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Effect of integrated system of plant nutrition management on growth, yield and flower quality of chrysanthemum cv. PDKV Ragini

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Abstract
A field investigation entitled "effect of integrated system of plant nutrition management on growth, yield and flower quality of chrysanthemum cv. PDKV Ragini" was carried out during the two successive years, 2014-15 and 2015-16 at Floriculture Unit, Department of Horticulture, Dr. PDKV, Akola. In which significantly maximum plant height, number of branches plant^{-1}, minimum days to first flower bud initiation, opening of flower and 50% flowering, whereas, maximum flower heads plant^{-1}, flower yield plant^{-1}, diameter and shelf life of the flower were recorded with the application of biofertilizers and 50% RDF (15:100:100 kg ha^{-1} of NPK) + 10 t ha^{-1} VC (50% N through VC).

Keywords: chrysanthemum, integrated nutrient, quality and yield.

Introduction

Materials and methods

The experiment was carried out during the winter season of the years 2014-15 and 2015-16, at Floriculture Unit, Department of Horticulture, Dr. PDKV, Akola The experiment was laid out in Split Plot Design with three replications and fourteen treatment combinations. The treatments comprised of two levels of biofertilizers i.e. with biofertilizers (Azotobacter and PSB @ 5 kg ha^{-1}) and without biofertilizers in main plot and seven combination of organic and inorganic fertilizers including one treatment of recommended dose of fertilizers *viz*., 100% RDF (300:200:200 kg ha^{-1}), 75% RDF + 15 t ha^{-1} FYM (25% N through FYM) 50% RDF + 30 t ha^{-1} FYM (50% N through FYM, 75% RDF + 5 t ha^{-1} VC (25% N through VC), 50% RDF + 10 t ha^{-1} VC (50% N through VC), 75% RDF + 1.5 t ha^{-1} NC (25% N through NC) and 50% RDF + 3 t ha^{-1} NC (50% N through NC). Both vegetative and flowering parameters were recorded from five plants which were randomly selected and labeled in each plot. Vegetative parameters *viz*. plant height and number of branches^{-1}; flowering parameters *viz*. first flower bud initiation, opening of flower, 50% flowering; yield parameters *viz*. flower heads plant^{-1}, flower yield plant^{-1} and flower quality parameters *viz*. diameter and shelf life of the flower were recorded.

Results and discussion

Effect of bio fertilizers

Vegetative parameters *viz*. plant height and branches plant^{-1}; flowering parameters viz. first flower bud initiation, opening of flower, 50% flowering; yield parameters *viz*. flower heads plant^{-1}, flower yield plant^{-1} and flower quality parameters *viz*. diameter and shelf life of flower (Table 1, 3 and 5) were significantly influenced by application of bio-fertilizers.

Plant receiving biofertilizers (Azotobactor + PSB) recorded significantly maximum plant height 50.88, 50.36 cm, respectively) during the year 2015-16 and in the pooled data than the plants which were not applied with biofertilizers (M_2). The increase in plant height in biofertilizers applied treatment might be due to the beneficial effect of biofertilizers. Similarly higher number of branches plant^{-1} (7.37, 7.65 and 7.50, respectively) during both the years and in the pooled data) were recorded under treatment M_1. This could be attributed to the growth regulators like NAA and cytokinins released by Azotobactor and PSB might have resulted in breaking of apical dominance and accelerated higher number of branches. Similar findings were reported by Hoda and Mona (2014) [7] in Petunia, Patnvar *et al*. (2014) [13] in chrysanthemum and Chaurasia and Singh (2015) [6] in periwinkle.

Table 1: Effect of integrated nutrient management on growth parameters of chrysanthemum plants

Treatments	Plant height			Branches plant^{-1}		
Bio-fertilizers (M)	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
M_1 – With bio-fertilizers	49.83	50.88	50.36	7.37	7.65	7.50
M_2 – Without bio-fertilizers	46.99	47.19	47.09	7.01	7.08	7.04
'F' Test	NS	Sig	Sig	Sig	Sig	Sig
SE (m) ±	0.618	0.597	0.215	0.052	0.054	0.052
CD at 5%	-	3.631	0.613	0.314	0.326	0.206
Organic and inorganic fertilizers (S)						
S_1 - 100 % RDF	47.01	45.56	46.29	6.83	6.90	6.86
S_2 – 75 % RDF + 15 t ha^{-1} FYM	48.32	49.25	48.78	7.04	7.26	7.15
S_3 – 50 % RDF + 30 t ha^{-1} FYM	48.79	49.83	49.31	7.41	7.56	7.49
S_4 – 75 % RDF + 5 t ha^{-1} VC	48.75	49.74	49.24	7.30	7.39	7.34
S_5 – 50 % RDF + 10 t ha^{-1} VC	50.94	52.10	51.52	7.57	7.96	7.76
S_6 – 75 % RDF + 1.5 t ha^{-1} NC	47.31	48.13	47.72	7.04	7.02	7.03
S_7 – 50 % RDF + 3 t ha^{-1} NC	47.76	48.63	48.19	7.10	7.45	7.28
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	0.467	0.583	0.215	0.087	0.116	0.042
CD at 5%	1.364	1.702	0.613	0.254	0.339	0.119
Interaction (M x S)						
'F' Test	Sig	Sig	Sig	NS	NS	NS
SE (m) ±	0.661	0.825	0.431	0.123	0.164	0.083
CD at 5%	1.929	2.407	1.226	-	-	-

Table 2: Interaction effect of integrated nutrient management on growth parameters of chrysanthemum plants

Treatments	Plant height			Branches plant^{-1}		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
M_1S_1- Biofertilizers + 100 % RDF	44.04	45.46	44.75	7.07	7.38	7.22
M_1S_2- Biofertilizers + 75% RDF + 15 t ha^{-1} FYM	50.47	51.42	50.94	7.31	7.55	7.43
M_1S_3- Biofertilizers + 50% RDF + 30 t ha^{-1} FYM	50.67	51.73	51.20	7.59	7.83	7.71
M_1S_4- Biofertilizers + 75% RDF + 5 t ha^{-1} VC	50.58	51.59	51.08	7.52	7.76	7.64
M_1S_5- Biofertilizers + 50% RDF + 10 t ha^{-1} VC	54.08	55.27	54.67	7.63	8.13	7.88
M_1S_6- Biofertilizers + 75% RDF + 1.5 t ha^{-1} NC	49.49	50.34	49.91	7.03	7.25	7.14
M_1S_7- Biofertilizers + 50% RDF + 3 t ha^{-1} NC	49.49	50.39	49.94	7.39	7.62	7.51
M_2S_1- 100 % RDF	49.98	45.67	47.82	6.59	6.41	6.50
M_2S_2- 75% RDF + 15 t ha^{-1} FYM	46.17	47.08	46.62	6.77	6.98	6.87
M_2S_3- 50% RDF + 30 t ha^{-1} FYM	46.91	47.93	47.42	7.23	7.30	7.26
M_2S_4- 75% RDF + 5 t ha^{-1} VC	46.91	47.88	47.40	7.08	7.03	7.05
M_2S_5- 50% RDF + 10 t ha^{-1} VC	47.81	48.94	48.37	7.51	7.78	7.64
M_2S_6- 75% RDF + 1.5 t ha^{-1} NC	45.12	45.93	45.53	7.05	6.79	6.92
M_2S_7- 50% RDF + 3 t ha^{-1} NC	46.02	46.88	46.45	6.81	7.27	7.04
'F' Test	Sig	Sig	Sig	NS	NS	NS
SE (m) ±	0.661	0.825	0.431	0.123	0.164	0.083
CD at 5%	1.929	2.407	1.226	-	-	-

Table 3: Effect of integrated nutrient management on flowering parameters of chrysanthemum

Treatments	Days to first flower bud initiation			Days to opening of flower			Days to 50% flowering		
Bio-fertilizers (M)	**2014-15**	**2015-16**	**Pooled**	**2014-15**	**2015-16**	**Pooled**	2014-15	2015-16	Pooled
M_1 – With bio-fertilizers	102.21	99.85	101.03	125.20	123.39	124.30	142.14	138.48	140.31
M_2 – Without bio-fertilizers	110.88	108.66	109.77	134.70	132.48	133.59	158.38	148.86	153.62
'F' Test	NS	Sig	Sig	NS	Sig	Sig	Sig	Sig	Sig
SE (m) ±	2.382	1.417	1.960	2.416	1.417	1.980	1.730	1.460	1.601
CD at 5%	-	8.621	7.695	-	8.621	7.775	10.529	8.881	6.285
Organic and inorganic fertilizers (S)									
S_1 - 100 % RDF	114.42	112.51	113.46	137.65	137.66	137.65	162.00	155.83	158.92
S_2 – 75 % RDF + 15 t ha^{-1} FYM	108.19	105.00	106.59	132.09	128.90	130.49	151.17	144.67	147.92
S_3 – 50 % RDF + 30 t ha^{-1} FYM	99.91	97.68	98.79	122.56	120.33	121.44	143.67	135.67	139.67
S_4 – 75 % RDF + 5 t ha^{-1} VC	106.89	105.28	106.09	130.09	128.48	129.29	148.67	143.33	146.00
S_5 – 50 % RDF + 10 t ha^{-1} VC	94.51	92.39	93.45	116.61	114.49	115.55	132.50	127.50	130.00
S_6 – 75 % RDF + 1.5 t ha^{-1} NC	111.69	109.20	110.45	136.34	133.85	135.10	159.00	150.67	154.83
S_7 – 50 % RDF + 3 t ha^{-1} NC	110.21	107.74	108.97	134.31	131.84	133.07	154.83	148.00	151.42
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	3.644	4.133	1.591	3.839	4.133	1.628	3.281	4.109	1.517
CD at 5%	10.637	12.065	4.523	11.206	12.065	4.630	9.576	11.994	4.316
Interaction (M x S)									
'F' Test	NS	NS	NS	NS	NS	NS	NS	NS	NS
SE (m) ±	5.154	5.846	3.181	5.430	5.846	3.275	4.640	5.812	3.035
CD at 5%	-	-	-	-	-	-	-	-	-

During the year 2014-15, the effect of biofertilizers on days to first flower bud initiation and opening of flower was found statistically non significant however, during the year 2015-16 and in pooled data the days to first flower bud initiation (99.85 and 101.03 days, respectively) and opening of flower (123.39 and 124.30 days, respectively) were noted significantly minimum with the treatment of biofrtilizers (M_1). Similarly, in case of 50 % flowering significantly minimum days (142.14, 138.48 and 140.31, respectively) during both the years as well as during pooled data were recorded with the treatment of biofertilizers (M_1). The earliness in bud initiation, opening of flower and 50 % flowering in biofertilizer applied plants might be ascribed due to easy uptake of nutrients and simultaneous transport of growth promoting substances like cytokinin to the axillary buds, resulting in breakage of apical dominance. Ultimately, this has resulted in a better sink for faster mobilization of photosynthates and early transformation of plant parts from vegetative to reproductive phase. These results are in congruent with the findings of Moghadam and Shoor (2013) [10] and Bohra and Kumar (2014) [5] in chrysanthemum.

The yield parameters *viz*. flower heads plant^{-1} (104.31, 111.70 and 108.01, respectively) and flower yield plant^{-1} (501.07, 502.32 and 501.70 g, respectively) during both the years and in pooled data were recorded significantly maximum with the treatment of bio fertilizers (M_1). This might be due to the fact that, biofertilizers produces growth promoting substances such as IAA, GA, vitamin B12, thiamine, riboflavin etc, which might have enhanced the soil fertility which might enhanced root and shoot development and their by growth. There after it might have influenced the reproductive phase and induced flowering which resulted in increased number of flower heads plant^{-1} and flower yield plant^{-1}. These results are in close conformity with the results of Palagani *et al*. (2015) [11] in chrysanthemum and Kabariel *et al*. (2016) [9] in marigold

The flower quality parameters *viz.* diameter (5.44, 5.05 and 5.24 cm, respectively) and shelf life (4.00, 3.89 and 3.94 days, respectively) were recorded significantly maximum with the treatment of biofertilizers (M_1) during both the year of experimentation as well as in pooled data. Azotobacter and PSB lead to the enhanced level of auxins which divert the photo assimilates to the developing flower buds, resulting in increased petal number and thereby, increasing the diameter and shelf life of flower. Similar results were also observed by Palagani *et al*. (2013) [12] in petunia, Airadevi and Mathad (2012) [3] in chrysanthemum.

Effect of organic and inorganic fertilizers

Vegetative parameters *viz*. plant height and branches plant; flowering parameters *viz*. first flower bud initiation, opening of flower, 50% flowering; yield parameters *viz*. flower heads plant^{-1}, flower yield plant^{-1}; flower quality parameters *viz*. diameter and shelf life of flower (Table 1, 3 and 5) were significantly influenced by application of organic and inorganic fertilizers.

Significantly maximum plant height (50.94 and 52.10 and 51.52 cm, respectively) during the year 2014-15 and 2015-16 as well as in pooled data was recorded with the treatment of S_5 which was followed by the treatments S_3 (48.79 and 49.83 cm, 49.31 cm respectively) and S_4 (48.75 and 49.74 cm, 49.24 cm respectively). Whereas, significantly minimum plant height was recorded under the treatment S_1 (47.01 and 45.56 and 46.29 cm, respectively). Similarly, the treatment S_5 had recorded significantly maximum branches plant^{-1} (7.57 7.96 and 7.76, respectively) during both years as well as in pooled data. However, significantly minimum branches plant^{-1} were noted under the treatment S_1 (6.83, 6.90 and 6.86, respectively) during both years i.e. 2014-15 and 2015-16. The increase in plant height and branches plant^{-1} with treatment S_5 (50% RDF + 10 t ha^{-1} vermicompost) might be due to the beneficial effect of vermicompost, as vermicompost enhanced the microflora, enzymatic activity, enhanced availability of nutrients at vital periods of growth, greater synthesis of carbohydrates and translocation, improved water status of plant and increased nitrate reductase activity. These results could paint in the same direction of Singh *et al*. (2015) [14] in African marigold and Bohra and Kumar (2014) [5] in chrysanthemum.

During both the years i.e. 2014-2015 and 2015-16 and also in pooled data, the treatment S_5 had recorded significantly minimum days to first flower bud initiation (94.51 and 92.39 93.45 days, respectively), opening of flower (116.61 and 114.49 115.55 days, respectively) and 50% flowering (132.50, 127.50 and 130 days, respectively). Whereas, significantly maximum days to first flower bud initiation (114.42 and 112.51 113.46 days, respectively), opening of flower (137.65 and 137.66 137.65 days, respectively) and 50% flowering (162.00, 155.83 and 158.92 days, respectively) were noted under the treatment S_1. The possible reason for earliness in flowering was amplification of nutrients especially, nitrogen, phosphorus and potassium from different sources *viz*., organic manures and inorganic fertilizers, which promoted the translocation of phytohormones to the shoots resulting in the early flower initiation. It may be also due to presence of gibberellins in vermicompost which was associated with regulation of flowering which might have lead to early flowering through better uptake of nutrients. Optimum availability of all the nutrients to the plants thereby, plant completed its vegetative growth soon, resulting in early flowering i.e. earlier flower bud initiation, opening of flower buds and 50% flowering. The similar results were also reported by, Airadevi and Mathad (2012) [3] in chrysanthemum and Azmeera *et al*. (2015) [4] in African marigold.

In case of yield parameters, during both the years i.e. 2014-15 and 2015-16 as well as in pooled data, the treatment S_5 recorded significantly maximum number of flower heads plant^{-1} (106.01, 113.35 and 109.68, respectively) and flower yield plant^{-1} ((520.39, 543.68 and 532.03 g, respectively). Whereas, significantly minimum number of flower heads plant^{-1} (91.79, 98.13 and 94.96, respectively) and flower yield plant^{-1} (391.10, 395.20 and 393.15 g, respectively) were noted under the treatment S_1 during. This might be due to the fact that, application of vermicompost along with chemical fertilizers, which might have enhanced the soil fertility and thus enhanced the root and shoot development and their by growth. There after it might have influenced the reproductive phase and induced flowering which resulted in increased number of flower heads plant^{-1} and flower yield plant^{-1}. Similar findings were registered by Palagani *et al*. (2015) [11] in chrysanthemum, Singh *et al*. (2015) [14] and Azmeera *et al*. (2015) [4] in African marigold.

During both the years i.e. 2014-15 and 2015-16, also in pooled data, the treatment S_5 recorded significantly maximum diameter of flower head (5.52 and 5.37 5.45cm, respectively), and shelf life of flower (4.07 and 3.94 4.00days, respectively) Whereas, the significantly minimum diameter of flower head (4.85 and 4.38 4.61cm, respectively) and minimum shelf life of flower (3.44 and 3.46 3.45 days, respectively) were noted

under the treatment S_1. The increase in diameter and shelf life of flower with application of vemicompost along with 50 % RDF might be ascribed to the vermicompost which is rich in humic acid which contain cytokinin and auxin which also responsible for higher retention of water in the cells of flowers, increasing in diameter and lower desiccation. These results could paint in the same direction of Airadevi (2012) [1] in chrysanthemum and Azmeera *et al*. (2015) [4] in African marigold.

Interaction effect

In case of interaction effect (Table 2, 4 and 6) which was found significant for plant height, flower heads plant and flower yield plant^{-1} where as it was found to be statistically non significant for the parameters *viz*. branches plant^{-1}, days to first flower bud initiation, days to opening of flower, days to 50% flowering, diameter of flower and shelf life of flower.

In case of plant height, during the years 2014-15 and 2015-16 as well as in pooled data the treatment combination of M_1S_5 had recorded significantly maximum plant height (54.08, 55.27 and 54.67 cm, respectively) as compared to all other treatments, however, significantly minimum height of plant was noted under the treatment combination M_1S_1 (44.04, 45.46 and 44.75 cm, respectively). Increase in height might be due to the fact that nitrogen is fixed by Azotobacter and N being a constituent of protein and chlorophyll, plays a vital role in photosynthesis. It enhances accumulation of carbohydrates which, in turn, increased the plant height. These results are in conformity with the results reported by Patnvar *et al*. (2014) [13] in chrysanthemum and Singh *et al*. (2015) [14] in marigold.

Table 4: Interaction effect of integrated nutrient management on flowering parameters of chrysanthemum

Treatments	Days to first flower bud initiation			Days to opening of flower			Days to 50% flowering		
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	Pooled
M_1S_1- Biofertilizers + 100 % RDF	110.51	109.05	109.78	131.67	134.05	132.86	155.00	152.00	153.50
M_1S_2- Biofertilizers + 75% RDF + 15 t ha^{-1} FYM	103.18	100.62	101.90	126.98	124.42	125.70	143.00	139.67	141.33
M_1S_3- Biofertilizers + 50% RDF + 30 t ha^{-1} FYM	96.82	94.42	95.62	119.32	116.92	118.12	134.67	131.33	133.00
M_1S_4- Biofertilizers + 75% RDF + 5 t ha^{-1} VC	102.18	99.63	100.90	125.18	122.63	123.90	140.67	136.00	138.33
M_1S_5- Biofertilizers + 50% RDF + 10 t ha^{-1} VC	90.03	87.78	88.90	112.03	109.78	110.90	124.33	122.33	123.33
M_1S_6- Biofertilizers + 75% RDF + 1.5 t ha^{-1} NC	107.02	104.36	105.69	131.52	128.86	130.19	151.00	145.33	148.17
M_1S_7- Biofertilizers + 50% RDF + 3 t ha^{-1} NC	105.74	103.09	104.42	129.74	127.09	128.42	146.33	142.67	144.50
M_2S_1- 100 % RDF	118.33	115.97	117.15	143.63	141.27	142.45	169.00	159.67	164.33
M_2S_2- 75% RDF + 15 t ha^{-1} FYM	113.19	109.37	111.28	137.19	133.37	135.28	159.33	149.67	154.50
M_2S_3- 50% RDF + 30 t ha^{-1} FYM	103.00	100.94	101.97	125.80	123.74	124.77	152.67	140.00	146.33
M_2S_4- 75% RDF + 5 t ha^{-1} VC	111.61	110.93	111.27	135.01	134.33	134.67	156.67	150.67	153.67
M_2S_5- 50% RDF + 10 t ha^{-1} VC	98.99	97.01	98.00	121.19	119.21	120.20	140.67	132.67	136.67
M_2S_6- 75% RDF + 1.5 t ha^{-1} NC	116.37	114.04	115.21	141.17	138.84	140.01	167.00	156.00	161.50
M_2S_7- 50% RDF + 3 t ha^{-1} NC	114.67	112.38	113.53	138.87	136.58	137.73	163.33	153.33	158.33
'F' Test	NS	NS	NS	NS	NS	NS	NS	NS	NS
SE (m) ±	5.154	5.846	3.181	5.430	5.846	3.257	4.640	5.812	3.035
CD at 5%	-	-	-	-	-	-	-	-	-

Table 5: Effect of integrated nutrient management on yield and quality parameters of chrysanthemum flowers

Treatments	Number of flower heads plant^{-1}			Flower yield plant^{-1} (g)			Diameter of flower head (cm)			Shelf life of flower (days)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Bio-fertilizers (M)												
M_1 – With bio-fertilizers	104.31	111.70	108.01	501.07	502.32	501.70	5.44	5.05	5.24	4.00	3.89	3.94
M_2 – Without bio-fertilizers	95.36	101.78	98.57	426.20	426.98	426.59	5.03	4.57	4.80	3.64	3.54	3.59
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	1.358	1.529	1.446	10.558	10.556	10.557	0.046	0.065	0.057	0.056	0.045	0.051
CD at 5%	8.266	9.305	5.679	64.244	64.232	41.452	0.282	0.398	0.222	0.342	0.274	0.199
Organic and inorganic fertilizers (S)												
S_1 - 100 % RDF	91.79	98.13	94.96	391.10	395.20	393.15	4.85	4.38	4.61	3.44	3.46	3.45
S_2 – 75 % RDF + 15 t ha^{-1} FYM	100.29	107.23	103.76	464.99	465.98	465.48	5.25	4.78	5.01	3.85	3.73	3.79
S_3 – 50 % RDF + 30 t ha^{-1} FYM	101.72	108.76	105.24	482.24	474.57	478.41	5.32	4.85	5.08	3.89	3.78	3.84
S_4 – 75 % RDF + 5 t ha^{-1} VC	101.26	108.26	104.76	473.43	469.54	471.49	5.28	4.83	5.06	3.89	3.76	3.82
S_5 – 50 % RDF + 10	106.01	113.35	109.68	520.39	543.68	532.03	5.52	5.37	5.45	4.07	3.94	4.00

t ha^{-1} VC												
S_6 – 75 % RDF + 1.5 t ha^{-1} NC	98.16	104.94	101.55	449.23	444.14	446.69	5.15	4.68	4.92	3.77	3.65	3.71
S_7 – 50 % RDF + 3 t ha^{-1} NC	99.62	106.51	103.07	464.05	459.44	461.75	5.27	4.76	5.01	3.82	3.70	3.76
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	0.960	1.024	0.405	7.967	10.894	3.896	0.064	0.107	0.036	0.045	0.044	0.018
CD at 5%	2.801	2.989	1.152	23.253	31.797	11.078	0.188	0.131	0.103	0.132	0.129	0.052
Interaction (M x S)												
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	NS	NS	NS	NS	NS	NS
SE (m) ±	1.357	1.448	0.810	11.266	15.406	7.792	0.091	0.152	0.072	0.064	0.063	0.036
CD at 5%	3.961	4.227	2.303	32.884	44.968	22.156	-	-	-	-	-	-

Table 6: Interaction effect of integrated nutrient management on yield and quality parameters of chrysanthemum flowers

Treatments	Number of flower heads plant^{-1}			Flower yield plant^{-1} (g)			Diameter of flower head (cm)			Shelf life of flower (days)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
M_1S_1- Biofertilizers + 100 % RDF	93.38	99.99	96.68	401.61	394.73	398.17	5.02	4.46	4.74	3.54	3.56	3.55
M_1S_2- Biofertilizers + 75% RDF + 15 t ha^{-1} FYM	105.17	112.62	108.89	503.39	505.87	504.63	5.46	5.03	5.24	4.03	3.91	3.97
M_1S_3- Biofertilizers + 50% RDF + 30 t ha^{-1} FYM	105.81	113.30	109.56	518.26	510.80	514.53	5.48	5.06	5.27	4.06	3.93	4.00
M_1S_4- Biofertilizers + 75% RDF + 5 t ha^{-1} VC	105.47	112.95	109.21	510.71	508.57	509.64	5.48	5.04	5.26	4.05	3.92	3.98
M_1S_5- Biofertilizers + 50% RDF + 10 t ha^{-1} VC	113.01	121.02	117.02	586.07	608.39	597.23	5.85	5.84	5.84	4.34	4.20	4.27
M_1S_6- Biofertilizers + 75% RDF + 1.5 t ha^{-1} NC	103.19	110.50	106.84	489.16	486.90	488.03	5.36	4.93	5.15	3.96	3.83	3.90
M_1S_7- Biofertilizers + 50% RDF + 3 t ha^{-1} NC	104.16	111.54	107.85	498.29	500.99	499.64	5.41	4.98	5.19	4.00	3.87	3.93
M_2S_1- 100 % RDF	90.19	96.27	93.23	380.58	395.67	388.12	4.68	4.30	4.49	3.33	3.35	3.34
M_2S_2- 75% RDF + 15 t ha^{-1} FYM	95.42	101.84	98.63	426.58	426.08	426.33	5.04	4.53	4.78	3.66	3.55	3.60
M_2S_3- 50% RDF + 30 t ha^{-1} FYM	97.64	104.21	100.92	446.22	438.35	442.28	5.15	4.65	4.90	3.73	3.63	3.68
M_2S_4- 75% RDF + 5 t ha^{-1} VC	97.05	103.58	100.31	436.16	430.52	433.34	5.08	4.62	4.85	3.73	3.61	3.67
M_2S_5- 50% RDF + 10 t ha^{-1} VC	99.02	105.67	102.34	454.72	478.96	466.84	5.19	4.91	5.05	3.80	3.68	3.74
M_2S_6- 75% RDF + 1.5 t ha^{-1} NC	93.13	99.39	96.26	409.30	401.38	405.34	4.95	4.44	4.69	3.57	3.46	3.52
M_2S_7- 50% RDF + 3 t ha^{-1} NC	95.09	101.48	98.28	429.81	417.89	423.85	5.12	4.55	4.83	3.65	3.53	3.59
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	NS	NS	NS	NS	NS	NS
SE (m) ±	1.357	1.448	0.810	11.266	15.406	7.792	0.091	0.152	0.072	0.064	0.063	0.036
CD at 5%	3.961	4.227	2.303	32.884	44.968	22.156	-	-	-	-	-	-

In case of yield parameters, during both the years i.e. 2014-15 and 2015-16, as well as in pooled data significantly maximum flower heads plant^{-1} (113.01, 121.02 and 117.02, respectively) and flower yield plant^{-1} (586.07, 608.39 and 597.23 g, respectively) were harvested with the treatment combination M_1S_5. Whereas significantly minimum flower heads plant^{-1} (90.19, 96.27 and 93.23, respectively) were harvested under the treatment combination M_2S_1. Whereas, in case of flower yield plant^{-1} were found to be minimum with the treatment combination M_2S_1 (380.58 and 388.12 g, respectively) during the year 2014-15 and in pooled data and the treatment combination M_1S_1 (394.73 g) during the year 2015-16. The increased in flower heads plant^{-1} and flower yield plant^{-1} might be due to the combined beneficial effect of biofertilizers along with 50% RDF and vermicompost. These results are in accordance with the findings of Jadhav *et al*. (2014) [8] in African marigold and Airadevi (2014) [2] in chrysanthemum.

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