haak Yip), swelling (Wai Chee) or sharp pointed (Kwai May Red). Similarly, the protuberances on each segment can be smooth as in Haak Yip, sharp pointed as in Kwai May Red and Bengal or hair like and sharp as in Tai So. The presence or absence of an obvious suture line can distinguish some cultivars such as Haak Yip and Souey Tung.

The texture, juiciness, taste and aroma of the flesh can aid description, although experience is needed to make clear distinctions. For example, Wai Chee is watery, Kwai May Red is firm, Kwai May Pink is spicy and Bengal is very sweet. The proportion of small or shriveled seeds is important, but varies with season and orchard. Cultivars with a high proportion of chicken tongue seeds are favoured. Salathiel produces nearly always fruit with small seeds, while Bengal, Souey Tung, Haak Yip and Wai Chee produce hardly any. Other varieties such as Tai So and Kwai May Pink vary. A key to Indian cultivars classification is given in the following table (Table 4).

Table 4. Key to important litchi cultivars

Key	Cultivars
1. Flush pink, leaf boat shaped, dark green, panicle long, fruits oblong with round apex	
- Colour of fruit deep pink	Shahi/Trikolia
- Rose flavour	Rose Scented
- Colour of fruit light and greenish	Green
- High cracking and big seed	Ajhauli
- Late in maturity	Dehra Dun
2. Deep pink flush, leaf with twist along the length, curved upward from the midrib and down along their length, panicle long, fruit oblong with pointed apex	
- Colour of the fruit pink	China
- Fruits deep pink	Purbi/Mandraji
- Fruits in bunches	Bombaia/Calcuttia
- Early maturity	CHES-2
3. Dark pink flush, oval shaped leaves, compact and small panicles. Fruit round, smooth, chicken tongue seed (aborted seed)	
- Early maturing	Early Bedana/Early Seedless
- Late maturing	Late Bedana/ Late Seedless
- Deep pink colour and mid season maturity	Swarna Roopa
4. Deep pink flush, boat shaped and dark green long leaves, panicle long, largest fruit, deep in colour	Kasba
5. Small elongated leaves, light green in colour, panicle compact, fruit medium in size, very late maturity	
- Pulp sweet and excellent flavour	Longia
- Pulp sour	Kaselia/Khatti/Piyazi

Litchi cultivars of India

There are many cultivars grown in India, but the same cultivar may be known under different names in different places (Table 5). Important varieties in Bihar are China, Deshi, Dehra Rose, Purbi, Bedana, McLean and Muzaffarpur. In Uttar Pradesh/Uttrakhand, Punjab and Haryana the varieties are Early Seedless, Late Seedless, Early Large Red, Calcuttia, Rose Scented, Khatti and Gulabi, whereas the varieties recommended for growing in Punjab and Haryana are Saharanpur, Dehra Dun, Calcutta, Muzaffarpur, Seedless Late and Rose Scented. Bombai, Elachi Early, Elachi Late and China are considered important both for quality and yield and are grown in West Bengal.

NRC Litchi, Muzaffarpur

Table 5. Major litchi cultivars grown in different Indian States

State	Cultivars grown
Bihar/Jharkhand	Deshi, Ajhauli, Green, Purbi, China, Kasba, Bedana, Dehra Rose, Shahi, Mandraji, Longia, Trikolia, Kaselia, Swarna Roopa, Rose Scented
Uttar Pradesh/ Uttrakhand/Himachal Pradesh	Early Large Red, Bedana, Late Large Red, Rose Scented, Calcuttia, Extra Early, Gulabi, Pickling, Khatti, Dehra Dun, Piyazi
West Bengal/Assam	Bombai, Ellaichi Early, China, Deshi, Purbi, Kasba, Green, Kalyani Selection
Haryana/Punjab	Calcuttia, Early Seedless, Late Seedless, Seedless-1, Seedless-2, Muzaffarpur
Chhattisgarh	Sarguja-1, Sarguja-2

World Litchi Cultivars

Many litchi cultivars are known in various parts of the world, including 26 major and 40 minor cultivars identified in Guangdong, China, 33 cultivars in India and numerous local selections in Australia, Florida, Taiwan, Thailand and Hawaii (Table 6 & 7). Because, litchi is one of the most environmentally sensitive fruit trees, improper selection of cultivars can result in erratic or no fruit production.

Table 6. Leading litchi cultivars grown in different countries

Cultivar	Country of origin/cultivation
Bombai	India
Bowsworth 3	Australia (Hawaii)
Brewster	Florida
Calcuttia	India
Chacapat	Thailand
China	India
Dazao (Tai So, Hong Huai, Mauritius)	China (Thailand, South Africa, Florida, Israel, Australia)
Feizixiao (Fay Zee Siu)	China (Taiwan, Australia)
Floridian	California (Israel)
Groff	Hawaii
Guiwei (Kwai Mai)	China (Taiwan)
Heiye (Haak Yip)	China (Taiwan, Hawaii, Florida, Australia)
Huazhi (Wai Chee)	China (Australia)

Kaimana	Hawaii (Australia)
Khom	Thailand
No Mai Chee	China (Taiwan)
Sah Keng	Taiwan (Australia)
Salathiel	Australia
San Yue Hong (3 months red)	China (South Africa)
Shahi	India
Souey Tung	China (Australia)

Table 7. Major litchi cultivars grown in different countries

Country	Major cultivars
China	Sum Yee Hong, Baitangying, Fay Zee Siu, No Mai Chee, Bah Lup, Souey Tung, Kwai May Red
Vietnam	Vaithieu
Thailand	Tai So (Hong Huay), Chacapat (Chakrapad), Wai Chee (Kim Cheng), Haak Yip (O-Hia), Kom
India	Shahi, China, Bombai, Rose Scented, Bedana, Calcuttia, Longia
Nepal	Mujafpuri, Raja Saheb, Dehradun, Calcuttia, China
Bangladesh	Bombai, Muzaffarpur, Bedana, China 3
Indonesia	Local Selections
Philippines	Sinco, Tai So, UPLB Red
South Africa	Mauritius, McLean's Red
Israel	Mauritius, Floridian
Madagascar, Mauritius and Reunion	Mauritius
Florida, USA	Mauritius, Brewster
Brazil	Bengal

A description of commercial and other cultivars of world is presented in this section. Most of the cultivars are cultivated, however, a few are just identified strains or breeding lines. Some of the entries are important from germplasm point of view, for the present and future needs of litchi cultivation. These lines/varieties will be useful in the future breeding programmes after their evaluation. Such germplasm sources will be very useful for the transfer of one or few important traits to the cultivated litchi cultivars. The physico-chemical characteristics of a few Indian strains/ cultivars are given in Table 8.

Table 8. Physico-chemical characteristics of important litchi cultivars

Cultivar	Fruit wt. (g)	Pulp wt. (g)	Seed wt. (g)	Cracking (%)	TSS (^{0}Brix)	Acidity (%)	Ascorbic acid (mg/100g)	Total sugars (g/100g)	Fruit Yield (kg/tree)
Ajhauli	17.34	09.77	2.88	51.20	20.00	0.40	53.80	12.87	70-95
Green	18.10	13.53	3.22	49.10	18.90	0.35	50.40	12.56	80-90
Purbi	20.77	13.40	3.96	7.60	20.60	0.31	53.80	11.00	90-100
Late Bedana	19.50	13.19	2.18	24.50	20.70	0.30	59.60	13.00	80-100
Early Bedana	19.32	14.99	1.47	4.50	19.50	0.24	50.40	13.91	50-60
China	20.30	12.30	3.83	0.00	20.80	0.44	45.30	11.85	90-100
Kaselia	11.56	07.42	2.68	24.80	18.70	0.78	51.30	10.90	60-70
Deshi	17.90	11.63	3.07	33.40	21.40	0.28	43.80	13.37	80-90
Dehradun	16.80	11.30	2.46	32.80	17.80	0.72	30.00	11.30	80-90
Kasba	20.30	14.20	2.80	0.00	18.80	0.46	50.60	14.37	60-70
Dehra Rose	17.77	11.78	2.81	29.70	22.10	0.31	45.60	13.59	80-90
Rose Scented	18.44	13.52	3.42	28.70	21.70	0.30	41.40	14.57	80-90
Longia	13.80	09.68	2.54	0.00	19.80	0.41	47.40	12.52	35-40
Shahi	20.98	12.33	3.88	31.50	22.60	0.26	53.60	13.85	80-100
Trikolia	18.25	13.28	2.18	32.30	22.40	0.32	40.40	13.95	80-105
Bombai	18.93	12.97	3.83	0.00	20.50	0.28	49.40	11.68	80-90
Calcuttia	22.00	13.53	3.49	0.50	18.20	0.43	43.60	11.00	80-100
Swarna Roopa	18.95	14.52	3.10	0.00	19.00	0.39	47.00	12.50	70-80
CHES-2	21.33	14.23	3.26	0.00	19.80	0.20	48.20	11.70	80-90

The description of the litchi cultivars/breeding lines in the world in alphabetical order is as under:

Aili: It was selected from local *Litchi chinensis* seedlings. It is a dwarf selection, producing fruits weighing 24.8g on average. This selection is recommended for cultivation in Hainan Province (Miao *et al.*, 1998).

Ajhauli: This is an early maturing variety selected from Ajhauli village. It yields about 80-100 kg fruit from a sixteen year old tree. Fruits are red in colour, weighing 15 to 18 g and have big seeds. It cannot be distinguished from Shahi on vegetative characteristics as it has many similarities. This variety is highly prone to cracking but under irrigated conditions cracking is minimized (Singh and Babita, 2001).

Fig. 2 Fruits of Ajhauli and its low seeded selection

Amboina: The fruits of this variety are medium, bright red and borne in clusters of 6-20. It ripens from April to May. The tree is slow growing and bears regularly in warm climate.

Bah Lup: It is a productive Chinese cultivar and has better quality than other available cultivars at the same time. It is grown in Guangdong province of China and is an important early cultivar for export. The tree is medium in vigour and dome-shaped. Leaflets are long, narrow, dark glossy green with a short point. Fruits are near heart-shaped, medium to large (20-25g) with thin, soft, brilliant red to slightly purple skin. Protuberances are obtuse. The flesh is juicy and delicately sweet. Fruits usually have large oval seeds. Flesh recovery is up to 77 per cent (Anonymous, 2001).

Bai-Teng-Ying: In this litchi cultivar, floral differentiation occurs between October and February, which is one month earlier than for standard cultivar Hei-Ye in that area. The temperature range for its flower bud development is also greater than that of cultivar Hei-Ye. The tree is dwarfing in vigour, precocious, early maturing, produces consistently high yields of good quality fruits and has good tolerance to some adverse environmental factors (Ooyang, *et al.,* 1994).

Bengal: It is a seedling selection of Indian cultivar Purbi, sent to Florida in 1929. It was selected in Florida in 1940 and does not resemble any Chinese cultivar. It was the second most important cultivar after Tai So in Australia, but has now lost favour. Fruits are attractive and pleasant tasting, but have large seeds and poor flesh recovery. They also ripen unevenly. Average cropping is disappointing, although trees can have very high yields in an on year. Trees are vigorous and spreading with thin branches, but are reasonably resistant to wind damage. Leaflets are large, mid-green and

have a distinctive twist or curl along their length. The new flush of growth is reddish-brown. The fruits (23-27g) are formed in large clusters of up to 50 or more. The thick skin is very rough and attractive bright-red. The fruits are egg-round to lopsided heart-shaped, with uneven shoulders. The fruit tip is distinctly pointed. Protuberances are sharp-pointed to wedge-shaped. The flesh is soft, sweet and moderately juicy. Fruits do not keep their flavour if left to hang. There are very few abortive seeds. Under drought conditions, the aril is often undeveloped and may not cover the seed at the pointed end. This gives a flesh recovery of 50 per cent or lower. For these reasons, it is not considered a good marketing type (Anonymous *et al.*, 2001). The fruits resemble Brewster, but are elongated, are home in large clusters, and the flesh is firm, not leaking juice when peeled. All the fruits have fully developed seeds, but smaller in proportion to flesh than those of Brewster. The habit of the tree is more spreading than that of Brewster; it has larger, more leathery, darker green leaves and the bark is smoother and paler. The original tree and its air-layered progeny have shown no chlorosis on lime-stone in contrast to Brewster trees growing nearby (Morton, 1987).

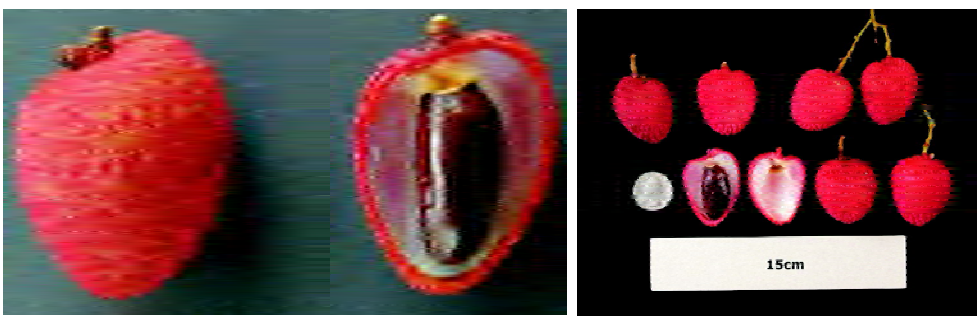


Fig. 3 Litchi Cultivar Bengal

Bombai: It is an important cultivar of West Bengal in India and Bangladesh. The trees are regular bearers and yield 80 to 90 kg of fruit. Ripe fruits have attractive deep-red colour. Tubercles turn carmine red on maturity and interspaces are uranium green. It is similar to China cultivar grown in other areas (Anonymous, 2001). It is a vigorously growing cultivar attaining a height of 6-7 m and spread of 7-8m. The cultivar matures early (second week of May). Fruits are large in size (3.5cm long and 3.2cm diameter), obliquely heart shaped, and weigh 15-20 g and bear in large bunches. Like the Chinese cultivar 'Nuomici', this cultivar also has a tiny

under-developed fruit attached to the fruit stalk of each fully developed fruit. The pulp is grayish-white, soft, juicy, sweet, containing 17° brix TSS, 11 percent total sugars and 0.45 percent acidity and pulp: seed ratio is 4.5-5.5: 1. The elongated, smooth and shining seed of light chocolate colour is 2.3cm long, 1.6cm in diameter and weighs 3.4g. The fruits of this cultivar are good for canning (Bose, *et al.*, 2001).

Fig. 4 Fruits of Cultivar Bombai

Brewster (Chen family purple): It was obtained from Fujian (China) by the Reverend W.M. Brewster and propagated in Florida in 1903. It was also sent to Australia, but is not popular. Groff (1948) suggested that Brewster was, in fact, the recognized Chinese variety Chen Zi (Chen Family Purple) and recent information indicates that they are the same cultivars. In Fujian, the trees of Chen Zi, grown along the rivers yield consistently, with a high proportion of fruits with small seeds. Fruits with chicken-tongue seeds shed more readily under drought or heat than those with full seeds. The trees are small and upright, with wide, strong crotch angles and dense foliage. Brewster is one of the few cultivars with distinct lenticels of corky outgrowths on the branches. Leaflets are large, dark green and pointed at the tips. The new flush of growth is reddish-brown. The medium to large fruits (20-26g) are heart-shaped and have a bright pinkish-red, thick, rough skin and are borne in small loose clusters. The shoulders are uneven, with one raised along the suture line of the shoulder. The fruit tip

is round in full seeded fruit to pointed in chicken-tongue fruits, and have small nipple-form protuberances. The flesh is slightly fragrant, juicy and sweet when fully ripe, but acid when immature. Seeds are small to medium, with up to 80 per cent undeveloped after cool weather. Plump seeds are oblong with a blunt tip. Flesh recovery is 65 to 75 per cent (Anonymous, 2001). The fruits are large, conical or wedge-shaped, red, with soft flesh, more acid than that of Kwai Mi, and the seeds are often fully formed and large (Morton, 1987). Brewster bears in midseason and is important though the seed is nearly always fully formed and large.

This cultivar was subsequently recognized as the Chinese cultivar Chenzi (Chen Family Purple). Litchi orchards in Florida have been almost exclusively confined to this cultivar. It requires a relatively severe winter (minimum temperature below 7^0C) to initiate flowering (Chauhan, 2001).

Fig. 5 Fruits of Cultivar Brewster

Calcutta: This variety is very successful for growing in comparatively hot and dry areas. The tree has less vigorous growth and attains a height of 4m and spread 6m. It is a heavy bearing variety, yielding 80-100 kg fruits/tree. It matures in the last week of June. Fruits are lopsided to oblong, deep carmine red in colour, weigh 22 g. Pulp is dirty-creamy white, soft, juicy, very sweet with agreeable flavour. TSS is 18.7 per cent, sugars 11.0 per cent, acidity 0.43 per cent, pulp: seed ratio 4.34: 1. Seed is bold, pointed at apex and weighs 3.4 g on average. It is less susceptible to sunburn and cracking (Bose, *et al.*, 2001).

Chacapat/ Chakrapad: It is grown in Thailand and has also been imported into Australia. It is the last cultivar in both areas, and very popular

in Thailand. Fruits are sweet and acceptable in Thailand, but often acidic in Australia. Trees may set small fruits with small seeds and hence cannot be considered a good marketing type. Trees are moderately vigorous, erect and have long branches and dense foliage. Leaflets are small, long, narrow, pointed and dark green. They curl upwards from the midribs and downwards along their length towards the tip. The new flush growth is green. Fruits are normally large (28-32g) and round to slightly heart-shaped. The skin is thin and soft, deep red with yellow markings. Shoulders are flat and the fruit tip round. Skin segments are swelling with obtuse protuberances. Flesh is moderately juicy, remaining acid when fully ripe. Seeds are large, giving a flesh recovery of 60 to 70 per cent (Anonymous, 2001).

CHES-2: It is a late maturing cultivar developed as clonal selection from Bombaia at Central Horticultural Experiment Station, Ranchi. It has inside canopy bearing habit, which helps in reducing the sunburn as well as fruit cracking. Fruits are free from sunburn and cracking. The fruits are deep red, conical shaped and appear in a cluster of about 15-20. The fruit has an average weight of 21.3 g containing 3.8 g seed and 16.1 g pulp. The fruits have 19.8^0 brix TSS and 0.20 per cent acidity. The skin: pulp: seed ratio is 18.0: 66.7: 15.3 (Rai, *et al.*, 2001). The vegetative characteristics of this cultivar are similar to China, however flowering and fruiting is earlier (Singh and Babita, 2001).

China: It is known as Purbi, Calcuttia, Bengalia, Bombaiya and Manragi in different regions. It is an important cultivar in India that ripens when most of the other cultivars have been harvested. Its origin has not been determined, although there is a similar cultivar in Bangladesh- China Number Three. It is tolerant to hot winds, fluctuations in soil moisture and fruit cracking. Medium-late in season and fruits ripen during first week of June. Fruits ripen during the end of May in West Bengal, the first week of June in Jharkhand and North Bihar and the third week of June in Uttar Pradesh. Trees are dwarf (4.0 m high, 6.0 m spread) and high yielders (80-100 kg/tree), but prone to alternate bearing. Fruits are large sized (3.86 cm length and 3.26 cm diameter), medium-heavy in weight (22.0 g/fruit), oblong in shape and tyrian rose in colour with dark tubercles at maturity. The flesh is soft, juicy and very sweet, but not as good as Shahi (Anonymous, 2001). Aril is creamy-white, soft, juicy, sweet having 18.2^0 brix TSS, 11.0

per cent total sugars and 0.43 per cent titrable acidity. The flavour of the pulp is not pleasant like Shahi, but owing to its high yield and no cracking this cultivar is popular. This cultivar cannot be distinguished from Manraji and Purbi grown in the eastern part of Bihar state (Singh and Babita, 2001). Seeds are glaucous, dark chocolate in colour, oblong to concave or planoconvex in shape, medium in size (2.9 cm length and 1.5 cm diameter), average in weight (3.49 g/seed). The ratio of rind: pulp: seed is 16.42: 69.22: 14.36 (Rai, *et al.*, 2001).

Fruits of China cultivar

A bearing tree of China Cultivar

China

A bunch-bearing clone of China cv.

Early and late maturing China cv. plant

Fig. 6.Early-maturing China plant

China-3: It is one of the best varieties grown in Bangladesh. The trees attain an average height of 5-6m with relatively smaller leaves. Bearing is regular if proper management and care is taken, otherwise they show an irregular bearing habit. This is a late variety and fruits ripen in the last week of June. Fruits are globose, with a mixture of red, orange and patches of green colour. Average weight of fruit is 25g. Pulp is creamy white, soft and juicy. TSS 18^0 brix, seed small, pulp:seed ratio 15:1.

Chu Ma lsu or Chu Ma Isz (China grass fiber): It has distinctive, lush-foliage. The leaves are large, over-lapping, with long petioles. The fruits are large with prominent shoulders and rough skin, deep-red inside. While very fragrant, the flesh is of inferior flavour and clings to the seed, which varies from large to small (Morton, 1987).

Dahong Nuomizi: It matures in late June to early July, producing large fruits weighing 20-25g. Fruits are bright red with a small stone and plump, juicy flesh with a rich sweet flavour and a soluble solids content of 18-21%. Eating quality is high, but yields are not stable and transportability is poor. The cultivar is grown in Guangzhou, Dongguan and Conghua counties of Guangdong province of China (Li, 1996).

Dahongpao: It is grown in Eastern Sichuan province of China. Dahongpao is an early, red variety, which matures in mid-late July, producing large fruit clusters weighing 500-1000g; fruit shelling rate is 81.6% and eating quality is very good (Wong, 1999).

Dehra Dun (Dehra Rose, Dehra Dhun): It is an important cultivar in Uttrakhand, Uttar Pradesh and Punjab in India and Pakistan. Fruits have small seeds, but are susceptible to cracking (Anonymous, 2001). It produces fruits of good quality (Morton, 1987). It is a late maturing cultivar and fruits mature by third week of June. Tree vigour is medium (5 m height and 7 m spread), yields about 80-90 kg/tree. Fruits are medium to large in size (3.7 cm long, 3.5 cm diameter, 16.8 g weight), having oblique-heart to roundish shape. Fruits have attractive bright-rose pink colour when fully mature. Pulp is grayish-white, soft, moderately juicy (61.9%) with 17.8^0 brix TSS, 10.4 per cent total sugars and 0.72 per cent acidity. Seeds are small (2.4 cm long and 1.4 cm in diameter), light-weight (2.4 g), shrunken, mostly oblong in shape and dark chocolate in colour. The rind: pulp: seed ratio is 18.4: 64.4: 17.2. It is highly susceptible to sunburn and cracking

(Rai, *et al.*, 2001; Chauhan, 2001). The fruits start ripening by the third week of June in Uttar Pradesh but in Jharkhand it matures with Shahi. Under rain-fed conditions, this cultivar is highly prone to cracking. The name of the cultivar suggests that it is a selection made in Dehra Dun (Singh and Babita, 2001). It is precocious in bearing (Bose, *et al.*, 2001).

Dehra Dun **Dehra Rose**

Fig. 7 Litchi Cultivar Dehra Dun and Dehra Rose

Deshi: It is an early cultivar, mainly grown in Bihar and West Bengal. Trees are of medium vigour and attain a height of 5.5 m and spread of 6.5 m. Maturity starts in the third week of May. Fruit yield is high (90-100 kg/tree). Bearing is regular and profuse and fruits are generally heavy (22-24 g). Fruit shape is oval to oblong-conical, and the fruits are bright rose-pink at maturity. The fruit pulp is grayish-white, soft, and juicy. The TSS in pulp is 20.8^0 brix and acidity is 0.35 per cent. Seeds are smooth, dark-chocolate, mostly oblong shaped and 3.7 g in weight. The skin, seed and aril percentage is 15.6, 16.7 and 67.7, respectively. It is less susceptible to sunburn and cracking. This cultivar is suitable for canning (Chauhan, 2001).

Dong Si Ji Li: It is a rare litchi line in China and is used in hybridization programmes. Although it has uneven elongated-oval fruits with soft textured sour aril, but the characters like flowering all around the year, high TSS and vitamin C (53.7 mg/100g) makes it much suitable as a parent in breeding programmes (Rai, *et al.*, 2001).

E Dan Li: This cultivar is suitable for canning because of its sparkling and spotless white aril. Reddish yellow, oval or cordate fruits with thin and fragile skin have 18.2-21.9 g weight, 70.4-77.3 per cent edible portion

with 15.3-18.0^0 brix and 22.1-27.6 mg/100 g vitamin C. It ripens during late June in China (Rai, *et al.*, 2001).

Early Bedana (Early Seedless): It is a popular early cultivar in Bihar, Uttar Pradesh, Uttrakhand, Punjab and Bangladesh. Tree has medium canopy attaining an average height of 5.0 m and spread of 6.2 m. It is regular bearing and medium yielder (50-60 kg/tree) cultivar. Fruits are medium sized (15-18g), oval or heart-shaped, with rough, deep red skin at maturity. Over all fruit quality is good (Singh and Babita, 2001).

It is known as Early Seedless because of its early ripening and small seeds. Aril is creamy white, soft, juicy (69.0%) and sweet containing 19.5^0 brix TSS, 13.91 per cent total sugars and 0.24 per cent titrable acidity. Seed is very small, shrunken, glabrous, dirty chocolate in colour with an average weight of 1.47 g. The rind: pulp: seed ratio (by weight) of the cultivar is 13.06: 83.19: 3.75. The overall fruit quality is good (Rai, *et al.*, 2001).

Bedana

Early Bedana

Fruits of Early Bedana

A fruit laden plant of Bedana cv.

Fig.8. Different strains of Early Bedana in Assam

Early Large Red: This cultivar has fruits, which are slightly more than 3.4 cm long, usually obliquely heart-shaped; crimson to carmine red in colour, with green interspaces. The skin is very rough, firm and leathery, adhering slightly to the flesh. Flesh is grayish-white, firm, sweet and flavoured and is of very good quality. It is a moderate bearer and early maturing (Morton, 1987).

Fig. 9. Fruits and bearing tree of cultivar Early Large Red.

NRC Litchi, Muzaffarpur

Edanli: It is a local cultivar, grown in Hainan Province of China. Due to its large fruits and high quality, it is still commonly planted in recent years. It produces fruits that weigh 52g and this has edible flesh around 72%. The soluble solids content of Edanli is a bit higher than that of Ziniangxi. The ascorbic acid content of Ziniangxi is 1.0% higher than Edanli and reaches 90%, while for Edanli is only 50%. The fruit colour of Edanli is dark greenish red (Li, *et al.,* 2003).

Elachi (Elaichi, Ellaichi): It is an important cultivar in West Bengal and has bright prospects for commercialization. The tree is moderately vigorous, 5-6m high, 6-7m spread and mostly regular bearer. Fruit yield is 50-60 kg/tree. It matures in the mid season, i.e. in the first week of June. Fruits are mostly conical, a mixture of nasturtium red and marigold orange in colour, weighing 12-15 g. Fruit pulp is creamy-white, sweet, soft, juicy with agreeable flavour. TSS is 18.0^0 brix, sugars 11.5 per cent, acidity 0.45 per cent, pulp: seed ratio 6.91:1. Seeds are relatively small, shining with average weight of 1.5-2.0 g. The fruits are less susceptible to sunburn and cracking (Bose, *et al.,* 2001; Rai, *et al.,* 2001). This cultivar has not assumed commercial success (Singh and Babita, 2001).

Fig. 10. **A fruit laden plant of cultivar Elachi.**

Emperor: It is the largest of the litchi fruits achieving golf ball size, and often produces aborted chicken tongue seeds. The tree is a slow compact grower that produces every three out of four years, but it is not a mainstream commercial variety. Juvenile trees are somewhat difficult to grow, but they do perform well in both Florida and California. The fruit is hard with a fine sub-acid flavour. It is good tasting with a large seed. The skin of the fruit has very distinct bumps. This is a mountain variety, adapts well to container culture and tends to fruit consistently.

Fig. 11. Fruits of cultivar Emperor

Extra Early Green: The fruits of this cultivar are 3.2 cm long; mostly heart-shaped, rarely rounded or oblong; yellowish-red with green interspaces. The skin is slightly rough, leathery and slightly adhering. The flesh is creamy-white, firm, of good quality and slightly acidic in flavour. Seeds are oblong, cylindrical or flat. This cultivar is of different quality. It is very late in the season (Morton, 1987).

Fay Zee Siu: It is a new litchi cultivar for use in South Africa. The most important characteristics of this early cultivar are its fruit size (24-32g), fruit quality (small seeds, good colour, nice smell and juiciness), early ripening (early-to-mid-November) and good storage quality. Crop yields and quality are also comparable to the common cultivars HLH Mauritius and McLean's Red (Froneman, 1999).

It is ranked as one of the best export litchi cultivars in China, and has also been imported into Australia. The fruit is amber coloured, the size and shape of goose egg, and the sweetness of honey. It is mainly grown in and

around Guangzhou, with fruit maturing early in the season before Tai So. The tree is vigorous with long, sparse, fragile branches that can break. Leaflets are large, narrow and deep glossy green. Fruits are large (24-32g), round to oval-shaped with thin, light red and splotchy skin. The flesh is firm, sweet, delicious and very fragrant. Seeds are variable, giving a flesh recovery of 77 to 82 per cent (Anonymous, 2001).

Fei Tsu Hsiao or Fi Tsz Siu (Imperial Concubine's Laugh or Smile): This cultivar has large, amber-coloured, thin-skinned fruits, with very sweet and fragrant flesh. The seeds vary from large to very small. It ripens early in the season (Morton, 1987).

Feizixiao: It is an early bearing cultivar, with high and stable yields. Fruits are large, weighing up to 60g, with an attractive appearance. The flesh is plump with a small pit, juicy and sweet, of excellent eating quality. Fruits are non-cracking and at their best for eating when the skin is green with a slight red tinge. Trees grow vigorously, but are sensitive to shortage of calcium in litchi orchards (Wu and Zhang, 1997). It is a mid-season in maturity and high yielding with attractive fruits, suitable for growing at altitudes between 600m and 1300m (Zhuang, 1999).

Fig. 12 Litchi Cultivar Feizixiao

Fengli: It was selected from local *Litchi chinensis* seedlings. Four-year-old trees of Fengli produced an average of 11.6kg fruits, with very high soluble solids content (18%). This selection is recommended for cultivation in Hainan Province of China (Miao, *et al.*, 1998).

Green (Extra Early Green): The fruit is 3.2cm long, mostly heart-shaped, rarely rounded or oblong, yellowish red with green interspaces, skin slightly rough, leathery and slightly

Fig. 13 Fruits of cultivar Green

adhering. Flesh creamy-white, firm, having good quality with slightly acid flavour. Seed oblong, cylindrical or flat, with different quality. Very early in season.

Groff: It is a seedling of Haak Yip cultivar with outstanding characters, which was first designated as H.A.E.S. Selection 1-18-3 (Hawaiian Agricultural Experiment Station) and was given the name Groff in 1953. It is an upright tree of medium vigour. It is a consistent bearer late with season maturity . The fruit is of medium size, dark rose-red with green or yellowish

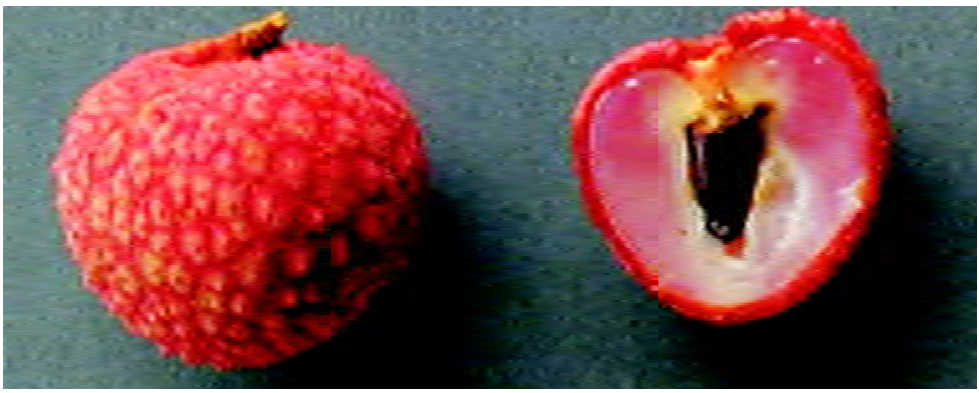


Fig.14 Litchi Cultivar Groff

tinges on the apex of each tubercle. The flesh is white and firm without leaking juice. The flavour is excellent, sweet and sub-acid. Most of the fruits have abortive, chicken tongue seeds and accordingly have 20 per cent more flesh than if the seeds were fully developed (Morton, 1987).

Guiwei: This cultivar is grown in Eastern Sichuan province of China (Wong, 1999). It is a good and late litchi variety suitable for growth in area along the upper and middle course of Yangtze River in the Sichuan Province. This variety is suitable for the growing in those area, where the mean yearly temperature is over 18^0C (Yuan and Zhu, 2001). It matures in early mid August in the Luzhou district. Fruits are large, weigh 24g on average, and have a dark red skin. Flesh is pure white, tender and juicy, with a soluble solids

Fig. 15 Litchi Cultivar Guiwei

content of 18.2^0 brix, vitamin C (ascorbic acid) content of 58.96mg/100ml and a slight aroma. The trees are precocious and productive, with 6-year-old trees producing over 5kg fruit, and some up to 26.5kg (Zhu and Yuan, 1999).

Gulabi: It is an important cultivar in north India and matures late in the season, i.e. fourth week of June. Early rains can deteriorate its quality. Tree is of medium vigour (6 m height and 7.0 m spread), bears profusely and regularly, giving a yield of 90-100 kg fruits/tree. Fruits are medium to large sized (3.4 cm length and 3.1 cm diameter), weigh up to 20.0 g. Fruit shape is variable from oblong-oval to heart-shape. Fruit colour on maturity varies from pinkish-shrimp red to carmine red with mandarin red tubercles. Pulp is firm, grayish white, sweet with 18.2^0 brix TSS, 10.7 per cent total sugars and 0.49 per cent titrable acidity. Seeds are rather big (2.4 cm long and 1.5 cm diameter), heavy (3.3 g), oblong-cylindrical in shape with shining chocolate colour. The rind: pulp: seed ratio is 17.8: 67.2: 15.0 (Rai, *et al.,* 2001). The fruits of this cultivar are of very good quality and late in maturity during the season (Morton, 1987; Chauhan, 2001; Singh and Babita, 2001).

Fig. 16. A heavy bearing plant of cultivar Gulabi in Assam

Haak Yip (Hak Ip, Hei Yeh, Black Leaf): It is popular cultivar in China, Taiwan Province of China and Thailand (O-Hia), but has undergone limited distribution elsewhere. It is commonly canned in Taiwan. Fruits mature about a week after Tai So. Trees are medium in vigour and medium-sized, with dense foliage and long, thin, fragile branches. The leaflets are very dark, glossy green, long, narrow-pointed and slightly curled at the tip. Black leaf refers to the dark green to black leaves of this superb variety. The heart-shaped fruits are medium sized (20-22g) and formed in large compact clusters (15-30 fruits). The purplish red skin is thin and soft and

prone to insect attack and has a distinctive suture line. Shoulders are wide and even. The skin is smooth, with no raised protuberances. The flesh, which separates easily from seed, is sweet, crisp, slightly aromatic and of excellent quality. Seeds are medium and fully developed, giving a flesh recovery of 68 to 76 per cent. Fruits are exported from China.

Fig. 17. Fruits of cultivar Hak Yip

Haak Yip can be distinguished from the related Souey Tung by its slightly later maturity, even shoulders, obvious suture line, firmer flesh and more uniform and slightly larger seeds. Both the cultivars are good marketing types when grown well (Anonymous, 2001; Chauhan, 2001). This cultivar is rated as one of the best water lychees (Morton, 1987).

HLH Mauritius: HLH Mauritius (Tai So) is the most widely grown cultivar in South Africa. It is mid season cultivar, with good quality, medium to large fruit. The trees exhibit high productivity. If grown in warmer areas, the fruit will ripen earlier in the season; however, the trees can be grown in cooler areas where the fruit will come into production later in the season.

Hongxin: It is a promising litchi selection from cultivar Dahongpao and was selected in the Ibin prefecture in China. It is productive and produces larger fruits (24.2 g) with higher soluble solids content (17.4-18.1^0 brix) (Li, *et al.*, 1999).

Hsiang Li or Heung Lai (fragrant lychee): It is a tree with distinctive erect habit, having upward-pointing leaves. The fruit is small, very rough and prickly, deep-red, with the smallest seeds of all, and the flesh is of superior flavour and fragrance. It is late in the season (Morton, 1987).

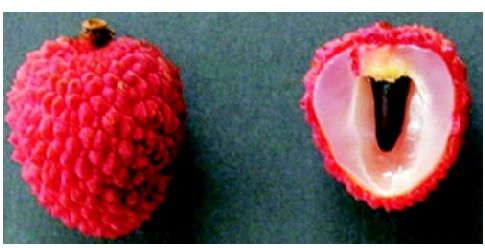


Fig.18 Litchi cultivar Hsiang Li or Heung Lai

Hsi Chio Tsu or Sai Kok Tsz (rhinoceros horn): It is borne by a large growing tree. The fruit is large, rough, broad at the base and narrow at the apex; has somewhat tough and fibrous, but fragrant and sweet flesh. This cultivar ripens early in the season (Morton, 1987).

Huai Chih or Wai Chi (the Wai River lychee): It has medium-sized, blunt leaves. The fruits are round with medium smooth skin, a rich red outside, pink inside; and leaking juice. This is not a high class cultivar, but the most commonly grown, high yielding and late in the season (Morton, 1987).

Jiangmiaolan: It is grown in Eastern Sichuan province of China. The fruits of Jiangmiaolan are dark red in colour and maturity is in late July (Wong, 1999).

Jixin: It is a promising litchi selection from cultivar Dahongpao and was selected in the Ibin prefecture in China. It is productive and produces larger fruits (24.2 g) with higher (17.4-18.1^0 brix) total soluble solids content (Li, *et al.*, 1999).

Kaimana or Poamoto: It is an open-pollinated seedling selection of Haak Ip cultivar, was developed by R.A. Hamilton at the Poamoto Experiment Station of the University of Hawaii, and was released in 1982. The fruit resembles Kwai Mi, but is twice as large, deep-red; of high quality and the tree is a regular bearer (Morton, 1987). It has also been distributed to Australia for evaluation. Small trees can bear heavily in Kona and some other parts of Australia. Fruits are available in the mid-season. Trees are medium, spreading with long, strong branches. Leaves are large, elongated and mid-green. The new flush growth is green in colour. Fruits are large

Fig. 19 Fruits of cultivar Kaimana

(25g), heart-shaped with purple-red skin. The skin segments are swollen and the protuberances become smooth when the fruits are mature. The flesh is crisp, sweet and excellent quality. Seeds are medium (Anonymous, 2001).

Kalkattia (Calcuttia or Calcutta): This is one of the popular cultivars grown in north India. It is resistant to hot winds and can be successfully cultivated even in hotter areas provided there is protection from strong hot winds and provision for plenty of water for irrigation. Trees bear fruits profusely and regularly with an average yield of 80-100 kg/tree. It is a late season cultivar and ripens in the last week of June. Trees attain a height of 4 m and spread of 6 m. Fruits are large in size with average weight of 22 g, 4 cm long, shape oblong or lopsided and colour at maturity rose with dark tubercles. Pulp is dirty creamy white, soft, juicy, TSS 18.17^0 brix, acidity 0.43 per cent. Seed is dark-chocolate in colour, oblong, concave or Plano convex shaped, size medium, 2.5 cm long and 1.5 cm in diameter, average weight 3.4 g. Fruits are of very good quality. It is a heavy bearer and withstands hot winds (Morton, 1987; Chauhan, 2001).

Kasba: This is one of the important cultivars of Bihar. Trees are medium in vigour attaining a height of 6.0 m and spread of 7.0m. Fruits ripen in the third week of May to first week of June. Fruit yield is high with 85-100 kg/ tree. Fruits are oval to oblong-conical shaped, with bright rose pink colour at maturity. This is a large fruited cultivar selected from Kasba village for its attractive fruit size and colour. The tree is large and compact having broad and elongated leaves. The plant shows very positive response to stress and nutrient application. Fruit weighs between 23-27g, perhaps the

Fig. 20. Fruits of cultivar Kasba

heaviest fruit among the known varieties, but the number of fruit is less. Pulp is grayish-white, soft, juicy, TSS 16.8^0 brix and acidity 1.14 per cent. Seed is smooth, dark in colour, shining, mostly oblong shaped, average weight 3.5 g. The skin, seed and aril percentage is 17.6, 19.5 and 62.9, respectively. Fruits are less susceptible to sunburn and cracking. Interestingly, the cultivar performs better in marginal soils as it has the capacity to absorb more nutrients (Singh and Babita, 2001; Chauhan, 2001).

Kaselia: This is a late maturing cultivar found growing in isolation. The tree is medium in size. Fruits attain a pink red colour. The pulp content is comparatively low and the seeds are big. This cultivar is also known as 'Khatti' or 'Pickling'. The cultivar has not assumed commercial success (Singh and Babita, 2001).

Fig. 21. Fruits of cultivar Kaselia

Khom: It was developed from the material imported from China in Thailand. It is the most popular among the tropical cultivars. It has been imported into Australia, but has not been distributed elsewhere. Fruits mature about a week before Tai So and are variable in size, shape and flesh recovery, depending on the season. Average fruit size is better in Thailand. Khom is high yielding. It is not considered a good marketing type, because of its small fruits and poor flavour. Trees are vigorous and erect, and have long, strong branches and dense foliage. Leaflets are narrow, pointed, medium and dark green. They are generally flat, but curve downwards slightly towards the tip. The new flush growth is red in colour, changing to green with maturity. Fruits are variable in size (8-20g), and long-heart to nearly round, depending on the season. They tend to be small and long heart-shaped after cool weather. The fruits have very thick skin, which turns to blotchy yellow to purplish red at maturity. Shoulders are flat or even, and the fruit apex is obtuse. The skin segments are smooth at maturity and variable in size, shape and arrangement. The protuberances are sharp-pointed. Fruits are borne in small loose clusters. The flesh is tough to fibrous, and mild becoming bland once matures. Seed and fruit size are in proportion, with small fruits having chicken tongues. Flesh recovery ranges from 60 to 80 per cent (Anonymous, 2001).

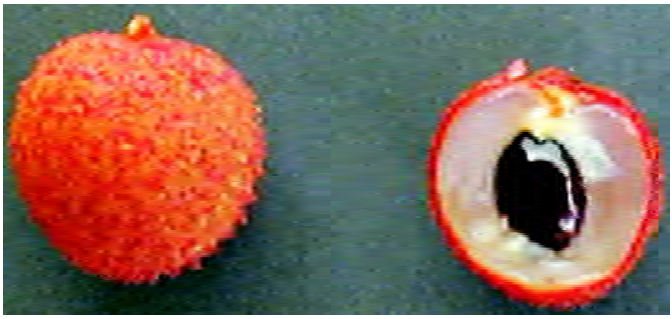


Fig. 22 Litchi Cultivar Khom

Kwa Luk or Kua Lu (Hanging green): It is a famous cultivar of litchi. The fruits are large, red in colour, with a green tip and a typical green line; dry and clean. The fruits are of outstanding flavour and fragrance. This cultivar in olden times was considered to be a special fruit for presentation to high officials and other persons in positions of honour (Morton, 1987).

Kwai May Pink: It is thought to have originated in China, possibly as a variant or seedling of Kwai May Red. It is popular in Australia, but not well-known elsewhere. It has a good bearing ability. It has a long harvesting period, possibly due to the development of acceptable sweetness and flavour well before fruit maturity. Fruits are available in mid-season. Trees are large and very erect, and have long, thin branches that point upwards. They are reasonably strong in storms. Leaflets are narrow, long, oval-shaped and shiny light green. They curl upwards slightly from the midrib and downwards along the length. The new flush of growth is an attractive red in colour. Fruits are medium sized (18-22g), and round, with very rough and thick skin. The skin changes from yellow to yellow-pink to orange-pink with maturity, with some green on the shoulders. Fruits are over-

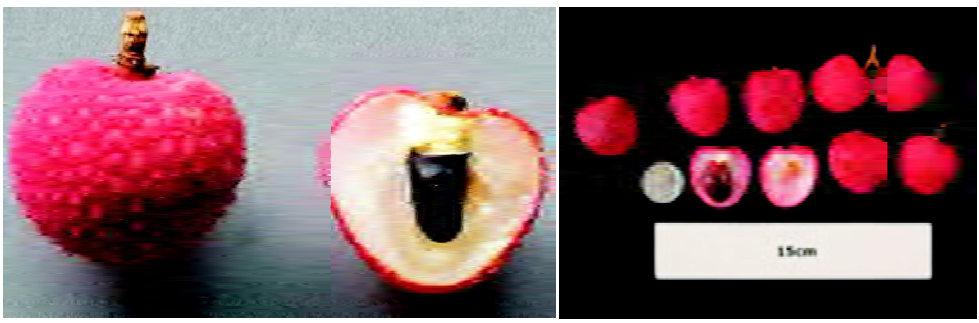


Fig. 23 Fruits of cultivar Kwai May Pink

mature when fully coloured. Shoulders are usually flat, but one is sometimes raised along the suture line. Flesh is firm, crisp, sweet, juicy and aromatic. Fruits are sweet well before full maturity. Seeds are variable, with up to 70 per cent chicken tongues. Flesh recovery is 67 to 77 per cent. Fruits are of export quality and are exported (Anonymous, 2001).

Kwai May Red: It is a highly regarded cultivar in China, but is not grown widely in other parts of the world. Fruits are of good quality, although the tree is a shy bearer. Panicles normally carry only a few fruits due to poor set. In Australia, the trees resemble to those of Kwai May Pink, but are more spreading. They have long and thin branches that curve upwards towards their tips. Leaflets are small, oval-shaped and shiny green. Leaflets are slightly larger than Kwai May Pink and flatter. The new flush of growth is red in colour. Fruits are almost identical to those of Kwai May Pink, except that Kwai May Red has red rather than pink-orange skin, firmer flesh, a higher proportion of chicken-tongues (50-60%), higher flesh recovery (70-80%), and a slightly better flavour. The fruits are distinctly aromatic and are exported from China (Anonymous, 2001).

Kwai Mi or Kue Wei (Cinnamon flavour): It came to be called as Mauritius. The fruits are smaller, heart-shaped, with rough red skin, tinged with green on the shoulders and usually having a thin line running around the fruit. The seed is small and the flesh very sweet and fragrant. The branches of the tree curve upwards at the tip and the leaflets curl inward from the midrib (Morton, 1987). In northern Queensland, Kwai Mi is the earliest cultivar, and about 10 per cent fruits have chicken tongue seeds.

Fig. 24 Fruits of cultivar Kwai May Red

It is the only variety grown in South Africa, but it is called as Mauritius as nearly all the trees are descendents of those brought from that island. The fruits of Mauritius are medium sized, nearly round, but slightly oval and reddish-brown. Flesh is firm, of good quality and usually contains a medium-sized seed, but certain fruits with broad, flat shoulders and shortened form tend to have chicken tongue seeds (Morton, 1987). The

first lychee cultivar introduced into Hawaii was Kwai Mi. It is also called sometimes as Charlie Long. The quality of this variety caused the lychee to become extremely popular and widely planted fruit in Hawaii (Morton, 1987).

Late Bedana (Late Seedless): In this cultivar the seeds are present, but are shriveled and very small. It is a late maturing cultivar grown in northern India (Anonymous, 2001). This is a late maturing cultivar, usually

Fig. 25 Bearing trees and fruits of strains of Late Bedana from Assam

NRC Litchi, Muzaffarpur

ripens in the second week of June. The fruits mature in the end of May in Jharkhand, first week of June in Muzaffarpur and last week of June in Uttarakhand. The trees are vigorous having an average height of 5.5m and spread of 7.0m. It is a high yielder, giving an annual yield of 80-100kg/ tree. The new flush is dark pink in colour and its leaf can be distinguished from other cultivars. The panicle is compact (Singh and Babita, 2001). The fruits are conical with vermilion to carmine in colour having dark blackish brown tubercles at maturity. The fruit skin is rough, firm and non-adherent. Pulp is creamy white, soft, juicy (65.4%), sweet having 19.5 ^{0} brix TSS, 13.0 percent total sugars and 0.30 per cent acidity. Although the fruit size is medium, the pulp content is high and the fruits are of very good quality. Seeds are small (2.0 x 1.0 cm in size and 2.18 g in weight), shrunken, glabrous, chocolate coloured having fusiform shape similar to dog's tooth. The rind: pulp: seed ratio is 14.76: 81.89: 3.35. Overall quality is very good (Rai, *et al.,* 2001; Morton, 1987; Chauhan, 2001).

Late Long Red or Muzaffarpur: This cultivar is grown in Bihar, Punjab and Uttarakhand. The fruits are less than 4cm long, with fruit shape usually oblong-conical. Fruit colour at maturity is dark red with greenish interspaces. Fruit skin is rough, firm and leathery, slightly adhering to the flesh. Flesh is grayish-white, soft, of good and sweet flavour. Seeds are cylindrical and fully developed. Fruit quality is good. This cultivar is a heavy bearer and fruit maturity is late in the season (Morton, 1987).

Liquili: It is a litchi cultivar from Guangxi Province of China. It ripens 15-20 days later than other local cultivars and 5-15 days later than other late cultivars. It begins flowering in the middle of April and the fruits ripen in early August. The weight of a single fruit is 15.68-21.3g. The fruits contain 15.02-18.45 per cent soluble solids, 37-38 mg ascorbic acid/100g of fruit pulp and 13.5-14.9 per cent sugar. The tree starts bearing fruits three years after planting and yields 8-10kg/tree. The cultivar is noted for its good fruit production, high and stable yield, lateness, wide adaptability and resistance to adverse environmental conditions (Xie, 1995).

Longia: This cultivar is well distributed in North Bihar, and is preferred for late maturity. The tree is medium in size, leaves are small and light in colour and it has compact panicles. Fruits are medium in size and the aril has an excellent aroma. Due to shy bearing habit, there is a declining preference for this cultivar (Singh and Babita, 2001).

Fig. 26 Fruits of cultivar Longia

Madras: This cultivar is growing in the orchards of Subtropical Horticulture Station, Nelspruit. It is a heavy bearer of choice fruits, which are bright red in colour, but have very rough skin and large seeds. The fruits are very sweet with luscious flesh (Morton, 1987).

Maguili: This cultivar originated as a chance seedling and was discovered in 1979. It is a promising extra late litchi variety, maturing in mid to late August (at 300-500m altitude) and late September (700-800m altitude). Fruits are large, weighing 39.6g on average, with a bright red shell. The flesh is pure white with a soluble solids content of 17-21^0 brix, ascorbic acid of 50.2mg/100 ml of pulp, and has very good eating quality. The trees are precocious and the average production of 3-year-old trees is 4.38kg (Ooyang, *et al.,* 2002).

Mandraji: The trees of this cultivar are vigorous and attain a height of 6.0 m and spread of 6.0 m. The large fruits (22-26g) are formed in clusters. The thick skin is very rough and has attractive bright red colour. Fruit shape is oblong with medium shoulders. Pulp is soft, juicy with pleasant flavour. The fruits contain 19.5^0 brix TSS and 0.43 per cent acidity. The seeds are smooth with shining light chocolate colour. It matures in the last week of May to first week of June (Chauhan, 2001).

Fig. 27 Fruits of cultivar Mandraji

NRC Litchi, Muzaffarpur

Mauritius: It originated in China, but is named for the island off the southeast coast of Africa, where extensive commercial plantings have been in production for decades. It is the variety of choice for commercial growers in Florida, because it is a regular and heavy bearer. The fruit is sweet, pink to red, and produces chicken tongue seeds in about one out of ten fruits. It is an important cultivar cultivated in the highlands of the Philippines. It is an introduction from South Africa. It has round to broadly ovate fruits with bright red skin. The fruits are larger than those of Sinco (Sotto, 2001).

Fig. 28 A fruit laden tree of cultivar Mauritius

Mianbaoli: This cultivar was selected from local litchi seedlings. The fruits of this cultivar have a soluble solids content of 17.5%. This selection is recommended for cultivation in Hainan Province of China (Miao, *et al.*, 1998).

Mombaia (Mumbai): It is one of the most important cultivars of West Bengal and has vigorous canopy attaining a height of 6-7 m and spread of 7-8 m. The fruits mature early, i.e. first week of June and yield 80-90 kg fruits/tree. Fruits are larger in size (3.5 cm long and 3.2 cm in diameter), obliquely heart-shaped, weighting 15-20 g. The colour of ripe fruits is attractive carmine red with uranium green skin background. Similar to Home Shinchi, a Chinese cultivar, it also has a small, tiny under developed fruit attached to the stalk of each fully developed fruit. Fruit pulp is grayish-white, soft, juicy, sweet containing 20.5^0 brix TSS, 11.68 per cent total sugars and 0.28 per cent acidity. Seeds are large, elongated, smooth and shining and have chocolate colour and 2.3 cm long with 1.6 cm diameter and weighs 3.83g. Rind: pulp: seed ratio is 12.1: 70.1: 16.8 (Rai, *et al.*, 2001; Chauhan, 2001).

Muzaffarpur: It is one of the best litchi cultivars grown in Bihar and is also known as Late Large Red. Trees are medium in vigour and attain an average height of 5.5 m and spread of 6.0 m. It bears profusely and regularly and the average yield is 80-100 kg/tree. Fruits are less prone to cracking and generally ripen in the first week of May in Bihar (early) and in the middle of June in northern India (late). Fruits are large with 3.7 cm length

and 3.2 cm diameter and average fruit weight is 18.2 g. Fruit shape is oval and oblong conical. The colour at maturity of pericarp is uranium green that of tubercles is crimson red. Fruit pulp is white, soft and juicy (60%). The pulp has 17.7^0 brix TSS and 0.48 per cent acidity. Seeds are large, 2.4 cm long and 1.54 cm in diameter, average weight 3.4 g, smooth, dark chocolate in colour. The skin, seed and aril percentage is 13.7, 16.5 and 69.8, respectively (Chauhan, 2001; Bose, *et al.,* 2001).

Fig. 29 Fruits of cultivar Muzaffarpur (Syn. Late Large Red)

Muzaffarpuri: This variety was brought from India and mainly grown in the northwestern districts of Bangladesh. The trees are medium in vigour and attain an average height of 5m. The fruits are pink in colour, oval shaped and mature in 2nd week of May. Average weight of fruit is 20g, pulp is long and sweet. TSS 17-18^0 brix, seeds big and pulp:seed ratio 4.75:1.

Nafarpal: This is an important cultivar of West Bengal but it could not attain the status of commercial cultivar. The fruits have resemblance with China cultivar.

Fig. 30 Fruits of cultivar Nafarpal

Nanmuye: This cultivar is grown in Eastern Sichuan province of China. The fruits of Nanmuye mature in mid August and are yellowish red in colour, are borne in large, long clusters weighing 400-1100g. Fruit shelling rate is 72.7% and the soluble solids content is 15.49^0 brix. The trees are productive (Wong, 1999).

No Mai Chee: It is one of the highly-priced cultivars and is widely grown in China. The fruit appear on the market late in the season and commands a high price, usually three to four times than that of other cultivars. The fruits are large (21-28g) and nearly all with chicken-tongues,

Fig. 31 Litchi Cultivar No Mai Chee

giving a flesh recovery of 75-85 per cent. The flesh is smooth, firm and clean, with a distinctive sweet fragrant flavour. It is suitable for fresh fruit and drying. The tree is large and tall with a dense canopy and slim branches that hang down. The leaves are small, soft and thin, with a wavy edge. No Mai Chee is also cultivated in Australia on a very small scale (Anonymous, 2001).

No Mai Tsze or No Mic Tsz (glutinous rice): It is the leading variety in China. The fruits are large, red, dry and clean. The seeds are often small and shriveled. It is one of the best cultivars for drying, and fruit maturity is late in the season. It does best when grafted on to the mountain type lychee (Morton, 1987).

Fig. 32 Fruits of cultivar No Mai Tsze

Nuomizi: It is a late cultivar, suitable for growing at altitudes between 800 and 1400m (Zhuang, 1999).

O-Hia (Baidum): It is third most important cultivar after Tai So and Wai Chee in northern Thailand. It resembles Haak Yip in some characteristics. Fruits are slightly smaller, less uniform in size, have blotchy markings on the skin, which is yellow-red rather than purple-red at

Fig. 33 Fruits of cultivar Ohia

maturity. Fruits are not as sweet as Haak Yip and have more chicken tongues. It is a mid-season cultivar. Trees are medium, with dense foliage on long, thin branches. Leaflets are large, narrow, dark green and slightly curled upwards from the midrib. The new flush of growth is reddish-brown. Fruits are medium (20-22g) and heart-shaped. The skin changes from blotchy yellow to deep red with maturity. Skin segments are irregular in size, shape and arrangement, swelling, with smooth to obtuse protuberances. Flesh is juicy and sweet. Seeds are mostly plump (10-15% chicken tongues), giving a flesh recovery of 65 to 75 per cent (Anonymous, 2001).

Olan: The Department of Agriculture in Lipa, Batangas (Philippines) identified this selection and it was named after its owner. It is a seedling selection from a seed, which was brought from Thailand. The fruit is ovate and weighs 26 g. The aril is 6 mm thick with a TSS of 17.5° Brix and is 62 percent of the whole fruit by weight. The owner claims that this variety is a regular bearer (Sotto, 2001).

Pai La Li Chih or Pak Lap Lai Chi (White wax lychee): Also called Po le tzu, or Pak lik tsz (white fragrant plant), is large, pink, rough, with pinkish, fibrous, not very sweet flesh and large seeds. It ripens very late (Morton, 1987).

Panjore Common: This cultivar is mainly grown in Punjab. Fruit is large, heart-shaped with deep-orange to pink colour. Fruit skin is rough, very thin and apt to shift. Tree bears heavily and has the longest fruiting season, for an entire month beginning near the end of May (Morton, 1987).

Pat Po Heung (eight precious fragrances): It is erroneously called Pat Po Hung (eight precious red), somewhat resembles No Mai Tsze, but is smaller. The fruit skin is purplish-red, thin and pliable. Juice leaks when skin is broken. The flesh is soft, juicy and sweet even when slightly unripe; the seed varies from medium to large. The tree is slow growing and of weak, spreading habit. It bears well in Hawaii. It is not a commonly planted cultivar (Morton, 1987).

Peerless: It is believed to be a seedling of Brewster, originated at the Royal Palm Nursery at Oneco (Florida); was transplanted to the T.R. Palmer Estate in Belleair, where C.E. Ware noticed from 1936 to 1938 that it bore fruits of larger size, brighter colour and higher percentage of abortive seeds than that of Brewster. It has a good productivity (Average 174 kg/tree/

year) and abortive seeds ranged from 62 to 80 per cent. In the initial years of plantings, most of the fruits have fully developed seeds, but the rate of abortive seeds increases year after year and finally up to 70 per cent. The cultivar was named with the approval of Florida Lychee Growers Association. Two seedling selections by Col. Groveie Yellow Red and Late Globe have been made from this to which Prof. Groff believed to be natural hybrids of Brewster and Mountain (Morton, 1987).

Purbi: It is also called Bengal in West Bengal. It is the second most important cultivar in Australia. Trees are vigorous and attain a height of 6.5 m and spread of 7.5 m. The fruit is large (23-27 g) and is formed in large clusters of fifty or more fruits. The fruit yield is 90-100 kg/tree. The thick skin is very rough with attractive bright red colour. The fruits are egg-round to lopsided heart-shaped with uneven shoulder. The fruit tip is distinctly pointed. The tubercles are red in colour on pinkish brown background. Pulp is soft, juicy with pleasant flavour, having TSS 19.0^0 brix and acidity 0.44 per cent. The seeds are smooth and shining light chocolate in colour. The percentage of skin, seed and aril is 16.9, 22.9 and 60.2, respectively. Fruits are less susceptible to cracking and ripen in the third week of May under Bihar conditions (Chauhan, 2001).

Fig. 34 Fruits of cultivar Purbi

Pyazi: The fruits of this cultivar are 3.4 cm long, oblong-conical to heart-shaped; have a blend of orange and orange red, with yellowish-red and not very prominent tubercles. Skin is leathery, adhering. Flesh is gray-white, firm, slightly sweet, with flavour reminiscent of boiled onion. Seeds are cylindrical and fully developed. It has poor quality fruits and is early in maturity (Morton, 1987).

Qinzhou red: It is a new variety of litchi, derived from spontaneous mutation of cultivar Black Leaf. It is early fruiting and has high yield, big fruits, bright red rind, excellent quality and seed rate of 36.15% (Peng, *et al.,* 2001).

Qinzhouhongli: It is a very promising selection, which matures in mid-June and produces large fruits, weighting 44.7g with bright red skin, clear white flesh, crispy, sweet flavour and is of good eating quality (Su, *et al.,* 2001).

Rose Scented: This is a popular cultivar of North Bihar, Jharkhand, Uttarakhand and Uttar Pradesh. The fruits have distinct aroma and hence called as Rose Scented. It is also known as Shahi in Bihar. It is one of the most popular mid season cultivar, which ripens during last week of May to first week of June. Trees are very vigorous (7.6 m high and 8.2 m spread) and high yielders (80-90 kg/plant) but mature fruits are prone to cracking. Fruits are medium to large (3.2 cm length and 3.1 cm diameter), medium in weight (18.44 g/fruit), globosely-heart or obtuse in shape with rough skin and having purplish rose colour with red tubercles at ripening. Pulp is grayish-white, soft, moderately juicy (54.8%) and sweet with 21.7^0 brix TSS, 14.57 per cent total sugars and 0.30 per cent total acidity. Seeds are small (1.89 cm length, 1.32 cm diameter and 2.07 g weight), smooth, shining, round-ovate in shape and blackish-chocolate in colour. Rind: pulp: seed ratio is 12.22: 75.93: 11.85. Fruits have excellent aroma (Rai, *et al.,* 2001). Fruits are moderately susceptible to sunburn and cracking (Chauhan, 2001).

Fig. 35 Fruits of cultivar Rose Scented

Saharanpur Selection: It is an early and heavy bearing cultivar of litchi. The fruits are large, heart shaped and deep orange to pink in colour. It matures in first week of June. Its plant and fruit characteristics resemble to those of Early Large Red and Panjore Common and it is considered to be their synonym (Bose, *et al.,* 2001). It had only 2% split fruits compared to

11-28% in other cultivars. It was also noted for the next higher TSS content (19.8^0 brix) to Late Seedless (20.9%). The fruits weigh 17.6g on average and ripen in the 3rd week of June (Lal and Nirwan, 1980).

Sah Keng: It was developed in Taiwan Province of China in the 1970s and appears to be a seedling of Haak Yip. It was introduced into Australia, but is not grown commercially outside Taiwan. Sah Keng produces large and small-seeded fruits, with significant variation amongst trees in a single orchard. Fruits are available in mid-season. Yields are heavy, but irregular. Trees are medium, dome-shaped with short, fragile branches. Leaflets are 6-8 cm long and mid-green. The new flush of growth is green. Fruits are large (30-35g), heart-shaped, with purple-red skin. The skin segments are swollen and protuberances blunt. The flesh is soft and sweet. Seeds are variable, often small, giving a flesh recovery of 57 per cent (Anonymous, 2001).

Salathiel: Salathiel appears to have been originated in Australia, possibly as a chance seedling of No Mi Ci (Batten, 1984). It was found growing near Cairns in northern Australia, but its parentage is unknown. It is similar to No Mai Chee from China, but is not identical in all characteristics. Yields are variable in subtropical districts and light in tropical areas. Fruits are harvested late, just before Wai Chee. Trees are small and compact, and sometimes produce long branches with undeveloped leaves. Leaflets are small, broad and curve down slightly at the tip. The tip of the leaflet is round with a short distinctive point. The new flush is red, changing to green with maturity. Fruits are small (15-18g), egg-shaped to ball-shaped in cooler areas, and borne in small loose clusters. The skin is thick, moderately rough with prominent markings. The skin changes from blotchy-yellow to deep red at maturity. The fruit tip is obtuse changing to round in cooler areas. Flesh is thick, crisp and juicy and very sweet. Fruits are sweet long before they are fully coloured. It is of excellent quality, comparing more than favourably with the highly rated No Mi Ci. Most of the fruits have chicken tongue seeds, giving a flesh recovery of 76 to 80 per cent. Occasionally, the fruit can be almost seedless, although these fruits are very small and unmarketable. Fruit attract a high price in domestic markets and are also exported to Asia (Anonymous, 2001).

San Yueh Hung or Sam Ut Hung (third month red): It is also called Ma yuen, Ma un, Tsao kuo, Tso kwo, Tsao li or Tsoli (early lychee). It is

grown along dykeys. The branches are brittle and break readily; the leaves are long, pointed and thick. The fruits are very large, with red, thick, tough skin and thick, medium-sweet flesh with much rag. The seeds are long but aborted. This is a popular cultivar mainly because it comes into season very early (Morton, 1987).

Seedless Late: The trees are very vigorous and attain an average height of 7.5 m and spread of 10.0 m, but are not regular bearers. The yield is 40 kg/tree in a lean year to 80 to 100 kg/tree in a heavy year. Maturity is usually by the end of the third week of June. Fruits are mostly conical, but may be ovate in some cases, bright brick-red colour and big sized (29.0 g). Fruit pulp is creamy-white, soft, juicy, TSS 18.0^0 brix, sugars 13.8 per cent, acidity 0.44 per cent and pulp: seed ratio is 28.09: 1. Seed is very small, shriveled, glabrous, chocolate in colour, with average weight of 0.85 g. The fruits are moderately susceptible to cracking. Seedless is a misnomer, because the fruits are not completely devoid of seeds, but the seeds are shriveled and the proportion of flesh is relatively high (Bose, *et al.*, 2001).

Shahi (Muzaffarpur, Rose Scented): This is the most popular cultivar grown in North Bihar, Jharkhand, Uttarakhand and Uttar Pradesh regions of India and is also grown in Bangladesh. Besides having high quality fruits, it has a distinct rose aroma and hence is called 'Rose Scented'. It is known as Shahi in Bihar, Rose Scented in Uttarakhand and Muzaffarpur in Western Uttar Pradesh. The vegetative flush of this cultivar is light. The fruits are

Fruits of Shahi cv.

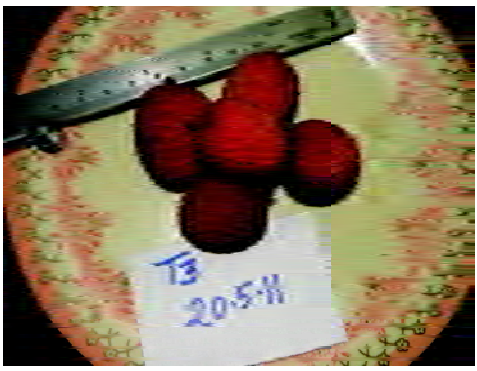

Fruit laden plants of Shahi cv.

Fruits of early maturing Shahi plant from Assam

Fruits of late maturing Shahi plant from Assam

A >150 years old Shahi plant in Assam

Intense red coloured fruits of Shahi (Assam)



Fruits of early maturing and a plant of late maturing Shahi from Tripura

Bunch-bearing clone of Shahi

Early and heavy-bearing Shahi plant

Fig. 36 Different type of Shahi plants and fruits in different growing areas

medium sized (3.7 cm long and 3.2 cm in diameter) and the fruit weight ranges from 20-25 g. This cultivar is earliest in maturity, and ripens during the second week of May to the first week of June at various locations. It matures on 12-15 May in Jharkhand, the 25th May in North Bihar and by the first week of June in the Terai region of Uttarakhand. Trees of this cultivar are very vigorous and produce fruits ranging from 100-150 kg per plant and bear regularly. Mature fruits are prone to cracking in zones with low humidity and poor moisture content in the soil. Fruits are globous-heart or obtuse in shape having rose madder and fuchsia purple background with red tubercles at ripening. Fragrant pulp is grayish-white, soft, moderately juicy (60%) and sweet. TSS ranges from 19.00 to 22° brix and acidity is 0.48 per cent. It has large seeds (2.4 cm long and 1.5 cm in diameter), weighing 3.4 g, with smooth, shining and dark chocolate seed

coat. The rind: pulp: seed ratio is 11.5: 73.6: 14.4. On the same plant larger fruits have big seeds while seeds in small fruits are shrunken. The fruits are known for excellent aroma and quality. This cultivar occupies a major area under lychee in India. Fruit cracking is a serious problem in this cultivar (Singh and Babita, 2001; Rai, *et al.,* 2001).

Shan Chi or Shan Chih (mountain lychee): Also called Suan Chih or Sun Chi (sour lychee) grows wild in the hills and is often planted as a rootstock for better varieties. The tree is of erect habit with erect twigs and large, pointed, short-petioled leaves. The fruit is bright-red, elongated, very rough, with thin flesh, acid flavour and large red tubercles (Morton, 1987).

Shatouli: It is a late maturing selection, which matures in early August and produces small fruits weighing 21.6g with red skin, crispy, white flesh, soluble solids content of 18.5% and very good eating quality (Su, *et al.,* 2001).

Sheung shu wai or Shang hou huai (President of a Board's embrace): This cultivar is borne on a small-leaved tree. The fruit is large, rounded and red with many dark spots. It has sweet flesh with little scent and the seed size is variable. It is rather late in the season (Morton, 1987).

Shuidong: It is an early cultivar, suitable for growing at altitudes of 1000m (Zhuang, 1999).

Shuyou: It is a promising litchi selection from cultivar Dahongpao and was selected in the Ibin prefecture in China. It is productive and produces larger fruits (24.2 g) with higher (17.4-18.1^0 brix) soluble solids content (Li, *et al.,* 1999).

Sinco: It is an important cultivar cultivated in the highlands of the Philippines. It is a local seedling selection from China. Fruits of this selection are round to ovate and dull red (Sotto, 2001).

Songmei 2: This variety was selected in the litchi producing areas of Hainan province of China. Fruits of this cultivar have good eating quality and storage life (Miao, *et al.,* 1997).

Songmei 5: This variety was selected in the litchi producing areas of Hainan province of China. It has large, strongly aromatic fruits, weighing 39.1-50g (Miao, *et al.,* 1997).

Songmei 9: This variety was selected in the litchi producing areas of Hainan province of China. It has exceptionally high and stable production (Miao, *et al.*, 1997).

Songmei 12: This variety was selected in the litchi producing areas of Hainan province of China. It is a dwarf variety, 7 year-old tree height being 2.48m, about 64.8% of the height of standard variety Nuomizi (Miao, *et al.*, 1997).

Souey Tung: It is a popular early cultivar in Fujian province of China. It has been distributed to Australia, but is not widely grown. It can tolerate high water table. Rains near the fruit harvest causes the fruit skin to discolour due to black mildew. The tree is relatively poor in vigour with thin, long, spreading branches that point downwards. Leaflets are large, flat, dark glossy green and pointed. The new flush of growth is bronze, changing to red and green with maturity. Fruits are medium (20-22g) and heart-shaped with distinctive uneven shoulders. The skin is thin, dull dark red to purple and smooth. The fruit tip is obtuse or blunt. The flesh is soft, juicy, sweet and of excellent quality. Seeds are variable in size, but mostly medium, giving a good flesh recovery of 65 to 75 per cent. There are only 5-10 per cent abortive seeds (Anonymous, 2001).

Sum Yee Hong: It is the earliest cultivar in Guangdong province of China and finds a ready market in spite of its average fruit quality compared to other later cultivars. It is grown in the suburbs of Guangzhou and Zhong Shan District and can be a heavy cropper. It was also introduced into Australia. The tree is medium-sized with an open, spreading habit and long, thin, fragile branches. The leaves are long, narrow, shiny dark green and much thicker. The fruits are exceptionally large (26-42g), with bright red and thick skin that peels off easily. The flesh is very juicy and sweet acid. The seeds are generally large (Anonymous, 2001).

Swarna Roopa: It is a clonal selection of seedless group released by CHES, Ranchi. The tree is medium tall with medium spread, dense foliage, 18.5-22.0 cm long compact panicle, 9.5-11.5 cm x 3.2-3.5 cm leaf with dark green foliage where as new flush is pink in colour. The leaves are similar to Bedana in shape and size. It is a mid-season maturing cultivar and fruits mature by the third week of May. It bears 8-20 fruits/cluster. The fruits are attractive red in colour, medium-sized (3.0 x 2.7 cm), and weighing

18.95 g. The fruit contains high pulp (76.62%), small seeds (3.1 g), medium acidity (0.39%), highly sweet (TSS 19.0^0 brix). Total sugars are 12.5 per cent and reducing sugars are 8.5 per cent. The skin: pulp: seed ratio is 8.7: 76.62: 16.36 (Rai, *et al.*, 2001). This is a cracking resistant cultivar of lychee. The cultivar is suitable for extended harvest as it matures after China in Bihar and is prized for its attractive fruit colour. This cultivar is recommended for commercial production (Singh and Babita, 2001).

Sweet Cliff: It is small pink fruit that has a pebbly shell. The fruit is of good eating quality, but the tree is yet another alternate bearer. It is relatively well known cultivar, but is not planted much anymore due to the availability of superior varieties.

Sweetheart: It is a consistent bearer and is the finest litchi. It produces huge heart-shaped fruit all having chicken tongue seeds. Production is close to that of Mauritius inspiring small commercial plantings by growers targeting high-end produce markets and gourmet restaurants. It is quickly becoming the variety of choice by dooryard growers for its reliability and superior quality.

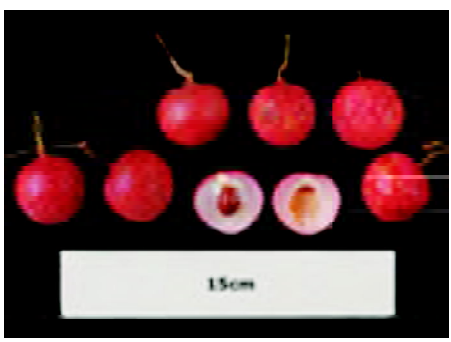


Fig. 37 Fruits of cultivar Sweet Cliff

T and Po or T Ong Pok (pond embankment): It forms a small-leaved tree. The fruit is small, red and rough with thin, juicy and acid flesh and very little rag. It is a very early-maturing cultivar (Morton, 1987).

T Im Ngan or T Ien Yeh (Sweet cliff): It is a common variety of lychee, quite widely grown in Kwangtung (China), but not really on a commercial basis (Morton, 1987).

Fig. 38 Fruits of cultivar Sweetheart

Tai So: It is the most widely grown cultivar in southern Queensland, Australia and is commercially grown in South Africa in the name of Mauritius. It is a common cultivar in China, Thailand and Australia. Its yields tend to be irregular. Trees generally flower poorly or have insufficient female flower to provide good fruit set.

Trees are vigorous and spreading with an open crown, and have branches with weak crotch angles that can split. Leaflets are large, glossy dark green and have an upward curl from the midrib to be almost canoe-shaped. The new flush of growth is bronze changing to dull mid-green to pale green with advancing maturity. Fruits are large (22-26g) and somewhat egg-shaped, with flat shoulders and a round tip. Thin skin is bright red changing to dull red at maturity. Protuberances are hair-like/sharp-pointed when the fruits are ready to harvest. Fruits are not of good quality until fully mature. Flavour is sweet-acid when immature, sweet when fully ripe, and bland with overripe. Flesh is slightly chewy becoming moderately crisp when fully mature. Taste is sweet when fully ripe, TSS 17.0^0 brix. Percentage of skin, seed and aril is 19.0, 15.5 and 65.5, respectively (Chauhan, 2001). Seeds are medium, giving a fair flesh recovery of 60 to 70 per cent. Up to 50 per cent of fruits have chicken-tongue seeds, depending on the season. Fruits often split or brown in hot and dry weather (Anonymous, 2001).

Fig. 39 Litchi Cultivar Tai So

Ta Tsao or Tai Tso (large crop): It is widely grown litchi cultivar around Canton. The fruits are somewhat egg-shaped. The fruit skin is rough, bright-red with many small, dense dots. Flesh is firm, crisp, sweet, faintly streaked with yellow near the seed. The juice leaks when the skin is broken. The fruit ripens early (Morton, 1987).

Tatuo: This cultivar produces the larger fruits (25.6g), which have pink rind and a soluble solids content of 19.3^0 brix (Yuan and Zhu, 2001).

Trikolia: This is an early strain of litchi identified from land race orchard stock of East Champaran. This genotype has resemblence with Shahi with improved fruit retention capacity. The average fruit weight is 18-20 g.

Fig. 40 Fruits of strain Trikolia

NRC Litchi, Muzaffarpur

UPLB Red: In the lowlands of the Philippines, an outstanding cultivar from a seedling tree, which was introduced from Thailand in 1968, had been approved by the National Seed Industry Council for commercial planting. It was named 'UPLB Red'. Marcotted and grafted plants from this variety bear fruits in 3 to 4 years from field planting. The trees flower from December to January and the fruits are harvested from April to May. Fruits of UPLB Red weigh 14 g, are ovate to almost round with a rough skin that turns dark red when fully ripe. The aril is 6 mm thick, is 61 per cent of the whole fruit by weight and has a total soluble solids content (TSS) of 20° Brix (Sotto, 2001).

Wai Chee: It is one of the most commonly grown litchi cultivars in China and is also popular in Thailand (Kim Cheng) and Australia. Wai Chee accounts for over 80 per cent of plantings in Guanxi and bears consistently, because it flowers late and avoids cool weather in spring. It is mostly regular in China, but variable in Australia. Mature fruits can hang on the tree for several days. This adds some flexibility to harvesting and extends the production season. Trees initially lack vigour and establish slowly after planting. They are low, dome-shaped with thick branches, compact foliage and many growing points. They are susceptible to wind damage unless thinned out and lower branches removed. The small leaves are oval-shaped and curve upwards from the midrib and down along their length. New flushes of growth are deep red. The small (16-18g) rounded fruits are formed in small loose clusters. The skin is deep red. Shoulders are flat, although often ridged on one side along the suture line. The skin is of medium texture (less rough than Haak Yip). The flesh is soft, very juicy and sweet. The percentage of skin, seed and aril is 23.6, 8.1 and 68.2, respectively. Average seed weight is 2.0g (Chauhan, 2001). Most seeds are fully developed giving a flesh recovery of 63 to 73 per cent. Although fruits have full flavour, their larger seeds and soft flesh reduce eating quality and price (Anonymous, 2001). It is a new cultivar of litchi for use in South Africa. The most important characteristics of this cultivar are regular high yields and harvesting during February-March with possibilities for delayed harvesting (up to 14 days after ripening). Crop yields and quality are also comparable to the common cultivars HLH Mauritius and McLean's Red (Froneman, 1999).

Yogda Selection 1: This is a chance seedling selection from Yogda Ashram, Ranchi and considered as one of the oldest plant in the premises. The fruits are small and round in shape having proximity with Bedana with high bearing potential. The fruit weight has not crossed the limit of 15g each under institute condition.

Fig. 41 Fruits of germplasm Yogda selection

Yuan Yang Mi: It is a promising litchi (*Litchi chinensis*) selection from cultivar Dahongpao and was selected in the Ibin prefecture in China. This selection has high soluble solids content (19.2^0 brix), but its fruits are smaller (20.7g) (Li, *et al.*, 1999).

Yuan Gyang Hong: It is a promising litchi selection from cultivar Dahongpao and was selected in the Ibin prefecture in China. This selection has high soluble solids content (19.5^0 brix), but with smaller (23.4g) fruits (Li, *et al.*, 1999).

Zeng Cheng Gua Li: It is an excellent cultivar of China with respect to fruit quality. Fruit are oval to near round, 14.4-29.5 g weight, and green to dull red skin and contain 61.5- 76.9 per cent edible portion. The aril is sweet, crisp and fragrant, containing 17-21.5^0 brix and 13.4-31.2 mg/100 g vitamin C. The cultivar ripens during last week of June to first week of July in China (Rai, *et al.*, 2001).

Ziniangxi: It was selected from local litchi seedlings. It is a local cultivar, grown in Hainan Province. Due to its large fruits and high quality, it is still commonly planted in recent years. It produces fruits that weigh 52g and has edible flesh around 72%. Its soluble solids content is a bit lower than that of Edanli. The ascorbic acid content of Ziniangxi is 1.0% higher than Edanli and reaches 90%, while for Edanli is only 50%. The fruit colour of Ziniangxi is purple red. Due to high production of Ziniangxi, it is recommended for cultivation in Hainan province (Li, et al., 2003; Miao, *et al.*, 1998).

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For further details contact :

Director

National Research Centre for Litchi

(Indian Council of Agricultural Research)

Mushahari, Muzaffarpur – 842 002, Bihar, India

Ph.: 0621-2289475, 2281160; Fax: 0621-2281162

E-mail: nrclitchi@yahoo.co.in