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Fertigation Studies on Gerbera (*Gerbera Jamesonii* Bolus Ex Hooker F.) for Growth and Yield Under Cover in Southern Hills (Shevaroy)

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ABSTRACT: *Gerbera is used as cut flower in many countries and has gained popularity as an ornamental flower and is in great demand in the floral industry, a study was conducted to evaluate fertigation studys of gerbera. A polyhouse experiment was conducted at Horticultural Research Station, Yercaud during 2010-11 to assess the fertigation levels on cut Gerbera cv. Palm Beach along with micro nutrients and humic acid as foliar spray under in Shevaroy hills. The experiment was laid out in Randomized block design (RBD) with two replications. The treatments consisted of three level of fertigation regimes (125, 100 and 75% of recommended dose of fertilizer), foliar spray of micronutrient mixture (0.004%) and humic acid (0.2 %). The results revealed that the morphological parameters namely, plant height, number of leaves, leaf area, plant spread, suckers number and plant density had progressive increase at different stages of plant growth at 100% RDF+0.004% MN Mixture + 0.2% humic acid (T_{11}) while, the treatment T_{12} (75 % RDF + 0.004% MN Mixture + 0.2% humic acid) had induced the first flowering. The treatment T_{11} (100% RDF+0.004% MN Mixture + 0.2% humic acid) recorded the highest flower yield, longest flower stalk length, flower stalk girth and largest flower diameter. Hence this treatmental combination could be recommended for commercial cultivation of cut gerbera.*

Keywords: *Gerbera jamesonii, Fertigation, Polyhouse, Micronutrient and Growth*

INTRODUCTION

Gerbera (Gerbera jamesonii L.) also commonly known as Transvaal Daisy is an important cut flower grown throughout the world (Pattanashetti *et al.*, 2012), with long stalks and daisy-like flower, belongs to the family Asteraceae, increasing commercial significance a variety in colour has made this flowering plant attractive for use in garden decorations, such as herbaceous borders, bedding, and pots and for cut flowers as it has a long vase life (Bose *et al.*, 2003; Chung *et al.*, 2005; Chauhan, 2005). It ranks fourth in the international cut flower market and a popular cut flower in Holland, Germany and USA (Choudhary and Prasad, 2000). In India, commercial production of gerberas is centered around Pune and Bangalore, parts of Sikkim, Nagaland, Meghalaya and Uttarakhand, from where flowers are being sent to local and international market. The non-availability of good quality planting material of commercially important strains is a major constraint for its widespread cultivation in India. It is difficult to get good quality cut flowers of gerbera under open field conditions. Performance study of gerbera varieties, Sankar *et al.* (2003), Singh and Ramachandran (2002), Singh and Mandhar (2002) and Kandpal et al. (2003) grew gerbera under protected conditions and observed better growth, yield and quality characteristics under protected.

India with its varied agro climatic conditions, vast land and labour resource has great potential for commercial production of gerbera. Further, liberalization of import policy has facilitated the introduction of improved high yielding gerbera cultivars with excellent flower quality. Among the factors responsible for high crop yield, nutrition plays a major role. Gerbera being a herbaceous perennial plant, requires plenty of organic matter and adequate nutrients especially phosphorus and potassium for profuse flowering. In many researches it was reported that application of NPK proved

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effective in increasing the number of leaves, suckers and production of more number of larger flowers. It is also of vital importance to apply proper quantity of fertilizers at appropriate time to enhance the productivity.

Fertigation is one such technique of applying nutrients through micro irrigation systems directly at the site of active root zone. Though a new concept in India, it has potential for more accurate and timely crop nutrition leading to increased yields, enhanced quality and early crop maturity. Fertigation also helps in reducing the wastage of nutrients through enhanced fertilizer use efficiency, besides providing flexibility in timing of fertilizer application in relation to crop demand based on physiological stages of growth (Papadopoulos, 1992). Biostimulants like humic acid and panchagavya have a significant role in providing resistance to pest, diseases and increasing the overall quality and yield in flower crops (Suguna, 2005). The use of humic acid (HA) is a promising natural resource to be utilized as an alternative for increasing crop production. Bohme and Thi Lua (1997) reported that humic acid had beneficial effects on nutrient uptake by plants, and was particularly important for the transport and availability of micronutrients. Hypothetical mechanisms include enhanced uptake of metabolic ions and increases in cell permeability (Chen and Aviad, 1990). As a consequence, the use of humic substances has often proposed as a method to improve crop production. Application of NPK has been effective in improving vegetative growth and flower production (Skalska, 1980a, 1980b; Mantrova *et al*., 1982). Nutrient use through drip irrigation to enhance the crop productivity is well established (Papadopoulos, 1992). An increased flower yield in roses through N fertigation was also reported by several workers (Borrelli, 1981; Feign *et al*., 1986; Narayana Gowda, 1994; Hazan *et al*., 1994). Fertigation with 80% WSF in tuberose improved flower yield (Munikrishnappa, 1996). Hence the present investigation on i) To standardize the fertigation schedule for Gerbera under cover for Shevaroy hills or eastern ghats ii) To asses the growth and yield parameters of flowers.

MATERIALS AND METHODS

The experiment was conducted at Horticulture Research Station, Tamil Nadu Agricultural University, Yercaud. under cover (Polyhouse) during Aug. 2010 and Apr. 2011. The experiment was laid out in Randomized Block Design (RBD) with 13 treatments two replicated, spacing 30 x 30 cm, number of plants / treatment, total number of plants 416. The treatments consist of gerbera varieties palm beach T_1 - 125 % of RDF (18.75:12.5:37.5 g of NPK/m^2/ month), T_2 - 100% of RDF (15:10:30 g of NPK/ m^2/ month), T_3 - 75% of RDF(11.25:7.5:22.5 g of NPK/ m^2/ month), T_4 - 125% of RDF +MN Mix. @ 0.004% as foliar spray, T_5 - 100% of RDF +MN Mix. @ 0.004% as foliar spray, T_6 - 75% of RDF + MN Mix. @ 0.004% as foliar spray, T_7 - 125% of RDF + HA @ 0.2% as foliar spray, T_8 - 100 % of RDF + HA @ 0.2% as foliar spray, T_9 - 75 % of RDF + HA @ 0.2% as foliar spray, T_{10} - 125 % of RDF + MN Mix. @ 0.004 % +HA@ 0.2% as foliar spray, T_{11} - 100 % of RDF + MN Mix. @ 0.004 % +HA@ 0.2% as foliar spray, T_{12} - 75% of RDF + MN Mix. @ 0.004% +HA@ 0.2% as foliar spray, T_{13} - Control.

Fertigation schedule

Table 1
The source and levels of fertilizer applied to gerbera during the experimental period

Fertigation levels	*NPK/bed (6m^2)/ month (g)*	*NPK/bed (6m^2)/ week (g)*	*Urea/ week(g)*	*MAP/ week(g)*	*Multi-K/ week (g)*
125%	112.5:75:225	28.12:18.75:56.25	18	30.72	124.5
100%	90:60:180	22.5:15:45	14.4	24.57	99.6
75%	67.5:45:135	16.87:11.25:33.75	10.8	18.43	74.7

Observations made

The detailed observations were grouped into vegetative, flowering and yield parameters. vegetative and yield parameters *viz*., plant height(cm), leaf number / plant, leaf area / plant, number suckers per plant, plant density /m^2, plant spread (cm), flowering parameters, days taken for first flowering, length of the flower stalk, flower stalk girth, flower diameter, yield parameters, number of flowers / plant, flower yield / m^2, flower yield /1000m^2.

Statistical analysis

The statistical analysis was done by adopting the standard procedures of Panse and Sukhatme (1985). The critical difference was worked out at five per cent (0.05) probability.

RESULTS AND DISCUSSIONS

Effect of fertigation on growth parameters of gerbera

Plant height

Better growth and development occurs under ideal fertigation level. Among the varying levels of N, P and K along with micronutrient mixture and humic acid, the treatment which received 15:10:30 g NPK / m^2 / month (100% RDF) along with 0.004% MN Mixture + 0.2% humic acid (T_{11}) produced the best results (Fig. 1). The uniform and higher level of availability of N fertilizer throughout the cropping period might be the reason for the highest plant height. Micronutrient mixture and humic acid combination has enhanced its vegetative growth including the plant height. This is in line with the findings of Yadav *et al*., 1985 in rose cv. Montezuma; Muthumanickam *et al*. (1999) in Gerbera ; Barman and Pal(1993) in tuberose and Rajput *et al*. (2003) in African marigold.

Leaf number per plant

The highest number of leaf production (31.90) at 240 DAP indicated that fertigation with 100% WSF in addition to micronutrient mixture and humic acid was most suitable for leaf production(Table 1). This is in consonance with the findings of Sujatha *et al., (*2002) in gerbera and Munikrishanappa (1996) in tuberose. The increase in the mineral constituents might have exerted more number of leaves, since nitrogen is the chief constituent of amino acid and coenzymes of biological importance. This is in concurrence with the findings of Dursan *et al.* (1999) and Adani *et al.* (1998) in tomato.

Table 2
Effect of fertigation on leaf number of gerbera

Treatments	*Leaf number at*							
	30 DAP	*60 DAP*	*90 DAP*	*120 DAP*	*150 DAP*	*180 DAP*	*210 DAP*	*240 DAP*
T_1 - 125% RDF	7.30	8.40	10.70	13.00	14.60	16.40	20.10	23.80
T_2- 100% RDF	7.10	9.10	11.30	14.10	16.50	18.80	21.90	22.00
T_3- 75% RDF	6.90	8.50	11.70	13.80	15.90	16.00	19.50	22.30
T_4- 125% RDF+0.004 %MN Mix	7.40	9.00	14.25	15.80	16.30	20.20	23.70	26.20
T_5- 100% RDF+0.004 %MN Mix	7.30	10.72	12.92	16.80	18.50	21.10	24.20	28.30
T_6- 75% RDF+0.004 %MN Mix	7.20	9.80	12.50	15.20	16.70	19.10	23.70	25.30
T_7- 125% RDF +0.2% HA	7.10	9.80	12.50	14.50	20.73	19.30	22.50	25.70
T_8- 100% RDF +0.2% HA	7.80	11.16	16.01	17.50	20.90	23.30	26.40	29.98
T_9- 75% RDF+0.2% HA	7.20	10.00	12.20	14.20	17.90	20.30	23.50	26.70
T_{10}-125% RDF+0.004%MN Mix+0.2%HA	7.60	9.60	11.30	15.30	17.70	20.20	24.30	27.60
T_{11}-100% RDF+0.004%MN Mix+0.2%HA	8.31	13.23	16.38	19.47	22.96	25.50	28.20	31.90
T_{12}- 75% RDF+0.004%MN Mix+0.2% HA	7.71	9.70	11.32	14.30	17.30	19.90	24.30	25.70
T_{13}- Control	6.70	7.54	8.30	10.29	11.43	14.76	16.71	18.12
Mean	7.35	9.73	12.14	14.93	17.11	19.60	23.00	25.66
SEd	0.07	0.20	0.26	0.32	0.40	0.41	0.42	0.51
CD (0.05)	0.15	0.44	0.57	0.69	0.86	0.89	0.92	1.11

Leaf area

Data indicated that leaf area was highest (7304.69 cm^2 at 240 DAP) in the plants received 15:10:30 g NPK / m^2 / month (100% RDF) along with 0.004% MN Mixture + 0.2% humic acid (T_{11}). (Fig. 3). Similar to the number of leaves, leaf area also showed a positive response to N application. Further, more leaf area in this treatment might be due to the combination of micronutrient mixture and humic acid which enhanced the cytokinin level and thereby cause manifold increase in cell division resulted in enhanced leaf area. Similar observations were reported by Sujatha *et al.* (2002) in gerbera; Hardeep Kumar *et al.* (2003) and Yadhav *et al.* (2003) in tuberose; Senthamizhselvi (2000) in jasmine and Singh and Singh (2000) in gladiolus.

Plant spread

Data indicated that plant spread was highest (56.41 cm at 240 DAP) for the plants which received 15:10:30 g NPK / m^2 / month (100% RDF) along with 0.004% MN Mixture + 0.2% humic acid (T_{11}). The ability of zinc and iron in enhancing plant spread has been reported by Deshmukh and Wavhal (1998) in China aster and Nag *et al*. (2003) in African marigold.

Number suckers per plant

Number of sucker production has responded positively to fertilizer application application at 15:10:30 g NPK / m^2 / month (100% RDF) along with 0.004% MN Mixture + 0.2% humic acid (T_{11}) (Fig. 4). The significant variation with respect to number of sucker production per plant was in accordance with the results obtained by Singh and Ramchandran (2002) and Thomas *et al*. (2004) in gerbera.

Effect of fertigation on yield parameters of gerbera

Number of days taken for first flowering

The early flowering coupled with lower flower yield in the treated plants sprayed with 0.004% MN Mixture + 0.2% humic acid in addition to 11.25 : 7.5 : 22.5 g NPK / m^2 /month(100% RDF)(T_{12}) might be due to early transformation from vegetative phase to reproductive phase (Fig. 1). Balanced nutrition is of considerable importance in improving the yield and reducing the duration of flowering. The higher production of auxin and growth substances by humic acid at early phase of growth would have contributed to early flowering and reduction in the duration of flowering. This could also be attributed to the gibberellin like activity of humic acid as reported by Vaughan *et al*. (1985). Early flowering might be due to the role of zinc favouring the storage of more carbohydrates through photosynthesis as improved photosynthetic product, which might be the attributing factor for the positive effect of ferrous sulphate on flowering (Senthamizhselvi, 2000). The findings are in line with the consequences of Som Dutt and Bhambota (1971) and Singh and Bhattacharjee (1997).

Table 3
Effect of fertigation on number of days taken for first flowering of Gerbera

Treatments	*Number of days taken for first flowering(d)*
T_1 - 125% RDF	118.50
T_2- 100% RDF	98.50
T_3- 75% RDF	117.20
T_4- 125% RDF+0.004 %MN Mix	107.50
T_5- 100% RDF+0.004 %MN Mix	106.00
T_6- 75% RDF+0.004 %MN Mix	112.00
T_7- 125% RDF +0.2% HA	100.00
T_8- 100% RDF +0.2% HA	98.50
T_9- 75% RDF+0.2% HA	112.00
T_{10}-125% RDF+0.004%MN Mix+0.2%HA	106.00
T_{11}-100% RDF+0.004%MN Mix+0.2%HA	98.50
T_{12}- 75% RDF+0.004%MN Mix+0.2% HA	92.50
T_{13}- Control	117.38
Mean	106.62
SEd	1.08
CD (0.05)	2.40

Flower yield

Increased flower yield in the plants which received 100 % RDF along with foliar spray of 0.004% MN Mixture + 0.2% humic acid (T_{11}) might be due to the organic acids present in humic acid inhibit IAA oxidase enzyme and thereby increased the flowering process with effective auxin activity. These findings are in agreement with those of Padmapriya (2000) and Subesh Ranjith Kumar (2003) in Chrysanthemum and Saravanan (2001) in Dendrobium. According to Durga Devi *et al*. (1997) increase in flower yield (Table 2) might be attributed to the fact the application of iron and zinc relieved the plants from chlorosis and produced healthy green leaves which in turn resulted in higher assimilate synthesis and partitioning of the flower growth.

Similar observations were earlier reported by Senthamizhselvi (2000) in jasmine; Muthumanickam *et al.*, (1999) in gerbera and Mukesh Kumar *et al.,* (2001) in tuberose.

Length and girth of flower stalk

The results of the study indicated that increase in stalk length (Fig. 7) in the plants sprayed with 0.004% MN Mixture + 0.2% humic acid along with 15:10:30 g NPK / m^2 / month (100 % RDF) (T_{11}) (55.31 cm at 211-240 days) and increased stalk girth (Fig. 8) in the treatment T_{11} received 100 per cent RDF along with 0.004% MN Mixture + 0.2% humic acid (2.69 cm at 211-240 days) might be due to the better uptake of nutrients especially the N, due to the combination of NO_3^- and NH_4^+ as water soluble fertilizers. Similar result had been already reported by Cox and Reisenauer (1973). The increase in stalk length when compared to control might be due to the gibberllin like substances in humic acid. This result goes in line with the reports of Vaugham *et al.* (1985), Ashok kumar (2006) in paprika and Sathish (2006) in turmeric.

Flower diameter

Increased flower diameter is related to flower development index. In the present study it was observed that the highest flower diameter (11.41 cm at 211-240 days) (Fig. 13) in the treatment T_{11}, where the plants received 100 % RDF in addition to the foliar spray of 0.004% MN Mixture + 0.2% humic acid. It was due to higher fertigation dose and its interaction

Table 4
Effect of fertigation on flower yield/ m² of Gerbera

Treatments	*90-120 days*	*121-150 days*	*151-180 days*	*181-210 days*	*211-240 days*	*Total*
T_1 - 125% RDF	11.2	19.8	23.1	27.5	34.1	115.7
T_2- 100% RDF	17.6	23.1	24.2	29.7	41.8	136.4
T_3- 75% RDF	13.2	16.5	23.1	26.4	34.1	113.3
T_4- 125% RDF+0.004 %MN Mix	17.6	20.9	25.3	26.4	36.3	126.5
T_5- 100% RDF+0.004 %MN Mix	20.9	26.4	27.5	30.8	41.8	147.4
T_6- 75% RDF+0.004 %MN Mix	14.3	19.8	20.9	29.7	35.2	119.9
T_7- 125% RDF +0.2% HA	18.7	20.9	23.1	26.4	37.4	126.5
T_8- 100% RDF +0.2% HA	23.1	27.5	38.3	40.7	45.1	174.7
T_9- 75% RDF+0.2% HA	14.3	18.7	20.9	25.3	37.4	116.6
T_{10}-125%RDF+0.004%MN Mix+0.2%HA	18.7	23.1	24.2	29.7	37.4	133.1
T_{11}-100%RDF+0.004%MN Mix+0.2%HA	29.7	41.8	45.1	44.0	47.3	207.9
T_{12}-75%RDF+0.004%MN Mix+0.2% HA	17.6	22.0	25.3	28.6	34.1	127.6
T_{13}- Control	9.9	14.3	15.4	18.6	23.1	081.3
Mean	17.45	22.79	25.64	29.78	37.93	132.83
SEd	0.67	0.81	0.93	0.86	0.68	3.93
CD (0.05)	1.45	1.77	2.04	1.87	1.49	8.57

with humic acid used in this treatment. Obviously, the diameter of flower is contributed by number of petals, petal length and width in that particular flower. This is well supported by Ashok (1998) in rose and Pawar *et al*. (2002) in anthurium. Improved flower diameter recorded with the foliar spray of 0.004% MN Mixture + 0.2% humic acid in addition to 15:10:30 g NPK / m^2 / month (T_{11}) could be due to the inherent nature of this cultivar in response to the continuous availability of nitrogen in both NH_4 and NO_3 forms pertaining to this treatment. This is well supported by Muthumanickam *et al*., (1999) in gerbera.

CONCLUSIONS

The response of Gerbera to different treatments is the impact of prevailing plant growth, quality and flower yield by inducing earliness in bud burst and reducing the time taken for full bloom coupled with other favorable vegetative growth parameters viz., number of leaves/plant, leaf area and plant height and yield per plant(Kg). From the results obtained in this experiment, it could be concluded that application of 100% RDF+0.004% MN Mixture + 0.2% humic acid will significantly improve the growth, yield and quality parameters which ultimately result in increasing the net return in Gerbera cv. Palm beach under protected cultivation.

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