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Wick system – An efficacious technique for gerbera cultivation

Gerbera, being the most globally-traded flower crop, is commercially grown on soil beds using drip irrigation system. Although drip system saves 30-50% of water compared to the traditional irrigation methods, there is an increasing urge to improve the water- and nutrient-use efficiency of the crop by adopting efficient production system in the present context of expanding urbanization, diminishing agricultural area and reducing water availability. Wick system which exploits the principle of capillary action is one such technique that could effectively enhance the production and quality along with increased net returns and water saving. Adopting wick system for gerbera increased the flower production by 53% and water saving by 44% over the drip system. Moreover, the physical and chemical properties of the soil are least bothered under wick system as there is no external force or pressure exerted on the soil unlike the trickling water droplets in drip system. Hence, the superior crop performance of gerbera could be considered as the resultant of lesser soil compaction, consistent water availability and better soil physical properties under wick system.

GERBERA is popularly known as Transvaal daisy, African daisy and Barberton daisy. It is native to Southern Africa and holds huge demand in the global flower industry owing to its vibrant colour, prolonged vase life and faster rehydration. As per the First Advance Estimates (2023-24) published by Ministry of Agriculture and Farmer's welfare, gerbera is cultivated in an area of 5,280 ha with the production of 26,660 MT in India. It is obvious that the food and water demand are increasing exponentially due to the rising population and urbanization. The irrigation water demand has been projected to increase from 688 billion cubic metre in 2010 to 1072 billion cubic metre by 2050. While, the Ministry of Jal Shakti predicted a dip in per capita water availability with 1191 m^3 in 2050 against 1545 m^3 during 2011. While, a gerbera plant requires 500-700 ml of water per day which annually amounts to 1500-2100 m^3 per ha. Thus, it is evident that the annual water requirement of gerbera is higher than the per capita availability. Though India receives about 4000 cubic kilometre of water via precipitation, the average annual potential flow in rivers is only 1869 cubic kilometre, out of which hardly 1123 cubic kilometre is exploitable (690 and 433 cubic kilometre of surface and ground water resources, respectively). Water scarcity is becoming a real threat to the sustainability of irrigated agriculture. Since agriculture consumes massive fresh water, focus should be turned towards amplifying the water-use efficiency in the agricultural system. Surprisingly as per some reports, China produces 0.46 kg of rice and 1.08 kg of cereal with 1000 L of water while, India produces only 0.23 and 0.36 kg, respectively. Hence, replacing the currently booming drip system with a new technology with higher efficiency is the pressing priority. Wick system had been proven as one such technique owing to its water saving, reduced electricity consumption and cultivation cost.

Growth in wick system

Drip system

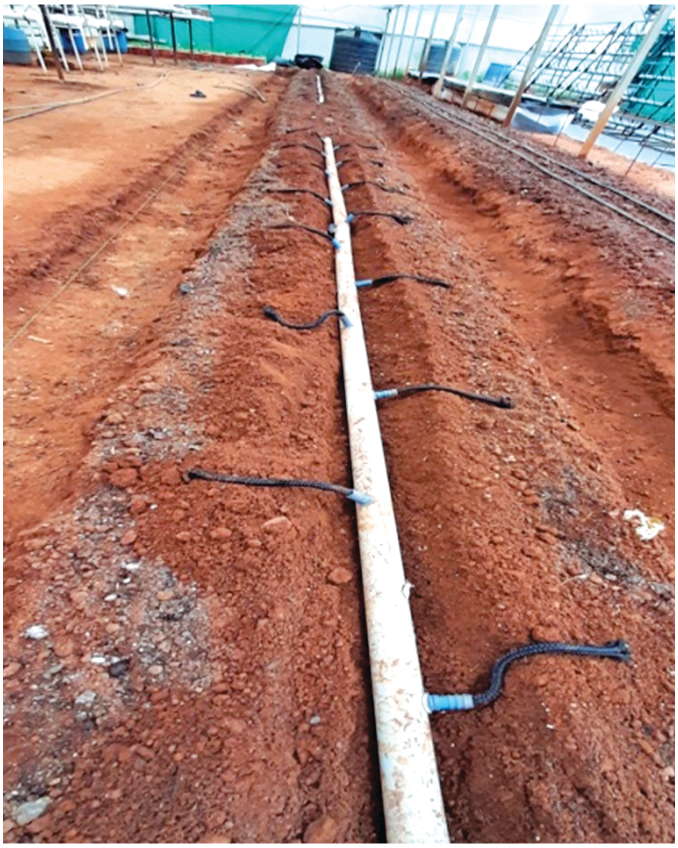
Drip irrigation system, also known as 'Trickle irrigation' is a system renowned for its enhanced water and nutrient saving. It conserves water by curbing the evaporation and drainage losses. The water and the dissolved nutrients are supplied directly to the root zone fostering the plant growth and development thus saving 30-50% of water applied in conventional surface irrigation and sprinkler systems. Adopting drip system helps in uniform distribution of water and nutrients to the plants thus improving the resource-use efficiency. It also reduces the problems associated with soil erosion and nutrient leaching. Reports have mentioned that drip system has been widely adopted in an area of 83.19 lakh hectares in India since 2014-15. Despite, the present scenario of plunging water availability underscores the need of more water and nutrient efficient systems.

Wick system

Wick irrigation is a sub-surface irrigation system which applies the principle of capillary action. Capillary action is the spontaneous movement of a liquid through a narrow tube such as capillary. In this system, the plants take up the water and dissolved nutrients through capillary movement assisted by the wicks. This occurs against the gravity and is achieved with the help of adhesive and cohesive forces interacting between the solution and the wick. The plant could take only the required amount of water facilitated by the transpiration pull and after attaining the saturation point, the wicks stop the water uptake and thus curb the excessive water loss. Moreover, the wick system usually operates in a closed cycle, without runoff, permitting appropriate plant nutrition and reducing the heavy metal contamination and environmental pollution. It has greater water and nutrient-use efficiency and reduced cultivation cost owing to minimal electricity usage and lesser manpower. It also does not deteriorate the soil physical properties, *viz.,* bulk density, particle density and air porosity. Whereas the physical and chemical properties of soil like air porosity and nutrient availability are likely to be disturbed in case of drip system, due to continuous dripping of water droplets on the soil which in turn creates a pressure on soil leading to soil compaction. But in case of wick system, the water is taken up by the plants through capillary action and hence the soil structure remains undisturbed. Furthermore, wick irrigation system has been reported to render enormous advantages in the cultivation of chrysanthemum, poinsettia, kalanchoe and cyclamen. Keeping these advantages into consideration, ICAR-Indian Institute of Horticultural Research, Bengaluru designed a low-cost wick system on conventional soil beds and compared its performance over drip system in the cultivation of gerbera.

Installation of wick system on soil bed

Red soil, farmyard manure and sand were mixed in the ratio of 2:1:1. Soil fumigation was carried out to prevent the incidence of soil-borne pests and diseases. Beds of 60 cm width, 30 cm height and convenient length were prepared after thorough-mixing of the soil mixture.



Wick system installation

Holes are drilled on the food grade PVC pipes of 2 inch diameter at a spacing of 30 cm. Nylon wicks of 30 cm length were inserted into the PVC pipes with 5-7 cm of wicks lying inside the pipes. Before inserting the wicks, washers and take-offs were fitted over the holes to prevent water leakage. The pipes were then laid at a depth of 10-15 cm inside the soil beds and the wicks were adjusted according to the plant spacing. A reservoir was placed in a pit below the ground level to harness the circulating water/ nutrient solution and a submersible pump was fitted to circulate the water. The reservoir was always kept closed to avoid algal growth.

Planting and nutrition

Micro-propagated plants of gerbera var. Arka Nesara were hardened in polytunnels using cocopeat for a month. After hardening, the plants were transplanted on the soil beds at a spacing of 30 cm × 30 cm. The plants were provided only with the rainwater for a week as the emerging roots would be sensitive to salts present in the nutrient solution. Later on, the plants were supplied with 19:19:19 @ 2 g/L up to 3 months after transplanting. The dose was gradually increased to 3 g/L during the flowering stage. Bi-weekly spray of 0.3% Fertilon® combi 1 (containing 0.5% boron, 1.5% copper, 4% iron, 4% manganese, 0.1% molybdenum and 1.5% zinc) was practiced to supplement the necessary micronutrients.

Intercultural operations

Leaf pruning was practiced once in 15 days by removing the older and diseased leaves. Only 16-18 leaves were retained per plant and the remaining leaves were pruned with sharp secateurs. Weeding was also practiced as and when needed to reduce the plant-weed competition for nutrients. Insecticides like Fipronil based phenyl pyrazole, Diafenthiuron and Cartap hydrochloride were sprayed to keep whiteflies and aphids under check. Similarly, Tebuconazole and Trifloxystrobin combination at 0.1% was sprayed as a control measure for powdery mildew.

Harvesting

Harvesting can be done either with sharp secateurs or by gently twisting the basal end of the flower stalk. The flowers were harvested when the disc florets were perpendicular to the flower stalk. The harvested flower stems were kept in a bucket of tap water to reduce the field heat and then transferred to cold storage after trimming the basal stalk end.

Flower production under drip (left) and wick system (right)

Comparison of drip and wick system

Plant parameters

Wick system exhibited superior results with respect to growth, flowering and yield parameters compared to drip system (Table 1). Average plant height and number of leaves per plant grown under wick system were 13.79 and 33.47% higher than those grown on drip system. Wick system enhanced the leaf area of the plants by 33.22% over drip system. The improved vegetative growth in wick system might be attributed to the better aeration, uninterrupted water supply and nutrient availability near the root environment.

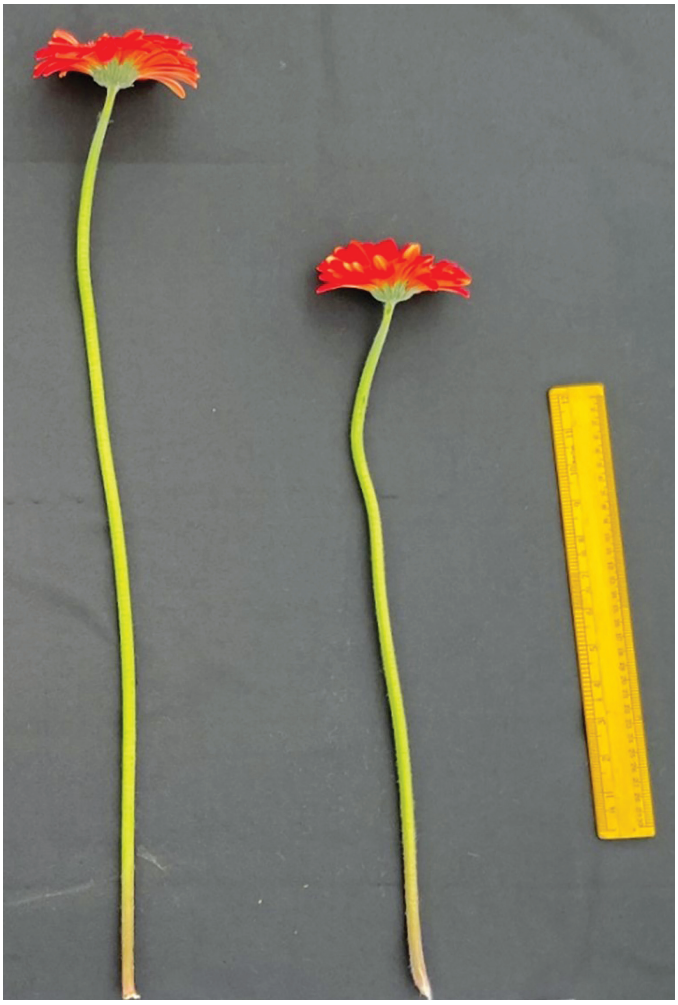
With respect to flowering, the plants under wick system produced harvestable flowers 9.96 days prior to drip system with doubled flower yield of 36.58 flowers per plant per year (i.e. 53.05% > drip system). Earlier flowering and greater flower production were found associated with the enhanced leaf area, number of leaves and better source-sink relationship in wick system as a result of ample moisture, optimal pH and fertilizer retention. Moreover, plants grown on wick system produced flowers with longer stalk (10.54%), thicker neck (16.18%) and extended vase life (5.41%) in comparison to drip system. Prolonged vase life under wick system might be correlated with the sufficient availability of carbohydrates in the flower stalk.

Table 1. Comparative analysis of drip and wick system

Parameter	Drip system	Wick system
Plant parameter		
Plant height (cm)	26.39	30.03
Number of leaves	9.68	12.92
Leaf area (cm²)	82.12	109.40
Days to flower harvest	159.76	149.80
Number of flowers/ plant/ year	23.90	36.58
Stalk length (cm)	45.56	50.36
Neck diameter (cm)	4.08	4.74
Vase life (days)	7.40	7.80
Soil parameter		
pH	7.74	7.23
Electrical conductivity (dS/m)	0.63	0.75
Organic carbon (%)	17.31	19.53
Bulk density (g/cc)	0.819	0.841
Particle density (g/cc)	1.343	1.410
Pore space (%)	38.56	41.39
Volume of expansion (%)	5.66	16.85
Water holding capacity (%)	48.99	51.04
Water use and economics		
Water consumption per plant per day (mL)	555	307
Amortized cost of cultivation (₹)	1,33,148	1,47,212
Net returns (₹)	38,932	1,16,163
Benefit cost ratio	1.29	1.79

Soil parameters

Concerning the soil chemical properties, a pH of 7.23 has been noticed under wick system depicting the nearly neutral root environment favourable for crop growth and development. Almost all the essential nutrients are readily available in acidic to neutral pH, hence the lower pH in wick system might have assisted the plant with consistent nutrient uptake. Moreover, the organic carbon (19.53%) and electrical conductivity (0.75 dS/m) were maximum with capillary action system which indicates that the



Stalk length of gerbera under drip (right) and wick system (left)

higher organic matter production and instant nutrient availability in the soil. This could be attributed to the better air exchange and soil adhesion properties.

Greater porosity, volume of expansion and water holding capacity in wick system might be associated with the enhanced root growth and nutrient absorption. The physical properties of the soil were not greatly influenced by the wick system as the water is absorbed by capillary action principle while in case of drip system, the pressure exerted on soil by water droplets led to soil compaction thus affecting the pore space and water holding capacity.

Water-use and economics

The amount of water consumed in wick system was 44.68% lesser than drip system and hence it can be stated that the water-use efficiency and water saving were comparatively greater in wick system. Further, the water was supplied to the sub-surface layer thus the water loss due to evaporation was minimal under wick system. While comparing the economics, it was obvious that the net returns were ₹ 77,231 higher in wick system than drip system despite the higher cultivation cost. Moreover, the benefit cost ratio of wick system was worked to be 1.38 times greater than that of the drip system.

SUMMARY

Ad opting a production system with greater productivity, water- and nutrient-use efficiency is of utmost importance in the present scenario of burgeoning population, food demand and water scarcity. Drip system which is in current practice seems to be costlier for the near future with respect to input use efficiency. Therefore, evolution of a production system that could save water, enhance crop performance and increase the farmers' net returns is the absolute necessity. Wick system which exploits the capillary action principle is identified as one such system with higher crop water productivity, crop growth, enhanced yield and quality along with lesser impact on the soil structure. Hence, it could be highly remunerative and economical if employed as an alternative for drip system in the gerbera flower production.

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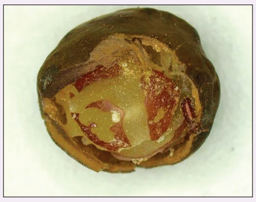
Infestation of lesser grain borer on roasted makhana seeds under storage

The internal stored grain insect (lesser grain borer), *Rhizopertha dominica* (Coleoptera: Bostrichidae) was found infesting on the roasted makhana seeds of 3 standard size grades, i.e. 7 mm, 9 mm and 11 mm. It was recorded that insects preferred to feed on 11 mm size seeds, followed by 9 mm and 7 mm, respectively. Both grub and adult stages were able to cause substantial damage. The adult laid the eggs on the seeds by entering inside the kernels through the apical natural opening. The average temperature and relative humidity for *R. dominica* development was maintained as 32.5 ± 1°C and 70 ± 5°C, respectively. It took 35–50 days for completing its life cycle, which included four stages: egg, larva, pupa and adult. Females laid about 200–500 eggs in their lifetime, singly. Incubation period lasted for 5±0.3–9±0.4 days, while larval and pupal period took 30±5 and 8±2 days, respectively. Mean longevity of adult male and female was 26 and 17 weeks, respectively. The damage potential was assessed using the artificial infestation (purposive samples) with different numbers of tested insect. The study indicated that significant loss of roasted makhana seeds during 15 days of storage with 40±1.24% losses, caused by 10 adults per 100g seeds. The total quantitative losses observed for 6 months storage period was 64±1.16% in the samples with 10 adults per 100g of roasted makhana seeds. The initial losses were very high and became slow after 20 days. Presently available method of fumigation by aluminium phosphide was practised and found feasible for the insect control.



Internal makhana feeding

Lesser grain borer (adult and grub)

Source: ICAR Annual Report 2022-23