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Response of gerbera under soil and soil-less production systems

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ABSTRACT

Response of gerbera var. Arka Nesara was studied under different soil-less production systems with the aim to improve quality, productivity and water use efficiency, in completely randomized design with eight treatments *viz*., deep flow technique (DFT), nutrient film technique (NFT), aggregate wick system (AWS) with pots on NFT bench, AWS with pots on ground, AWS with grow bags on ground, AWS on soil bed, aeroponics and conventional soil-based drip system, which were replicated five times. Results revealed that AWS with pots on ground recorded maximum plant height (31.66 cm), leaf length (21.31 cm), leaf breadth (9.96 cm) and stalk diameter near neck (4.75 mm), minimum stem deviation (1.27 cm) and stem deflection (2.2°), prolonged vase life (9.2 days), greater water use efficiency (92 mL/plant/day) and water saving (83.46%). Hence, cultivation of gerbera var. Arka Nesara under aggregate wick system with pots on ground could be the superior alternative for traditional soil cultivation.

Keywords: Capillary action, gerbera, water saving, wick system

INTRODUCTION

Gerbera jamesonii, family Asteraceae, is an important cut flower ranked one among the most-traded ornamental plants in the global market. In India, it is cultivated in an area of 5,730 ha with the production of 28,620 MT (Anon., 2023). Gerbera is usually grown on conventional soil beds under protected structures. However, soil as a substrate has several inherent problems like compaction, nutrient immobilization, soil alkalinity, salinity, soil-borne pests and diseases limiting the crop productivity. Therefore, a soil-less cultivation system could be highly helpful for lucrative gerbera cultivation.

Deep flow technique, nutrient film technique, floating technique, root dipping technique, capillary action (wick) technique and aeroponics are the different types of soil-less cultivation. Adopting the appropriate soil-less system is imperative to achieve better yield and quality in gerbera. Moreover, focus should be turned towards amplifying the water use efficiency considering the diminishing water availability. Wick irrigation system has been known to have superior advantages in terms of water and nutrient use efficiency along with reduced cultivation cost. Keeping these points in view, a study was carried out to identify the suitable soil-less system for growing gerbera under protected condition.

MATERIALS AND METHODS

The experiment was conducted in a naturally ventilated polyhouse at Division of Flower and Medicinal Crops, ICAR-IIHR, Bengaluru from November 2021 to February 2023. The experiment was laid out with eight treatments in completely randomized design with five replications. The treatments comprised of T_1 - deep flow technique (DFT), T_2 - Nutrient film technique (NFT), T_3 - aggregate wick system (AWS) with pots on NFT bench, T_4 - AWS with pots on ground, T_5 - AWS with grow bags on ground, T_6 - AWS on soil bed, T_7 - aeroponics and T_8 - conventional soil-based drip system.

The DFT structure used was an A-shaped frame consisting 7 cylindrical PVC pipes of food grade stacked horizontally one over the other with three tiers on each side. NFT structure had a vertical stand 1 meter above the ground level with 6 rectangular channels rested over it. In AWS with pots on NFT bench, 8-inch round pots with one nylon wick per pot were placed on the NFT bench. In AWS with pots on ground, PVC pipes of 2-inch diameter drilled with holes were laid beneath the ground and 10-inch pots with two nylon wicks each were inserted onto the holes. In AWS with grow bags on ground, HDPE grow bags of 12-inch diameter with 2 nylon wicks each were kept on drilled PVC pipes. AWS on soil beds was setup by placing the PVC pipes inserted with nylon wicks 5-10 cm below the ground level on conventional soil bed. A low cost aeroponic structure was fabricated in which the semi-transparent rigid PVC panel with planting holes was rested over the vertical stand of 3 m length, 1 m width and 50 cm height. Net pots were used to hold plants in liquid culture systems. The growing medium comprising Arka fermented cocopeat: FYM (1:1) was employed for AWS with pots on NFT bench, pots on ground and grow bags on ground. Arka fermented cocopeat was prepared as per Selvakumar et al. (2016).

Uniform, hardened tissue-cultured plants of gerbera var. Arka Nesara were used as planting material. Water soluble fertilizer, 19:19:19 N: P_2O_5: K_2O was supplied at the TDS 600-650 ppm (vegetative stage) and 900-1000 ppm (flowering stage) via nutrient reservoir. Further, calcium nitrate (0.5%) and magnesium sulphate (0.5%) were sprayed once in a week. Also, a micronutrient mix 'Fertilon Combi-1®' (0.3%) (containing 0.5% boron, 1.5% copper, 4% iron, 4% manganese, 0.1% molybdenum and 1.5% zinc) was sprayed twice in a week. Plant protection measures were carried out as and when required.

Observations on plant growth, flowering and yield parameters were noted down. Days to flower bud initiation and days to first flower harvest were counted from the date of planting till the appearance of first flower bud and first harvest, respectively. Whereas, days to bud opening and harvestable maturity were calculated from the date of bud initiation to the date of flower bud opening and the attainment of harvestable maturity (i.e. when the disc florets were perpendicular to the flower stalk), respectively. Stalk diameter near neck and at base were measured using vernier caliper at the point immediately below the flower head and at the distal end of the flower stalk 1 cm above the cut end, respectively. Stem deviation was recorded by measuring the deviation of flower stalk from the straight axis, whereas stem strength was assessed by observing the degree of deflection from the horizontal plane by holding the base of flower stalk horizontally (Anon., 1994). Comparison of treatment means and analysis of variance were worked out in Microsoft Office Excel 2007 as per the statistical method described by Panse & Sukhatme (1985).

RESULTS AND DISCUSSION

Effect on vegetative growth

Different production systems had significant impact on vegetative growth of gerbera var. Arka Nesara (Table 1). Results revealed that plants grown on AWS with pots on ground exhibited maximum plant height (31.66 cm), leaf length (21.31 cm) and leaf breadth (9.96 cm) at 3 months after planting. Conversely, more number of leaves per plant (12.92) was observed in AWS on soil bed. Hence, it can be inferred that AWS with pots on ground showed the enhanced vegetative growth which might be attributed to the continuous

Table 1 : Vegetative growth of gerbera var. Arka Nesara under different production systems at 3 months after planting

Treatment	Plant height (cm)	Leaves per plant (Nos.)	Leaf length (cm)	Leaf breadth (cm)
Deep flow technique	15.54	5.34	11.16	5.94
Nutrient film technique	17.07	6.84	11.78	6.02
AWS with pots on NFT bench	29.70	11.24	18.69	9.20
AWS with pots on ground	31.66	12.28	21.31	9.96
AWS with grow bags on ground	30.70	10.44	19.51	8.65
AWS on soil bed	30.03	12.92	20.93	9.62
Aeroponics	15.86	6.96	11.00	5.97
Drip system on soil bed	26.39	9.68	18.23	8.28
S.E.m±	0.38	0.17	0.17	0.10
C.D. at 5%	1.10	0.49	0.50	0.28
C.V. (%)	7.78	8.16	5.22	6.13

Table 2 : Flowering and yield parameters of gerbera var. Arka Nesara as influenced by different production systems

Parameter	AWS with pots on NFT bench (T_3)	AWS with pots on ground (T_4)	AWS with grow bags on ground (T_5)	AWS on soil bed (T_6)	Drip system on soil bed (T_8)	S.E.m±	C.D. at 5%	C.V. (%)
Days to bud initiation	135.80	133.56	134.28	132.76	137.80	0.71	NS	2.62
Days to bud opening	13.04	11.32	12.20	10.80	14.96	0.18	0.52	7.09
Days to harvestable maturity	20.00	17.68	17.76	17.04	21.96	0.25	0.73	6.59
Days to first flower harvest	155.80	151.24	152.04	149.80	159.76	0.77	2.28	2.51
Stalk length (cm)	44.98	46.54	47.79	50.36	45.56	0.44	1.29	4.65
Flower diameter (cm)	9.66	9.99	9.68	10.32	9.53	0.07	0.21	3.62
Stalk diameter near neck (mm)	4.64	4.75	4.72	4.74	4.08	0.06	0.18	6.48
Stalk diameter at base (mm)	9.54	9.24	9.04	9.32	8.14	0.15	NS	8.23
Stem deviation (cm)	1.50 (1.22)	1.27 (1.13)	1.29 (1.14)	1.44 (1.20)	1.33 (1.15)	0.01	0.03	4.16
Stem strength (º)	2.60 (1.60)	2.20 (1.48)	2.40 (1.54)	3.56 (1.89)	3.40 (1.84)	0.03	0.08	8.05
Vase life (days)	8.0	9.2	8.4	7.8	7.4	0.16	0.46	9.59
No. of flowers/plant/year	25.66	30.16	28.76	36.58	23.90	0.43	1.26	7.35

*Values in the parentheses are square-root transformed.

** T_1, T_2 and T_7 showed 100% plant mortality after 4 months of planting. Hence, flowering and yield parameters were not recorded.

supply of water and nutrients through the capillary action. Uninterrupted water and nutrient supply might have had an indirect role on faster cell division and differentiation resulting in the superior vegetative growth. Moreover, the capillary movement of water and nutrients might have left the media structure undisturbed thus providing better aeration by curbing the media compaction ultimately making the nutrients readily available to the plants. The similar results were also reported by Hahn et al. (2001) and Arathi (2016) in gerbera.

Effect on floral traits

It is obvious from Table 2 that accelerated flower bud opening (10.80 days), harvestable maturity (17.04 days) and first flower harvest (149.80 days) with the highest number of flowers per plant per year (36.58), stalk length (50.36 cm) and flower diameter (10.32 cm) were recorded with AWS on soil bed. However, AWS with pots on ground showed on par results with respect to days to harvestable maturity (17.68) and days to first flower harvest (151.24). The earlier bud initiation might be due to the greater source-sink relationship, faster translocation of nutrients and growth stimulating substances leading to earlier floral bud differentiation (Ruby et al., 2020). Further, plants grown on AWS with pots on ground exhibited minimum stem deviation (1.27 cm) and stem strength (2.20 cm) with thicker neck (4.75 mm) and prolonged vase life (9.2 days). The extended vase life could be related to the higher accumulation of photosynthates and metabolic substances in the flower (Arunesh et al., 2020).

On the perusal of data presented in Table 3 revealed that days to bud initiation showed the strongest correlation with days to bud opening (0.995), days to harvestable maturity (0.988) and days to first flower harvest (0.997). Further, leaf length (-0.910, -0.914 & -0.892) and number of flowers per plant per year (-0.905, -0.890 & -0.884) were negatively correlated with days to flower bud initiation, days to bud opening and days to first flower harvest. Also, number of leaves per plant exhibited positive correlation with the flower diameter (0.937). Similar results were reported by Hahn et al. (2001), Arathi (2016) in gerbera, and Wahome et al. (2011) in gypsophila. However, plants grown on liquid culture systems failed to produce flowers and started rotting at 4 MAP, which might be due to inadequate mechanical support and poor aeration near root environment.

Table 3 : Correlation data on vegetative, flowering and yield parameters of gerbera var. Arka Nesara

Trait	PH	LN	LL	LB	DBI	DBO	DHM	DFH	SL	FD	ND	BD	SD	SS	VL	FNY
PH	1.00	.662	.764	.753	-.851	-.867	-.873	-.864	.338	.518	.956*	.800	-.102	-.677	.857	.548
LN		1.00	.866	.937*	-.854	-.889	-.763	-.810	.600	.937*	.737	.726	.310	.011	.408	.855
LL			1.00	.863	-.910*	-.914*	-.869	-.892*	.639	.870	.722	.505	-.199	-.191	.666	.834
LB				1.00	-.777	-.828	-.692	-.736	.335	.785	.739	.740	.152	-.271	.642	.661
DBI					1.00	.995**	.988**	.997**	-.764	-.860	-.897*	-.697	-.018	.200	-.571	-.905*
DBO						1.00	.973**	.987**	-.717	-.865	-.914*	-.747	-.067	.224	-.590	-.890*
DHM							1.00	.997**	-.754	-.780	-.907*	-.667	.064	.275	-.601	-.859
DFH								1.00	-.761	-.822	-.905*	-.684	.024	.239	-.588	-.884*
SL									1.00	.817	.477	.244	.070	.395	-.014	.927*
FD										1.00	.614	.511	.205	.246	.240	.965**
ND											1.00	.899*	.151	-.497	.668	.664
BD												1.00	.507	-.412	.479	.496
SD													1.00	.384	-.483	.159
SS														1.00	-.847	.235
VL															1.00	.211
FNY																1.00

PH- plant height, LN- number of leaves/plant, LL- leaf length, LB- leaf breadth, DBI- days to bud initiation, DBO- days to bud opening, DHM- days to harvestable maturity, DFH- days to first harvest, SL- stalk length, FD- flower diameter, ND- stalk diameter near neck, BD- basal stalk diameter, SD- stem deviation, SS- stem strength, VL- vase life, FNY- number of flowers/plant/year

Effects on plant water consumption

Data presented in Table 4 revealed that plants grown on AWS with pots (T_4) and grow bags (T_5) on ground consumed minimum amount of water (92 and 96 mL/ plant/day), thus, saving around 83.46 and 82.70% of water as compared to soil-based drip system, respectively. The better water use efficiency in AWS might be associated with reduced drainage loss and efficient water usage attributed by capillary action. Yeager and Henley (2004) reported similar results in capillary wick irrigation systems.

Table 4 : Water consumption in different production systems

Treatment	Water consumption per plant per day (mL)	Water saving over drip system (%)
AWS with pots on NFT bench	103	81.39
AWS with pots on ground	92	83.46
AWS with grow bags on ground	96	82.70
AWS on soil bed	307	44.75
Drip system on soil bed	555	0.00

Table 5 : Economics of different production systems

Treatment	Annual (amortized) cost of cultivation (Rs.)	*No. of flowers/unit/ year	**Gross returns (Rs.)	Annual net returns (Rs.)	BC ratio
AWS with pots on NFT bench	1,22,908	15,396	76,980	-45,928	0.63
AWS with pots on ground	1,27,028	36,192	1,80,960	53,932	1.43
AWS with grow bags on ground	1,45,052	34,512	1,72,560	27,508	1.19
AWS on soil bed	1,47,212	52,675	2,63,375	1,16,163	1.79
Drip system on soil bed	1,33,148	34,416	1,72,080	38,932	1.29

*1 unit = 180 m^2 ; **price @ Rs. 5/ flower; T_1, T_2 and T_7 showed 100% plant mortality at 4 months after planting.

Economics

It is evident from Table 5 that the annual net returns (Rs. 1,16,163) and benefit cost ratio (BCR) (1.79) were higher in AWS on soil beds (T_6) followed by AWS with pots on ground (T_4) with the annual net returns of Rs. 53,932 and BCR of 1.43. Greater returns in T_6 were exclusively associated with higher flower yield whereas in T_4, it was contributed by both cost saving and yield returns when compared with control (T_8).

CONCLUSION

Gerbera plants of var. Arka Nesara grown under aggregate wick system on pots, grow bags and soil bed showed better results compared to the liquid culture systems. Aggregate wick system with pots on ground exhibited superior vegetative growth, flower stem quality and water use efficiency, while, aggregate wick system on soil bed resulted in earlier harvest and higher production with bigger flowers and longer stalks. Considering the maximum water saving, aggregate wick system with pots on ground could be employed as an alternative for conventional soil-based drip system.

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