

Protected Cultivation Technology of Lilium

Floriculture is gaining recognition as a profitable alternative to traditional field crops due to its ability to yield higher returns per unit area. The liberalization of the Indian economy led to the transformation of the domestic horticulture trade from an unorganized sector to an organized one, marked by the active involvement of corporate giants. Lilies rank amongst the world's top ten flowers, recognized for their high value due to striking colours, admirable vase-life and in some instances, invigorating fragrance. It is extensively utilized in the floral industry, both as cut flowers and as potted plants. The paper discusses the protected cultivation technology of lily for commercial purpose.

THE genus *Lilium* is a member of the Liliaceae family. Extensively employed in the floral industry, it is commonly used as both cut-flowers and potted plants. *Lilium* species are categorized into three principal groups crucial for commercial cut-flower cultivation: Asiatic hybrids, LA hybrids and Oriental hybrids. These varieties are marketed almost year-round. Climatic conditions, growing methods and post-harvest technologies are very crucial for superior flower quality and the bulb production of the lilies under hills and Northern plains conditions.

Lilium is a precious, non-traditional flower crop that is regarded as the king of flower bulbs. The genus *Lilium* contains about 100 species, 7 parts and 10,000 known cultivars. *Lilium* is a flowering plant that is often referred

to as a 'lily' and its shape, elegance and colour of the bloom are all very beautiful and appealing. It is one of the utmost common bulbous ornamental plants and ranks fourth amongst the world's top ten cut flowers. *Lilium* belongs to the sub-row of Liliaceae and it is a winter bulb that grows 35 to 200 cm tall.

Lilium cultivation in shade-net-house

Commercial floriculture has demonstrated a higher potential per unit area compared to other field crops, rendering it a profitable industry. The liberalization of industrial and trade policies has paved the way for the expansion of cut flower exports. Considering the continuously growing demand for cut flowers,



Lilium cultivation in shade net house

potted plants and planting materials, there is a need for a reconciliatory mechanism that considers the interests of both participants in flower and ornamental plant markets.

The upsurge in flower production in India can be attributed to the adoption of modern farming technology, enhanced varieties/hybrids, improved cultural practices, and upgraded storage facilities. These factors collectively minimize crop losses stemming from both biotic and abiotic factors, ultimately yielding high-quality produce.

Maintenance: For the greenhouse, a variety of types, often hybrids, are grown. They are grouped into the following diverse classes

based on the species and the interspecific hybrids from which they were derived. Asiatic hybrids (Division-I), Martagon hybrids (Division-II), Candidum (Euro-Caucasian) hybrids (Division-III), American hybrids (Division-IV), Longiflorum hybrids (Division-V), Trumpet lilies (Division-VI), Oriental hybrids (Division-VII), Other hybrids (Division-VIII) and true species (Division-IX).

Because of its high selling value in agriculture and greenhouses, the genus *Lilium* is very popular as potted plants and cut flowers.

Climate and selection of site: *Lilium* thrives well in partial shade during its growth period and can be cultivated under protected environments. In regions with a cool climate during its growth, high-quality flowers can be cultivated successfully under shade/polyhouse conditions. For high-quality flower production, lilies require a light intensity of 2000-3000 foot candles. In conditions of low light, such as a photoperiod of less than 12-14 hours, implementing an 8 hr night interruption is crucial to prevent bud drop in lilies. Lilies benefit from shading, typically around 40-50% shade. The most suitable temperature for achieving optimum growth of lily plants falls within the range of 8-20°C.

Soil and soil preparation: *Lilium* has the ability to thrive in various soil types, as long as the soil possesses favourable structure and drainage. However, optimal flowers are obtained in sandy loam soil. The presence of heavy clay soil, characterized by inadequate drainage, hampers plant growth by impeding root development and excessive soil moisture conditions result in disease incidence. Yet, heavy soils can be rendered into cultivable form by incorporating sand along with well-rotted FYM. Cultivation is best suited for soil with a pH range between 5.5-6.5. For both flower and bulb production, lily requires weed-free, well-prepared sandy soil.

Soil treatment: Soil sterilization can be carried out using 2% formaldehyde at a rate of 25 Lit/acre and this should be done at least 1 month before planting. A depth of 30-40 cm soil is excavated from the beds and the bottom soil is swiftly saturated with a formaldehyde solution. Subsequently, trench is refilled and levelled with excavated soil. Following this, bed is promptly closed with polyethylene sheets for about 15 days. After sheet removal, thoroughly irrigate before planting.

Selection of cultivars: The choice of cultivars for cut-flower production is contingent on several factors, like suitable cultivar for the chosen site, plant height, flower size, market preferences regarding colour and the availability of bulbs. Pure white, yellow and pink colours are predominantly favoured and exhibit high demand in the markets.

Nutritional requirements: *Lilium* does not require excessive fertilization. As lily is salt sensitive, the elevated salt levels in the soil due to excessive fertilization can impede both root growth and flowering. The fertilizer needs differ, based on soil type, fertilizer used, soil salt content and prevailing climatic conditions. To improve soil structure, mix well-decomposed FYM @ 5-8 kg per m² on soil surface. The soil was prepared for bulb planting by integrating a specified amount of sand, FYM, Phosphorus and Potassium in the form of Single Super Phosphate

(SSP) and Muriate of Potash (MoP). Calcium Ammonium Nitrate (CAN), preferred @ 1 kg/100 sqm in two split doses after sprouting the lily bulbs in field conditions.

Irrigation: For swift and undisturbed rooting, ensure that the soil contains adequate moisture before planting *Lilium* bulbs. Hence, it is advisable to water the field a few days before planting, ensuring the bulbs are properly inserted into the soil. When there is ample moisture during planting, minimal watering is necessary until the plants begin to emerge.

Planting time and method: In the plains of North-India, *Liliums* were planted in winter, specifically in November and December. In hilly regions, it is done from November onwards. The planting time can vary according to the specific climate and altitude of the selected location. The planting method is also contingent on factors like the selected site, soil type, prevailing climatic conditions and the irrigation system. Based on the prevailing conditions, *Lilium* can be planted either in raised or flat beds and ridges. For light soils like sandy and sandy loams, it is recommended to plant in ridges or on 1-meter-wide raised beds. In hilly regions experiencing high rainfall at the time of crop season, it is advisable to plant in raised beds and ridges. This facilitates efficient drainage and helps in securing the anchor of the plants.

Bulb size: The size of the planted bulb determines the quality of the lily flowers.

A larger size bulb results in taller and more robust plants, showcasing consistent flowering and yielding heavier blooms compared to that of the smaller bulbs. For Asiatic and LA lilies, commercial-sized bulbs have a circumference of 12-18 cm. However, for Oriental lilies, it is suggested to plant bulbs with a circumference of 14-22 cm for high-quality flowers.

Planting density: Planting density of lily varies from type-to-type of lily, cultivars and bulb size. *Lilium* planting density is also influenced by the planting time. When the bulbs are 14-16 cm diameter, bulbs are planted at spacing 15 × 15 cm row-to-row and bulb-to-bulb and about, 40-50 bulbs were planted per m² of net cultivated area.

Depth of the planting: The planting depth of a bulb in the soil primarily hinges on factors such as the bulb's size, soil type, and the planting time. By considering these aspects and the intended purpose of the planting, bulbs and bulblets can be sown at a depth ranging from 4-12 cm. It is recommended to plant a bulb, ensuring a soil layer covering of 4-10 cm.

Dormancy of bulbs: Following bulb harvesting, bulbs will not sprout, if sown immediately, as the bulbs require a dormancy of 45-60 days. The dormancy period varies among cultivars and growing conditions. Storing the bulbs in cold storage is a method to break this dormancy. For the swift emergence of shoots and flowering, lilies necessitate a cold treatment for a minimum of 10-14 weeks at temperatures of 20-4°C before planting. When receiving frozen bulbs from a planting material supplier, it is advisable to thaw the bulbs gradually at temperatures between 7-13°C over a period of 1-3 days.

Propagation: Lily can be multiplied by the means

Characteristics and Cultivars of Lilium

Type	Characteristics	Cultivars	Pictures
Asiatic hybrid lily	Indeed, Asiatic hybrid lilies are the result of hybridization involving 7 distinct Asian species having the features of early flowering (10-12 weeks), easy to propagate, upright flowers and resistance to various insects and diseases.	Enchantment, Salmon-Beauty, Jollanda, Grand Paradiso, Alaska, Monte-Rosa, Red-Tiger, Tresser, Navona, Pollyanna, Snow-Star, Roma, London, etc.	
LA lily	LA hybrids are evolved by crossing <i>Lilium longiflorum</i> and Asiatic hybrid lilies showing the characteristics of Asiatic hybrid lilies except dwarf and sturdy nature.	Bright Diamond, Yellow Diamond, Casa-Rosa, Evening-Star, Pavia, Royal-Dream, Salmon-Queen, etc.	
Oriental hybrid lily	These lilies are derived from various species. These lilies are characterized by flat & horizontally oriented, recurved, fragrant and late flowering (14-16 weeks).	Casa-Blanca, Mona-Lisa, Lareve, Everest, Acapulco, Sans-Souci, Primeur, Siberia, Canberra, Rialto, etc.	



High Quality bulb-size 14-22 cm

of seed, scale, bulblet and bulbil. Successful large-scale multiplication has been achieved through the method of micropropagation.

- **Seed:** Seed can be sown indoor in flat pot during the winter and later transplanted outdoors in the spring. An ideal soil mixture for seed sowing comprises 7 parts of loam, 3 parts of peat and 2 parts of sand. The seeds are planted in pots and then covered with finely screened leaf mould. It is crucial to maintain adequate moisture in the compost. Sowing the seeds in rows is suggested to facilitate the transplanting.
- **Bulblet:** Lily is typically propagated through the division of bulblet that form on the stems, situated just underneath ground level, but above mother bulbs. Separating and planting bulblet individually aids in the production of flowering-sized bulbs after a year of growth.
- **Bulbil:** Bulbil is found in leaf axils. The bulbil is planted in the beds, flats/frames and provided protection over the winter. Typically, it takes 2-3 years for bulbils to develop and produce robust blooms.

Tiger and LA lilies exhibit this behaviour.

- **Scale:** The scale method is a swift method of multiplication. In early autumn, the bulbs would be lifted and the scales should be carefully detached from the outer whorl of the bulbs. After being treated with fungicide, the scales were planted in the well-prepared sandy-soil beds. After planting, it is essential to provide a protective winter mulch. Small bulblets quickly emerge at the base of the scales, but it is advisable to leave them for an additional year of growth before transplanting them to their designated flowering location.

Support: Providing support to lilies with wire or netting is essential throughout their active growing period. This support can be extended parallel to the growth of the plants until the flower stems are harvested.

Physiological disorders: *Bud drop:* It is categorized by wilting and whitening of flower bud, followed by necrosis. It typically occurs when the bud is 2-3 cm in length. Bud drop is linked to low light and short-photoperiod, often



In vivo bulblets production through scales

Insects and diseases

a) Insects

Insect	Damage	Control
Aphids	Sucks the saps from the younger plants Transmits the viral diseases	Foliar spray of metasystox or rogor @ 1.5 ml/lit water.
Thrips	Feeds on blooms and petal sheaths Cause the silvery and the whitish streaks	Spray Dimethoate @ 2ml per lit. water
Cut worms	Feeds on the different plant parts and sever the plants at the base	Spray of metasystox or rogor @ 1.5 ml/lit water.
Mites	Feed on the leaf blades under the warm and the shady areas White coloured specks seen on the leaves which later turns to bronze/silver	Spray miticides viz. Dicofol @ 1ml /lit water or Omite@ 0.3ml/lit water.

b) Diseases

Disease & Casual Organism	Symptoms	Control
Root rot complex (<i>Fusarium solani</i> , <i>F. oxysporum</i> , <i>Pythium</i> spp., <i>Rhizoctonia solani</i> , <i>Phytophthora cactorum</i>)	Here the infected parts become shrunken, plants then wither and die, but the bulbs remain undamaged. Stem become brown-blackish & weak, tends to break the plant.	i. Proper drainage should be provided. Dug up and destroy infected plants ii. Spray copper fungicide in early spring. iii. Treat the bulbs before planting with solution of Carbendazim @ 2g/litre water
Bulb rot (<i>Fusarium oxysporum</i> var. <i>lilii</i> & <i>Cylindrocarpon destructans</i>)	Restricted to the base of scales that are separated from the basal section of the bulbs. The lower leaves arising from infected bulbs turn yellow or purple and prematurely dry out.	i. Removal of infected plants ii. Drenching of soil with formalin iii. Drenching of Captan @ 0.2% solution
Bacterial soft rot (<i>Erwinia carotovora</i>)	Bulbs show a soft and wet decay.	Discard infected bulbs Proper drainage Avoid bulb injury during digging from soil

exacerbated by high temperatures. **Leaf scorch:** It takes place during the critical visible bud stage. Initially, the young leaves exhibit a slight inward curl, followed by greenish-yellow to whitish spots on the scorched leaves, a few days later. It occurs when there is an imbalance between water absorption and transpiration, leading to 'Ca' deficiency in young leaves. Applying a foliar solution of 1% CaCl_2 just before the visible buds become apparent can help reduce leaf scorch.

Harvesting: The flower spikes are harvested at a height of 15 cm above the ground level when they begin to show color and just become loosely attached. The residual portion of plant is permitted to continue growing so that the development of bulbs can persist in soil. Subsequently, the spikes are sorted based on the number of the flower buds per stem, length of the stem and its firmness. The lilies are then bunched into a bundle of six stems. For proper packing, foliage must be removed from the lower 10 cm of the flower spikes.

Storage: Following the bundling process, Lilium spikes are immersed in a suitable preservative (STS) with an optimal storage temperature of 2-3°C for a shorter duration. Harvesting at higher temperatures may lead to the development of brown spots on the outer petals. Remedy is to store at a temperature of 4°C. The bulbs should be carefully packed in the perforated trays, either in peat moss or sawdust, and stored at a temperature range of 2-3°C with 70% relative humidity for a minimum period of 2 to 3 months in cold storage.

Yield and economics: Yield of the Lilium depends on mostly the type of cultivar used. Lilium produces a flower stem for every bulb with 100% flowering represented. It is

a prosperous exotic bulbous crop that offers a numerous benefit from protected cultivation. It is important for farmers to carefully plan their greenhouse operations, consider the initial investment costs and acquire the necessary knowledge and skills for successful greenhouse management. Lilium generates a net income of ₹ 300,000 to 350,000 in Asiatic hybrid or LA hybrid Lilium and ₹ 400,000 to 450,000 in case of Oriental hybrid lilium cultivation under 1000 m² protected area.

CONCLUSION

The protected cultivation technology for lilium presents a strategic and systematic approach to cultivating this high-value and profitable crop. By incorporating practices such as precise harvesting, grading, and post-harvest preservation, growers can optimize the quality and market value of lilium spikes. The use of controlled storage conditions, including appropriate temperatures and humidity levels, further contributes to the preservation of the bulbs. Overall, the implementation of these technologies not only enhances the yield and quality of Lilium but also establishes it as a financially rewarding venture for those engaged in its cultivation. This methodical approach to protected cultivation positions lilium as a promising and lucrative crop within the horticulture sector.

For further information, please contact:

Division of Floriculture and Landscaping, ICAR-Indian Agricultural Research Institute, Pusa, New Delhi 110012.