Lilium

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Lilium

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Preface

Floriculture is considered as one of the most diversified and potential components of horticulture industry. It is one of the fastest growing sectors in domestic and international trade and holds high business potential and prospect. Now a days, it is the key component in the trade of diversified range of products. There is a dynamic shift from sustenance production to commercial production in this era and there by significant increase in trade of flowers at domestic level and profit to farmers; because of rapid urbanization, increase in income level, *etc.* Commercial floriculture has assumed the status of most important component of export basket nowadays. The liberalization of industrial and trade policies and new seed policy are the major factors that paved the way for development of export-oriented production of cut flowers.

Lilium enjoys a universal acceptance and there is hardly any other bulbous flower which can match its beauty, colour and fragrance. Great diversity in flower colour, shape, size, fragrance, good keeping quality and morphological characteristics made lilium top ranking cut flower in the flower trade. Among the cut flowers, cultivation of lilium is highly lucrative profession and also has good export potential. There is a tremendous scope for its commercial cultivation in Himachal Pradesh, Jammu & Kashmir, Uttarakhand and similar other hilly terrains of India. The main strength of lilium cultivation in these areas lies in the suitability of climate for quality cut flower production and bulb multiplication, availability of manpower, lesser cost of cultivation compared to major temperate bulb growing countries.

It is expected that the analytical approach and forward looking concepts presented in this technical bulletin will prove useful for the stakeholders to address the future challenges for growth and development of the lilium industry. We thank Dr. N. K. Krishna Kumar, Deputy Director General (Horticultural Science) ICAR, for his constant encouragement, support and guidance for promotion of Floriculture. We extend debt of gratitude to Dr. K P. Singh, Director, DFR, Pune for bringing the information in the form of this technical bulletin.

(M.Q. Sheikh, Z.A. Bhat,
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1. Introduction

Flower bulbs, also called ornamental geophytes, exhibit great diversity in their morphology, growth and developmental biology, and physiological responses to environmental factors. Horticulturally, they contribute significantly to the global ornamental industry, and are utilized for commercial bulb and flower production, including outdoor and forced fresh-cut flowers and potted plants, and for landscaping, including private gardening. Although ornamental geophytes belong to more than 800 different genera, the industry is dominated by 7 genera: *Tulipa*, *Lilium*, *Narcissus*, *Gladiolus*, *Hyacinthus*, *Crocus*, and *Iris*. Most of the traditional flower bulbs are cultivated in temperate-climate regions of the world. However, as the global demand for all ornamental geophytes continues to increase, it is obvious that innovative production and marketing efforts are needed. Geophytes are especially suitable for commercial floriculture production because the storage organs can be harvested, stored, and forced into flowering (programmed). Production time required for forcing is often short because the storage organ provides stored photosynthates for rapid growth.

The genus *Lilium* belongs to the Liliaceae family which comprises of about 80 species and thousands of cultivars. The lily species are taxonomically classified into seven different sections based on various morphological and physiological characteristics. The diversity of flower colour, shape, fragrance and other phenotypic and physiological characteristics are found in the wild species which are dispersed in the Northern Hemisphere (10° to 60°), mainly in Asia, North America and Europe. Especially, China, Nepal, Korea and Japan are the gene centers of this genus around the world. All over the world the lily occupies a prominent place in horticulture as a cut flower, pot and garden plant. As a cut flower, lily is ranked as the fourth most important crop in the Netherlands. At present, commercial cultivation of lilium in India is centered in and around Himachal Pradesh, Uttrakhand, Jammu and Kashmir and Haryana, from where flowers are being sent to local and international market.

2. Botanical description

Lilies belong to family liliaceae. The bulb is made up of over-lapping scales and bulb tunic. The stem is unbranched and leafy with the leaves scattered up the stem or arranged in whorls. Leaves are narrow to broadly oval. Flower stalks are long and sturdy. Size of flowers varies from 10-20 cm across and stem length ranges from 50 -120 cm depending on the variety. The lily inflorescence may be a raceme, an umbel, or a single terminal flower. The forms of the flower vary between species and cultivars, some being pendulous, others erect or horizontal and there is variation in the extent of recurving of the perianth segments. Flower colours include white, yellow, pink, orange, and red. Many lilies have flowers with secondary colours or speckled blooms. The fruit is a capsule containing numerous flat seeds. Lilies produce different kinds of roots like contractile, feeder and stem roots. Some lilies produce roots along the stem from the top of the bulb, slightly above the soil surface. These roots help in supporting the plant and absorbing water and nutrients. Lily bulb have a solid basal plate that produces roots from its bottom

and a concentric series of tight-to-loose, fleshy, over-lapping scales of varying width from its top. Mature bulbs are 4-9 inches in circumferences.

3. Classification and varieties

Lilies are classified into Asiatic, oriental and longiflorum hybrids each with their specific characteristics. Most of the cultivars, however, are interspecific hybrids within the sections (especially Leucolirion, Archelirion and Sinomartagon) and represent the most important cultivated groups which are:

i. The Longiflorum hybrids which originate from intra- or interspecific hybridization in the Leucolirion section, have trumpet-shaped, pure white flowers, a distinctive fragrance, year-round forcing ability and mostly outward-facing flowers. Important cultivars are: Ace, Nellie White, Snow Queen, Casa Rosa, Deliana etc.

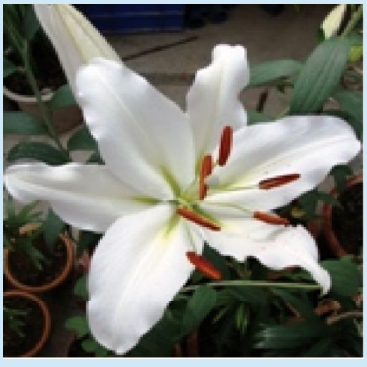
ii. The Asiatic hybrids are derived from interspecific crosses among at least 12 species of the Sinomartagon section. Cultivars of Asiatic hybrid lilies have a wide colour variation in their flower tepals (orange, white, yellow, pink, red, purple and salmon) and early to late flowering. Some species in this section show resistance to *Fusarium* and viruses. Important cultivars are: Brunello, Elite, Navona, Pollyanna, Tresser, Dreamland, Prato, Vivaldi, Torento, Grand Paradiso, Shiraj, London, Detroit etc.

iii. The Oriental hybrids are nowadays the most important lily hybrid group. They result from hybridization among five species of the Archelirion section. Generally, Oriental hybrids are late-flowering, with big and showy flowers with a pleasant fragrance. Commercially important cultivars are Stargazer, Siberia, Tiber, Casendra, Barnini, Lombardia, Casa Blanca, Le Reve etc.

Recently, the demand of LA (Longiflorum x Asiatic) hybrids and LO (Longiflorum x Oriental) hybrids have gained momentum and replaced the Asiatic hybrids. LA hybrids are more floriferous than the Asiatic ones. Important LA-hybrids are: Pavia, Brindisi, Ceb- Dazzle, Diabolo, Fangio, Samur, Ercolano, Cilesta, Bestseller, Honesty, Indian Summerset, Mastermind, White Heaven etc.

Stargazer

Siberia



Rialto

Pavia

Bright Diamond

Yellow Tycon

Elite

Navona

Brunello

Different cultivars of lilium

Different varieties recommended for commercial cultivation for various locations under the AICRP (Floriculture) programmes are listed in Table 1.

Table1. Varieties recommended for cultivation

Varietiy	Growing period (day)	Plant height (cm)	Number of buds	Colour
Brunello	90 -100	90-100	6-7	Orange
Bariton	80-90	120-130	7	Orange
Gironde	90-100	110-120	7	Yellow
Navona	90-100	80-90	6	White
Nello	110-120	120-130	6	Orange/red
Tresser	100-110	100-110	6-7	Orange
Oriental hybrid				
Acapulco	90-100	120-130	4	Dark pink

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Varietiy	Growing period (day)	Plant height (cm)	Number of buds	Colour
Bernini	100-110	120-130	5	Dark pink
Laguna	100-110	100-110	5	White
Mero Star	90-100	120-130	6	Pink/Red
Mother Choice	100-110	120-130	6	White
Rialto	110-120	120-130	5-6	White
Siberia	110-120	100-110	5	White
Sorbonne	110-120	100-120	5	Pink, White Edge
Tiara	90-100	110-120	5	Pinkish White
Tiber	100-110	100-110	6	Reddish Pink
LA-hybrid				
Bright Diamond	90-100	130-135	5	White
Ceb Dazzle	90-100	100-110	6-8	Yellow
Cilesta	80-90	120-130	6	Orange
Courier	80-90	100-110	6	White
Ercolano	90-100	90-100	5	White
Eyeliner	90-100	120-130	5	Yellow
Golden Tycoon	100-110	120-130	6	Yellow
Litowen	80-90	120-130	6	White
Menorca	90-100	130-135	5	Salmon
Serrada	90-100	110-120	6	Yellow
Pavia	90-100	100-110	6	Yellow
OT-hybrid				
Avocado	110-120	130-140	6	Salmon /yellow
Yelloween	100-110	130-140	5	Yellow
Torriana	100-110	110-120	4	Pink
Rexona	80-90	110-120	4	White
Belladonna	100-110	100-110	4	Yellow
Addison	100-120	120-130	7	White

4. Propagation

Lilium is propagated by bulblets, axillary bulbils, separation of scales, division of bulbs, leaf cuttings and through micro-propagation. Vegetative propagation allows plants to grow into true-to-type. Propagation through scales is a rapid means of multiplication.

i. Scale

Vegetative propagation by scaling is the most cost-efficient and rapid method to increase a clone. Most lilies can be propagated readily from bulb scales. Only clean, large, disease-free bulbs from the stock are used for scale propagation. Break the scales off cleanly at the basal plate to permit good bulblet formation. Dip the scales in a suitable fungicide (Carbendazin 2g/l for 20 minute); thiabendazole, (TBZ) or in 200 ppm NAA or IBA or BA (100ppm) for 30 minute. Pack the scales thinly in layers in a moist medium in trays or boxes. The sphagnum peat and vermiculite are excellent media for scaling. Incubate the scales in a well-ventilated room at 24±1^{0}C until the bulblets and roots are fully formed. The duration of incubation depends on the variety. Asiatic hybrid lilies require 10-12 weeks, trumpet species and hybrids 12 to 14 weeks, and Oriental hybrid lilies 16 to 18 weeks.

Bulblets formation from scales

ii. Stem bulblet

Bulblets may be formed on the underground or above ground part of the stem. The number and size depends on the species or cultivar and the strength of the individual bulb. Stem of a vigorous one can generate up to a dozen or more bulblets. Perfectly formed small bulbs with scales and roots behave independently once the stem dies back. The number of these bulblets to be harvested from the buried part of the stem is positively correlated to the amount and vigor of the stem rooting. To increase the harvest by number and, even more significantly, by weight and volume, stem rooting needs to be encouraged. This can be done initially by providing an open, gritty, humus-rich soil and planting the bulbs with

at least 10-15cm deep above their noses, kept moist but not over-wet. Stem rooting activity can be dramatically increased by humus mulches from late spring onwards.

iii. Axillary bulbils

Small, dark bulbils appear in the leaf axils; they swell to become purple-black mini-bulbs, sometimes starting to produce leaves and roots before they are fully ripe and fall to the ground. Bulbils formation can be enhanced by removal of flower buds. If bulbils are harvested and potted up before late season, a good proportion of reasonable sized plants can be obtained to bear one or more flowers in the very next season.

iv. Tissue culture

Tissue culture is a method of propagating plants in the laboratory. Tiny amounts of plant tissue are placed in a sterile nutrient medium. Plant growth hormones are added to the medium to induce these cells to multiply and differentiate until they form tiny bulblets. This technique has revolutionized the horticultural industry by permitting the production of vast number of offsprings from an individual plant. It is possible to select a seedling and within two years produce several thousand bulblets, which can be marketed in another two years. The material used to initiate a lily tissue culture usually comes from bulb scales, but stem segments with an internode, or flower buds, can also be used. To avoid sacrificing a precious plant, bulbs may be carefully dug, leaving the stem intact in the ground, where it usually produces stem bulblets. The material to be cultured should be kept fresh and packed dry to prevent fungal growth.

5. Production technology

Growing environment

Most of the lilies are commercially grown under protection in greenhouse or polyhouse, and under shading nets. These require sufficient light and proper ventilation.

Location: Lilies prefer location having cool temperature, free from water logging and strong winds. Asiatic lilies are relatively easier to grow and can be grown in elevated locations, even in the plains during the cooler months. Oriental hybrid lily can be successfully grown in cool hilly regions.

Climate

Temperature: Asiatic lilies require a night temperature (in greenhouse) of 13-17^{0}C and not higher than 21^{0}C day temperature; while oriental lilies require 17-18^{0}C night temperature (in greenhouse) and day temperature should be ideally around 29^{0}C. In general, Asiatic lilies took 30-35 day to flower and oriental took 50-55 day. When seasonally warm temperatures occur, keeping the soil and air temperatures below 20^{0}C is recommended. Temperature below 15°C can result in bud drop and yellowing of foliage in oriental hybrids.

Light: Light influences flowering both, photoperiodically and photosynthetically. Long photoperiods enhance floral initiation, making lilies a quantitative long day plant. Long photoperiods can substitute for cold on weekly basis. Lilies require a medium to high light intensity (> 2500 foot candles) in greenhouse cultivation, especially during the short days of the winter. In locations where the day length is shorter than 12 hours, lilies respond to assimilation lighting during the winter. This aids in reducing flower abortion and flower abscission with sensitive varieties. Extremely high light intensities and the accompanying high temperatures can cause flower abortion, leaf scorch and/or leaf sun burning. For quality flower production in lilium, 2000 – 3000 foot candles of light is essential.

Humidity: Humidity is the amount of moisture present in the air. If the temperature is higher, air can contain more humidity as compared low temperature. Plants require humidity of 75 to 85% when grown in polyhouse/greenhouse/tunnels. If the humidity reaches 100%, the plants can become wet and it generally occurs when the temperature drops too much during the night. When plants of lilies remain for several hours in such a condition, there is a great risk of *Botrytis* infection on leaves and cell bursting. When humidity drops below 60% in combination with warm weather, the plant leaves will get weak and drop down. To prevent this type of incidence, watering in the morning and putting a shade net above the lilies is recommended. For successful cultivation of lilium, large fluctuation in humidity in combination with temperature should be avoided (to prevent *Botrytis* and leaves burn/scorch). Humidity can be controlled with proper ventilation, circulation, heating and screening.

CO_2: CO_2 has a positive effect on the growth and flowering of lilies. An optimum concentration of 800 to 1000 ppm is recommended for commercial cultivation. The use of 1000 ppm CO_2 in conjunction with supplemental lighting improve quality, reduced flower bud abortion and reduce the number of days to flower. A higher concentration (2000 ppm) is needed for the Longiflorum hybrids, as this group needed high levels of CO_2.

Ventilation: It has been observed that, a lot of heat build-up underneath polyfilm inside a polyhouse. Sometimes, temperature can rise to record high if no provision is made for proper ventilation. To have proper ventilation inside the greenhouse, it is advisable to build a structure with a top ventilation gap of

minimum 3 feet. Depending on design and size of the greenhouse, one can have a provision for side ventilation as well. If the distance from side to center of the greenhouse is less than 30 feet, side ventilation in combination with top ventilation is recommended. The side should not be closed completely, as to keep the natural airstreams flowing.

Protected cultivation of lilium

Bedding media and cultivation

Soil: Lilies can be forced into flower in almost any type of soil. The soil used for cultivation of lilies should have good structure, particularly the top layers and should also be kept well drained during the entire growing period. Heavy soils usually reduce the height of the crop. In addition to water and nutrients, having enough aeration in the soil is also essential for good healthy root system and thus for plant development. Maintaining the optimum pH of soil plays a major role in root development and uptake of nutrients. It is advisable to maintain a pH of 6 to 7 for the Asiatic and Longiflorum hybrid groups, and pH of 5.0 to 6.5 for the oriental, OA, LO, and OT hybrids. The electrical conductivity (EC) less than 1.0 is best suited for growing the lilium crop. The Chlorine in the soil should not exceed 1.5 mmol/lit.

Planting depth: Lilium bulbs should initially be planted at a depth of 15 cm. After planting and irrigation, the soil will settle down about an 3-4 cm leaving 10 cm of soil on top of the bulb. This is sufficient for the stem roots to develop properly. Shallow planting will result in poor stem-root development and hence

compromise on the quality of the flower. Planting depth varies according to the size of the bulb. Bulbs planted at 5cm deep delays the flowering time, while bulbs planted by kept nose at soil line and ½ bulb exposed resulted earlier flowering. Generally bulb should be planted to the depth of three times more than the diameter of the bulb.

Planting density: Due to the differences in plant growth produced by the various groups, cultivars and bulb sizes, the planting density should vary accordingly. Planting density will also depend on the planting period and the type of soil used. For flowering during months with high temperatures and high light intensities, the planting density can be higher. In darker periods (winter) or under conditions of low light, the planting density should be lower. On heavy soils such as peat soil, the plants will exhibit denser habit so that a lower planting density should be kept. The following table indicates the planting densities per square meter area according to the bulb sizes.

Table 2. Indication of planting density according to bulb size per net square meter

Bulb size (cm)	Bulb /m^2	Planting distance (cm)
8-10	49	15 x15
10-12	42	16 x15
12-14	36	16 x18
14-16	36	16 x18

Mulching: One way of conserving moisture in between watering is by mulching. Mulching is advantageous for lilies. It keeps the soil cool, loose, discourages weeds, control soil borne pathogens and control black body radiation. It provides a fluffy, nutritious medium for the stem-roots to revel in, and it keeps the soil from baking and packing and catches and holds every little shower. The mulch can consist of rice hulls, rice straw, pine needles, upgraded black peat, etc. A certain amount of care should be taken when mulching, due to the possible presence of the fungus *Rhizoctonia solani* in some mulching materials.

Stalking: A plant support system may be necessary depending on the cultivation period and cultivar. A crop produced during the winter months always require support; at other times of the year, cultivars taller than 80-100 cm will usually need support. The usual way of providing this support is the use of wire grids similar to those used in chrysanthemum cultivation. These grids are then raised as the crop grows taller. Such a grid can also be used during planting as a way to determine planting density.

Irrigation: The amount of irrigation water depends on type of soil, greenhouse climate and the variety. Too much or too little watering will result in uneven, delayed emergence and growth; reduction in stem length; *Pythium* (by excessive watering); and even flower bud desiccation among certain susceptible

cultivars. Water requirement in summer is 6 to 8 l/ m^2 / day and in other season are 4 to 5 l/ m^2 / day. First two weeks, irrigation only by using water can or shower is advised. Third week onwards, it is recommended to use drip for irrigation. Lilies are sensitive to salt. High salt contents will produce roots that are hard, brittle and yellow to brown in colour. A high salt content will also reduce the roots capacity to absorb water, and this will lead to a reduction in the height of the crop. The electrical conductivity of irrigation water should be 0.5 mS/cm or lower. The maximum acceptable chlorine level of irrigation water used for greenhouse irrigation is 200 ppm.

Fertilization

For satisfactory growth and flowering, regular supply of nutrients is essential. Since, lilium is a bulbous crop, most of its nutrients are already present in the bulb itself. Lilium is a very salt sensitive crop and therefore one should take care while applying fertilizers. Especially in the first three weeks when the rooting takes place, no external fertilizers application are required. Good root development is important at this stage. It is however advisable to apply 15:15:15, NPK@ 2kg/100m^2 at least one week before plantation. Three weeks after plantation: Calcium Nitrate @ 1 kg/100m^2. Six week after plantation : Potassium nitrate @ 1 kg/100m^2. If plants are not strong enough during growing period due to Nitrogen deficiency, a top dressing of Ammonium Nitrate @ 1 kg/100 m^2 can be applied up to three weeks before harvesting.

Table 3. Nutrient standards for Coco peat media in lilium

Nutrient	Standards in mmol/l	
	Asiatic hybrid	Oriental hybrid
Nitrogen (N=NO_3,NH_4)	2.0	3.0
Phosphate (P)	0.15	0.15
Potash(K)	1.0	1.3
Calcium (Ca)	1.5	1.8
Magnesium(Mg)	0.8	1.0
Sulphate (SO_4)	1.5	1.5

Table 4. Fertilizer requirement in kg/1000 l of water for A and B tanks

A' Tank fertilizer grade	Fertilizer requirement (kg/ 1000 l water)	
	Asiatic	Oriental
Calcium Nitrate	69	76
Ammonium Nitrate	9	7
Potassium nitrate	22	17

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'B' Tank fertilizer grade	Fertilizer requirement (kg/ 1000 l water)	
	Asiatic	Oriental
Potassium nitrate	51	48
Magnesium sulphate	49	52
Borax	0.5	0.5

When the balance of elements in the soil is disturbed by being too much of one in proportion to another, it impair the absorption of some elements by the plant. The following table lists the elements that can affect each other in this way.

Table 5. Elements that affect the absorption of other elements

Excess element	Reduce the absorption of this element
NH (Ammonium)	Ca (Calcium), Mg (Magnesium)
K (Potassium)	Ca (Calcium), Mg (Magnesium)
Mg (Magnesium)	NH (Ammonium)
Mn (Manganese)	Fe (Iron)
High EC level	Ca (Calcium)

Field view of lilium

Harvesting

Postharvest treatment of lilium flower

- Lilies should be harvested at the cutting stage, i.e. 8 to 10 cm above the ground when lower first bud shows the colour of flower.
- Stems drying should be avoided during and after harvesting.
- After harvesting, stems are graded according to number of flower buds per stem, length sturdiness of stem, and any disorders affecting leaves and flower bud.
- During bunching, trimming of 10 cm of foliage from end of the stems and the stems cut to equal lengths and subsequently sleeve the flowers.
- Immediately after bunching, the cut flowers should be placed in cold water in cold storage room at $2^{\circ}C$ to $3^{\circ}C$. Addition of sucrose (2%) and GA_3 (100ppm) as a preservative agent improve the vase life of flower.
- During transportation, only perforated boxes should be used to maintain a proper temperature.

Harvesting stage of lilium cut flower

Grading of lilium cut stem

Packaging in cellophane sleeve

Postharvest study in lilium

Procedure for postharvest treatment of bulbs

- Maintenance of soil moisture level in such a way that bulb scales should not dry out. Excessive moisture may lead to rotting of bulbs.
- The bulbs should remain in the beds for 4 to 5 weeks (above ground stem portion should dry out and can be pulled out from bulb easily).
- After 5 weeks, remove the bulbs from soil along with dried stem.
- Dried stem should be carefully without damaging the bulb.
- Washing of bulbs with clean water and treat them with Carbendazim (2%) solution for 10 minute.
- The bulbs should be air dry in shade. Too much drying may loosen root-skin. Such bulbs after planting may develop root rot.
- Immediately after drying, pack the bulbs in plastic crates with moist coco peat wrapped with perforated plastic sleeves.
- Coco peat used for packing must be sterilized.
- Keep the crates in cold storage at 2^{0}C for 6-8 week or 2 week and then at -1^{0}C for 6 week for longer storage.
- Keep crates open for one day in cold storage and then close with plastic sleeves.

Lilium Bulb production

Lilium Bulblets

Tresser

Turandot

Luries

Pavia

Bulb & Bulblets formation in different cultivars of Lilium

6. Plant protection

Table 6. Major disease and insect of lilium, their symptom and control measure

Diseases	Symptom	Control measure
Penicillium	During storage; brown rotten spots covered first with white and later on with fluffy bluish green fungus are visible on the scales. Affected bulbs produce plants with retarded growth.	Store the bulbs at the lowest recommended temperature. Keep soil moist and remove infected scales.
Bulbs and scale rot	Underground brown spots on top and side of bulb. Later on start to rot. Retarded growth. Pale foliage.	Soil disinfection. Maintain lowest possible soil and greenhouse temperature. Remove infected scales/bulbs.
Fusarium	Premature yellowing of the lower leaves which turn brown and then drops to orange to dark brown spots on stem.	Soil disinfection. Maintain lowest possible soil and green house temperature.
Rhizoctonia solani	Sunken light brown spots on leaves and first leaves above ground rotted. Wilted and leaving brown scars on stem, delayed emergence, poor flowering or non existent.	Keep soil temperature below 15°C. Soil disinfection before planting, planting bulbs with healthy bulb root system.
Phytophthora nicotianae	Retarded growth, wilting of foliage, stem base- dark green to dark brown in color spreading upwards, leaves become yellow.	Soil disinfection. Ensure that soil is well drained. Maintain soil temperature low during summer months.
Pythium ultimum	Plants remain short, pale foliage; flower bud desiccation and bud drop takes place. Smaller flowers. Transparent light brown rotting spots on bulbs. Stem roots are completely limpy and watery.	Soil disinfection. Maintain a low soil temperature. No excessive water. Soil drenching of Ridomil @2.5 g/l.

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Diseases	Symptom	Control measure
Botrytis elliptica	Small, dark brown spots on foliage. Infected tissue gradually dies off. Raised brown spots on outer, bud rotting, deformed development on opened flower grey, watery, round spots.	Keep crop dry, by adjusting plant density, weed control, irrigation in morning, alternate spraying captan (2g/l) + Carbendazim (2g/l)or Carbendazim (2g/l) + Dithane M-45 (2g/l).
Sclerotium rolfsii	Shoot emerge slowly, leaves wilt and rot, brown spots appear on the foot of stem, presence of white strands of hyphae, bulbs rotted.	Keep soil temperature low, crop rotation.
Pest	**Symptom**	**Control measure**
Aphids	Upper leaves are curled and deformed. Green spots on young buds; flower could be deformed and remain partially green.	Weed control, spray with chloropyriphos (2ml/l) or Nuvan (1ml/l).

7. Nutrient deficiency

i) Iron (Fe)

Symptoms: The leaf tissue between the veins of young leaves becomes yellowish-green, particularly in plants with rapid growth. The greater the iron deficiency the more yellow plant will become.

Control

- Well drained soil with low pH level.
- Application of Chelated- Fe (2-3 g/m^2) before planting and after planting (maximum 2 g / m^2).

ii) Nitrogen (N)

Symptoms: The whole leaf becomes lighter in colour and this is often more noticeable when plants are about to bloom. The plant often seems rather slight yellow in appearance. Soil with a low nitrogen level produce a crop with stems which are lighter in weight and have less flower buds. The foliage in the vase will turn yellow more quickly.

Control

- Application of sufficient quantities of nitrogen, preferably based on the results of soil sample.
- Application of additional nitrogen, if the nitrogen deficiency is diagnosed during cultivation.

iii) Phosphorus (P)

Symptoms: Deficiency initially appeared as very stunted plants with normal green leaf pigmentation. Later symptoms developed in the lowest leaves as uniform chlorosis of the entire leaf. This was followed slowly in the lower leaves by tan-brown necrosis. Chlorosis and necrosis progressed up the plant. These latter two symptoms were similar to the symptoms of N deficiency in appearance, location, sequence, and progression.

Control

- Application of di-calcium phosphate.
- Apply phosphate previous to tilling the soil.

iv) Potassium (K)

Symptoms: Deficiency symptoms occurred initially on the leaves of the upper half of the plant, either as dark brown spots or streaks. This brown pigmentation developed in a zone covering the mid 40–60% of these leaves between their tip and base. Position of the initial symptom within this zone varied from leaf to leaf appearing either on the margins of the leaf, along the mid-vein, or across the entire leaf width. The pigmented tissue became necrotic and appeared to desiccate. Tissues at the terminal end of these leaves turned light green. The symptoms of dark pigmentation and necrosis spread toward both ends of the affected leaves and to leaves lower on the plant.

Control

- Fertilizing the crop with nitrate of potash through sprinkling.

8. Physiological disorder

i) Leaf scorch

Cause: Leaf scorch occurs when there is a disturbance in the balance between absorption and evaporation of water. This is the result of inadequate absorption or evaporation which causes a calcium deficiency in the cells of the youngest leaves. Cells are destroyed and die. A sudden change in the relative humidity inside the greenhouse can affect this process related to poor root system and high salt level in the soil. Large bulbs are more susceptible than smaller one. Oriental hybrids are more susceptible than Asiatic and LA hybrids.

Control

- Disease and pest which could damage the roots should be controlled effectively.

- Soil should be moistened before planting.
- Avoid using susceptible varieties or avoid using larger bulbs, as these are extra sensitive.
- Plant bulbs with a good root system.
- Proper depth of planting. Allow 6 to 10 cm of soil on top of the bulb.
- Prevent large differences in greenhouse temperature and humidity. Maintain RH level of 75% is advisable.
- Rapid growth of the crop must be prevented.
- Maintain even transpiration rate and avoid excess transpiration by shading.

ii) Bud drop and bud desiccation

Cause: Bud drop occurs when plants receive insufficient light. In light deficient conditions the stamens in the bud produce ethylene causing the bud to abort. There is an increased risk of bud desiccation if rooting conditions are poor, e.g. too dry soil.

Control

- Avoid using varieties susceptible to bud drop to grow in poor light conditions.
- To prevent bud desiccation, bulbs should be allowed to dry out during planting. The bulbs should root well and grown in favourable condition, particularly light and transpiration are concerned.

9. Technology standardized and developed under AICRP on Floriculture by different centers

i) Germplasm conservation and evaluation

At SKUAST (K), Srinagar, different cultivars of lilium were evaluated. Cultivars viz., London, Merced and Pollyanna were found best suited for cut flower purposes and Novecento for pot culture (Table 7). The cultivars Cilesta, Eyeliner, Ercolano, Brunello, Tresser, Bright Diamond, Yellow Tycon and Pavia are recommended for commercial cultivation under open field conditions for hilly areas of Himachal Pradesh (Table 8a& b).

ii) Standardization of forcing techniques

Cultivar Elite was found better than Pollyanna in respect of more number of flowers and earlier flowering. Out of various cold storage treatments, 8 weeks storage of bulbs at 2^{0}C was found better in both the cultivars (Table 9 & 10). Lilium bulbs which received eight weeks of cold store treatment were of 87.33 cm height. However, the height reduced to 82.22 cm when the same bulbs used for planting for third time under Dr. Y.S.P.U.H.F, Solan condition.

iii) Standardization of propagation technologies

Cultivars Pavia and Courier produced more number of bulblets /scale when scales were treated with NAA (500 ppm) and planted in cocopeat + perilite + vermiculite propagation media. Earliest bulblet sprouting was recorded with NAA (500 ppm) when scales were planted in Perlite + Vermiculite media. In cultivar Pavia, maximum average weight of bulblets (15.9 g) was recorded with cocopeat when bulb were treated with NAA (500 ppm).

iv) Standardization of growing media for cultivation

Earliest sprouting (63.0 day), maximum spike length (116.6 cm) and earliest flowering (158.6 day) were recorded when bulbs were grown in media comprising of cocopeat and FYM (Table 11 -14).

v) Standardization of postharvest technology

In a vase life study of Asiatic hybrid lily through different holding solutions, the treatment sucrose (2%) + 8-HQC (200 ppm) + GA_3(200ppm) was found better. The treatment takes minimum days (2.00) for flower opening and showed more vase life days (27.94) as compared to 3.96 days for flower opening and 21.15 days vase life in control treatment (Table 15). In another postharvest life study of Asiatic hybrid lily through wrapping material and storage duration, the treatment cellophane sheet was found to be the best wrapping material among other treatments in terms of days to flower opening, flower diameter, per cent unopened flower bud, vase life, weight loss after storage and weight gain after storage. So far as the storage duration is concerned six days storage duration recorded the better plant attributes among other storage treatments (Table 16).

Table 7. Enrichment and assessment of lilium cultivars at Srinagar centre.

Cultivar	DF	DuF	PH	SL	NFPP	FD	NLPP	NBPP
London	165.00	45.00	65.00	51.33	4.20	14.80	47.25	1.66
Merced	156.33	43.33	60.25	47.25	5.10	17.00	40.66	2.60
Novecento	175.50	40.50	47.66	41.50	4.50	15.00	43.00	2.25
Pollyanna	181.66	46.25	53.50	42.66	6.10	16.25	37.66	1.50
Courier	169.23	44.45	59.30	45.60	4.10	14.20	33.75	2.50
Menocraca	150.29	47.21	62.50	56.10	4.25	15.35	40.42	2.20
Dreamland	154.81	49.71	54.90	48.23	4.60	14.80	60.20	1.60
RoyalTrinity	160.20	39.38	57.52	52.40	4.90	15.10	50.52	2.10
Brindisi	163.71	36.21	59.21	54.20	4.85	15.45	60.30	2.90
Stargazar	102.42	38.20	69.24	63.08	5.90	20.10	60.70	2.95
Elite	100.20	40.40	72.20	56.91	6.30	14.20	65.15	2.70
C.D. (P=0.05)	2.61	1.12	2.90	2.42	0.19	0.65	3.03	0.13

DF:Days to flowering FD:Flower diameter DuF:Duration of flowering (Day)
NLPP:No. of leaves per plant SL:Spike length (cm) NBPP:No of bulbs/plant NFPP:Number of flowers per plant

Table 8a. Performance of lilium cultivars at Katrain centre

Cultivar	Days to bud formation	Days to 1st flowering	Plant height (cm)	Spike length (cm)	Bud length (cm)	No.of flowers /spike	Flower size (cm)	No.of leaves/ Plant	Leaf length (cm)	No.of shoots/ bulb	No.of daughter bulbs	No.of bulblets	Size of bulbs (mm)	Size of bulblets (mm)
Bright Diamond	66.0	109.7	91.7	74.5	10.1	3.3	19.9	60.3	11.3	1.0	1.0	4.0	38.2	21.3
Golden Tycon	73.3	106.7	76.7	63.7	10.0	3.0	16.2	63.0	13.7	1.0	1.0	7.0	36.7	12.3
All Star	67.7	107.0	74.8	59.6	10.7	3.0	13.7	63.7	11.3	1.0	1.0	5.0	38.7	13.3
Salmon Classic	61.7	90.0	66.7	54.0	9.6	3.3	13.6	47.3	11.0	1.0	1.0	3.3	40.3	20.7
Pavia	76.7	130.7	79.3	64.7	10.0	8.7	17.5	71.0	17.7	1.0	1.0	22.3	60.0	26.3

Table 8b. Performance of oriental cultivars at Katrain centre

Cultivar	Days to flowering (day)	Plant height (cm)	Spike length (cm)	Rachis length (cm)	No. of flowers	Flower bud length	Flower diam. (cm)	No. of leaves/plant (cm)	Leaf length (cm)	Leaf width (cm)
Stargazer	126.3	41.1	32.6	16.0	1.8	7.9	19.4	22.1	8.3	2.7
Barnini	124.4	39.8	32.7	16.4	1.7	11.1	19.8	21.4	8.0	2.6
Lombardia	128.5	31.2	28.3	14.9	1.5	10.2	19.3	24.1	7.1	1.9
Siberia	131.2	40.1	33.7	16.1	2.2	6.2	19.3	25.6	8.0	2.3
Casendra	126.2	36.4	30.1	17.4	2.9	10.2	18.9	31.0	7.2	2.0
C.D. (P=0.05)	4.15	(NS)	3.43	0.76	(NS)	0.99	(NS)	2.99	0.79	0.58

Table 9. Effect of storage temperature and durations on growth and flowering in Asiatic lilium hybrids (Pollyanna & Elite)

Storage duration	Days to sprouting			Plant height (cm)			Days to bud formation			Days to 1st flowering		
	Pollyanna	Elite	Mean	Pollyanna	Elite	Mean	Pollyanna	Elite	Mean	Pollyanna	Elite	Mean
0	132.7	126.3	**129.5**	73.3	76.3	**74.8**	200.0	177.0	**188.5**	232.2	207.0	**219.6**
6	27.6	26.8	**27.3**	80.2	76.1	**78.1**	140.4	97.8	**119.1**	170.7	124.8	**147.7**
8	25.6	26.4	**23.5**	85.2	71.3	**78.2**	114.5	84.8	**99.7**	145.3	113.3	**129.3**
12	18.1	19.0	**18.6**	69.5	65.3	**67.4**	93.7	80.0	**86.8**	123.7	110.0	**116.9**
Mean	**51.0**	**48.4**	–	**77.3**	**72.3**	–	**137.1**	**109.9**	–	**168.0**	**138.8**	–
	C.D. (P=0.05) Hybrids: 2.34 Durations: 3.31 Hybrids x Durations: 4.68			**C.D. (P=0.05)** Hybrids: 1.39 Durations: 1.96 Hybrids x Durations: 2.78			**C.D. (P=0.05)** Hybrids: 2.75 Durations: 3.89 Hybrids x Durations: 5.51			**C.D. (P=0.05)** Hybrids: 2.73 Durations: 3.85 Hybrids x Durations: 5.45		

Table 10. Effect of storage temperature and durations on growth and flowering in Asiatic lilium hybrids (Pollyanna & Elite)

Storage Duration	Days to sprouting			Plant height (cm)			Days to bud formation			Days to 1st flowering		
	Pollyanna	Elite	Mean	Pollyanna	Elite	Mean	Pollyanna	Elite	Mean	Pollyanna	Elite	Mean
0	15.3	13.7	**14.5**	15.2	11.6	**13.4**	65.9	103.9	**84.9**	2.03	4.47	**3.25**
6	15.4	13.1	**14.2**	15.5	10.3	**12.9**	61.7	89.0	**75.4**	2.73	4.47	**3.60**
8	14.8	12.1	**13.4**	16.3	9.6	**12.9**	63.2	76.7	**69.9**	3.80	4.27	**4.03**
12	14.2	11.8	**13.0**	15.1	9.2	**12.1**	50.9	68.7	**59.8**	2.33	3.50	**2.92**
Mean	**14.9**	**12.7**	–	**15.5**	**10.1**	–	**60.4**	**84.6**	–	**2.72**	**4.17**	–
	C.D. (P=0.05) Hybrids: 0.47 Durations: 0.66 Hybrids x Durations: 0.94			**C.D. (P=0.05)** Hybrids: 0.35 Durations: 0.49 Hybrids x Durations: 0.69			**C.D. (P=0.05)** Hybrids: 2.36 Durations: 3.34 Hybrids x Durations: 4.72			**C.D. (P=0.05)** Hybrids: 0.37 Durations: 0.53 Hybrids x Durations: 0.75		

Table 11. Effect of growing media on days to 50% sprouting and plant height (cm) on lilium cultivars

Growing media	Days to 50% sprouting			Plant height (cm)		
	Courier (Asiatic)	Cilesta (LA)	Mean	Courier (Asiatic)	Cilesta (LA)	Mean
1. Sand + Soil + FYM(1: 1: 1; v/v)	107.7	107.0	107.3	56.1	106.0	81.1
2. Sand + Soil + FYM(2: 1: 1; v/v)	89.7	93.0	91.3	75.2	102.7	88.9
3. Cocopeat + FYM (1: 1; v/v)	78.7	63.0	70.8	75.3	129.3	102.8
4. Cocopeat + Soil + FYM (1:1:1; v/v)	85.0	90.3	87.7	83.0	126.3	104.7
5. (Sand + Soil + FYM) + cocopeat (1: 1; v/v)	92.0	89.7	90.8	83.9	105.9	94.9
6. (Sand + Soil + FYM) + vermicompost (2: 1; v/v)	92.3	91.0	91.7	68.9	124.5	96.7
7. (Sand + Soil + FYM) + vermicompost + cocopeat (2: 1: 1; v/v)	94.3	104.3	99.3	67.6	97.3	84.4
Mean	**91.2**	**91.2**	–	**73.0**	**113.1**	–
	C.D. (P=0.05) **Cultivars = NS** **Growing media = 2.35** **Cultivars x Growing media = 3.33**			**C.D. (P=0.05)** **Cultivars = 2.40** **Growing media= 4.49** **Cultivars x Growing media = 6.35**		

Table 12. Effect of growing media on spike length (cm) and number of days taken for the lower most bud to show colour (day) on lilium cultivars

Growing media	Spike length (cm)			No. of days taken for lower most bud to show colour		
	Courier (Asiatic)	Cilesta (LA)	Mean	Courier (Asiatic)	Cilesta (LA)	Mean
1. Sand + Soil + FYM(1: 1: 1; v/v)	33.7	90.6	62.2	175.7	159.0	178.3
2. Sand + Soil + FYM(2: 1: 1; v/v)	49.7	86.7	68.2	169.0	166.7	174.4
3. Cocopeat + FYM (1: 1; v/v)	47.4	116.6	82.0	162.0	147.0	167.2
4. Cocopeat + Soil + FYM (1:1:1; v/v)	70.5	112.9	91.7	168.4	172.0	171.3
5. (Sand + Soil + FYM) + cocopeat(1: 1; v/v)	67.4	88.5	77.9	169.3	167.5	171.0

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Growing media	Spike length (cm)			No. of days taken for lower most bud to show colour		
	Courier (Asiatic)	Cilesta (LA)	Mean	Courier (Asiatic)	Cilesta (LA)	Mean
6. (Sand + Soil + FYM) + vermicompost (2: 1; v/v)	54.9	113.5	84.2	169.2	172.5	171.3
7. (Sand + Soil + FYM) + vermicompost + cocopeat (2: 1: 1; v/v)	46.4	82.0	64.2	171.5	172.0	173.1
Mean	**52.9**	**98.7**	–	**169.3**	**165.3**	–
	C.D. (P=0.05) **Cultivars = 1.55** **Growing media = 2.90** **Cultivars x Growing media = 4.10**			**C.D. (P=0.05)** **Cultivars = 1.26** **Growing media= 2.35** **Cultivars x Growing media = 3.33**		

Table 13. Effect of growing media on days to flowering (days) and Number of flowers per spike on lilium cultivars

Growing media	Days to flowering			No. of flowers per spike		
	Courier (Asiatic)	Cilesta (LA)	Mean	Courier (Asiatic)	Cilesta (LA)	Mean
1. Sand + Soil + FYM(1: 1: 1; v/v)	178.3	161.3	169.8	3.0	4.7	3.8
2. Sand + Soil + FYM(2: 1: 1; v/v)	174..4	168.7	171.5	4.3	5.0	4.6
3. Cocopeat + FYM (1: 1; v/v)	167.2	150.0	158.6	4.1	5.9	4.9
4. Cocopeat + Soil + FYM (1:1:1; v/v)	171.3	173.3	172.3	3.6	5.4	4.5
5. (Sand + Soil + FYM) + cocopeat(1: 1; v/v)	171.0	169.5	170.3	3.5	4.1	3.8
6. (Sand + Soil + FYM) + vermicompost (2: 1; v/v)	171.3	174.8	173.0	3.2	5.5	4.4
7. (Sand + Soil + FYM) + vermicompost + cocopeat (2: 1: 1; v/v)	173.1	173.5	173.3	2.8	6.4	4.6
Mean	**172.4**	**167.3**	–	**3.5**	**5.3**	–
	C.D. (P=0.05) **Cultivars = 1.04** **Growing Media = 1.95** **Cultivars x Growing media = 2.75**			**C.D. (P=0.05)** **Cultivars = 0.41** **Growing media= 0.77** **Cultivars x Growing media = 1.09**		

Table 14. Effect of growing media on bud length (cm) in lilium cultivars

Growing media	Bud length (cm)		
	Courier (Asiatic)	Cilesta (LA)	Mean
1. Sand + Soil + FYM(1: 1: 1; v/v)	9.3	11.7	10.5
2. Sand + Soil + FYM(2: 1: 1; v/v)	8.9	10.3	9.6
3. Cocopeat + FYM (1: 1; v/v)	9.3	11.6	10.5
4. Cocopeat + Soil + FYM (1:1:1; v/v)	9.4	12.3	10.9
5. (Sand + Soil + FYM) + cocopeat(1: 1; v/v)	9.4	11.7	10.6
6. (Sand + Soil + FYM) + vermicompost (2: 1; v/v)	9.2	12.1	10.7
7. (Sand + Soil + FYM) + vermicompost + cocopeat (2: 1: 1; v/v)	9.2	9.2	9.2
Mean	**9.3**	**11.3**	
	C.D. (P=0.05) **Cultivars = 0.19** **Growing Media = 0.37** **Cultivars x Growing media = 0.52**		

Table 15 :Standardization of pulsing solution as on postharvest life of Asiatic hybrid lily

Treatment	Solution consumed (ml)	Freshness and colour	Days to flower opening	Flower diam. (cm)	% unopened flower bud	Vase life (day)	Wt. change (%)
Distilled water (control	5.14	70.75	3.96	16.20	3.50	21.15	70.12
2% sucrose + 100ppm 8-HQC	6.45	80.65	3.14	16.45	2.00	26.76	73.70
2% sucrose + 200ppm 8-HQC	6.65	80.70	3.15	17.35	1.95	26.75	74.00
2% sucrose +300ppm 8-HQC	7.00	82.15	2.75	17.60	1.90	27.00	74.18
2% sucrose + 100ppm 8-HQC+50ppm GA3	8.06	83.70	2.72	17.75	1.45	27.10	74.15
2% sucrose + 100ppm 8-HQC+100ppm GA3	8.14	84.00	2.70	18.00	1.35	27.22	74.47
2% sucrose + 100ppm 8-HQC+150ppm GA3	8.45	84.10	2.60	18.05	1.29	27.25	74.51
2% sucrose + 100ppm 8-HQC+200ppm GA3	8.65	84.15	2.55	18.30	1.27	27.61	74.60
2% sucrose + 200ppm 8-HQC+50ppm GA3	8.70	84.17	2.50	18.25	1.23	27.63	74.65
2% sucrose + 200ppm 8-HQC+100ppm GA3	9.10	85.14	2.45	18.35	1.19	27.65	74.95
2% sucrose + 200ppm 8-HQC+150ppm GA3	9.25	85.70	2.10	18.40	1.17	27.75	74.17
2% sucrose + 200ppm 8-HQC+200ppm GA3	9.50	86.15	2.00	18.65	1.14	27.94	74.14
2% sucrose + 300ppm 8-HQC+50ppm GA3	7.75	87.10	2.95	16.85	1.97	27.12	74.31
2% sucrose + 300ppm 8-HQC+100ppm GA3	7.77	79.47	2.90	16.80	1.95	27.37	74.24
2% sucrose + 300ppm 8-HQC+150ppm GA3	7.50	77.75	2.80	16.75	1.90	27.17	74.19
2% sucrose + 300ppm 8-HQC+200ppm GA3	7.00	77.25	2.77	17.70	1.85	27.15	74.17
C.D. (P=0.05)	0.19	2.13	0.04	0.31	0.05	0.47	1.21

Table 16: Studies on wrapping materials and storage durations on postharvest life of Asiatic hybrid lily cv. Texus.

Treatments	Solution consumed (ml)	Freshness and colour	Days to flower opening	Flower diam. (cm)	% unopened flower bud	Vase life (day)	Wt. loss after storage	Wt. gain after storage
Wrapping material								
Without wrapping (control)	17.12	80.17	3.00	16.18	3.95	21.90	21.95	20.81
New paper	18.77	82.14	2.35	17.12	1.85	24.25	21.51	20.71
Cellophane sheet	19.00	83.15	2.25	17.12	1.85	24.25	21.51	20.71
Polythene sheet	18.10	81.14	2.75	16.70	2.15	23.70	21.41	21.76
Butter paper	18.71	82.07	2.39	17.07	2.00	23.75	23.75	21.78
CD(P=0.05)	0.21	2.10	0.06	0.37	0.43	0.23	0.09	0.07
Storage duration								
Zero day	18.75	84.15	2.95	19.15	2.00	24.14	0.00	0.00
Three day	18.65	84.10	2.80	19.10	2.15	24.07	19.95	20.15
Six days	18.47	84.00	1.95	18.20	2.18	23.75	20.00	21.25
Nine day	17.95	83.17	1.90	17.15	2.25	23.25	23.15	20.10
C.D. (P=0.05)	0.23	2.25	0.09	0.41	0.47	0.27	0.10	0.11

Field view of Lilium cultivar Brindsi

Field view of Lilium cultivar Courier

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