Calceolaria arachnoidea: A new crop to revitalize the ornamental market

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Executive summary

In this paper the Calceolaria arachnoidea is evaluated as a crop to be introduced to the commercial market. This crop contains flavanoids which can be used for medicinal purposes. The main potential for this crop is for ornamental purposes. The flower morphology of this crop is aesthetically appealing and will interest growers who are on the lookout for new additions to their garden. The hardiness of this crop is also appealing as it is suited for cooler climates. This crop has great potential to overtake the ornamental market once commercialized production begins. In this paper pollination, scheduling, flower initiation, and many potential uses of this crop will be discussed in detail.

I. Introduction

A. Study Species.

The species being studied is *Calceolaria arachnoidea*. This crop will be evaluated as a product for the market. How it is bred, selected, and produced will be assessed.

B. Taxonomic Classification and Geographic Distribution in the Wild.

Calceolaria arachnoidea is a plant from the *Scrophulariaceae* family, and it is in the *Scrophulariales* order. This crop has many common names which include slipper flower, ladies slipper flower, and slipperwort. *Calceolaria arachnoidea* is native to the Andes Mountains in Chile. The common name used by the locals of this area is capachito. These plants have rhizomatous root systems. The leaves are lance to spoon-shaped, pubescent, and gray to green in color. From summer to autumn the flowers are compact and have two-lipped, deep reddish to purple flowers with a pouched lower petal. Because this crop is native to the Andes mountains, *Calceolaria arachnoidea* is very hardy and can be successfully grown in winters down to -15º - 20º C. Furthermore, it is native to extreme altitudes well beyond the timberline. *Calceolaria arachnoidea* can be grown in USDA hardiness zone 7 and even 6b (Reserva Nacional Altos del Lircay). The climate in Chile is largely influenced by El Niño weather events. These events are characterized by cold temperatures and rainfall which are typically followed by dry and hot years (Murúa et al. 2017).

II. CROP SPECIES

A. History and Potential Uses.

This crop is not edible, but it does have several other uses that have been made use of by the local people of Chile. *Calceolaria arachnoidea* has been known to have astringent properties which are used for medicinal purposes. Also, the flowers of this crop contain flavonoids. Flavonoids are metabolites found in plants that regulate cellular activity and fight off free radicals that cause oxidative stress on the human body (Wollenweber et al. 2000) In addition, it has been used to create red dyes. This species now serves as the bases for creating new varieties (Reserva Nacional Altos del Lircay).

This crop has great potential to be grown as a potted flower. Its stunning purple flowers give the appearance of orchid flowers, but they persist much longer. In addition, they bloom for several seasons. *Calceolaria arachnoidea* can give the aesthetic appeal many growers look for while being hardier. Because this is a flower from the Scrophulariaceae family, the petals are fused giving it a unique aesthetic appeal. For this reason, they can also be used as ornamental plants in outdoor gardens.

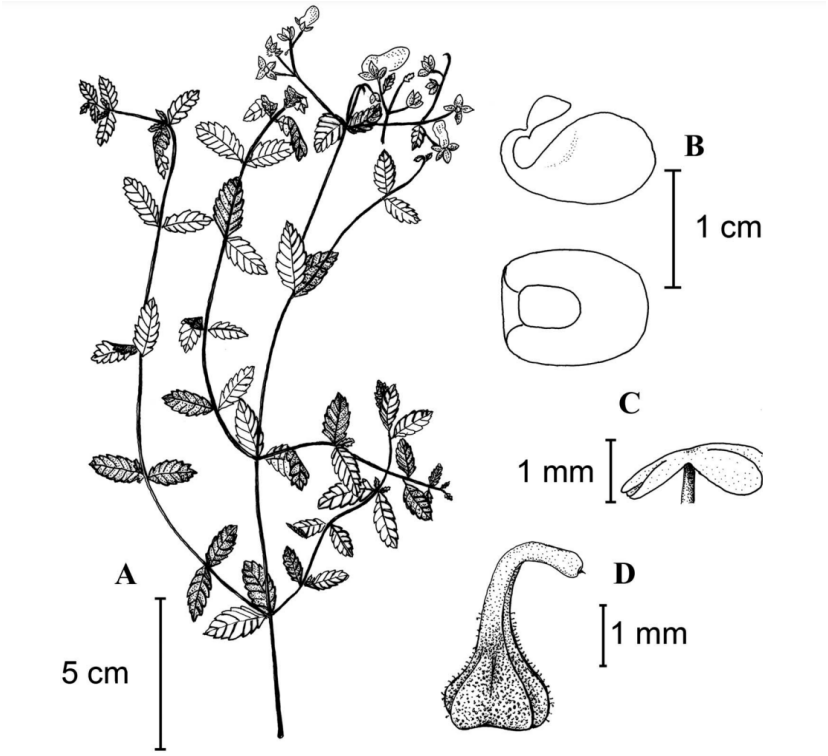


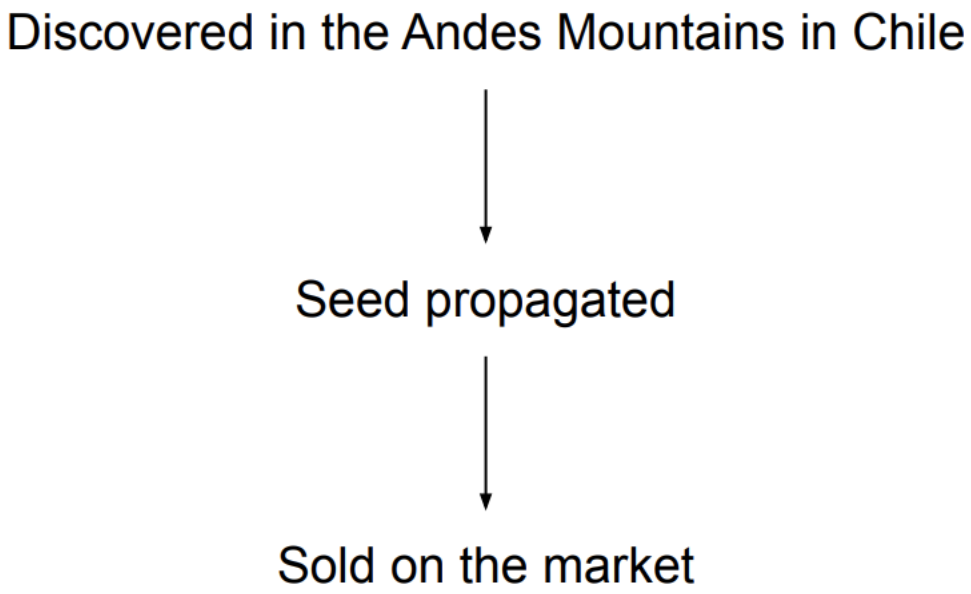
Figure 1. This figure, from *New species of Calceolaria (Calceolariaceae) from Northern Peru* by Romero-hernández et al. (2017) shows the morphological characteristics of the flowers of the Calceolaria crop.

Figure 2. This picture, from *Reserva Nacional Altos del Lircay,* shows the Calceolaria arachnoidea in bloom.

The cultivar that is currently on the market is Graham. At its mature height, it can reach 8 to 12 inches, and it will bloom from May to June. This plant is very currently very limited on the market, so the species available are wild species. There have not been cultivars bred for the market. No information was found regarding the sources or breeding firms involved in the domestication or production of cultivars currently available on the market.

The major challenges this crop will face in production are self-compatibility and pollination. This is an autogamous and self-compatible crop (Cisterna & Murua, 2018). The flowers are nectarless and produce non-volatile oils that pollinator rewards. The morphology of

these flowers restricts pollinating bees' access to floral resources. Murua et al. (2017) explain, that these flowers “have zygomorphic flowers with a small superior lobe that covers the reproductive structures and an inflated lower lobe that contains the oil-secreting glands”. Due to this restrictive pollination requirement, this crop may face challenges when bring introduced to the market. A hybrid cultivar may need to be developed in order to facilitate production in varying habitats.



III. PRODUCTION INFORMATION

A. Anticipated Cultural Requirements.

This crop is an evergreen perennial herb. This plant has the aesthetic appeal of an orchid, but it can survive snowy winters (Romero-hernández et al. 2017). It can be used as an ornamental perennial for the outdoor landscape of gardens, or it can be grown in pots indoors. It is especially desirable for its appealing flowers which are a rich purple color.

Because *Calceolaria arachnoidea* is natively found in the Chilean Andes, it can be grown in USDA Hardiness Zone 7, or even in zone 6b. This crop can be covered by snow for 1 to 8 months (Reserva Nacional Altos del Lircay). A heat zone has not been defined for this crop, but in its native range temperatures can reach 71°F to 82°F. Due to these parameters, this crop would be a great ornamental plant to add to garden and landscape designs.

This plant needs to be grown in partial shade with some shadows. From sowing the seeds to transplant (3 to 5 weeks) 18 hours of light are required. After transplant, for 4 to 6 weeks, 8 hours of light are required. Following this period, 18 hours of light are needed until the plant flowers (Erwin 1994). Temperatures can fluctuate throughout the season from 60°F to 80°F. Calceolarias have relatively low nutrient requirements. Erwin (1994) suggests that they are to be fertilized weekly with a 100-0-11 to 200-0-200 ppm fertilizer solution. It is also recommended to apply nitrate forms of nitrogen only as Calceolaria are sensitive to high levels of ammonia. This crop also requires plenty of water. It is naturally found in water or has roots within a permanent water source (Reserva Nacional Altos del Lircay).

B. Market Niche.

The goal is to produce this crop to be available on the market during the spring. Many consumers design their gardens in the spring, and this is the time when they will purchase the crop they will be planting. When a consumer is looking in the market, they may be accustomed to seeing the same crops in varying colors throughout the years. Introducing this crop with a new unique flower morphology will allow consumers to expand their interests and reach it. A potential limitation will be pollination. This crop will need to have bees visit the flowers in order to be pollinated. Aside from outdoor landscapes, this plant can be sold in pots for indoor growing. This will compete with orchids specifically due to the similarities in their flowers. This will also face the challenge of pollination.

IV. PRODUCT INFORMATION GUIDE (PIG) & CROP SCHEDULE

Plants from the Scrophulariaceae family are generally known to be seed propagated, and this crop is no exception. The Calceolaria seeds are very small. There are up to 30 thousand seed per 1 g. At the moment they are not pelleted, but once commercial demand begins, seeds should be pelleted for ease of handling. Seeds will germinate well on pea which has been sterilized using heat at 90-100 ° C, and to reduce acidity, 15-20g of ground chalk is added to the 1 kg of peat. In addition, one part sand is well mixed with seven parts peat to create the germination medium. Seeds should be sown randomly on the surface of the germination media. Seeds should not be covered as they require light to germinate. Also, germination will occur at a temperature of 18 °C. The crops should be covered with plastic wrap or glass, but they should be regularly checked to ensure no condensation has formed. If condensation occurs, the coverings should be turned over to prevent rot or damping-off from occurring. Seeds should germinate in 10 to 14 days (Evans).

After germination has occurred, it is necessary to ensure the peat is always moist. After two true leaves have formed, the plants should be transplanted into 7-centimeter containers. The media used should be two parts hummus and one part sand. The growth requirements are as follows (Erwin, 1994):

Temperature: After germination has occurred, the temperature should be lowered to 12-16 °C.

Light: These plants will not tolerate direct light, so diffused light is necessary.

Watering: Calceolarias will not tolerate dry soil. Frequent watering is needed to ensure the soil remains moist. The pubescent leaves should not be wet, so only the soil should be watered during irrigation.

Humidity: This crop needs very high air humidity. To achieve this, pots can be placed on top of trays containing pebbles or expanded clay.

Fertilization: A 10-10-10 or 5-10-10 NPK ration fertilizer is best suited for this crop. Fertilizer should be applied every two weeks beginning after the second transplant, which is described in the following section. This should continue until flowering begins.

Once rosettes begin to form, the crop should be transplanted again into 9-11 centimeter containers. The media used should be two parts sod, one part peat, and ½ part sand. Before this occurs, the plants are pinched. Only 2 or 3 leaves are left from the axils of which lateral shoots appear. Pinching will allow the Calceolaria to grow into bushes.

To induce flowering in Calceolaria plants, temperature and day length is crucial. As previously mentioned, the temperature should not exceed 16 °C. This temperature can inhibit flower induction or cause flowers to drop in early development. This temperature can not be exceeded for a minimum of six weeks following induction, and ideally, the temperature should remain at 13 °C. In addition, Calceolaria plants require a minimum of 10 long days, meaning the daytime exceeds the length of the daytime, in order to initiate flower production. The day length during this time should be 14-15 hours long, and the night length should be 9-10 hours (Erwin, 1994).

Table 1. Flower induction requirements for Calceolaria.

Temperature	LD	SD
cool temp. 10°C (50°F)	flowers	flowers
warm temp. 20°C (68°F)	flowers	no flowering

Table 1. This table, taken from *Calceolaria Production* by John Erwin, illustrates the temperature and light constraints of the Calceolaria flower induction period. This also illustrates that for maximum flower production a shorter chilling period will entail a greater need for continued growth under long-day conditions.

Once the plants have matured, they are ready for commercial retail.

Due to the specificity of these growth parameters, production would be best suited for a greenhouse environment. In a greenhouse, almost all aspects of growing, such as light, humidity, temperature, airflow, and soil moisture, can be regulated to suit the specific needs of a crop. A limitation that may be encountered is shipping conditions. Calceolaria flowers may being to drop if temperatures exceed 16 °C. Because of this, the crop must be shipped in vehicles with adequate cooling systems. This would be a limitation if shipping is taking place during the summer or in areas with very warm climates. If plants are being shipped long distances, measures must be taken to ensure the soil remains moist. This would mean ensuring high humidity within shipping containers. In order to avoid these limitations, this crop should not be shipped until a minimum of six weeks after flower induction has occurred (Erwin, 1994). The following production schedule was adapted from *Calceolaria Production* by John Eriwin (1994).

Production Schedule for Spring Flowering:

Sow seed: sow seeds in mid-November

Growing time for cultural segment: 3-4 weeks

Temperature: 18 °C

Day length: Natural

Transplant to 7-centimeter container:

Growing time for cultural segment: 2-3 weeks

Temperature: 12-16 °C

Day length: Natural

Transplant to 9-11 centimeter container:

Growing time for cultural segment: 4-5 weeks

Temperature: 12-16 °C

Day length: Natural

Flower indiction:

Growing time for cultural segment: 6 weeks

Temperature: 13 °C

Day length: long-days

Following this production schedule, this crop will take 18 weeks from sowing for the plants to be ready for commercial distribution. Sowing should take place in mid-November to ensure the crops are ready for commercial sales in the spring. It is recommended that this crop be grown in an environment that has a cool and mild winter climate for optimal production. San Luis Potosi, Mexico has average winter temperatures on 5 to 12 °C, so this is a recommended area for production.

In the future, this crop could be improved through breeding practices. A large limitation to the production of this crop is the flower initiation growth requirements. Breeding efforts should be made to introduce a day-neutral cultivar. This would limit the need for variation in day length. With such advances, the need for greenhouse production could be eliminated. This would lower production costs and could make production more efficient. In addition, such cultivars could be produced in more areas around the world to increase international availability. Breeding efforts could also be focused on developing more drought-tolerant cultivars. This would result in more sustainable production by reducing the amount of water needed. Furthermore, such cultivars would be used in drought-prone areas.

V. ACKNOWLEDGMENTS

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VI. LITERATURE CITED

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