

Original Research Article

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Impact of INM Practices on Vegetative Growth and Flowering of Hybrid Gerbera (*Gerbera jamesonii* B.) cv. Shimmer in Open Condition

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ABSTRACT

The present investigation on Impact of INM practices on growth and flowering of Gerbera was carried out in premises of Biotechnology cum Tissue Culture Centre OUAT Bhubaneswar during 2015-16 and 2016-17. The objective of the study was to develop an INM model for cut flower production of gerbera in open field condition. Eight fertilization treatment combinations were used consisting of 100 % RDF, Vermicompost, 75 % RDF, PSB, *Azospirillum*, *Azotobacter*, and foliar application of macro and micro elements. The result revealed that application of 75 % RDF (15:10:30 g NPK/m²) + Vermicompost+ (25 g/m²) + *Azospirillum*/*Azotobacter* (20 g/m²) + PSB+ macro and micro element spray increased all of vegetative parameters of gerbera. In flowering parameter, number of flower/plant were maximum in the same treatment. It can be concluded that reducing level of chemical fertiliser to 75 % RDF along with application of different organic source of nutrient can improve flower yield of gerbera in open field condition.

Keywords

RDF, *Azospirillum*,
Vermicompost,
PSB, *Azotobacter*

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Introduction

Gerbera (*Gerbera jamesonii* B.) also known as Transvaal daisy, Barbeton daisy or African daisy belonging to family Asteraceae occupies 5th place as cut flower in international flower trade (Sujatha *et al.*, 2002). It is popular because of it is attractive colour, long vase life and suitability for long distant transport (Bose *et al.*, 2003 and

Chauhan, 2005). It is used for fresh and dry flower arrangement, exhibition, decoration, bouquet preparation (Patra *et al.*, 2015). Local and improved cultivar is grown in garden, flower bed, pots, borders, dish garden and rock garden. Flowers are of different colour like white cream, yellow, pink, orange, brick red, scarlet, salmon, maroon and bicolor and are available in single, semi-double or double form.

Use of chemical fertiliser gradually deteriorates soil health and fertility. Leaching of fertiliser to water also creates environmental hazards. In such situation adoption of INM practices is better option to address such problem. Integrated nutrient management reduce fertiliser use and increases productivity and quality of gerbera (Majumdar *et al.*, 2014).

Materials and Methods

The present study was conducted in premises of Bio-technology cum Tissue Culture Centre, Odisha University of Agriculture Technology, Bhubaneswar from Nov. to Oct. 2015-16 and 2016-17 in open condition.

The experimental site is situated 63 km away from Bay of Bengal at an altitude of 25 m above MSL and extended between 20° 15' North latitude and 85° 50' East longitude. The average rainfall of the site is 1646 mm. The maximum temperature during the experimental period was 38.8 °C to 40.8°C and minimum temperature was 14.1°C to 15.2°C. The relative humidity during the experimental period was 37 % to 94 %. The experimental soil was sandy loam with pH 5.83, EC 0.64 ds/m, OC 0.475 %; N 125 kg/ha, P₂O₅ 67.1 kg/ha, K₂O 166.6 kg/ha. The growing media was composed of Soil, FYM and Coco peat in 1: 1: 1 proportion.

Earthen pot with a hole at the bottom was used for planting. The pot was filled with soil mixture. Four leaved tissue culture plantlets of gerbera cv. Shimmer a variety suitable for protected cultivation were used for planting. Experiment was laid down in Completely Randomized Design (CRD) with eight treatment combination and three replications per treatment. There were 30 plants per treatment making a total population of 240 plants. The treatment consisted of RDF (15:10:30 g NPK/10 plants) in alternate

month (T₁), RDF @ 15:10:30 g NPK/10 plants in every month (T₂), 75 % RDF + Vermicompost @ 25 g/10 plants (T₃), 75 % RDF + Vermicompost @ 25 g/10 plants + *Azospirillum* @ 20 g/10 plants + PSB @ 20 g/10 plants (T₄), 75 % RDF + Vermicompost @ 25 g/10 plants+ *Azotobacter* @ 20 g/10 plants + PSB @ 20 g/10 plants (T₅), 75 % RDF + vermicompost @ 25 g/10 plants + sprayable macro and micro elements @ 2 ml/l (T₆), 75 % RDF + vermicompost @ 25 g/10 plants + *Azospirillum* @ 20 g/10 plants + PSB @ 20 g/10 plants + sprayable macro and microelements @ 2 ml/l (T₇) and 75 % RDF + vermicompost @ 25 g/10 plants + *Azotobacter* @ 20 g/10 plants + PSB @ 20 g/10 plants + sprayable macro and micro elements @ 2 ml/l (T₈).

The biofertiliser were applied after incubation with vermicompost for 7 days. Recommended dose of fertilizer were applied 3 month after planting as top dressing and subsequently as per treatment.

The observation were recorded from 5 randomly selected plant within each replication of treatment for different vegetative parameters like plant spread, number of leaves/plant, leaf length, length of petiole, leaf width, number of suckers/plant, leaf area and chlorophyll content.

The data collected on vegetative and flowering parameters were analysed statistically following the method of Gomez and Gomez (1984) using one way ANOVA in CRD. A comparison of treatment means were done at 5% level of significance (P=0.05).

Results and Discussion

The results of the experiment obtained in the year 2015-16 and 2016-17 were pooled and presented in Table 1 and Table 2 and discussed under the following headings.

Plant spread

Pooled data of both the consecutive year (Table-1) revealed that in winter plants applied with 75 % RDF+ Vermicompost + PSB+ *Azospirillum* + sprayable macro and micro elements (T₇) represent maximum plant spread (77.19 cm) which was at par with T₈ (75 % RDF+ Vermicompost + PSB+ *Azotobacter* + sprayable macro and micro elements), T₄ (75 % RDF+ Vermicompost+ PSB+ *Azospirillum*) and T₅ (75 % RDF+ Vermicompost+ PSB+ *Azotobacter*) whereas minimum plant spread (55.84 cm) was observed in T₂ (RDF in every month). Increase in plant spread in T₈, T₇, T₅, T₄ might be due to beneficial effect of vermicompost when applied with bio-fertiliser incubated in it. Vermicompost contain several growth hormones enzymes and rich in plant nutrients which accounts for profuse vegetative growth of gerbera.

Besides, bio-fertiliser like PSB, *Azospirillum*, *Azotobacter* stimulate growth of plant by mobilizing or solubilising plant nutrient in soil solution which are readily taken by plants. On the other hand lowest plant spread in T₂ (RDF in every month) might be due to application of 100 % RDF in every month which create residual toxicity of fertiliser in soil resulting poor and sick growth of plant. When level of fertiliser was increased (as in T₂) which was more than the requirement of plant, it resulted decrease in plant spread.

Similar findings have been obtained by Kathiresan and Venketas (2002) with respect to application of vermicompost+ *Azospirillum*+ 75 % RDF in gladilous, Mathew and Shingh (2003) with respect to application of *Azospirillum*+ PSB+ *Azotobacter* in marigold. Similar trends in plant spread were also observed in summer and rainy season.

Number of leaves/plant

The data from Table-1 indicated that there was significant variation among treatments with respect to number of leaves/plant. In winter season the maximum number of leaves (25.23 no.) were found in T₇ (75 % RDF + vermicompost + PSB+ *Azospirillum* + sprayable macro and microelements) which was at par with T₈ (75 % RDF + Vermicompost + PSB+ *Azotobacter* + sprayable macro and micro element). Similar findings have been obtained by Seetha and Gowda (2002), Kathiresan and Venketasha (2002) with respect to application of Vermicompost and 75 % NPK as RDF in Gerbera.

The minimum number of leaves (13.81) were found in T₂ (RDF in every month) in winter season which shows that balanced fertilisation was required for production maximum number of leaves which corroborates with the finding of Khosa *et al.*, (2011) with respect to application of NPK + micro nutrient in Gerbera. A similar trend in number of leaves/plant was also observed in summer and rainy season.

Length of leaf and leaf width

It was evident from the Table-1 that in winter season maximum length of leaf (39.98 cm) and leaf width (9.96 cm) were observed in T₈ (75 % RDF + Vermicompost+ PSB+ *Azotobacter* + sprayable macro and micro elements) and T₇ (75 % RDF+ Vermicompost + PSB + *Azospirillum* + sprayable macro and micro elements). It indicates that balanced fertilisation with organic and inorganic source of nutrient and foliar spray of nutrients encourage vegetative growth like leaf length, leaf width, and length of petiole while minimum value of these character was found in T₂ (RDF in every month).

This results was in alliance with the findings of Patil and Chaitra (2006) who stated that application of *Azospirillum*, Vermicompost, PSB and 50 % RDF in China aster increased leaf length. Mathew and Shingh (2003) also reported increased leaf length in marigold due to application of *Azotobacter*, *Azospirillum* and PSB. Similar trends in leaf length and leaf width was also observed in summer and rainy season.

Length of petiole

It is evident from the Table-2 that in winter season maximum length of petiole was observed in T₈ (12.36 cm) and T₇ receiving 75 % of RDF+ PSB+ Vermicompost+ *Azospirillum*/*Azotobacter* + sprayable macro and micro elements which was at par with T₄ and T₅ receiving 75 % RDF+ PSB+ Vermicompost+ *Azotobacter*/*Azospirillum*. The minimum petiole length was found in T₂ receiving 100 % RDF in every month.

In summer season maximum length of petiole was found in T₈ and T₇ receiving 75 % RDF + PSB+ Vermicompost+ *Azotobacter*/*Azospirillum*+ sprayable macro and micro elements which was similar to T₄ and T₅ receiving 75 % RDF+ PSB+ VC + *Azospirillum*/*Azotobacter*. The minimum leaf width was recorded in T₂ receiving 100 % RDF in every month. Similarly in rainy season longest petiole length was observed in T₈ and T₇ receiving 75 % RDF + VC + PSB+ *Azotobacter* / *Azospirillum*+ sprayable macro and micro element (75 % RDF+ VC+ PSB+ *Azotobacter*/ *Azospirillum*). The minimum leaf width was found in T₂ receiving 100 % RDF in every month.

Increase in length of petiole in T₇ and T₈ in all the season might be due to beneficial effect of vermicompost incubated with bio-fertilizer and spray of macro and micro element. Foliar application macro and micro elements helps in quick absorption of nutrients through leaf encourage growth resulting longer leaf and

petiole. Decrease in length of petiole might be due to toxicity effect of chemical fertilizer when applied @ 100 % RDF in every month.

Number of suckers/plant

Pooled data form Tabel-2 reveals that in winter season maximum number of suckers (3.61 no.) was obtained in T₈ (75 % RDF + Vermicompost +PSB+ *Azotobacter* + sprayable macro and micro elements) and T₇ (75 % RDF+ Vermicompost+ PSB+ *Azospirillum* + sprayable macro and micro elements). Increased number of suckers might be due to application of balanced fertiliser, bio-fertiliser with foliar application of macro and micro nutrients which encourage vegetative growth allowing more number of suckers per plant. Similar finding have been reported by Seetha and Gowda (2002) in gerbera. The minimum number of suckers (1.59 no.) in T₂ (RDF in every month) might be due to supply of excess nutrients than the requirement resulting poor and sick growth of plants. Similar trends in number of suckers/plant were also observed in summer and rainy season.

Leaf area

Pooled data from Table-2 revealed that in winter season maximum leaf area (160.93 cm²) was recorded in T₈ receiving (75 % RDF + Vermicompost + PSB+ *Azotobacter* + sprayable macro and micro elements) which was at par with T₇ (75 % RDF + Vermicompost + PSB+ *Azospirillum* + sprayable macro and micro elements). It indicates that combined application of organic and inorganic source of nutrients enhance microbial activity in soil and supply nutrients to plant by solubilising/mobilizing nutrients in soil. The minimum leaf area (91.78 cm²) was observed in winter in T₂ (RDF in every month) might be due to poor and sick growth of plants due to application of fertilizer more than the requirement by application of RDF in

every month. Similar trends in leaf area were also observed in summer and rainy season.

Chlorophyll content

From Table-2 it is evident that in winter season maximum chlorophyll content was observed in T₈ (3.14 mg/g leaf) and T₇ (75 % RDF + Vermicompost+ PSB+ *Azotobacter/Azospirillum*+ sprayable macro and micro elements). The increase in chlorophyll content might be due to combined application of vermicompost, biofertiliser along with 75 % of RDF. Application of bio-fertiliser incubated in vermicompost improve soil physical, chemical and biological properties which result in more availability of nutrient to plants and more assimilation of photosynthates. Similar finding have been obtained by Jagadish and Jayamma (2008) with respected to application of biofertiliser with 50 % RDF in jasmine, Rodriguez (2000) with respect to application of vermicompost in gerbera and Singh *et al.*, (2012) with respect to application of ZnSO₄, FeSO₄ as foliar spray in *Lilium*. Minimum chlorophyll content (2.18 mg/g leaf) in T₂ in winter might be due to sick and poor growth of plant due to excess of inorganic fertiliser applied than the requirement of plant. Similar trends in chlorophyll content were also observed in summer and rainy season.

Number of flowers/ m²/month

The pooled data from both the year (Table-3) revealed that there were maximum number of flowers (29.48) per m²/month in winter in T₈ (75 % RDF+ vermicompost+ PSB+ *Azotobacter*+ sprayable macro and micro elements) which was at par with T₇ (75 % RDF+ vermicompost+ PSB+ *Azospirillum* + sprayable macro and micro elements) which were closely followed by T₄ and T₅ (75 % RDF + Vermicompost + PSB+ *Azospirillum/Azotobacter*). This indicates that treatment with vermicompost and biofertiliser have higher capability of Carbon assimilation than

other treatments. PSB solubilises insoluble and fixed from of P₂O₅ in soil making it's availability to plant. Similarly *Azospirillum/Azotobacter* fix atmospheric N and supply to the plants. Vermicompost is rich source of macro nutrients and micro nutrient like Zn, Fe etc which accelerates enzymatic activity in the plant. Besides, vermicompost has growth promoting effect due to presence of hormones. All of these organic source of nutrient might have augmented maximum dry matter accumulation in plant which resulted higher number of flower yield/plant/month than others. Similar results have been obtained by Seetha and Gowda (2002), Subramaniam (2002). Application of macro and micro elements in form of foliar spray augmented flower production in T₇ and T₈ which is in conformity with the finding of Muthumanickamm *et al.*, (1999) with respect to application of 2 % MnSO₄, ZnSO₄ and FeSO₄ as foliar spray in gerbera. The lowest flower yield (11.84) per m²/month in winter in T₂ (RDF in every month) may be due to excessive nutrient application in soil which create toxicity effect of fertilizer with sick and poor growth of plant resulting low carbon assimilation and so lowest number of flower/plant. Similar result of increased in number of flowers per m²/month in summer and rainy season was observed in T₈ and T₇(75 % RDF+ vermicompost + PSB+ *Azotobacter/Azospirillum* + sprayable macro and micro elements).

From the above finding it can be concluded that application of 75% RDF (15:10:30 g NPK/10 plants) + Vermicompost+ (25 g/10 plants) + PSB (20g/m²10 plants) + *Azospirillum/ Azotobacter* (20g/10 plants) + macro and micro element spray increased all of vegetative parameters of gerbera with maximum number of flowers/m²/month. The result will be torch bearer for the researcher as well as gerbera grower for enhancing quality flower production under open field condition.

Table.1 Treatment means (Pooled over year 2015-16 and 2016-17) for plant spread, number of leaves, leaf length and leaf width of gerbera (Shimmer)

Treatments number	Treatment	Plant spread(cm)			Number of leaves/plant			Leaf Length(cm)			Leaf width(cm)		
		Winter	Summer	Rainy	Winter	Winter	Winter	Winter	Summer	Rainy	Winter	Summer	Rainy
T ₁	RDF in alternate month	62.12	47.94	52.36	19.46	14.79	17.63	33.77	24.74	26.50	8.86	6.68	7.29
T ₂	RDF in every month	55.84	41.62	43.76	13.81	10.52	11.19	29.65	19.59	21.75	7.79	4.66	6.12
T ₃	75% RDF + Vermicompost	57.98	46.71	50.83	17.07	13.77	15.69	31.43	23.18	24.42	8.38	6.00	6.79
T ₄	75% RDF + VC + <i>Azospirillum</i> + PSB	71.29	53.67	56.72	22.17	19.67	21.61	37.05	27.91	31.46	9.62	7.37	8.42
T ₅	75% RDF + VC + <i>Azotobacter</i> + PSB	71.46	53.70	56.90	22.23	19.46	21.54	37.18	28.15	31.56	9.63	7.47	8.41
T ₆	75% RDF + VC + macro and micro elements	62.38	48.91	52.59	19.63	14.73	17.92	33.83	25.13	26.88	8.84	6.54	7.34
T ₇	75% RDF + VC + <i>Azospirillum</i> + PSB + macro and microelements	77.19	58.61	59.67	25.23	22.21	24.29	39.93	31.04	34.27	9.92	8.19	8.93
T ₈	75% RDF + VC + <i>Azotobacter</i> + PSB + macro and micro elements	77.15	58.65	59.97	25.21	22.36	24.42	39.98	31.04	34.44	9.96	8.17	8.91
	SE (m) ±	2.488	1.716	1.235	1.876	0.648	0.675	0.336	1.396	0.737	0.276	0.160	0.223
	CD (0.05)	8.32	5.74	4.13	6.27	2.17	2.26	0.96	4.67	2.46	0.92	0.54	0.75

Table.2 Treatment means (Pooled over year 2015-16 and 2016-17) for length of petiole, number of suckers, leaf area and chlorophyll content of gerbera (Shimmer)

Treatments number	Treatment	Length of petiole (cm)			Number of suckers/plant			Leaf area(cm ²)			Chlorophyll content(mg/g leaf)		
		Winter	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy
T ₁	RDF in alternate month	9.88	6.24	8.38	2.63	1.65	2.23	125.99	101.02	116.21	2.52	1.62	2.09
T ₂	RDF in every month	8.74	4.66	7.03	1.59	1.02	1.41	91.78	55.43	70.92	2.18	1.07	1.68
T ₃	75% RDF + Vermicompost	9.43	5.83	7.93	2.30	1.38	2.06	114.34	89.09	101.20	2.44	1.42	1.95
T ₄	75% RDF + VC + <i>Azospirillum</i> + PSB	10.60	7.60	9.28	3.13	2.21	2.77	139.85	114.25	135.38	2.82	1.72	2.29
T ₅	75% RDF + VC + <i>Azotobacter</i> + PSB	10.61	7.64	9.29	3.11	2.15	2.83	141.79	113.78	135.15	2.84	1.75	2.32
T ₆	75% RDF + VC + macro and micro elements	9.85	6.31	8.40	2.65	1.84	2.42	126.72	99.96	116.85	2.67	1.59	2.05
T ₇	75% RDF + VC + <i>Azospirillum</i> + PSB + macro and microelements	12.33	8.70	9.93	3.57	2.71	3.19	160.33	131.33	150.74	3.08	2.07	2.55
T ₈	75% RDF + VC + <i>Azotobacter</i> + PSB + macro and micro elements	12.36	8.67	9.96	3.61	2.65	3.21	160.93	131.30	150.62	3.14	2.08	2.58
	SE (m) ±	0.604	0.302	0.370	0.155	0.056	0.061	2.430	2.351	5.701	0.093	0.102	0.041
	CD (0.05)	2.02	1.01	1.24	0.52	0.16	0.17	6.95	6.72	19.06	0.31	0.34	0.12

Table.3 Effect of INM on number of flowers/plant /m²/month

Treatments number	Treatments	Number of flowers/m ² /month		
		Winter	Summer	Rainy
T ₁	RDF in alternate month	21.03	17.84	19.86
T ₂	RDF in every month	11.84	10.95	11.61
T ₃	75% RDF + Vermicompost	16.53	14.91	15.56
T ₄	75% RDF + VC + <i>Azospirillum</i> + PSB	24.05	21.20	23.06
T ₅	75% RDF + VC + <i>Azotobacter</i> + PSB	24.03	21.96	23.04
T ₆	75% RDF + VC + macro and micro elements	22.53	18.57	20.43
T ₇	75% RDF + VC + <i>Azospirillum</i> + PSB + macro and microelements	29.28	25.14	26.43
T ₈	75% RDF + VC + <i>Azotobacter</i> + PSB + macro and micro elements	29.48	25.53	26.42
	SE (m) ±	0.729	0.43	0.943
	CD (0.05)	2.44	1.22	3.15

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