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Production technology of tuberose (*Polianthes tuberosa* L.) cultivation

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Abstract

Tuberose is one of the important cut flower among the top ten cut flowers. In India, tuberose is commonly known as Gulchari and Galshabbo in Hindi, Rajanigandha in Bengali, Sukandaraji and Nelasanpengi in Telegu, Nilasompangi in Tamil and Sugandharaja in Kannada. Tuberose also uses for table purpose because it has long spike length, long post-harvest life and extremely fragrance due to present of Geraniol, Nerol, Benzyl alcohol, Eugenol, and Methyl anthranilate. Tuberose has around fifteen species under the genus of Polianthes but, twelve species are distributed from Mexico. Among of these flowers nine species have white, one is white tinged with red and two are red colour. Only *Polianthes tuberosa* L. are growing commercially and all the others are found growing wild. Tuberose is commercially propagated by vegetative methods (Bulb, Bulblet and Division of bulb) but, rarely tuberose propagated by seed, because seed propagated is very difficult. Now a day's tuberose also propagated by tissue culture to get virus-free planting material production.

Keywords: Tuberose, species, propagation and cultivation

1. Introduction

Tuberose is a half-hardy, perennial bulbous plant native to Mexico. It belong to family Amaryllidaceae and basic chromosome number ($n=30$). Tuberose is one of the important cut flower among the top ten cut flowers. In India, tuberose is commonly known as Gulchari and Galshabbo in Hindi, Rajanigandha in Bengali, Sukandaraji and Nelasanpengi in Telegu, Nilasompangi in Tamil and Sugandharaja in Kannada. Tuberose is suitable for under protected cultivation or open field condition (Brundell and Steenstra 1985) [2]. The tuberose occupies a very selective and special position among the ornamental bulbous plants for its beauty, elegance and sweet pleasant fragrance (Sadhu and Bose, 1973) [7]. It has a huge economic potential and more demand for cut-flower purpose (Usman, 2013) [12] and essential oil industry (Singh, 1995) [9]. Due to, it is cultivated all over the world.

Commercially Tuberose is growing various countries such as India, China, Bangladesh, Mexico, Kenya, Italy, France, Morocco, USA, Hawaii and South Africa. In India, tuberose commercial cultivated to West Bengal, Karnataka, Tamil Nadu, Maharashtra, Uttar Pradesh and North Eastern part of India. At present scenery tuberose is cultivation in India 7.95 lakh hectare and cut flowers is estimated to be 27.71 '000 MT and 1560.70 lakh No's respectively. (www.nhb.com)

2. Uses of tuberose

Tuberose can be successfully grown pot plant and bedding plants for it several uses. It commercially used for garland making, Aesthetic purpose, Birthday ceremony, floral arrangement such as; bouquets, rangoli, boutonnières, Potpourri. Tuberose also uses for table purpose because it has long spike length, long post-harvest life and extremely fragrance due to present of Geraniol, Nerol, Benzylalcohol, Eugenol, and Methyl anthranilate. The flowers emit very sweet fragrance that ability to open the heart refers your mind and clam effect the nerves. Tuberose flowers extremely used in perfume and essential oil industry (Qureshi *et al.*, 2018) [6]. Now a days tuberose also use for beverage industry and food industry. Dried tuberose bulbs in powdered form are used as a remedy for gonorrhoea. In Java, the flowers are eaten along with the vegetables juice.

3. Morphology of tuberose

Tuberose is a half-hardy, bulbous perennial plant and it propagates by bulb (25-30gm weight and 2-3cm diameter) and bulblets (1-1.5cm diameter). Bulbs are made up of small scales and leaf bases and the stem is a condensed structure which remains concealed within scales. Adventitious and shallows root mainly found in tuberose. The leaves are long, narrow, linear,

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grass-like, light green, and arise in rosette. Tuberos flowers basically funnel shaped and perianth part highly fragrant and waxy white flowers, about (20-25) mm long, single or double and borne in a spike. Number of stamens are six, anthers dorsifixed in the middle, ovary 3 locular, ovules numerous and fruits type are capsule.

4. Species and Cultivars

A. Species

Tuberose has around fifteen species under the genus of *Polianthes* but, twelve species are distributed from Mexico. Among of these flowers nine species have white, one is white tinged with red and two are red colour. Only *Polianthes tuberosa* L. are growing commercially and all the others are found growing wild. Different types of species of tuberose mention below

- 1. *Polianthes tuberosa*:** It is an erect herb, 70-130 cm high with stout and short bulbs; leaves basal, 8 to 10 in number, 30-50 cm long, about 1.5 cm wide, linear, bright green, reddish near the base, flowers star shaped, waxy white, the tube bent only near the base, filaments attached on upper part of corolla, fragrant in long terminal racemes.
- 2. *Polianthes Polustris*:** This species was collected in swamps on the western foothills of the Sierra Madre. This type of flowering species bulbs are oval to oblong, stem are erect, length 40 cm and basal leaves with parallel veins, flowers are 3 to 5 pair arising from single bracts, perianth slightly curved with segments short and spreading filaments short near the top of the tube, anthers not extended, ovary free at tip.
- 3. *Polianthes Montana*:** It is other species with white flowers tuberose. In this species the bulbs are oblong, the stem long and tender, and possessing 12 pairs of flowers all with pedicels. The flowers are short with lobes small, erect and rounded.
- 4. *Polianthes Durangensis*:** This species bulb are small and the flowers arranged in one to six pairs are all sessile, erect at first becoming curved and purplish with age.
- 5. *Polianthes Graminifolia*:** In this species deep red colour that is very common in Mexico. It closely resembles to *P. geminiflora* which has also saponaceous roots and were used as soap substitutes. The bulbs shape is long and tuberous. Slendery stem, densely hairy below and glabrous above. Leaves are long and grass-like. The flowers are in 10 to 15 pairs. The lower ones often on peduncles, deep red, bent downward near the base and the filaments are slender.
- 6. *Polianthes Gemini flora*:** This species was originally described as *Bravoa geminiflora*. Stems are smooth throughout with several basal leaves. Flowers colour is light orange-red and arranged in pairs of 7 or more. The Perianth is similar to that of the species *P. graminiflora*.
- 7. *Polianthes Longi flora*:** This species are tall in nature and flowers in three to five pairs. Perianth are white tinged with purple colour.
- 8. *Polianthes Platyphylla*:** In this species the flowers are white tinged with redish. The florets are arranged in fifth to seven pairs with tube of the floret bent at the base and with short, rounded lobes.
- 9. *Polianthes Pringlei*:** This species plant Plants have small bulbs and smooth stems. Flowers are sessile, in pairs of 4 or 5, curved, fragrant and white in colour which changes to slightly purplish on drying.

B. Cultivars

Tuberose has three types of cultivar, such as

(i) Single type: In this type of tuberose mainly found single row of petals. These type of flower colour are white and highly fragrance than double type of flower. Concrete content has been observed to be 0.08 to 0.11 per cent. in these flower basically use for loose flower such as garland making, flower arrangement and rangoli purpose. Different types variety commonly found under these cultivar such as; Arka Nirantara, Rajat Rekha, Shringar, Prajwal, Mexican Single, Hyderabad Single, Calcutta Single, Phule Rajani, Kahikuchi Single, Pune Single.

Arka Nirantara: It is released by Indian Institute of Horticultural Research (IIHR), Bangalore. It is white colour with prolonged blooming.

Shringar: This variety of tuberose develop through hybridization, cross between 'Single x Double' and was released by Indian Institute of Horticultural Research (IIHR), Bangalore. Flower is highly fragrance and medium spikes. Flower bud attractive due to pinkish tinge. Spike has more number of flowers and floretes are large in size. These type flowers basically use loose flower purpose and yield of these flower are 15,000-20,000 kg/ha.

Prajwal: This hybrid also develops through hybridization, cross between 'Shringar' x 'Mexican Single'. The hybrid was released by Indian Institute of Horticultural Research (IIHR), Bangalore. Colours of flower buds are slightly pinkish and flowers are white. The individual florets sizes are large, compared to 'Local Single'.

Rajat Rekha: In this variety develop through induce mutation (gamma ray). It is a single flowered variety released by National Botanical Research Institute (NBRI), Lucknow. Flowers are silvery white streaks along the middle of the leaf blade. Concrete content 0.089 per cent.

(ii) Double type: In this type of tuberose found more than three rows of petals. Swarna Rekha, Suvasini, Mexican Double, Calcutta Double, Pearl Double.

Swarna Rekha: It is developed through induce mutation (gamma ray) and release from National Botanical Research Institute (NBRI), Lucknow. The flowers are double with golden yellow streaks along the margins of leaf. Concrete content has been found to be 0.062 per cent.

Suvasini: It is double type flower with multi whorled variety and release from Indian Institute of Horticulture Research (IIHR), Bangalore. It is develop by hybridization, cross between 'Single' and 'Double'. These varieties produce more number of flowers per spike, bold flowers and uniformity flowers develop. Suvasini flower are white colour with fragrance. In this flower mainly use for cut flower purpose. Spike yield is higher 25% than Pearl Double cultivar.

Pearl Double: It is double type of tuberose but, main feather flower are reddish tinged. In these flower yield is very high with quality flower production. Mostly this flower use for flower arrangement and it also use for oil extraction purpose. Concrete recovery has been found to be 0.06%.

(iii) Semi-Double: This type cultivar found two to three rows of petals. In this type of tuberose flower spike are straight and

Flower colour is white and also tinged with pinkish red. Vaibhav are most important variety under this cultivar and it is suitable for cut flower purpose.

5. Soil and Climate requirement

1. **Soil:** Tuberose can be growing any type of soil but ideal for sandy-loam or loam soil. Soil should be well aeration and good drainage with pH (6.5-7.5) for quality flowers production (Sharga and Sharma, 1994). It can also be successfully grown as a commercial crop even in those soils which are affected by salinity and alkalinity conditions if better agronomical practices are adopted.
2. **Climate:** Tuberose is suitable for tropical to subtropical and temperate climates but, it prefers to grow in an open sunny condition. In India, the commercial cultivation of tuberose is mainly confined in warm humid areas with average temperature range from 20°C to 35°C. For its luxuriant growth, it requires high humidity and a temperature around 30°C. Temperature but, above 40°C reduces the spike length and quality of the flowers. Very low temperature and frost also damage the plants and flowers.

6. Cultural Practices

1. **Site selection:** Tuberose is a sun-loving plant, so it needs sufficient sunlight for better vegetative growth and maximum yield of flowers. The site should be chosen, where the plants will get enough sunlight throughout their growing period. The soil should have sufficient moisture holding capacity but not water logging condition. This field should be away from shade condition because shade condition plant showed lanky growth.
2. **Land preparation:** Land preparation is very important for the cultivation of tuberose. The field should be worked deep to a good plough and properly manure. If the soil is not thoroughly prepared and contains soil clods or un-decomposed organic matter, bulb production is highly affected and it also reduces the yield and quality of flowers. Well rotten cow dung or farmyard manure @ (50-60) tonnes/ha, should be incorporated with the soil about a month before planting. Care should be taken to make the land free from weeds.
3. **Seed or bulb treatment:** Before sowing bulb should be treated with GA₃ or Thiourea for breaking the dormancy and easily sprouting. Pre-plant bulb should be storage at (8-10) °C for one month will improve the plant growth, increase spike and flower yield. Pre-plant storage of bulbs at 10°C for a period of 30 days will improve the plant growth, increase spike and flower yield. Before planting bulbs treated with GA₃, etherel or thiourea promotes early appearance of flower spike and produces longer spikes with maximum number of florets. At first Bulbs totally cleaned after that treated with Bavistin (0.2%) for 30 minutes to reduce fungal infection. Dry in shade before planting or storing. Before planting treat bulbs in systemic fungicide and before storing in contact fungicide.

7. Propagation

Tuberose is commercially propagated by Vegetative methods (Bulb, Bulblet and Division of bulb) but, rarely tuberose propagated by seed, because seed propagated is very difficult. Nowa day's tuberose also propagated by tissue culture to get virus-free planting material production.

(A) Seed Propagation

Seed setting of Tuberose is observed under suitable climatic condition but, only single type cultivar. Seeds are sown in well prepared growing medium containing leaf mould, Vermicompost and garden soil in equal proportion under portrays nursery. Moisture and temperature have a marked effect on germination. Ideal soil temperature of 25°C is fully effective for increase seed germination. Before transplanting bed should be prepared by digging and sufficient quantity of FYM is to be mixed before sowing. The seedling is sown in rows 10-12 cm apart and 5 cm deep in heavy soil and 2.0 cm in light soil

(B) Vegetative propagation

1. **Propagation by Bulb:** Most common method practiced for the commercial multiplication of tuberoses is through propagation by bulbs. The bulbs remain dormant during the winter months in places where the temperature is low. The dormancy of the bulbs can be successfully broken by treated the bulbs with 4% Thiourea solution for one hour if early planting is desired and Ethylene chlorohydrins can also be used for breaking the dormancy of bulbs. Before sowing scale should be remove from the bulb so that easily sprouting. Selection of ideal size bulbs is very important for quality production. In general, spindle shaped bulbs free from diseases having diameter between 2.0 cm to 3.0 cm are suitable for planting. About 1.30 - 1.60 lakh bulbs (10-12 tons of bulbs) are required for planting one hectare.
2. **Propagation by division:** Other propagation method of tuberose is division of bulb. Sprouting is depends on the size of the bulbs and only the segments from large bulbs (2 cm or more in diameter) regenerate well (Hussain, 1999) ^[3]. Bulbs normally cut into 2-3 vertical sections, each segment must be contain bud and a part of the basal plate. Each of these sections is treated with fungicide and planted vertically in a rooting medium with their tips just showing above the surface. New bulblets along with roots develop from the basal plate. At this time they are transferred to the ground to continue growth.

(C) Micro-propagation

It is another hi-tech method for quality planting material production. The main focus of micro-propagation is free from nematode affected planting material production.

8. Spacing, Depth and time of sowing time

Planting density is highly effected for yield and quality flowers production. It depends upon soil, bulb size and climatic condition. High and low both planting density adversely affected for quality flowers production. For economic returns, bulbs are planted at an optimum spacing of 30 x 20 cm or 20 x 20 cm (Yadav *et al.*, 1984) or 30 x 30 cm (Nagaraja *et al.*, 1999) ^[4] with 5.0 to 7.0 cm depth. But, depth also depend upon size of bulbs (large bulb more depth and small bulb less depth). About 45,000 - 55,000 bulbs are required for one acre planting of tuberose.

Tuberose is generally planted in January-March in the plains and in April-May in the hills. On a medium fertile clay soil, the best time for planting during June month. In southern parts of India, the bulb should be planted in the month of July-August. Planting of bulbs in the month of April has shown to record the highest yield of spikes and flowers in the cv. Single.

9. Nutrient Management

Organic manure has vital role for quality flowers production but, organic manure unable to fulfillment of the demand of plant nourishment. So, in-organic fertilizer must be applying for proper growth and development but as a suitable dose. High dose of, N and P markedly promotes leaf and bulb formation (Singh and Ha 1990) ^[10] but other side, excess N as the flower spike become quite tall and soft, making it vulnerable to wind and the plants become more susceptible to diseases and pests.

Ideal fertilizer dose are FYM (20 tonnes/ha), a fertilizer dose of 120 kg N, 60 kg P₂O₅ and 80 kg K₂O per hectare is recommended for tuberose production. The dose should be apply half the N, the full dose of P and K has to be applied at the time of planting and the remaining half of N is apply two split dose such as 30 and 60 days after sowing.

10. Water Management

Water management has vital role quality production of flowers. It depends upon soil type, environment condition and cultivar. Optimum amount irrigation should be apply before sowing so that better sprouting and further irrigation should be avoided until the bulbs have sprouted. Too much moisture in the soil at the time of sprouting results in the rotting of bulbs and similar condition during flowering adversely affects the development of spikes and flowers. The tuberose fields should be irrigated at interval of 10-15 days, if the weather is dry (www.agritech.tnau.ac.in). It has been suggested that during summer months (April to June) the crop should be irrigated at weekly interval and during winter at 10 days interval.

11. Earthing up and Staking

Earthing up should be needed when plant height 20-25 cm and it done up to 10-15 cm high.

Staking is done by bamboo stick or iron angles are done in beds and string or rope may be tied in three rows along the plant to avoid lodging of tuberose plants.

12. Weed Control

Weeds become very big problem for tuberose cultivation. Weeds reduce yield more than (30-40) %. Weed free plot development is impossible because, simultaneously weed also take nutrient and water as a same field. If these weeds are not removed in time, growth and productivity will be markedly reduced. Manual weeding is effective if done frequently. But this method is very laborious and increases the cost of cultivation. Generally, after each irrigation, weeding is done. Hoeing between plants is also necessary to lose the soil and destroy the weeds.

Some chemical totally killed both monocot and dicot weeds. It has been found that pre-emergence application of Gramaxone at 3 lit/ha or Diaron at 3kg/ha and ATP+CIPC mixture 2.0+1.5 Kg/ha, effectively controlled weeds in tuberose field. Near about 70-80% reduction of weeds was noted by the application of these chemicals.

13. Effect of Growth regulators

Growth regulator has vital role for acceleration of vegetative and reproductive stage (Vendrame *et al.*, 2005) ^[13]. Foliar application of GA₃ at 50 to 100 ppm thrice at 40, 55 and 60 days after planting is found to be beneficial. Application of both together CCC at 5000 ppm and GA₃ at 1000 ppm; so result induces early flowering, increased flower stalk, number of flower florets production and improves the quality of flowers.

14. Disease and Pest controls

(A) Disease

- 1. Flower bud rot:** It is a bacterial disease and caused by *Erwinia sp.* Results found dry rotting of the buds with brown necrotic discoloration of peduncles. The diseased plants should be uprooted and destroyed. The disease can be controlled by the spray of Streptomycin (0.01%).
- 2. Leaf blight:** It is another important of tuberose and the disease is caused by *Botrytis elliptica*. This organism seriously damages the leaves. Application of ammoniacal copper at 2gal/100 gal of water or Greeno (0.5%) for 15 days intervals.
- 3. Alternaria leaf spot:** This disease is a very common disease for tuberose cultivation and it adversely affected to yield. This fungal leaf spot disease is caused by *Alternaria Sp.* The symptom of the disease is appearance of brown spots with faint concentric rings on the mid-rib. The disease can be controlled by the spray of Bordeaux mixture (0.4%), Zineb (0.5%)
- 4. Stem rot:** The infection is caused by the fungi *Sclerotium rolfsii*. The main symptom of the disease is prominent, coarse and mycelia masses appear on the leaf surface or near the soil level and later this sport enlarge and spread whole leaves. Result found that light green colour of the spot and later leaf fall down. Application of fungicide such as brassicol at 1 % or Zineb (20%) at the rate of 25 kg/Ha.

(B) Pest

- 1. Grasshopper:** This insects feed on young leaves and flower buds. Application of insecticide such as; 0.1 % Roger or 0.1 % Malathion for fortnightly interval.
- 2. Aphids:** - It is very small in size, soft bodied, green, deep purple or black in colour feed on the flower buds and growing points. These pests may be controlled by spraying 0.1 % Malathion or dimethoate at 10-day interval.
- 3. Nematodes:** Nematode is the very noxious pest among the others pest. Root-knot nematodes, reniform nematode and greasy streak nematode are extremely damage to the crop; result showed that stunted plants growth and extensive yield losses. The leaf size is reduced and the flowers look sickly and, ultimately, the roots rot. Application of Thimet or Furadan at 25 kg/ha or carbofuran 3-5 kg/ha, neem cake 1.5 tonne/ha controls nematode infestation.
- 4. Red Spider Mites:** In this type of insect appear hot and dry condition; and appear lower surface of the leaves. Mites are usually red or brown in colour and multiply very fast. In this type insect suck plant sap, result formation of yellow stripes and streaks on the foliage and stunted of the plant growth. Apply of Kelthane at 1.2% concentration is effective to control the mites.

15. Harvesting

It is very important culture technique among the others cultural techniques. It should be done within a proper time and proper stage, otherwise economically loss is high. Flowering of tuberose starts 3 to 4 months after planting and flowering time is July but, August-September is the peak period of flowering. Tuberose is year round production and harvesting is depending upon purpose and distance of market. Tuberose should be harvest when lower pair of flowers is fully open as a local market and as distant market lower

flower buds has just burst (Prasad. K. *et al.*, 2016), but ideal harvesting time at morning or evening by a sharp knife.

Harvesting of tuberose bulbs at proper stage of maturity is important for tuberoses bulbs and their growth. The bulbs reach maturity when the flowering is over and plant growth ceases. At this stage, the old leaves become dry before digging out the bulbs. The leaves are cut at the ground level and bulbs are taken out of the soil.

16. Yield

Flower production always depends upon varies, bulb size, planting time and density of plants. Flowers are ready for harvest in about 3 to 4 months after planting. At first year 4-5 lakhs/ha spikes production (cut flowers purpose) and 7-10 ton/ha flowers production (loose flowers purpose); Second and third years 5-6 lakhs/ha spikes production (cut flowers purpose) and 10-13 ton/ha flowers production (loose flowers purpose). In addition, 25-30 tonnes/ha of bulbs and bulblets may be harvested at the end of 3rd year.

17. Post-harvest handling and packaging

Loose flowers are packed in bamboo baskets holding about 10-15 kg flowers and are transported to the local market where they are sold by weight. Grading should be done for cut flowers purpose and it depend upon colour, number of floret, length of the spike, injury of the spike, weight of spikes and then bunched in round bundles each having about 100 sticks. The stem portion of the bundles is wrapped in wet newsprint sheets. To avoid damage of the flowers and buds, the whole bundle should be wrapped in soft, white tissue paper or polythene. Before packed spike should be dipping pulsing solution containing 200 ppm silver nitrate (AgNO₃) and 4mM silver thiosulfate STS (Bakash *et al.*, 1999) ^[1] or solution containing sucrose 2% + 8 HQC (200 ppm) + AgNO₃ (50 ppm) for increase self-life (Sudagar *et al.*, 2010) ^[11] and later bundles packed in the card-board boxes and shipped by air to reach the destination quickly.

18. Storage of Bulbs

The soil adhered to the clumps are removed and the off shoot is separated by rubbing off. Loose scales and long roots should be removed and bulbs are graded into different groups depending upon the size of bulbs diameter. They are stored separately in a cool, dry and shady place. During storage the bulbs should be stirred every few days to prevent and check the spread of mould and rot. Storage for 5-6 weeks is necessary before the bulbs are ready for planting.

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