



Comparative study on agronomic and physiological performance of gerbera (*Gerbera jamesonii*) under drip and aggregate wick systems

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Gerbera (*Gerbera jamesonii* Bolus) is one of the popular flower crop having huge demand in the global flower market. According to the first advance estimate of the year 2023–24, gerbera occupied an area of 5,280 ha with the production of 26,660 Mt in India (Anonymous 2024). Despite the traditional soil-based cultivation of gerbera using drip system poses biotic and abiotic stress to the plants. Moreover, the greater water usage and electrical conductivity arising from the continuous accumulation of fertilizers diminish the crop efficiency in the long run. Surprisingly, capillary wick system has been reported to potentially improve the plant performance, water and nutrient use efficiency with reduced cultivation cost and manpower. However, no research work had been previously carried out to study the effect of wick systems on crop performance of gerbera which could potentially enhance the factor productivity.

The inherent capacity of the plant to accumulate and assimilate the photosynthates and metabolic sugars is of greater importance for enhancing the crop productivity and quality produce. Plant productivity was inferred as the interaction of photoassimilate and nutrient concentration between the source and sink achieved by long distance transport through phloem (Smith *et al.* 2018). The physiological parameters were reported to be influenced by water availability with direct or indirect implications on crop yield potential and stress tolerance (Selvakumar *et al.* 2024). Hence, it seems important to explore the physiological activities of the plant in addition to the growth and yield parameters for the successful adoption of the capillary wick system for commercial cultivation. Keeping these points in view, an experiment was planned to assess whether the aggregate wick system could improve the growth, flowering, vase life, yield and physiological aspects of gerbera var. Arka Nesara as compared to the conventional drip systems.

An experiment was conducted during 2021–23 at ICAR-Indian Institute of Horticultural Research, Bengaluru (13°13'N and 77°49'E and an altitude of 890 m amsl), Karnataka. Experiment was laid out in a naturally ventilated polyhouse with 5 replications comprised of 5 treatments, viz. aggregate wick system (AWS) with pots on nutrient film technique (NFT) bench (T₁); AWS with pots on the ground (T₂); AWS with grow bags on the ground (T₃); AWS on the soil bed (T₄); and conventional drip system (T₅) (Fig. 1). Uniformly hardened plants of gerbera var. Arka Nesara were used as the planting material. Arka fermented cocopeat (AFC): farmyard manure (FYM) at 1:1 v/v was used as the growing substrate for the treatments, T₁, T₂ and T₃. AFC was prepared from raw coir pith using Arka decomposer and Arka microbial consortium (Selvakumar *et al.* 2016). Whereas the soil bed comprising red soil: FYM: sand (2:1:1 v/v) was employed in T₄ and T₅. Good agricultural practices were adopted and the plant protection measures were practiced as and when required.

Vegetative and floral parameters such as number of leaves/plant, leaf area, days to first flower harvest (from the date of planting), number of flowers/plant/year, per cent dry matter content in flower, per cent total dry matter production and vase life were recorded. Per cent dry matter content in flower and plant was calculated by dividing dry weight upon fresh weight and subsequently multiplying by 100. Chlorophyll, sugars and starch were determined by adopting Nelson-Somogyi method (Somogyi 1952), Anthrone method (Hodge and Hofreiter 1962), DMSO immersion method (Hiscox and Israelstam 1979), respectively.

Statistical analysis: The treatment means were compared and analysis of variance was worked out as per the method dealt by Panse and Sukhatme (1985) in Microsoft Office Excel 2007.

The different AWS and drip irrigation system exerted significant effects on the morphological and physiological parameters studied (Table 1). Number of leaves produced under AWS on the soil bed (T₄) and AWS with pots on the

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Fig. 1 Different aggregate wick irrigation systems (AWS).

ground (T_2) were 33.47 and 26.86% higher than that of the conventional drip system (T_5), respectively. Further, greater leaf area (115.31 cm^2) was noticed in AWS with pots on the ground (T_2) while, the drip system (T_5) resulted in lesser leaf area (82.12 cm^2). The continuous and steady supply of water and dissolved nutrients in AWS might have enhanced the leaf area and leaf production of gerbera by accelerated cell division and cell elongation processes (Chauhan *et al.* 2014). While, Aslani *et al.* (2019) associated the greater amounts of photo-assimilates in the leaves to the increased total leaf mass, leaf area, leaf thickness and carbohydrate accumulation.

AWS on soil bed (T_4) exhibited earlier flowering (149.80 days to first flower harvest) and higher flower production (36.58/plant/year). However, plants grown under the drip system (T_5) flowered 5–10 days later than the AWS systems with a lower yield of 23.90 flowers/plant/year. Thus, the different AWS systems enhanced the flower yield by 7.36–53.04% when compared with drip system. This might be associated with the higher sink: source ratio which induced earlier vegetative to floral transition (Lv *et al.* 2020). Moreover, the quicker nutrient assimilation and synchronized transport of growth-stimulating substances might have subsequently led to the faster differentiation of vegetative to reproductive parts (Ruby *et al.* 2020). While, the maximized flower production might be associated with the amplified leaf area, copious leaves, earlier flower bud initiation, greater assimilation rate, higher chlorophyll content, abundant photosynthate production and effective transport of photo-assimilates to the sink tissue (Naik *et al.* 2006, Lv *et al.* 2020).

Further, AWS with grow bags on the ground (T_3) recorded maximum dry matter percentage in flower (23.61%) and plant (22.75%) as compared to other treatments. While, the dry matter contents were lower in AWS with pots on NFT bench (T_1). The starch content in the leaves might have had a negative impact on dry matter production as stated by Sulpice *et al.* (2009). Water retention on the media might also have exerted an undesirable effect on the per cent dry matter content. Flowers obtained from AWS with pots on the ground (T_2) had the longest vase life (9.2 days) while the conventional system (T_5) exhibited the shortest vase life (7.4 days). The extended vase life might be associated with instant availability of reducing sugars and ample storage of carbohydrates in the flowers. Similar findings have been reported by Hahn *et al.* (2001), Blok and Vermeulen (2012) and Arunesh *et al.* (2020).

Higher levels of chlorophyll-a (1.88 mg/g) and total chlorophyll (2.44 mg/g) were observed with AWS on the soil bed i.e. T_4 (Fig. 2). This indicates the accelerated

Table 1 Effect of aggregate wick (AWS) and drip irrigation systems on vegetative, floral and physiological parameters of gerbera var. Arka Nesara

Parameter	T_1	T_2	T_3	T_4	T_5	SEm ($\pm$)	CD ($P=0.05$)	CV ($P=0.05$)
Number of leaves/plant	11.24	12.28	10.44	12.92	9.68	0.40	1.19	7.96
Leaf area (cm^2)	93.36	115.31	91.73	109.40	82.12	3.57	10.53	8.11
Days to first flower harvest	155.80	151.24	152.04	149.80	159.76	1.73	5.09	2.51
Number of flowers/plant	25.66	30.16	28.76	36.58	23.90	0.95	2.81	7.35
Dry matter content in flower (%)	16.65	20.11	23.61	21.05	18.98	0.53	1.57	5.91
Vase life (days)	8.00	9.20	8.40	7.80	7.40	0.35	1.03	9.59
Total chlorophyll (mg/g)	2.24	2.33	2.15	2.44	2.02	0.04	0.11	3.70
Total sugars (g/100 g FW)	1.065	1.061	1.038	1.121	1.217	0.02	0.06	4.50
Starch (g/100 g DW)	4.70	4.02	3.76	3.25	3.74	0.07	0.21	4.14
Total dry matter production (%)	17.45	20.12	22.75	21.23	19.63	0.16	0.46	3.84

T_1 , AWS with pots on nutrient film technique (NFT) bench; T_2 , AWS with pots on the ground; T_3 , AWS with grow bags on the ground; T_4 , AWS on soil bed; T_5 , Conventional drip irrigation system. FW, Fresh weight; DW, Dry weight.

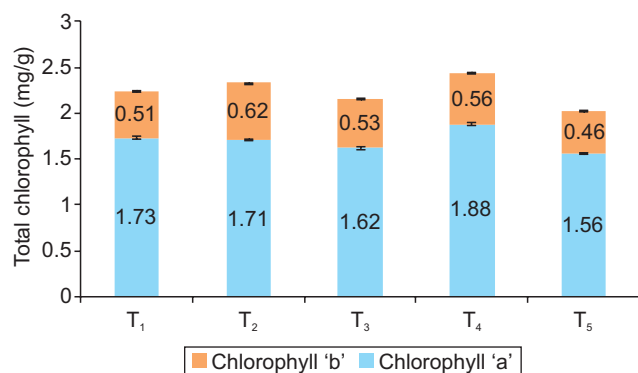


Fig. 2 Effect of aggregate wick system (AWS) and drip irrigation systems on chlorophyll content in leaves of gerbera var. Arka Nesara.

T₁, AWS with pots on nutrient film technique (NFT) bench; T₂, AWS with pots on the ground; T₃, AWS with grow bags on the ground; T₄, AWS on soil bed; T₅, Conventional drip irrigation system.

photosynthetic rate leading to greater production of photosynthates facilitating earlier and higher flower production. Further, greater accumulation of chlorophyll-b (0.62 mg/g) and reducing sugars (0.611 g/100 g FW) were prominent in AWS with pots on the ground (T₂). The higher chlorophyll-b content could be associated with the nitrogen reserves in the plant. While, the higher levels of reducing sugars in the leaves indicated greater photosynthetic efficiency at the source and lower sink demand. Sugars were reported to exhibit a profound role in transforming the vegetative plant parts into reproductive organs (Rolland *et al.* 2006). Further, sugar availability in the plant tissues was reported to influence the plant metabolism, growth, flowering and senescence (Ciereszko 2018).

The non-reducing sugars (0.813 g/100 g FW) and total sugars (1.217 g/100 g FW) were noted maximum with the conventional drip system (Fig. 3). Non-reducing sugars are usually preferred by the plants for long-distance transport and are converted to reducing sugars in the sink tissue. Higher concentrations of non-reducing sugars in the leaves evidenced the lower sink demand subsequently resulting in moderate plant growth. AWS with pots on NFT bench (T₁) possessed maximum starch (4.70 g/100 g DW) content in leaves. The photosynthates stored as starch are either directly utilized for metabolism or converted to non-reducing sugars for long-distance transportation to the sink tissues (Stitt *et al.* 2010). Thus, the abundance of starch in the leaves signified the scarcity of reducing sugars in the sink tissues indicating the moderate plant performance with respect to flower production and vase life.

It can be inferred from the present study that the higher flower yield, leaf production and leaf chlorophyll contents with accelerated flowering of gerbera var. Arka Nesara were achieved with the adoption of aggregate wick system on the soil bed. Further, reducing sugars was observed to play a key role in prolonging the vase life of gerbera which was

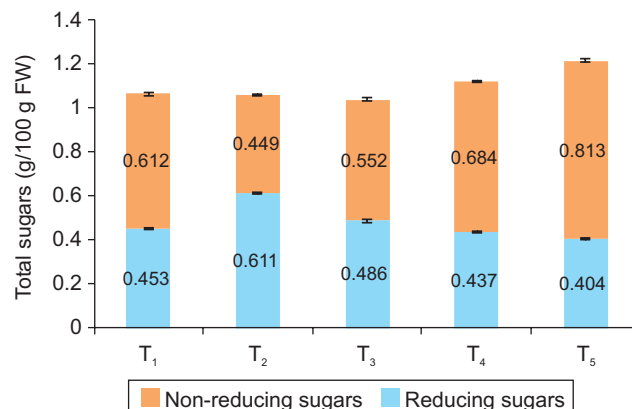


Fig. 3 Effect of aggregate wick system (AWS) and drip irrigation systems on total sugar in leaves of gerbera var. Arka Nesara.

T₁, AWS with pots on nutrient film technique (NFT) bench; T₂, AWS with pots on the ground; T₃, AWS with grow bags on the ground; T₄, AWS on soil bed; T₅, Conventional drip irrigation system.

apparent in the aggregate wick system with pots on the ground. Accumulation of non-reducing sugars in the leaves of plants grown under the drip system explained the poor source-sink relationship as the carbohydrate production and consumption are closely associated with the demand on sink and supply by the source, respectively. Thus, it can be concluded that gerbera plants grown on aggregate wick system performed superior than the conventional drip system with respect to physiological, growth, yield and quality attributes.

SUMMARY

Aggregate wick system (AWS) or capillary action technique is a kind of sub-surface irrigation system gaining popularity owing to its profound advantages of improved water and nutrient use efficiency resulting in superior plant growth and development. However, its effect on growth and physiology of gerbera crop has not been studied yet. Therefore, an experiment was conducted during 2021–23 at ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka to assess the effect of aggregate wick system on growth, flowering, vase life, yield and physiological aspects of gerbera var. Arka Nesara as compared to the conventional drip systems. It was apparent from the results that higher overall factor productivity in terms of number of leaves/plant (12.92), earlier first flower harvest (149.80 days) and copious flower production (38.58/plant/year) with enhanced chlorophyll content and optimal starch content were observed with AWS on the soil bed. However, AWS with pots on the ground resulted in extended vase life (9.20 days) with enhanced leaf area (115.31 cm²), chlorophyll-b, reducing sugars and decreased total and non-reducing sugars in leaves. Therefore, it can be concluded that the improved flower yield and vase life of gerbera in aggregate wick systems might be attributed to the greater chlorophyll production and reducing sugars in the leaves, respectively.

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