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Effect of integrated plant nutrient system for gerbera flower production under protected cultivation

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Abstract

A field experiment was carried out in Entisol soil at Horticulture Research Station, BCKV, Nadia to study the response of integrated plant nutrient supply system on gerbera under poly house condition. Different combinations of chemical fertilizer (100, 75 and 50% RDF), organic manure (FYM and vermicompost) and bio-fertilizer (*Azoztobacter* and PSB) were evaluated in Randomized Block Design. Healthy disease free tissue culture gerbera plants with uniform growth were planted in the bed of a size 10 x 1 m with a spacing of 50 x 50 cm. The growth attributes, flowering characteristics, flower quality (stalk length and flower size) was improved under the treatment receiving 75% RDF along with FYM, vermicompost and *Azotobacter* + PSB. The maximum numbers of flower with longest shelf life in field condition and vase life in room condition could be harvested with combined application of 75% RDF, FYM, vermicompost along with or without *Azotobacter* + PSB. The bio-fertilizer had significant role in flower quality improvement.

Key words: Integrated nutrient management, *Gerbera jamesonii*, poly hosuse, flower production, quality

Introduction

India has long history of traditional floriculture as references of flowers and gardens are found in ancient Sanskrit clomics like the Rig Veda, Ramayana, Mahabharata, Shudraka, Ashogodha, Kalidasa, Satrangdhara. The social and economic flower growing were however, recognized much later. With changing life style and increased urban affluence floriculture has assumed a definite commercial status more precisely modern cut flower gains additional attention (Sharma and Sharma, 2010). The gerbera (*Gerbera jamesonii* Bolus *ex* Hooker F.) under the family Asteraceae is popular ornamental flower as decorative garden plant, containers plant or mostly as cut flower (Singh, 2010). Gerbera can contribute largely to the floriculture industry by virtue of its yield potential, colour potential, colour variation and long vase life. The liberalized economy has given an impetus to Indian entrepreneurs for establishing export oriented floriculture units under controlled atmospheric conditions, *i.e.,* protected cultivation/ green house situation. To meet the demand for disease, pest free, blemish free quality flower in both domestic and export flower market, farmers are opting to protected cultivation. The production of gerbera in a very small green house (500 m^2) is 75000 to 90000 nos. $year^{-1}$ (Gill, 2000). Moreover, the integrated plant nutrient supply system holds a great promise in meeting up the growing nutrient demands of intensive agriculture/ horticulture and maintains the crop productivity at a fairly high level. It also aims at efficient and judicious use of all major resources of plant nutrients in an integrated manner so as to obtain sustainable production with minimum deleterious effect of chemical fertilizers on soil health and least disturbance to the plant-soil-environment relationship.

The commercial production of flower manipulation is important regarding sustainable production, quality produce and extending suitable agro-climatic situation under poly house condition to satisfy market demand. There is a need to standardize the commercial production system for gerbera using nutrient management judiciously. Most of the experiments of nutrient management were conducted on rose, marigold, chrysanthemum, tuberose *etc.* under open field condition. Information on integrated nutrient management including chemical fertilizers, organic manure as well as bio-inoculants on gerbera under close environment is lacking.

The present experiment was formulated with the objectives to evaluate the response of integrated plant nutrient supply system with special reference to different sources of organic manure (farm yard manure and vermicompost) and bio-fertilizer (*Azotobacter* and phosphate solubilising bacteria) along with varied level of inorganic fertilizer on the growth, flower production and quality improvement of gerbera under poly house condition in new alluvial zone of West Bengal.

Materials and methods

The experiment was carried out at Horticulture Research Farm, Mondouri, Bidhan Chandra KrishiViswavidyalaya, Nadia, West Bengal. The experimental site is situated at 23.5^0 N latitude and 89^0 E longitude with an altitude of 9.75 m above mean sea level and topographically the land is medium. The experimental soil was entisol and clay loam in texture. The soil comprised of 0.62% organic carbon, 0.06% total N, 28.50 kg ha^{-1} available P, 162.50 kg ha^{-1} available K. The experiment was laid out in Randomized Block Design (RBD) with nine treatments replicated thrice. The treatments comprised nine integrated nutrient application system *viz.*, T_1: Without fertilizer; T_2: 100% recommended dose of chemical fertilizer (RDF); T_3: 100% recommended dose of chemical fertilizer (RDF) + FYM (2 kg m^{-2} $year^{-1}$); T_4: 75% recommended dose of chemical fertilizer (RDF) + FYM (2 kg m^{-2} $year^{-1}$); T_5: 75% recommended dose of chemical fertilizer (RDF)

+ FYM (1 kg m^{-2} year^{-1}) + vermicompost (300 g m^{-2} year^{-1}); T_6: 75% recommended dose of chemical fertilizer (RDF) + FYM (1 kg m^{-2} year^{-1}) + vermicompost (300 g m^{-2} year^{-1}) + *Azotobacter* + PSB; T_7: 50% recommended dose of chemical fertilizer (RDF) + FYM (2 kg m^{-2} year^{-1}); T_8: 50% recommended dose of chemical fertilizer (RDF) + FYM (1 kg m^{-2} year^{-1}) + vermicompost (300 g m^{-2} year^{-1}); T_9: 50% recommended dose of chemical fertilizer (RDF) + FYM (1 kg m^{-2} year^{-1}) + vermicompost (300 g m^{-2} year^{-1}) + *Azotobacter* + PSB. The nutrient per cent in organic manure as per analysis was 0.5, 0.18 and 0.49% of N, P and K, respectively in farm yard manure and 1.8, 2.4 and 1.0% of N, P and K, respectively in vermicompost.

The recommended dose of nitrogen, phosphorus and potassium from chemical fertilizer for gerbera considered in the experiment were 20 g of urea, 20 g of single super phosphate and 15 g of muriate of potash m^{-2} month^{-1}, respectively. The talc powder (1:1) carrier (pH 6.5 to 7.5 and moisture 30-40%) based bio-fertilizer was used having CFU minimum 10^7 cells g^{-1} of carrier and no contamination was found at 10^5 dilution. There was a high-tech polyhouse with open air ventilation of 400 m^2 size (32 m x 12.5 m merging two units). The height of the green house was 6 m for proper air circulation. Length of the bed was 10 m and width was 1 m. To control light intensity and solar intensity, white shade net of 50-70% was used. Light intensity was approximately 400 w m^{-2} measured by lux meter in the polyhouse which is very useful for gerbera. The tissue culture plant of gerbera *cv.* Supernova (yellow flower) was planted at spacing of 50 cm x 50 cm. As per the specified bed each of the treatment in a replication consisted of 54 numbers of plants. The soil surrounding the plant raked at every fortnight for aeration. The plant height, numbers of leaf and leaf area was computed as vegetative parameters. On the other hand, appearance of first flower bud, days to flower bud opening, number of days required to full bloom of flower bud, stalk length, flower stalk diameter, fresh weight of flower stalk, flower diameter, disc diameter and fresh weight of flower were measured as reproduction parameters as well as yield component. Ultimately, flower production potential as number of flower plant^{-1} year^{-1}, number of flower per m^{-2} as well as quality parameters *viz.*, shelf life of flower in field condition and vase life of flower in room condition was recorded. The results so obtained were pooled over two years and were subjected to statistical analysis by analysis of variance method. The significance of different sources of variations was tested by Fischer and Snedecor's 'F' test at probability level 0.05.

Results and discussion

Growth attributes: The maximum number of plant height (28.67 cm), number of leaves plant^{-1} (28.81) and leaf area (215.73 m^2) were recorded when gerbera plant was fertilized with 75% recommended dose of chemical fertilizer (RDF) + FYM (1 kg m^{-2} year^{-1}) + vermicompost (300 g m^{-2} year^{-1}) + *Azotobacter* + PSB (T_6). It was closely followed by the treatment T_5 (75% RDF along with FYM 1 kg m^{-2} year^{-1}, vermicompost 300 g m^{-2} year^{-1}) and T_3 (100% RDF along with FYM 2 kg m^{-2} year^{-1}). Significant improvement regarding growth attributes of gerbera plant was noticed in all the integrated nutrient management treatments over control (T_1). The 25% reduction in recommended dose of chemical fertilizer in conjunction with organic sources of nutrient and bio-fertilizer resulted improvement in gerbera plant growth components over 100% recommended dose of mineral fertilizer. This might be due to the fact that organic manure not only supply primary plant nutrients but also acts as store house of secondary plant nutrients and micro nutrients. Thus availability of plant nutrients to the crop was also increased in a synchronized manner throughout the crop growth period. The results are in line with the findings of Haripriya *et al.* (2004) in case of rose.

Flowering attributes: The flower bud appeared early (75.55 days) in control plot (T_1) whereas it required more time for flower bud opening (6.47 days) and full bloom (16.67 days). The maximum delay in first flower bud appearance (95.55 days) was registered under the treatment having 100% recommended dose of mineral fertilizer (T_2). Application of higher level of chemical fertilizer in absence of organic sources lengthened the vegetative growth of gerbera plant, which ultimately delayed the initiation of reproductive phase. The results are also corroborated with

Table 1. Effect of integrated plant nutrient system on growth characters and flowering attributes of gerbera (Pooled data of two years)

Treatments	Growth attributes			Flowering attributes			Stalk behaviour		
	Plant height (cm)	Number of leaves plant^{-1}	Leaf area (cm^2)	Appearance of first flower bud (days)	Days to flower bud opening	Days to full bloom	Stalk length (cm)	Stalk diameter (cm)	Fresh weight of stalk (g)
T_1	17.95	18.65	155.29	75.55	6.47	16.67	29.69	0.42	1.70
T_2	24.12	24.10	201.21	95.55	5.84	16.19	35.90	0.47	2.51
T_3	27.35	26.55	210.40	94.01	5.74	15.90	38.45	0.54	2.93
T_4	25.46	24.60	202.50	90.05	5.26	15.45	35.55	0.50	2.60
T_5	27.43	27.50	212.35	86.35	5.23	13.43	39.90	0.55	3.02
T_6	28.67	28.81	215.73	80.60	5.08	12.40	42.73	0.57	3.15
T_7	21.40	23.15	194.45	84.11	5.40	15.49	34.90	0.47	2.35
T_8	23.20	23.95	199.81	81.21	5.27	15.12	36.17	0.49	2.62
T_9	25.90	26.15	204.87	78.95	4.69	11.05	37.91	0.50	2.65
S.Em.(±)	0.91	0.91	2.11	2.32	0.54	0.64	0.87	0.008	0.10
C.D. at 5%	2.70	2.72	6.31	6.94	1.61	1.90	2.60	0.23	0.28

T_1: Without fertilizer; T_2: 100% RDF; T_3: 100% RDF + FYM (2 kg m^{-2} year^{-1}); T_4: 75% RDF + FYM (2 kg m^{-2} year^{-1}); T_5: 75% RDF + FYM (1 kg m^{-2} year^{-1}) + vermicompost (300 g m^{-2} year^{-1}); T_6: 75% RDF + FYM (1 kg m^{-2} year^{-1}) + vermicompost (300 g m^{-2} year^{-1}) + *Azotobacter* + PSB; T_7: 50% RDF + FYM (2 kg m^{-2} year^{-1}); T_8, 50% RDF + FYM (1 kg m^{-2} year^{-1}) + vermicompost (300 g m^{-2} year^{-1}); T_9, 50% RDF + FYM (1 kg m^{-2} year^{-1}) + vermicompost (300 g m^{-2} year^{-1}) + *Azotobacter* + PSB

Table 2. Effect of integrated plant nutrient system on flower character and quality of gerbera flower (Pooled data of two years)

Treatments	Flower character			Flower production		Flower quality	
	Flower diameter (cm)	Disc diameter (cm)	Fresh weight of flower (g)	Number of flower plant^{-1}	Number of flower m^{-2}	Shelf life of flower in field condition (days)	Vase life of flower in room condition (days)
T_1	7.23	2.02	5.10	6.14	55.17	9.10	12.21
T_2	10.68	2.52	5.55	8.32	75.00	10.33	12.77
T_3	11.55	3.12	5.89	9.04	81.40	11.27	13.80
T_4	10.85	2.62	5.64	8.42	75.80	11.00	13.40
T_5	11.74	2.94	5.84	9.35	84.10	12.01	14.73
T_6	12.18	2.98	5.96	9.58	86.25	13.50	16.30
T_7	9.83	2.33	5.37	8.19	73.50	10.40	13.15
T_8	10.25	2.38	5.41	8.77	79.00	11.63	14.35
T_9	10.74	2.51	5.58	8.84	80.00	13.30	15.75
S.Em.(±)	0.37	0.08	0.06	0.12	1.15	0.16	0.19
C.D. at 5%	1.10	0.22	0.16	0.35	3.42	0.47	0.56

T_1: Without fertilizer; T_2: 100% RDF; T_3: 100% RDF + FYM (2 kg m^{-2} year^{-1}); T_4: 75% RDF + FYM (2 kg m^{-2} year^{-1}); T_5: 75% RDF + FYM (1 kg m^{-2} year^{-1}) + vermicompost (300 g m^{-2} year^{-1}); T_6: 75% RDF + FYM (1 kg m^{-2} year^{-1}) + vermicompost (300 g m^{-2} year^{-1}) + *Azotobacter* + PSB; T_7: 50% RDF + FYM (2 kg m^{-2} year^{-1}); T_8, 50% RDF + FYM (1 kg m^{-2} year^{-1}) + vermicompost (300 g m^{-2} year^{-1}); T_9, 50% RDF + FYM (1 kg m^{-2} year^{-1}) + vermicompost (300 g m^{-2} year^{-1}) + *Azotobacter* + PSB

the experimental evidence of Singh (2006). However, minimum days taken for flower bud opening (4.69 days) and full bloom (11.05 days) was observed under 50% RDF + FYM 1 kg m^{-2} year^{-1} + vermicompost 300 g m^{-2} year^{-1} + *Azotobacter* + PSB (T_9). It was closely followed by the treatment T_6 (5.08 and 12.40 days, respectively). The complete blooming of gerbera flower was quick when the crop was inoculated with *Azotobacter* + PSB in conjunction with FYM and vermicompost. Integrated use of chemical fertilizer, organic manure as well as bio-fertilizer known as balanced nutrition promotes synergistic interactions in the plant, proper growth and development of gerbera plant. Thus, integrated nutrient management aggravates the flower production. Similar type of positive response on flowering attributes of gladiolus due to integrated nutrient management was previously ascertained by Godse *et al.* (2006).

Stalk behaviour and flower character: The pooled data portrayed in Table 1 & 2 indicated that integrated plant nutrient supply treatments showed significant influence on the flower stalk behaviour (*i.e.* stalk length, stalk diameter and fresh weight of stalk) and flower characters (*i.e.* flower diameter, disc diameter and fresh weight of flower) of gerbera. The significant improvement in flower stalk quality and flower size was noticed in all the nutrient management treatments over control. However, it was also witnessed that when gerbera plant was fertilized with vermicompost @ 300 g m^{-2} year^{-1}, FYM 1 kg m^{-2} year^{-1}, *Azotobacter* + PSB in conjunction with either 75% or 50% RDF (T_6 and T_9) and 100% RDF + FYM 2 kg m^{-2} year^{-1} (T_3), produced flower with longest flower stalk with large size of flower as compared to the 100% RDF (T_2). This improvement might be due to the fact that balanced nutrition ensures the availability of all the essential plant nutrients throughout the crop growth period even at the reproductive phase. This positive role of integrated nutrient management on flowering attributes was also reported by Athalve *et al.* (2006).

Flower production: The pooled data of two years of experimentation indicated that the flower production potential *viz.*, number of flowers plant^{-1} and m^{-2} differed significantly due to integrated plant nutrient supply system (Table 3). The highest number of flower plant^{-1} (9.58) and m^{-2} (86.25) were recorded when gerbera plant was treated with 75% RDF + FYM @ 1 kg m^{-2} year^{-1} + vermicompost @ 300 g m^{-2} year^{-1} + *Azotobacter* + PSB (T_6), which was closely followed by the number of flower plant^{-1} (9.35) and m^{-2} (84.10) under the treatment T_5 (75% RDF + FYM @ 1 kg m^{-2} year^{-1} + vermicompost @ 300 g m^{-2} year^{-1}). Moreover, higher flower production potential of gerbera was also acquired with the addition of organic manure (FYM, vermicompost) in conjunction with reduced level of N, P and K (75 or 50% of RDF) through inorganic sources of nutrient. This might be due to the fact the supply of nutrient is more balanced under integrated plant nutrient supply system, which helps to keep plants healthy (low incidence of insect-pest-disease) and enhanced soil biological activity, which in turn improves nutrient mobilization from organic matter and soil reserves. The result confirms the findings of Prasad and Gill (2007). The enhancement in flower production due to integrated nutrient management in gerbera is an agreement with the findings of Thane *et al.* (2009). It was also noted that bio-fertilizer in presence of organic manure had positive impact on gerbera flower yield. The improvement may be due to the fact that bio-fertilizer containing organism are mostly chemo-organotrophs and derive carbon and energy from organic matter.

Flower quality: Integrated nutrient management treatments influenced significantly, the shelf life of gerbera flower in field condition and vase life of flower under tap water in room condition (Table 3). When the plant received 75% RDF + FYM @ 1 kg m^{-2} year^{-1} + vermicompost @ 300 g m^{-2} year^{-1} + *Azotobacter* + PSB produced gerbera flower with highest shelf life (13.50 days) and vase life (16.30 days). It was also registered that significant improvement on shelf life and vase life of gerbera flower was recorded in all the treatments having combined sources of nutrient (both organic and inorganic) over 100% RDF (T_2). The results are in line with the findings of Thane *et al.* (2007) in gerbera and Chopde *et al.* (2007) in tuberose. They showed that flower quality was significantly improved with the application of vermicompost + *Azotobacter* + PSB. Chaimani *et al.* (2008) reported that use of vermicompost enhanced concentrations of Ca and Mg in plant tissue compared to the control. On the other hand, bio-fertilizer due to their characteristics of yielding plant growth regulating substances apart from sources of nutrient greatly influenced the keeping quality of gerbera flower, which was ascertained by the experimental evidence of Abdel Wahid (2005).

It can be inferred from the above experiment that when gerbera plant fertilized with 75% recommended dose of nitrogen, phosphorus and potassium through chemical fertilizer along with FYM @ 1 kg m^{-2} $year^{-1}$, vermicompost @ 300 g m^{-2} $year^{-1}$ and *Azotobacter* + PSB increased quality flower production with longest shelf life and vase life. It can also be concluded that higher flower production with good quality flower may be achieved with 75% recommended dose of nitrogen, phosphorus and potassium through chemical fertilizer along with FYM @ 1 kg m^{-2} $year^{-1}$, vermicompost @ 300 g m^{-2} $year^{-1}$.

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