Application of Hydroponics in Floriculture Sector

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The global urban population is predicted to get doubled in 30 years, with 60% of the world's population in cities by 2030. To meet this demand, urban horticulture (UH) is being explored as a potential solution. However, improper handling of urban farming resources could negatively impact the environment and food safety. The floriculture industry offers a higher income per unit area. Floriculture exports have grown by 10% annually, with annual consumption ranging between $40 and $60 billion. However, soil-based agriculture faces challenges like limited land availability. No-soil culture, a technique using hydroponic and aeroponic growing methods, offers benefits such as better nutrition regulation, availability in non-arable land, efficient water and fertilizer use, simplicity, low-cost sterilization, and higher density planting, increasing yield per acre.

Objective

1. To get a brief overview of application of hydroponics system in floriculture crops globally.

2. To account research directions followed till date that can serve as baseline information to guide future research.

Methodology

Research findings and publications on the application of hydroponics in flowers from journals, books, reports etc. were studied thoroughly and the data was analyzed and represented here.

Result

The method of growing plants, without soil while submerging their stems in nutrient solution, is known as hydroponics (Maharana and Koul, 2011). Common mediums include expanded clay, coir, perlite, vermiculite, brick shards, polystyrene packing peanuts, and wood fibre. Several studies have been conducted with the application of hydroponics in floriculture.

Gerbera

Tahhereh *et al*. (2020) conducted a study to investigate the effects of silica nanoparticle and Ca-chelate on gerbera under hydroponic conditions in Iran. Results showed that 20 mg/L and 60 mg/L nanoparticles resulted in the longest flower longevity, flowering acceleration and increase of leaf number, stem ash and lignin content. The treatment with 80 mg/L nanoparticle-SiO_2 and 240 mg L Ca-chelate was found as the best treatment for increasing both protein content and degree of transparency. A study was conducted in COH, Thrissur by Arathi, 2016 to find out the suitability and performance of five different gerbera cultivars, *viz.* Donna Ellen, Goliath, Stanza, Intense and Balance. Maximum plant height was recorded in Intense. Cultivar Balance took the minimum time (125 days) to open first flower. Flower stalk characters were less in hydroponic condition than in pot culture. Vase life (13.9 days) and number of flowers (6.3) were recorded maximum in Balance.

Khalaj *et al.* (2011) conducted a study on gerbera to determine the effect of different substrates on growth and yield. Fourteen treatments comprising of different growth media were used and it was found that perlite, peat & expanded clay (25%+75%+5%) media produced maximum number of flowers per plant with best quality and shortest time (15months). It was also found that quality & yield of the crop has a strong relation with physic-chemical properties of the growing media. Cocopeat combinations produced good vegetative growth and good quality early flowers. Savvas *et al.* (2003) reported that pH of the drain solution increased when low NH_4 + :N was used for gerbera (*Gerbera jamesonii*), but did not change using a high ratio. Savvas and Gizas (2002) found that gerbera flower number and flower stem length were lower when the effluents were recycled and attributed this to reduced NH4 + in the supply solution resulting in increased pH and restricted supply of P, Fe, and Mn to the plants, and recommended higher NH_4 +: N ratios than those used for open systems.

Rose

Mattson and Leith (2007) conducted a study on hydroponically grown cut roses in USA to determine how macronutrient absorption varies in relationship to growth of new flower stems and test whether an existing mathematical model is suitable for describing nitrogen and potassium uptake across a crop cycle. Results showed that total nitrogen uptake decreased after harvest, then increased with flower stem elongation. K+ uptake decreased for 12 days, then increased with stem elongation. Ca2+ uptake decreased before harvest, and then increased before stem maturity. Farahi *et al.* (2013) conducted research to analyze the impact of polyamines on vegetative, flowering and post harvest life of rose cv. Dolcvita in hydroponic culture. They found that foliar treatment of polyamines had substantial impacts on floral stem length, fresh weight, vase life, flower bud girth, and length. The highest and lowest flower stalk lengths were measured in nutrient solutions containing 1.5mM spermidine and 100.66 and 71 cm, respectively, suggesting that polyamines have a significant impact on the qualities and properties of roses. Jiang *et al.* (2007) applied nutrient film technique (NFT) and deep flow technique (DFT) in production of rose, chrysanthemum and carnation. Das *et al.* (2012) reported that growth and flowering of rose were induced by Hoagland and Arnon composition (1950) of solution culture. With rose (*Rosa × hybrida*), recycling reduced NH_4 + in the solution and increased pH, which necessitated daily addition of HNO_3 - to reduce pH (Lykas *et al.*, 2001).

Chrysanthemum

Azeezahmed *et al.* (2016) conducted a study to determine the impact of different N-K concentration on flowering of chrysanthemum cv. Mother Teresa. The treatments consisted of five nutrient solution concentrations (NSC), having N (50, 100, 150, 200 and 250 ppm) and K levels (40, 80, 120, 160 and 200 ppm) during vegetative stage, and 60, 110, 160, 210 and 260 ppm during reproductive stage. The optimal therapy was found to be NSC-V of N250 C K200 during the vegetative stage and N200 C K260 during the reproductive stage, resulting in the greatest number of blossoms. Rahman *et al.* (2022) conducted a trial to find out the best media for chrysanthemum cv. Rajkumari under hydroponic system in AAU, Assam. Seven growing media combinations, *viz.* coco peat, coarse sand, cinder, coarse sand cinder, coarse sand and coco peat, coco peat and cinder, coco peat, coarse sand and cinder as growing media and two different concentrations of nutrient solutions EC 1.5dS/m and EC 1.8dS/m were utilized and the best quality and yield of flowers were produced under coco peat + cider and EC 1.8dS/m nutrient media.

Gladiolus

Agina *et al.* (2018) conducted a study in Benha University, Egypt to examine the relationship between the source of nutrients and water flow rate to determine if it is possible to grow gladiolus plants in a wastewater fish farm using nutrients that are different from those used in conventional nutrient solutions. The findings showed that in effluent fish farms as opposed to nutrient solutions, plant height rose and the average duration of a spike was longer. Additionally, the nitrate concentration in the effluent fish farm considerably rose as the flow velocity was increased. Nosir (2011) conducted an experiment in University of Aberdeen, UK to compare the effectiveness of three commercial fertilizers- Signral, 20-20-20; Nutrafin 23-33-24; and HeavyharvestBloom, Hydroempir for growth of Gladiolus in NFT system. Three purchased nutrients were used and Hoagland's solution was contrasted. The results showed that the gladioli corms demonstrated excellent adaptability to NFT cultivation during the two winter experiments, yielding high-quality blooms. This research will provide a new avenue for substituting ready-made hydroponic nutrition solutions with commercial nutrients. Wahome *et al* (2010) conducted a study aimed to determine the effects of different hydroponics systems and growing medium components on growth, yield and quality of gladiolus where three hydroponics systems (elevated tray, ground lay bed and bag culture) were used as the main plots and sub-plots were allocated to the different medium components *i.e.,* crushed stone, sawdust, sand and vermiculite. They concluded that for the hydroponics culture of gladiolus, bag culture hydroponics system may be used with sawdust as growing medium as it showed superior results.

Lily

Moghaddam and Nasir (2020) conducted an evaluation to study the effect of different concentrations of potassium on lily growth and postharvest life. A hydroponic experiment was conducted in Islamic Azad University, Tehran, Iran. The findings showed that most plant development parameters, such as shoot dry weight, declined with potassium consumption in nutrient solution, but improved at a potassium concentration of 6 mM. Seyedi *et al.* (2013) inspected the effects of calcium concentration on qualitative & quantitative characters of Lilium cv. Tresor in Islamic Azad University, Rasht, Iran. The Asiatic Hybrid Lilium bulbs of the "Tresor" cultivar, which were used in the present study, were seeded at three distinct calcium concentrations: 2, 4, and 6 mM. The highest height of the plant, stalk diameter, height at which reproduction begins number of buds, blossom diameter, and life of cut flowers were all generated by 6 mM calcium, according to a comparison of the data's mean values. Daood *et al* (2007) conducted a study on the response of Asiatic Lily (*Lilium* × *hybrida*) 'Zsa Zsa' to concentration of urea in a closed soilless culture and reported that as urea was increased up to 616 mgL^{-1}, stem height, shoot and root weight, and peduncle length all reduced before leveling out. Over 296 mgL^{-1} of urea decreased the number of floral buds by one bud. As urea levels rose, bud weight and length decreased. There was no effect on tissue N, P, Na, Cl, Mg, Mn, Cu, and Mo. The tissue K value that was highest was 296 mgL^{-1} urea. Applying 296 or 456 mgL^{-1} urea resulted in a decrease in Fe and Zn and an increase in tissue Ca. NH_4^+ and supply solution N were reduced at urea concentrations of 296 or 456 mgL^{-1}. EC and K increased with increasing urea. The greatest Na and Ca values were found for urea concentrations of 616 and 776 mgL^{-1}, respectively.

Gypsophila

Wahome *et al.* (2011) studied gypsophila production in hydroponics systems, revealing that vermiculite and sawdust produced taller seedlings and longer flower stems, respectively. Bag culture hydroponics system yielded the best vegetative development, blossom yield, and quality. Bar-Yosef *et al.* (2001) observed cyclic fluctuations in pH when NH_4^+ and NO_3^- were used for gypsophila (*Gypsophila paniculata*) in a closed system. During the first day, NH_4:NO_3 in the circulating solution was maximal and pH dropped, but because NH_4^+ uptake was faster than NO_3^-, NH_4:NO_3 decreased rapidly and pH increased.

Marigold

Sarmah et al. (2020) conducted a study on quality of marigold flowers grown under hydroponic system at AAU, Assam. Three levels of hydroponic nutrient solution (EC 1.0, EC,1.5 dS/m, and EC 2.0) were used in five different hydroponic systems. When comparing the systems, NFT produced flowers of a higher caliber than any other system. Early bud and floral development among the nutrients was found to be superior in EC 1.0. This leads to the inference that the treatment combo of NFT and EC 1.5dS/m is best for marigold flower output of high quality.

Other ornamentals

Pansy (*Viola* x *wittrockiana* Gams.), petunia, and vinca (*Catharanthus roseus* G. Don) produced higher substrate-pH in a study involving seedlings grown in a peat:perlite substrate, while celosia (*Celosia cristata* L.), tomato (*Lycopersicon esculentum* Mill.), and zinnia (*Zinnia elegans* Jacq.) produced lower substrate-pH (Huang *et al*., 2001). According to Johnson *et al.* (2013), impatiens was midway between geranium and petunia, with geranium being more acidic and lowering substrate-pH while petunia was more basic and resulting in a higher pH. Taylor *et al.* (2010) defined "sudden pH drop syndrome" in geranium as a sudden decline in substrate-pH caused by phosphate (P) deficit. In comparison to plants cultivated with appropriate P, plants grown with reduced P in soilless container substrate and lacking P in hydroponic solution corresponded with quick declines in root zone pH, the suppression of NO3 - N absorption, and a shift towards increased cation/anion uptake (Taylor *et al*., 2008a, 2008b, 2010). When tissue levels become low, intense H+ outflow from roots may be an adaptive reaction to solubilize P in mineral soils (Marschner, 2012, Ch 14.4). It is still unknown, though, if the pH reduction in geranium that Taylor *et al*. (2010) saw under low P circumstances was a result of increased cation/anion absorption following the limitation of a macronutrient anion supply, or if it was an adaptive response brought on by P deprivation. Miller *et al.* (2002) reported that 30-35% of the cut tulip crop is forced hydroponically for flowering.

Landscaping

Dhanasekaran (2020) evaluated the performance of foliage ornamentals on different nutrient solutions, proposed by Hoagland and Arnon (1938), Cooper (1979), Saparamadu (2010), Mattson and Peters (2014), and a control using irrigation water underneath a passive hydroponic vertical garden module. Results showed that T_3 (Cooper's solution) had the highest chlorophyll concentration, while T_2 (Hoagland solution) had the highest membrane integrity content. T_4 (Saparamadu's solution) had the lowest relative growth rate.

Conclusion

The application of hydroponics in floriculture is vast. This review is an initiative to brief the same so that future research works can get a baseline perspective. Rose, Gerbera, Gladiolus, Lily are the ones where extensive research has been practiced utilizing hydroponics system, further works can be done to get the technique exploited and economical for floriculture sector.

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