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Vertical farming of orchids

Vertical farming is fast becoming a popular option available to the growers to economize on the use of arable land and to realise higher yield and income per unit area. Use of this technology can result in a change in the conventional crop production technologies. Fine tuning the existing production practices for successful cultivation on the vertigrow system needs research on aspects like the growing media, nutrition, planting density, planting system, dispensing plant protection chemicals and other intercultural operations. Orchids are one of the high value cut flowers that are imported into India to meet the domestic demand. Cultivation of orchids on vertigrow systems with suitable agro-techniques has the potential to enhance the production of cut flowers per unit area, thereby meet the domestic demand and enhance the income of the growers.

VERTICAL farming system is one of the most effective alternative models to offset the constraint of space in urban and peri-urban areas. The major advantage of vertical farming is that it meets the commercial demand as it can accommodate a greater number of plants per unit floor area. Precise nutrient and water utilization, management of light, temperature and humidity requirements can increase production, reduce input costs and enhance the farmers' income. Vertical urban farms play an important role in nature-based solutions and ecosystem services for a city. In the face of a changing climate, progressive environmental degradation, and the related loss of agricultural land, vertical farms can be seen as an alternative to traditional cultivation practices and can create a new valuable ecological, social, and economic hub in the cities and surrounding areas.

Cut flowers and potted plants of orchids are widely valued in the global floriculture trade and they rank among the top ten traded plants. In spite of the conducive climatic conditions prevailing in our country, we are largely dependent on the imports from Thailand (80.6% of orchid cut flowers). The present system of orchid cultivation in India includes pot culture, cultivation on beds, in hanging pots, in coconut husk and on mounts under shade nets, polyhouses or in the open, depending on the suitability of the genus to the prevailing conditions. Orchids planted in pots are kept on flat horizontal benches. Thus, the vertical space above and below the benches remain unutilized. These growing systems involve large scale use of land which has become a scarce commodity on account of rapid urbanization.

Over the last few years, multi-storied vertical farms have been established in Japan, Singapore, Taiwan, China, Korea and the United States of America for vegetable crops, strawberry, herbs and aromatic plants and a few flower crops. However, for commercial vertical farming of orchids, information is lacking on the type of vertigrow system, suitable light weight media/substrate and containers, irrigation, nutrition and plant protection schedules. There is also a need to evaluate the performance

Vertical frames for orchid pots

of the orchids for productivity and the economics on vertical system in comparison to conventional farming. Further seasonality barriers can be overcome and quality of the spike enhanced by manipulation of the environmental conditions, nutrition and use of plant growth regulators. An attempt was made during 2021-22 at ICAR-IIHR, Bengaluru to cultivate orchids in vertical farming system under naturally ventilated polyhouse, in order to develop the protocols for commercial farming of orchids in this system.

Growing structures and mechanization

Single span, naturally ventilated polyhouse of 200 m^2 area, having gutter height of 4.0 m, ridge level of 6.5 m with saw tooth type top ventilation and 200 micron UV stabilized five layered polyethylene sheet cladding was constructed for housing the vertical growing structures. The side walls had rollable flaps for side ventilation, below the gutter level and was cladded with 40 mesh insect net and 50% shade net. Two layers of shade nets were used at truss level. The upper layer of shade net was fixed to permit 50% of incident light, whereas, the lower layer of retractable shade net permits 75% of light. Based on the prevailing weather conditions, the lower layer of shade net is either drawn or retracted manually. Automated drip irrigation system for vertical stands with timers, electric panels and controllers was installed for irrigation. Automated timer based fogging system with high pressure pump to produce droplets < 30 microns provided the humidity required for orchids. Concrete flooring was provided to permit free movement of the wheel mounted growing structures, spraying equipment and the ladders.

Vertical frames of height 2.65 m, 3.5 m length with one inch squared wire mesh welded on the frames on base frame of 1 m width were used to mount the pots. Twenty vertical frames can be accommodated in the polyhouse with adequate space in between the frames for the movement of spraying trolley and ladders for performing the cultural operations. The pots can be placed on both the sides of the frame.

Water softener plant of 200 litre capacity was installed with two tanks one for storage of raw water and the other for collection and storage of softened water, to be used for irrigation and for misting. Ideally the *p*H of the water should range between 5.5-6.5. Electrical conductivity of the water should be 0.8-1.2 dSm^{-1}.

Water softener and collection tanks

Mechanization of spraying operation was done using trolley mounted, sprayer of height 2.9 m with nozzle to nozzle distance being 0.78 m. This system ensures coverage of the plants on all the tiers of two vertigrow systems simultaneously with water soluble fertilizers and plant protection chemicals.

Wheel mounted ladder

Wheel mounted ladders of 2.3 m height and base width of 1.5 m were used to access the plants at different heights during cultural operations.

Influence of planting heights

Planting heights along the different tiers in the vertigrow structures have a profound influence on the plant growth and production of flowers. Varying light levels, seasonal effects and the shading effect in the different tiers are being considered for carrying out the cultural operations. The average light interception at the top-most tier is 22,500, 18,200 and 9,500 lux during the summer, winter and rainy seasons, respectively. Whereas, at the lowest tier, the average sunlight interception is 9800, 5800 and 1800 lux during the summer, winter and rainy seasons, respectively.

Type of containers

The type of containers is known to influence the

Netted conical pot

establishment, growth, development and flowering of the plants. Vertical garden plastic pots (black) of size 4", 6" and conical netted pots are being used in the vertigrow system to assess their suitability to sustain the plant growth and study the influence on production and quality of spikes. Growth and flowering performance indicate the netted conical pots have an edge over the vertical garden plastic pots.

Potting media

Potting media in epiphytic orchids is characterised by the ability to provide firm anchorage, retain optimum moisture levels and have porosity for adequate air circulation and for drainage. Charcoal, coconut husk, tile bits alone and a mixture of these in 1:1:1 v/v are used as potting media to determine the best potting media, that is light in weight, economical and supports plant growth and flowering. The interval for repotting is also being evaluated for these potting media.

Planting material

Tissue cultured uniform hardened plants were planted @1 plant per pot and the potting medium was firmed in to provide adequate support.

Planting geometry

The number of plants that can be accommodated per unit area of the vertigrow structure, is a pertinent factor to ensure the profitability of the vertigrow system. The placement of the plants in this system must be such that it minimises overlapping, shading and ensures good air circulation. Various planting systems are being assessed to standardize the best one for commercial orchid cultivation, wherein the optimum number of plants produce maximum number of quality spikes.

Nutrition

Nutrition management of the orchids is done through biweekly foliar spray of 19:19:19 N: P_2O_5:K_2O @0.2% along with a weekly spray of 0.2% of seaweed extract which has beneficial effects on plants. At flowering stage, *Dendrobium* orchids respond well to 0.2% of 10:60:20 N: P_2O_5: K_2O.

Flowering, harvesting and post-harvest management

Flowering starts one year after planting. However, during the initial flowering phase, spikes are short with 3-5 florets per spike. From the second year onwards, spikes meeting the cut flower standards can be harvested. Eight to ten spikes are produced per plant from the third year.

Staking and fixing the spikes should be done using bamboo/plastic stakes and clips or the flowers should be tied up loosely with a thread attached to GI wires, so that the spikes are not crooked or bent at harvest and are erect to have better visual appeal and are graded higher.

Harvesting is recommended when most florets on the spike have opened fully, with two or three buds. Flowers cut prior to maturity wilt. The stalk is cut at the base, close to the stem, and pasted with a fungicide. Harvesting is ideally done in the evenings and the spikes are pre-cooled and conditioned before packing and storage.

Grading is done based on the appearance, stage of maturity, blemishes, size of florets, erectness and length of spike. Each spike is inserted into a small plastic vial containing preservative solution. For long distance transport, individual spikes may be wrapped with newspaper or tissue paper. The spikes can also be loosely bunched with 5-10 spikes per bunch. Bunches or individual spikes are placed inside the well-ventilated cardboard with ethylene scrubbers and transported to the long distance destinations by air or sea cargo. For domestic market, road transportation is done.

Value-addition to the flowers such as making orchid garlands, bouquets, corsages, resin encapsulation of the flowers and dried flower preparations will also help in supplementing the growers' income.

Plant protection: Need base plant protection sprays should be taken up. The major pests are mites, aphids, thrips, beetles, scales, snails and slugs, whereas the major diseases are root rot, wilt, anthracnose, sooty mould and viral diseases. Mechanized spraying of suitable pesticides or fungicides can be done using trolley mounted sprayer.

CONCLUSION

For anticipating economic and ecological benefits from the vertical farming of orchids, it would be beneficial for the growers if cost effective vertigrow system of orchid farming using locally available materials is standardized. Mixed vertical farming with crops having similar growing requirements like cut foliage in the lower tiers can be explored as a means to have a wider range of materials for preparation of value-added products.

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