J Krishi Vigyan 2022, 11 (1) : 86-91 DOI : 10.5958/2349-4433.2022.00111.8

Effect of Inorganic, Organic and Bio-Fertilizers on performance of Gerbera under Shade Net Conditions

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ABSTRACT

The present investigation was conducted in the shade-net at Precision Farming Development Centre College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur during *rabi* season 2021-22. The experiment was laid out in randomized block design (RBD) with 3 replications and 13 treatments. The results revealed that the highest number of leaves per plant (26.03), number of flowers per plant (7.13), per plot (28.51) and per hectare (213800), number of suckers per plant (4.05) and stalk length (533.7 mm) was achieved due to application of 100% RDF whereas maximum leaf length, leaf width, leaf area was 31.26 cm, 13.16 cm and 279.72 cm^2 , respectively. Early appearance of first flower buds, 50% flowering and full bloom were 74.8d, 91.6d and 99.70 d, respectively, flower diameter (109.58 mm), disc diameter (32.51mm), stalk diameter (6.21 mm) and vase life (16.2d) were achieved when treated with 75% RDF + VC+ FYM (Incorporated with Azo + PSB). The maximum plant height (44.57 cm) was seen in plants treated with 75% RDF +25% VC.

Key Words: Gerbera, organic, FYM, Vermicompost, NPK, Bio-fertilizers, economics, growth, yield, vase life.

INTRODUCTION

Gerbera (*Gerbera jamesonii*) is a popular flower used as an ornamental garden plant, containers plant or chiefly as a cut flower (Singh, 2007) and produces very bright and attractive flowers. The flower grows in clumps and has a long slender stalk and the leaves are basal rosette, petiolate and pinnately veined (Bose *et al.* 1978). It's a crucial marketable flower and the 5th most used cut flower after rose, carnation, chrysanthemum and tulip in the world. Although inorganic fertilizers are a good source of nutrients for plants, they have a long-lasting and adverse effect on soil and the environment. Therefore, to minimize these adverse effects, standardization of suitable organic sources of nutrients is required. Nutrient availability of gerbera increases under the influence of organic substrates. Organic manures such as farm yard manure (FYM), Vermicompost (VC) and biofertilizers (Azotobacter and PSB) incorporated with inorganic fertilizers improved soil's physio-chemical and biological properties (Verma *et al*., 2018). The objective of this this study was to establish a suitable combination of organic and inorganic sources of nutrients during cut production and their effect on the vase life of gerbera cut flowers carried out under shade net conditions.

MATERIALS AND METHODS

The present investigation was carried out in a Shade net built in the premises of Precision Farming Development Centre (PFDC), Department of Horticulture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur during *rabi* season, 2021-22. During the experiment the highest temperature recorded throughout the crop period ranged from 19.8°C to 29.6°C. and minimum temperatures may drop to 7 to 9 °C. The experiment was conducted in silty loam soil with pH 7.5. The experiment was laid out in Randomized block design

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(RBD) with 13 treatments and 3 replications. The row x plant distance was 50 x 50 cm in a bed of size 12 m x 1 m. The treatments used in the experiment are as follows: T_1: 100 % RDF, T_2: 75% RDF + 25% Vermicompost, T_3: 75% RDF + 25% Vermicompost (Incorporated with Azo + PSB), T_4: 75 % RDF + 25 % FYM, T_5: 75 % RDF + 25 % FYM (Incorporated with Azo + PSB), T_6: 75 % RDF + 12.5 % FYM + 12.5 % Vermicompost, T_7: 75 % RDF + 12.5 % FYM + 12.5 % Vermicompost (Incorporated with Azo + PSB), T_8: 50 % RDF + 50 % FYM, T_9: 50 % RDF + 50 % Vermicompost T_{10}: 50 % RDF + 50 % FYM (Incorporated with Azo + PSB), T_{11}: 50 % RDF + 50 % Vermicompost (Incorporated with Azo + PSB), T_{12}: 50 % RDF + 25 % FYM + 25 % Vermicompost, T_{13}: 50 % RDF + 25 % FYM + 25 % Vermicompost (Incorporated with Azo + PSB).

Gerbera variety Stanza was used for the planting. Green shade net of 50-90% was selected which was 6 m tall and 15 m long. Raised beds were made with bed size 10 x 1 m with a spacing of 50 x 50 cm and 50 cm between each bed to allow for passage. The beds were thoroughly drenched with hydrogen peroxide (H_2O_2) @ 20 ml/l water and the shade net was closed for a few hours after that to manage and control the occurrence of soil-borne pathogens. The recommended dose of nitrogen, phosphorus and potassium from chemical fertilizer for gerbera considered in the experiment were 15g of urea, 13.7 g of DAP and 19 g of MOP m^{-2} $month^{-1}$ (150:137:190 Kg/ha NPK). Well rotten FYM @ 2Kg/ m^2 (20 t/ha), Vermicompost @ 500g/ m^2 (5 t/ ha) and Azotobacter @ 20g m^2 plants + PSB @ 20 g/m^2 plants administered to each experimental plot in accordance with the treatment before planting. Gerbera was planted using the zigzag method at a 50 x 50 cm spacing. Irrigation was applied using a drip irrigation system with drippers spaced 45 cm apart. The beds were watered with 500 ml of water per dripper per day during the growth period. Weeding and raking was done in the soil at every fortnight to ensure sufficient aeration in the plant's root zone. Disbudding is an operation done which helps in producing healthy and good quality flowers after 75-90 d of planting. To shield the plants against diseases brought on by fungal infection, the roots of the plants were treated with contact fungicide Mancozeb 75 % WP (Zinthane) @ 2.5g/l.

RESULTS AND DISCUSSION

Growth attributes

The maximum (44.57 cm) plant height was observed in plants treated with T_2 (75 % RDF + 25% Vermicompost)) and was followed by T_7 (42.64 cm) and T_1 (41.88 cm) Whereas, plants treated with treatment T_{13} [50% RDF + 25% FYM + 25% Vermicompost (Incorporated with Azotobacter + PSB)] produced the lowest plant height (38.69). The utmost number of leaves per plant (26.03) and number of suckers (4.05) was found in plants addressed with 100% RDF (T_1) whereas, the lowest number of leaves (16.79) and number of suckers (1.14) was obtained from plants administered with 50 % RDF + 25 % FYM + 25% Vermicompost (T_{12}) and treatment T_{13} [50 % RDF + 25 % FYM + 25% Vermicompost (Incorporated with Azo + PSB)] respectively. The plants treated with T_7 [75 % RDF + 12.5% FYM + 12.5% Vermicompost (Incorporated with Azo + PSB)] showed maximum leaf length (31.26 cm), leaf width (13.16 cm) and leaf area (279.72 cm^2). On the other hand, the shortest leaf length (25.86 cm), leaf width (10.04 cm) and leaf area (176.68 cm^2) were observed in plants treated with T_{13} [50 % RDF + 25 % FYM + 25% Vermicompost (Incorporated with Azo + PSB)].

The improvement in plant height was due the availability of not just primary nutrients but also micronutrients like iron and zinc during the entire growth period and was also associated with improved nutrient decomposition and mineralization. Similar findings were documented by Kumar *et al* (2016) in African marigold and Tirkey *et al* (2017) in gladiolus. The higher number of leaves and number of suckers was due to the stimulating effects of N, P and K caused synthesis of protoplasm, division

Table1. Observations noted for the following parameters.

Treatment	Growth attributes						Flowering attributes and stalk behavior			
	Plant height (cm)	**No. of leaves/ plant**	**Leaf length (cm)**	**Leaf width (cm)**	**leaf area (cm^2)**	**No. of suckers/ plant**	**Flower diameter (mm)**	**Disc diameter (mm)**	**Stalk length (mm)**	**Stalk diameter (mm)**
T1	41.88	26.03	28.56	12.1	234.91	4.05	105.39	40.25	533.7	5.79
T2	44.57	23.14	30.16	11.77	241.65	2.54	101.31	41.6	505.2	5.08
T3	40.29	21.52	30.27	10.88	223.82	2.15	104.81	40.13	520.9	5.11
T4	39.86	22.26	28.29	10.9	209.6	1.83	96.42	40.09	492	5.13
T5	40.12	21.26	27.6	11.17	209.62	2.17	94.54	39.14	475.4	4.89
T6	39.65	22.37	28.34	11.03	212.19	1.93	96.44	36.66	485.9	5.01
T7	42.64	21.28	31.26	13.16	279.72	3.23	109.58	42.17	521	6.21
T8	35.18	19.8	27.97	10.48	198.8	1.67	99.26	35.71	479	4.92
T9	34.94	17.95	26.85	10.62	193.71	1.79	95.02	37.27	485.1	4.9
T10	40.17	18.51	26.84	11.33	206.79	1.75	91.83	32.51	453.9	5.23
T11	39.62	20.32	27.79	10.82	204.45	1.83	93.44	33.73	440.6	4.89
T12	40.02	16.79	28.04	10.5	200.1	2.42	98.96	37	467.6	4.74
T13	38.69	21.59	25.86	10.04	176.68	1.14	89.08	37.17	441.7	4.65
S.Em	0.945	0.856	0.614	0.358	7.686	0.27	1.262	0.441	0.755	0.24
C.D (p=0.05)	2.774	2.513	1.802	1.051	22.568	0.792	3.707	1.296	2.217	0.706

of meristem cells as well as an increase in the manufacture of carbohydrates and proteins. The results were in agreement with the discoveries of Senapati *et al* (2020) in chrysanthemum, Ahmed *et al* (2017) in chrysanthemum and Fayaz *et al* (2016) in gerbera. The increase in leaf length, leaf width and leaf area were due to greater and more timely availability of N_2 and P_2O_5 for plant use, which aided in the colonization of the rhizosphere. Azotobacter and PSB improved nitrogen uptake and vermicomposting enhanced soil de-dehydrogenase activity, microbial biomass, humic materials, and other compounds that influenced the growth of leaf.

Flowering Attribute

The earliest flower bud (74.8 days), earliest 50% flowering (91.6 d) and earliest days to full bloom (99.70 d) was seen in the plants supplied with treatment T_7 [75% RDF + 12.5 % FYM + 12.5% Vermicompost (Incorporated with Azo + PSB)]. The maximum delay in the appearance of the first flower bud (90.3 d) was seen in plants administered with treatment T_8 (50 % RDF + 50 % FYM), The maximum delay (106.6 d) in 50% flowering was seen in plants treated with the treatment T_{11} [50 % RDF + 50% Vermicompost (Incorporated with Azo + PSB)] and the maximum delay in full bloom was found in plants treated with T_{10} [50 % RDF + 50 % FYM (Incorporated with Azo + PSB)].

Organic Manure and biofertilizers contain essential nutrients including primary and secondary nutrients enhancing the physiochemical characteristics of the soil, allowing plants to grow at an increasing rate and maximizing potential nutrient uptake and production of flowers at the earliest. The results were in close conformity to the outcomes of Kumar *et al* (2016) and Singh *et al* (2016) in African marigold.

Stalk behaviour

The most superior treatment with respect to stalk length (533.7 mm) reported in T_1 [100% RDF] and was statistically *at par* with treatments T_7 (521.0 mm) and T_3 (52.09 mm), while, the lowest stalk

Table 2. Flower attributes.

Treatment	Appearance of first flower bud	50% Flowering	Full bloom	Number of flowers / plant	Number of flowers/ plot	Number of flowers/ ha.	Vase life
T1	81.03	99.86	105.16	7.13	28.51	213800	14.7
T2	78.10	93.60	108.30	6.23	24.91	186800	15.4
T3	85.08	95.90	111.52	5.26	21.03	157700	13.1
T4	86.23	100.93	110.02	4.86	19.44	145800	14.7
T5	84.64	103.21	114.89	5.37	21.49	161200	14.3
T6	83.50	101.15	113.99	5.41	21.64	162300	15.5
T7	74.84	91.55	99.70	7.06	28.24	211800	16.2
T8	90.34	101.72	112.34	3.76	15.03	112700	13.2
T9	81.91	103.62	115.09	4.76	19.04	142800	13.4
T10	79.48	100.81	119.71	5.2	20.79	155900	12.9
T11	81.05	106.58	115.93	4.57	18.29	137140	13.9
T12	83.25	104.45	114.63	5.03	20.11	150800	11.5
T13	87.49	103.12	109.26	3.99	15.96	119700	12.4
S.Em	2.57	2.87	2.39	0.273	1.41	1.56	0.223
C.D (p=0.05)	0.87	0.98	0.81	0.801	4.16	4.72	0.655

length was noted in treatment T_{11} (440.6 mm). 100% RDF increased photosynthetic efficacy, source-sink interactions, and improved physiological and biochemical functions resulting in greater stalk length. The outcomes of the experiment were similar to the findings of Ahmed *et al* (2017) in chrysanthemum and Fayaz *et al* (2016) in gerbera. The maximum girth of stalk (6.21 mm) was found in the plants administered with T_7 *i.e.,* 75% RDF + 12.5 % FYM + 12.5% Vermicompost (Incorporated with Azo + PSB) and was found to be *at par* with treatments T_1(5.79 mm) and T_4 (5.13 mm). The lowest value (4.74 mm) regarding stalk diameter was obtained in treatment T_{12} (50% RDF + 25% FYM + 25% Vermicompost). The integration of chemical and organic sources of nutrients improved the diameter of the stalk as the plants received consistent supplies of nitrogen and other vital nutrients at a crucial period of the flower growth and development, which in turn caused the stalk to grow more quickly and effectively stimulating the development of floral structures by increasing protein synthesis. The results were in agreement with the findings of Jha *et al* (2020) and Satyanarayan *et al* (2017) in gladiolus; C Parya (2017) in gerbera.

Flower characters

The largest flowers diameter (109.58 mm) and disc diameter (42.17mm) observed in the treatment T_7 [75 % RDF + 12.5 % FYM + 12.5% Vermicompost (Incorporated with Azo + PSB)] and the smallest flower diameter (91.83 mm) and minimum disc diameter (32.51mm) were noticed in plants treated with T_{10} [(50 % RDF + 50 % FYM (Incorporated with Azo + PSB)]. The simultaneous application of chemical fertilizers and organic substrates supplemented by bioinoculants resulted in enhanced nutrient absorption and translocation to the sink thereby improving the quality of flowers. The results were in agreement with Singh *et al* (2015) in marigold; Kirar *et al* (2010) in China aster and C Parya (2017) in gerbera.

Flower production

The highest number of flowers per plant (7.13), per plot (28.51) and per hectare (213800) were evidently seen in plants treated with T_1 [100% RDF] on the other hand, treatment T_{11} [50 % RDF + 50% Vermicompost (Incorporated with Azo + PSB)] produced the least (3.76, 15.03 and 112700) number of flowers. Since there were a greater number of leaves when treated with 100% RDF, there were more photosynthesis and food production, which may have led to improved development, balanced nutrition and enough food resources to generate larger number of flowers. The data recorded was in accordance with Ahmed *et al* (2017) in chrysanthemum, Dhakal *et al* (2017) in gladiolus and Ayemi *et al* (2017) in gerbera

Vase life

The longest vase life (16.2 d) was noted in treatment T_7 [75 % RDF + 12.5% FYM + 12.5% Vermicompost (Incorporated with Azo + PSB)] and was statistically *at par* with T_6 (15.5 days) and T_2 (15.4 d). The shortest vase life (11.5) was seen in treatment T_{12} *i.e.,* 50 % RDF + 25 % FYM + 25% Vermicompost. The flower's vase life was extended as a result of the long stalk length and excessive sugar concentration in the stem, which is carried to the corolla and increases water intake and stem turgor. This can be attributed to biofertilizers helping the growth of tissues that transmit water. Vermicompost and biofertilizers both have favorable benefits on vase life. The results were in agreement with Harshavadhan *et al* (2016) in Carnation and C Parya (2017).

CONCLUSION

These observations concluded that the most efficient treatment for an overall increase in growth attributes, yield parameters and net returns is 100% RDF whereas the quality parameters of flower, post-harvest longevity and earliness in flowering were promising in 75 % RDF + 12.5% FYM + 12.5% Vermicompost (Incorporated with Azo + PSB).

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Received on 22/8/2022 *Accepted on 22/10/2022*