A Case Study on the Application of Hydroponics in Floriculture Sector

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ABSTRACT

Urbanization is increasing rapidly, with developing nations experiencing the fastest expansion. By 2030, there will be 4.98 billion metropolitan dwellers worldwide (UN, 2002). Urban horticulture is the practice of growing fruits, vegetables, flowers and herbs in confined spaces, such as unused plots, gardens, balconies and containers inside city homes (Zoysa, 2007). Food produced in urban spaces can harm the environment or food safety due to presence of contaminants, so the floriculture sector is being envisaged as an alternative there. Floriculture is an intensive type of agriculture with high income per unit area (Randhawa & Mukhopadhyay, 1986), making it a fast growing industry. Urban farming has faced difficulties due to the decline in land available per person, and will continue to shrink due to rapid urbanization, industrialization and iceberg melting. The presence of disease causing pathogens, nematodes, erosion etc. can cause serious problems to crop growth in soil based cultivation. Recently hydroponics has emerged as a potential alternative to produce green vegetables, flowers, seedlings, and herbs, mostly in periurban and urban areas. The primary benefit of soilless hydroponic cultivation is the year-round accessibility of green secure and healthy horticultural produce. To get a brief overview of the application of hydroponics system in floriculture crops globally as a tool of urban and periurban agriculture, a brief case study was carried out to trace the use of hydroponics in cut flowers like Rose, Gerbera, Chrysanthemum, Gladiolus, Lily etc and landscaping sector by studying research journals, books and the data was analyzed and represented to serve as baseline information to guide future research.

Keywords: Urban Horticulture, Soilless Cultivation, Hydroponics, Floriculture, Cut Flowers

Introduction

The world urban population is expected to double in 30 years, with 60% of the world's population expected to live in cities by 2030. To address this, ad hoc strategies are needed to ensure adequate food supply and distribution systems. Urban and peri-Urban agriculture (UPA) is the practice of producing food and other products through agricultural production and associated processes. Urban horticulture (UH) refers to the practice of growing fruits, veggies, flowers

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and herbs in confined spaces, such as unused plots, gardens, balconies, and containers inside city dwellings. Urban farming has been a worldwide activity since the beginning of urbanization, with farming enabling the development of cities and cities needing farming to support their populations.

However, if the resources required for food production in urban areas are handled improperly, it could harm the environment or even pose a threat to food safety. The floriculture industry is examined as a potential substitute for food production for the implementation of urban farming methods, as the amount of money generated per unit area from floriculture is significantly higher than that from any other form of intensive agriculture.

The International Trade Center (2013) has reported that worldwide floriculture exports have increased by 10% annually, while annual consumption is between US$40 and US$60 billion. Floriculture is a multi-billion dollar global business that produces bedding and garden plants, foliage plants, potted flowering plants, cut flowers, cut cultivated greens, and floriculture materials. Soil-based agriculture has faced significant difficulties since the dawn of society, such as the decline in the amount of land available per person. In some areas, such as metropolitan areas, there isn't any soil suitable for crop growing, or there aren't many fertile cultivable arable lands accessible due to unfavourable topographical or geographical conditions.

No-soil culture primarily refers to the hydroponic and aeroponic growing methods. The Greek words hydro, which means water, and ponds, which means labour, were combined to form the name hydroponics (Beibel, 1960). It is a technique for growing vegetation without soil using mineral nutrient solutions (Beibel, 1960). The primary benefits of hydroponics over soil culture include better regulation of nutrition, availability in areas of non-arable land, effective use of water and fertilizers, simplicity and low cost of medium sterilization, and higher density planting, which increases yield per acre.

Objective

- To get a brief overview of application of hydroponics system in floriculture crops globally as a tool of UPA.
- 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.

Case Study 1 - Gerbera

A. 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 inleaf number, stem ash and lignin content. The treatment with 80 mg/L nanoparticle-SiO2 and 240 mg L Ca-chelate was found as the best treatment for increasing both protein content and degree of transparency.

B. 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.

C. Khalaj et al. (2011) conducted a study on gerbera to determine the effect of different substrates on growth and yield. Fourteen treatments comprising 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 have a strong relation with physic-chemical properties of the growing media. Cocopeat combinations produced good vegetative growth and good quality early flowers.

D. Savass et al. (2002) conducted a study on gerbera in closed hydroponics system to investigate the impact of silicon and nutrients under induced salinity. They found that the application of Silicon (1.25mM) in the nutrient media induced the production of flowers graded as class 1 with better quality and thicker flower stems. Increased EC resulted in reduction of flower weight and numbers and Si had no impact. Si was also found to improve mechanical strength of the stem and balanced nutrient solution by increasing Ca uptake.

e. Sharavani et al. (2018) conducted a study in Rajendranagar, Telangana to use hydroponics to create visible signs of macro and micro nutrient deficits in Gerbera. Individual macro and micronutrient deficiencies were incorporated with a complete nutrient formula minus one of the nutrients in tissue cultured Savannah gerbera varieties. Macronutrients such as nitrogen deficiency, phosphorus deficiency, potassium deficiency, calcium deficiency, magnesium deficiency, copper deficiency, boron deficiency, iron deficiency, zinc deficiency, and Manganese deficiency all showed visible signs of visual deficiency. Manganese was the only nutrient that did not manifest any visual deficiency symptoms.

Case Study 2 - Rose

a. 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 N uptake decreased after harvest and remained the same for 5 days, then again decreased during 8-10th days and synchronically increased with flower stem elongation. K+ uptake decreased steadily for the first 12 days before increasing in time with stem elongation to reach maximum uptake rates of 0.05 to 0.09 mmol d-1 g-1 HDW as stems matured. Ca2+ uptake decreased just before harvest and remained low until day 7 of the new cycle, after which it increased until just before stem maturity. Mg2+ uptake increased, and it then started to decline right before harvest.

b. Farahi et al. (2013) researched 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.

Case Study 3 - Chrysanthemum

a. Azeezahmed et al. (2016) conducted a study to determine the impact of different N-K concentrations 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.

b. Rai et al. (2017) investigated the salinity tolerance of 22 varieties of chrysanthemum at five different salinity levels (0, 50, 100, 150, and 200 mmol/L). Measurements of changes in various physiological and morphological parameters were used to determine salt tolerance. It was found that as the concentration of salt increased, the amount of chlorophyll a, chlorophyll b, and total chlorophyll decreased, with Pusa Aditya, Haldighati, Lalit, Little Pink, and Jaya having the highest levels. The degree of stress and variation affect how quickly dry weight decreases.

c. 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.

Case Study 4 - Gladiolus

a. Agina et al. (2018) conducted a study at 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.

b. Singh et al. (2018) experimented to determine the effects of various growth regulators and various substrates on shoot and root development in cormels of gladiolus cv. American Beauty. Three different growth mediums were used: soil, sand, and hydroponics. Pre-soaking cormels in GA3 (50 ppm) and thiourea (0.2%) for 24 hours had a significantly greater impact on development and root characteristics than pre-soaking in distilled water. GA3 produced the maximum leaf length at 50 days and the maximum length of stems.

c. Jabbar et al. (2018) conducted a study to study the effect of cocopeat: perlite medium with three ratios (v/v) (1:1, 3:1 and 1:3) on some vegetative, flowering and biochemical parameters of two gladiolus cultivars. Results showed that most vegetative parameters such as plant height, leaf number

and leaf area, flowering parameters such as spike emergence, spike diameter, spike length, and number of florets per spike, and biochemical parameters like chlorophyll a, chlorophyll b, soluble sugars and N, P and K (%) uptake in leaf were significantly affected by cultivars, media and their interactions.

d. Nosir W (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.

Case Study 5 - Lily

a. Moghaddam and Nasir (2020) evaluated to study the effect of different concentrations of potassium on lily growth and postharvest life. A hydroponic experiment was conducted at 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.

b. 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.

c. Traykova et al. (2021) conducted a study in a Bulgaria to accelerate the growth and multiplication of Lilium bulbs. Results showed that the weights of the original and end bulblets did not correlate. Flood and discharge hydroponic systems produced the best results, with the first 10 plants being effectively acclimated outdoors and flowered.

Case Study 6 - Gypsophila

Wahome et al. (2011) researched to determine the viability of producing gypsophila in various hydroponics systems. Three primary areas were used: elevated tray, ground lay bed, and bag culture systems. At 12 weeks after

transplanting, plants grown in vermiculite produced the tallest seedlings (52.9 centimeters). Gypsophila plants cultivated in sawdust at 12 WAT nearly doubled in height compared to plants grown in sand. Sawdust produced the most branches per plant, with plants grown in sawdust in the bag culture hydroponics system producing the longest cut flower stems. The best vegetative development, blossom yield, and quality can be achieved by growing the plants hydroponically in bag culture.

Case Study 7 - 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 were 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.

Case Study 8 - Landscaping

Dhanasekaran D (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 control using irrigation water underneath a passive hydroponic vertical garden module. At 30, 60, and 90 days after sowing, physiological measures including chlorophyll content, membrane integrity (%), and relative growth rate were noted. Results showed that the foliage ornamentals grown under treatment T3 (Cooper's solution) recorded the maximum chlorophyll concentration and the other two viz., Wandering jew and Boat lily recorded the maximum membrane integrity content. T2 (Hoagland solution) also showed the highest relative growth rate, while T4 (Saparamadu's solution) showed 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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