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Impact of Organic and Inorganic Sources of Nutrients on Post Harvest Life of Cut Flowers of Hybrid Gerbera (*Gerbera jamesonii* B.) cv. Shimmer

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Authors' contributions

This work was carried out in collaboration between both authors. Author BG designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author SB managed the analyses of the study and managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

The present investigation was carried out in premises of Biotechnology cum Tissue Culture Centre, Odisha University of Agriculture and Technology, Bhubaneswar during 2015-16 and 2016-17. The objective of the study was to standardize suitable integrated nutrient management (INM) practices on post harvest life of gerbera cut flowers. Four leaved tissue culture plantlets of gerbera cv. Shimmer a hybrid suitable for protected cultivation were used for planting. Experiment was laid down in Completely Randomized Design (CRD) with eight treatments combination and three replications per treatment. The treatments of different combination of vermicompost, biofertilizer, chemical fertilizer and macro and micro nutrients spray were used. The biofertilizers 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. Treatment combination of 75% Recommended Dose of Fertilizer (RDF) + vermicompost + Phosphorus Solublising Bacteria (PSB) + *Azotobacter/Azospirillum* + macro and micronutrient spray recorded maximum percent gain in weight of flower stalk, maximum percent gain in stalk length in vase, maximum percent gain in flower diameter, highest solution uptake in vase and longest vase life.

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1. INTRODUCTION

Gerbera (*Gerbera jamesonii*) also known as Transvaal daisy, Barbeton daisy or African daisy belonging to family Asteraceae occupies 5th place as cut flower in international flower trade [1]. It is popular because of it's attractive colour, long vase life and suitability for long distant transport [2,3]. It is used for fresh and dry flower arrangement, exhibition, decoration, bouquet preparation [4]. Local and improved cultivar are 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.

The Green revolution resulted higher productivity with use of high yielding variety, chemical fertilizer and pesticides but it created unprecedented pressure on the natural resources on earth disturbing it's ecology. Application of more amount of inorganic fertilizer to soil which in due course of time leaches into the soil creating environmental hazards. The soil health is gradually degrading due to indiscriminate use of fertilizer for higher productivity. Besides, sustainability in agriculture is a global issue due to pressure of energy crisis on fossil energy is consumed during manufacture of chemical fertilizer. Sustainable agriculture suggest for replenishment of nutrient absorbed by plant from soil for optimization of yield and maintenance of soil fertility. Again recent crisis and hike in price of chemical fertilizer warned us for use of organic fertilizer. Integrated nutrient management (INM) is better option to solve this problem.

INM involves use of all possible sources of nutrients in an integrated manner to increase production without deterioration of soil health and environment for long term sustainability. Integrated nutrient management reduce fertilizer use and increases productivity and quality of gerbera [5]. Further, it has been established by several investigation that integration of both organic and inorganic source of nutrient increases growth and yield of crop than using inorganic fertilizer alone. Organic manure has vital role in maintaining sustained production and soil fertility as well. It maintain humic substance in soil, increases efficiency of bio fertilizer and chemical fertilizer added to soil. It make availability of micronutrient through chelating process. Bio fertilizer maintain soil health, improve efficiency of chemical fertilizer and help in sustainable production in long run. They are also economically and ecologically sound without any adverse effect on environment. *Azospirillum* and *Azotobacter* help in asymbiotic Nitogen (N) fixation while PSB solubilises insoluble Phosphorus (P) to available form in soil solution. They also suppress the activity of harmful microorganism and pathogen of plant. These are naturally gifted to us and do not require any non renewable energy for their production. Apart from fixing N, *Azospirillum* secrete hormone like auxin, gibberellin and cytokinin in plant rhizosphere. It also produce antifungal and antibacterial substances preventing plant from bacterial and fungal infection. It also help in organic matter decomposition, biological nitrogen fixation, solubilisation of insoluble phosphates and helps in availability of several essential plant nutrients through increasing microbial activity and biological properties of soil.

However very little information is available on INM practices in gerbera for higher productivity. Farmers are still using heavy dose of inorganic fertilizer to get higher productivity. The present investigation was carried out taking account of above situation.

Therefore the present research project has been proposed to study the impact of integrated nutrient management (INM) on post harvest life of cut flowers of gerbera hybrid cv. Shimmer.

1.1 Review of Literature

Muthumanickam, et al. [6] conducted a field trial to assess the effect of Micronutrient on vase life of gerbera Spraying of 2% $MnSO_4$, $ZnSO_4$, and $FeSO_4$, in combination at monthly interval results longest vase life than spraying individual micronutrient.

Barreto et al. [7] concluded that in gerbera vase life was maximum when it was supplied with vermicompost.

Seetha and Gouda [8] studies vase life of gerbera and revealed that flowers harvested from plant treated with *Azospirillum* + Vescicular Arbuscular Mycorrhiza (VAM) + 50% NP + recommended potassium (K) showed maximum number of days in vase.

Palagani and Singh [9] studied the influence of soil inoculation of bio fertilizer and foliar application of organic growth enhancer on gerbera. They revealed that application of *Azotobacter* @ 1 l/ha and VAM @ 2 g/plant along with foliar spray of spermine @ 25 ppm recorded higher fresh weight (30 gm), water uptake (33 ml) & extended vase life up to 10 days which is at par with treatment of bio-fertilizer+ vermiwash (4%).

2. 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. in 2015-16 and 2016-17 in open condition. The experimental site was situated 63 km away from Bay of Bengal at an altitude of 25 m above MSL and extended between 20º15' North latitude and 85º50' East longitude. The average rainfall of the site is 1646 mm. The maximum temperature during the experimental period was 38.8ºC to 40.8ºC and minimum temperature was 14.1ºC to 15.2ºC. The relative humidity during the experimental period was 37% to 94%. The experimental soil was sandy loam with p^H 5.83, electrical conductivity (EC) 0.64 ds/m, organic carbon (OC) 0.47%; N 125 kg/ha, P_2O_5 18.8 kg/ha and K_2O 166.6 kg/ha. (Table 4) The growing media was composed of soil, farm yard manure (FYM) and coco peat in 1: 1: 1 proportion.

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

With help of a precision balance the required amount of fertilizers in form of urea, single super phosphate and muriate of potash were measured for each treatment and applied in a ring around the plant. Similarly required quantity of vermicompost and biofertilizers were measured for each treatment and applied in a ring around the plant. Macro and micro nutrient solution was dissolved in water and sprayed on plant as per treatment combination. The biofertilizers 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 floral parameters like days taken to flower bud initiation, days taken to flowering, flower stalk length, stalk thickness, number of flowers per plant, flower diameter and bloom life in each month of two consecutive years and the pooled data has been given in Table 3 and Table 4.

The data collected on flowering parameters were analyzed statistically following the method of Gomez and Gomez [10] using one way analysis of variance (ANOVA) in CRD. A comparison of treatment means were done at 5% level of significance (P = 0.05).

Table 1. Treatment details for INM practices in gerbera cv. shimmer

Code	Different combination of nutrient source
T_1	Recommended dose of fertilizer (RDF) (15:10:30 g NPK/10 plants) in alternate month
T_2	RDF (15:10:30 g NPK/10 plants) in every month
T_3	75% RDF + Vermicompost (25 g/10 plants)
T_4	75% RDF + Vemicompost (25 g/10 plants)+ *Azospirillum* (20 gm/10 plants) + phosphorus solublising bacteria (PSB) (20 g/10 plants)
T_5	75% RDF + Vermicompost (25 g/10 plants)+ *Azotobacter* (20 g/10 plants) + PSB (20 g/10 plants)
T_6	75% RDF + vermicompost (25 g/10 plants)+ sprayable macro & micro elements (2 ml/l)
T_7	75% RDF + vermicompost (25 g/10 plants)+ *Azospirillum* (20 g/10 plants) + PSB (20 g/10 plants) + sprayable macro & microelements (2 ml/l)
T_8	75% RDF + vermicompost (25 g/10 plants) + *Azotobacter* (20 g/10 plants) + PSB (20 g/10 plants + sprayable macro & micro elements (2 ml/l)

3. RESULTS AND DISCUSSION

The results of the experiment obtained in the years 2015-16 and 2016-17 were pooled, analyzed statistically using one way ANOVA in CRD and presented in Table 3 and Table 4 and discussed under the following headings.

3.1 Percentage Gain in Flower Weight in Vase

The data (Table 3) on percentage gain in flower weight in vase from both the years revealed that in maximum percentage gain in flower weight in vase was observed in T_8 and T_7 receiving 75% RDF + vermicompost + PSB + *Azotobacter/ Azospirillum* + sprayable macro and micro elements while minimum percent gain in flower weight in vase was observed in T_2 receiving RDF in every month. Increase in percentage gain in weight of cut flowers may be due to accumulation of hormones, enzymes and nutrient in flower from organic sources like vermicompost and biofertilizers which improve qualitative parameters of cut flower. Similar findings of increase in fresh weight of flower was observed by Palgani et al. [11] in Chrysanthemum with respect to application of 75% NPK + vermicompost + *Azotobacter* + PSB. Dalwai and Naik [12] found increase in fresh weight of carnation by application of *Azospirillum* + PSB + FYM + Vermicompost with 75% RDF. Palgani and Singh [9] reported increase in fresh weight of flower of gerbera by application of biofertilizers and vermicompost. Lowest gain in fresh weight of flower in T_2 may be due to deterioration of qualitative parameters by application of 100% RDF in every month.

3.2 Percentage Gain in Stalk Length

Pooled data (Table 3) on percentage gain in stalk length from both the years revealed that maximum percent gain in stalk length of cut flower was observed in T_7 and T_8 receiving 75% RDF + vermicompost + PSB + *Azotobacter/ Azospirillum* + sprayable macro and micro elements while minimum percent gain in stalk length was recorded in T_2 (RDF in every month). Increase in stalk length of cut flower might be due to accumulation of nutrients from organic source like vermicompost, biofertilizer and supplementation of hormones and enzyme from vermicompost.

3.3 Percentage Gain in Flower Diameter

Maximum percentage gain in flower diameter was observed in T_7 and T_8 receiving 75% RDF + vermicompost + PSB + *Azospirillum/ Azotobacter* + sprayable macro and micro elements while minimum percentage gain in diameter of flower was recorded in T_2 (RDF in every month). Increase in diameter of flower in vase in T_7 and T_8 might be due to accumulation of dry matter in flower and more number of florets in flower because of balanced nutrition to plants along with vermicompost and biofertilizers.

Enzymes produced by bacteria like *Azospirillum/ Azotobacter* and hormones from vermicompost accumulated in cut flowers helped in increasing flower diameter due to opening of more disc florets. Minimum percentage gain in flower diameter in T_2 might be due to deterioration flower quality by application of 100% RDF in every month.

3.4 Solution Uptake in Vase

Pooled data (Table 4) on solution uptake in vase from both the years revealed that maximum solution uptake was observed in treatment T_7 and T_8 receiving 75% RDF + vermicompost + PSB + *Azospirillum / Azotobacter* + sprayable macro and micro nutrients while minimum solution uptake was observed in T_2 (RDF in every month). Maximum water uptake in T_7 and T_8 might be due to absorption of water due to absorption of water by accumulated dry matter in flower. Besides, hormones from vermicompost and enzymes synthesized from biofertilizer which are accumulated in flower enhance qualitative parameters of cut flowers absorbing more water from vase solution.

Similar result of maximum water uptake by carnation flower was observed by Harshavardhan et al. [13] with respect to application of 75% RD NPK + *Azospirillum*+ vermicompost. Pandey et al. [14] found that use of 75% RDF, vermicompost, *Azotobacter* in Chrysanthemum increased water uptake by flower in vase.

Palagani and Singh [9] observed increased water uptake by gerbera cut flower in vase with respect to application of biofertilizer + vermicompost. Application of micronutrient in form of foliar spray trigger biochemical process, enzymatic activity in flower resulting more water uptake which is in conformity with Manjusha and Patil [15] in gerbera.

Table 2. Impact of INM practices on post harvest characters i.e. percentage gain in weight, percentage gain in length and percentage gain in diameter of cut flower (Pooled over years 2015-16 and 2016-17) of hybrid gerbera cv. shimmer

Treatments number	Characters / Treatments	Percentage gain in weight	Percentage gain in length	Percentage gain in diameter
T_1	RDF in alternate month	9.15 (17.56)	1.58 (7.27)	1.70 (7.49)
T_2	RDF in every month	5.60 (13.69)	0.76 (1.62)	1.20 (6.29)
T_3	75% RDF + Vermicompost	7.37 (15.79)	1.54 (7.04)	1.49 (7.04)
T_4	75% RDF + VC + *Azospirillum* + PSB	12.93 (21.05)	2.52 (9.10)	2.99 (9.98)
T_5	75% RDF + VC +*Azotobacter* + PSB	12.96 (21.13)	2.55 (9.28)	2.92 (9.81)
T_6	75% RDF + VC + macro and micro elements	9.14 (17.56)	1.79 (7.71)	2.01 (8.13)
T_7	75% RDF + VC + *Azospirillum* + PSB + macro and microelements	15.00 (22.79)	4.00 (11.54)	3.71 (11.09)
T_8	75% RDF + VC + *Azotobacter* + PSB + macro and micro elements	14.98 (22.79)	4.08 (11.68)	3.63 (10.94)
	SE (m) ±	0.267	0.053	0.057
	CD (0.05)	0.89	0.15	0.16

(ures in parentheses indicate corresponding angular value)

Table 3. Impact of INM practices on post harvest characters i.e. solution uptake in vase and vase life (Pooled over years 2015-16 and 2016- 17) of hybrid gerbera cv. Shimmer

Treatments number	Characters / Treatments	Solution uptake in vase(ml)	Vase life(days)
T_1	RDF in alternate month	24.67	8.61
T_2	RDF in every month	15.00	6.11
T_3	75% RDF + Vermicompost	24.00	8.33
T_4	75% RDF + VC + *Azospirillum* + PSB	27.83	9.56
T_5	75% RDF + VC +*Azotobacter* + PSB	28.22	9.67
T_6	75% RDF + VC + macro and micro elements	25.44	9.11
T_7	75% RDF + VC + *Azospirillum* + PSB + macro and microelements	35.67	11.06
T_8	75% RDF + VC + *Azotobacter* + PSB + macro and micro elements	35.89	11.06
	SE (m) ±	0.868	0.170
	CD (0.05)	2.90	0.48

Table 4. Physico chemical properties of initial soil of the experimental field

Particulars	Composition 2015-16	Methods adopted	Scientist
Mechanical analysis			
Sand(%)	81	Bouyoucos Hydrometer method	Piper, 1950
Silt(%)	9		
Clay (%)	10		
Physical properties			
Textural class	Sandy loam	International triangle method	Piper,1966
Soil pH	5.83	1:2 soil water suspension Systronics digital pH meter	
Organic carbon(%)	0.47	Walkely and Black rapid titration method	Jackson,1973
Electrical conductivity(dS/m)	0.64	1:2 soil water suspension Systronics conductivity meter	
Available Nitrogen(kg/ha)	125	Alkaline potassium permanganate method	Subbiah and Asija,1956
Available Phosphorus(kg/ha)	18.8	Bray's 1extract method	Page *et al.*1982
Available Potassium(kg/ha)	166.6	Ammonium acetate extraction method by flame photometer	Hanway and Heidel,1952
Exchangeable Calcium Centi mol (p+)/kg	7.8	Ammonium acetate lechate method	Page *et al.*,1982
Exchangeable Magnesium Centi mol (p+)/kg	6	Ammonium acetate lechate method	Page *et al.*,1982
Available Suphur (ppm)	11.3	Turbidimetric method	Chesnin and Yien, 1950
HWS Boron	0.58	Hot water extractable method	John et al., 1975
DTPA Zinc	2.56	Extracting soil with DTPA	Lindsay and Norvell,1978
DTPA Copper	0.19	Extracting soil with DTPA	Lindsay and Norvell,1978
DTPA Iron	21.36	Extracting soil with DTPA	Lindsay and Norvell,1978
DTPA Manganese	8.96	Extracting soil with DTPA	Lindsay and Norvell,1978

3.5 Vase Life

Pooled data (Table 4) on vase life from two years revealed that maximum vase life was recorded in T_7 and T_8 receiving 75% RDF + vermicompost + PSB + *Azospirillum/ Azotobacter* + sprayable macro and microelements while minimum vase life was recorded in T_2 (RDF in every month).

Increase in vase life in T_7 and T_8 might be due to accumulation of nutrients, hormones enzymes in flower from different organic sources like vermicompost and biofertilizers. As discussed earlier these treatment T_7 and T_8 recorded maximum percentage gain in flower weight and solution uptake in vase which helped in extending vase life in gerbera.

Similar results of increased vase life was observed by use of 75% RDF + vermicompost + *Azotobacter* + PSB in chrysanthemum as reported by Palagani et al. [11] and Pandey et al. [14]. Similar results of longest vase life was observed by use of *Azospirillum*, PSB, FYM and Vermicompost along with 75% RDF in carnation as reported by Dalawai and Naik [12] and Harshavardhan et al. [13]. Seetha and Gouda [8] observed longest vase life of gerbera cut flower by application of *Azospirillum* + vesicular arbuscular micorrhiza (VAM) + NPK.

Plate 1. Impact of INM practices on vase life of hybrid gerbera cv. Shimmer(1st year)

Plate 2. Impact of INM practices on vase life of hybrid gerbera cv. Shimmer (2nd year)

Combined application of vermicompost and biofertilizers in soil maintain hormone and enzyme level in cut flowers increasing vase life of flower. Similarly application of nutrients in form of foliar spray helps in quick absorption by plants and maintain nutrients balance in flower prolonging vase life which was in conformity with findings of Muthumanicam et al. [6] with respect to application of $MnSO_4$, $ZnSO_4$ and $FeSO_4$ in gerbera. The minimum vase life recorded in T_2 might be due to deterioration of flower quality by application 100% chemical fertilizer in every month.

4. CONCLUSION

From the above investigation it can be concluded that application of 75% RDF + vermicompost + PSB + *Azotobacter/ Azospirillum* + macro and micro elements spray increased percentage gain in flower weight, percentage gain in stalk length, percentage gain in flower diameter, solution uptake in vase and vase life. This result of this experiment will be useful for researcher and so also gerbera growers in post harvest management of the flower.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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