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Yield and quality of chrysanthemum as influenced by integrated nutrient management

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Abstract
An elaborate study on 'yield and quality of chrysanthemum as influenced by integrated nutrient management' had been carried out during the two consecutive years i.e. 2016-17 and 2017-18 at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The yield attributes *viz.* yield plant^{-1} and ha^{-1} as well as number of flower head plant^{-1} and quality attributes *viz.* diameter of flower head, length of peduncle, longevity of intact flower, shelf life of flower and weight of flower were recorded maximum with the treatment comprising of application of 75% RDF + vermicompost @ 5 t ha^{-1}+ Azotobactor + PSB.

Keywords: Azotobactor, chrysanthemum, management, nutrient, PSB, quality, yield

Introduction
The crop and is also known as 'Queen of the East'. Chrysanthemum is most interesting group among the ornamental plants in the world and represents perhaps the oldest ornamental flower; botanically known as *Dendranthema grandiflora* Tzvelev and is belongs to family Asteraceae. Conventional, chemical based farming is not sustainable because of many problems such as loss of soil productivity from excessive erosion and associated plant nutrient loss, surface and ground water pollution from fertilizers and sediment, impeding shortages of non-renewable resources and low farm income from high production costs. The main components of NMS is to maintain or enhance soil productivity through a balanced use of fertilizers combined with organic and biological sources of plant nutrients which is known to improve physicochemical and biological properties of soil. Hence, an attempt was made to reduce the amount of nitrogenous, phosphatic and potassic fertilizers by substituting with organic manures and biofertilizers.

Materials and Methods
The present investigation was carried out at Floriculture Unit, Department of Horticulture, Dr. PDKV., Akola during August, 2016 to February, 2017 and August, 2017 to February, 2018. Akola is situated in sub tropical region between 220 42' N latitude and 770 02' N longitudes. The altitude of place is 307.42 m above mean sea level. The climate of Akola is semi arid and characterized by three distinct season *viz*., hot and dry summer from March to May, warm and humid rainy season from June to October and mild cold winter from November to February. Average annual precipitation is 847.30 mm.

The plantation raised on healthy, light to medium black soil. In order to understand the chemical properties of soil, a representative soil sample was collected from orchard by using appropriate soil sampling techniques. Chemical analysis was carried out in Analytical Laboratories, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The investigation was conducted in randomized block design with thirteen treatments *viz.* T_1 - 100% RDF (300:200:200 kg NPK ha-1), T_2 - 20 t Vermicompost, T_3 - 20 t Vermicompost + Azotobacter + PSB, T_4 - 60 t FYM, T_5 - 60 t FYM + Azotobacter + PSB, T_6 - 75% RDF + 5 t vermicompost, T_7 - 75% RDF + 5 t vermicompost + Azotobacter + PSB, T_8 - 50% RDF + 10 t vermicompost, T_9 - 50% RDF + 10 t vermicompost + Azotobacter + PSB, T_{10} - 75% RDF + 15 t FYM, T_{11} - 75% RDF + 15 t FYM + Azotobacter + PSB, T_{12} - 50% RDF + 30 t FYM and T_{13} - 50% RDF + 30 t FYM + Azotobacter + PSB) which were replicated thrice. The allotment of treatments to the various plots were done randomly in each replication.

One month old well rooted uniform sized cutting were transplanted in field after treating with humic acid solution, at a spacing of 45 cm x 45 cm on flat bed. Light irrigation was given immediately after transplanting.

FYM and vermicompost were added at the time of land preparation whereas, biofertilizers (Azotobacter + PSB) were applied by thoroughly mixing with organic manures before transplanting as per treatments. Fertilizer dose of nitrogen, phosphorus and potassium were applied in the form of urea, single super phosphate and muriate of potash, respectively. Half dose of nitrogen and full dose of phosphorus and potassium fertilizers were applied one week after planting as per the treatments. Whereas, remaining half dose of nitrogen was given one month after transplanting as per the treatments, respectively. Various intercultural operations such as Irrigation, weeding, loosening of soil, earthing up, staking, pinching and plant protection were performed as and when required.

The statistical analysis was performed as per the method suggested by Panse and Sukhatme (1995) [10].

Results and Discussion

Yield Attributes

The data in respect of yield as influenced by different treatments of nutrient management was found to be significant (Table 1)

The treatment T_7 recorded maximum number of flower heads plant^{-1} (149.00, 158.26 and 153.63, respectively), flower yield plant^{-1} (687.39, 789.87 and 738.63 g, respectively) and flower yield ha^{-1} (33.94, 39.00 and 36.47 t, respectively) during the years 2016-17 and 2017-18 as well as in pooled data. Whereas, significantly minimum number of flower heads plant^{-1} (90.06 and 94.43, respectively) were noted under the treatment T_2 during the year 2016-17 and in pooled data. However it was recorded minimum during the year 2017-18 with the treatment T_4 (98.40). In case of minimum flower yield plant-1 (281.74 and 306.50g, respectively) yield ha-1 (13.91 and 15.13t, respectively) was recorded with the treatment T4 during the year 2016-17 as well as in pooled data, however during the year 2017-18 it was recorded with the treatment T2 (328.72g and 16.23t, respectively).

This might be due to the application of vermicompost and biofertizers along with chemical fertilizers in favoured to synthesize of amino acid act as precursor of polyamine and secondary messenger in flower initiation and development of more number of flowers per plant. Synthesis of this amino acid is also influenced by phytoharmone which are formed in plant due to the application of chemical and biofertilizers. In combination of vermicompost, biofertilizer with chemical fertilizers increased the soil microorganism, promotes the microbial population, support to better aeration to plant root, increases the availability of macro and micronutrients and thereby uptake by the plants resulting better number of flowers per plant. Similar findings were registered by Moghadam and Shoor (2013) [8], Palagani *et al.* (2013) [9], Bohra and Kumar (2014) [2] and Patanwar *et al.* (2014) [11] in chrysanthemum, Singh *et al.* (2015) [12] in marigold, Mahadik *et al.* (2017)[a] [6] and Mahadik *et al.* (2017)[b] [7] in chrysanthemum

Table 1: Effect of nutrient management on flower yield in chrysanthemum

Treatments	Number of flower heads plant^{-1}			Flower yield plant $^{-1}$ (g)			Flower yield ha $^{-1}$ (t)		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1 - 100% RDF	124.13	125.60	124.86	518.92	579.10	549.01	25.62	28.59	27.10
T_2 - 20 t VC	90.06	98.80	94.43	297.12	328.72	312.92	14.67	16.23	15.44
T_3 - 20 t VC + Azo + PSB	95.73	101.53	98.63	313.28	347.45	330.37	15.47	17.15	16.31
T_4 - 60 t FYM	92.53	98.40	95.46	281.74	331.27	306.50	13.91	16.35	15.13
T_5 - 60 t FYM + Azo + PSB	94.80	99.86	97.33	310.23	348.74	329.49	15.32	17.22	16.26
T_6 - 75% RDF + 5 t VC	110.23	117.73	113.98	454.86	497.40	476.13	22.46	24.56	23.50
T_7 -75% RDF + 5 t VC + Azo + PSB	149.00	158.26	153.63	687.39	789.87	738.63	33.94	39.00	36.47
T_8 -50% RDF + 10 t VC	100.93	115.53	108.23	359.57	424.48	392.02	17.75	20.96	19.35
T_9 - 50% RDF + 10 t VC + Azo + PSB	118.40	130.80	124.53	521.39	592.88	557.08	25.74	29.27	27.50
T_{10} - 75% RDF + 15 t FYM	106.20	114.86	110.53	433.27	479.01	456.14	21.39	23.65	22.52
T_{11} - 75% RDF + 15 t FYM + Azo + PSB	135.80	141.13	138.46	605.76	689.45	647.61	29.91	34.04	31.97
T_{12} - 50% RDF + 30 t FYM	104.80	103.13	103.96	351.70	365.33	358.51	17.36	18.04	17.64
T_{13} - 50% RDF + 30 t FYM + Azo + PSB	116.60	127.86	122.30	487.68	542.02	514.85	24.08	26.76	25.42
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) +	3.754	4.458	3.349	22.230	37.019	22.496	1.097	1.828	1.112
CD at 5%	10.952	13.006	9.772	64.858	108.005	65.632	3.202	5.333	3.244

Flower quality attributes

The data in respect of flower quality as influenced by different treatments of nutrient management was found to be significant (Table 2a & 2b)

The treatment T_7 recorded significantly maximum diameter of flower head (6.20, 6.53 and 6.36 cm, respectively), length of peduncle (11.18, 11.81 and 11.49 cm, respectively), longevity of intact flower (12.86, 13.78 and 13.32 days, respectively) and shelf life of flower (4.66, 4.80 and 4.73 days, respectively) during the years 2016-17and 2017-18 as well as in pooled data. Whereas, significantly minimum diameter of flower head (4.26, 4.66 and 4.46 cm, respectively) and length of peduncle (4.89, 5.32 and 5.11 cm, respectively) longevity of intact flower (9.46, 9.86 and 9.66 days, respectively) shelf life of flower (2.53, 2.66 and 2.60 days, respectively) was noted under the treatment T_4.

This may be due to Azotobacter which provides more amounts of nitrogen by fixing it through atmosphere. Similarly, PSB helped in increasing phosphorus availability by releasing enzymes. Phosphate in soil which helps the plants in healthy growing condition resulting into the production of flower having more diameter. Also, vermicompost rich in humic acid which containcytokinin and auxin that might have increased the flower diameter. Similar results were also found by Airadevi (2012) [1] and Palagani *et al.* (2013) [9], Bohra and Kumar (2014) [2] in chrysanthemum, Dalawai and Naik (2014) [3] in carnation, Mahadik *et al*. 2017[a] [5] and Mahadik *et al.* 2017[b] [6] in chrysanthemum.

The treatment T_7 recorded significantly maximum weight of flower (4.61, 4.99 and 4.80 g) during the year 2016-17, 2017-18 and in pooled data. Whereas, significantly minimum weight of flower (3.05 and 3.21 g) was noted under the treatment T_4 during the year 2016-17 and in pooled data. However it was recorded minimum with treatment T_2 (3.32 g). The increase in flower quality attributes with application of vermicompost along with chemical fertilizers could be due to the increased photosynthetic activity which, in turn, might have favoured an increased accumulation of dry matter and also efficient partitioning of photosynthates towards the sink. It might be attributed to the nature of interaction of physiological and growth parameters by way of increased dry matter production. *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 flower weight. Similar results were observed by Kumar *et al*. (2013) [4] and Mittal *et al.* (2010) [7] in Marigold and Mahadik *et al.* 2017b [6].

Table 2(a): Effect of nutrient management on flower quality attributes in chrysanthemum

Treatments	Diameter of flower head (cm)			Length of peduncle (cm)			Diameter of peduncle (mm)		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1 - 100% RDF	5.50	5.78	5.64	9.18	9.51	9.34	1.81	2.14	1.97
T_2 - 20 t VC	4.65	4.88	4.77	5.21	5.76	5.49	1.90	1.99	1.95
T_3 - 20 t VC + Azo + PSB	4.82	5.12	4.97	5.51	5.91	5.71	1.91	1.98	1.95
T_4 - 60 t FYM	4.26	4.66	4.46	4.89	5.32	5.11	1.52	1.61	1.56
T_5 - 60 t FYM + Azo + PSB	4.74	5.04	4.89	5.12	5.62	5.37	1.83	1.99	1.92
T_6 - 75% RDF + 5 t VC	5.10	5.40	5.25	8.02	8.35	8.18	1.90	2.00	1.95
T_7 -75% RDF + 5 t VC + Azo + PSB	6.20	6.53	6.36	11.18	11.81	11.49	2.12	2.19	2.15
T_8 -50% RDF + 10 t VC	4.89	5.29	5.09	6.05	6.28	6.17	1.98	2.01	1.99
T_9 - 50% RDF + 10 t VC + Azo + PSB	5.36	6.13	5.75	6.46	7.09	6.77	2.07	2.15	2.11
T_{10} - 75% RDF + 15 t FYM	5.02	5.45	5.57	6.88	7.22	7.05	1.91	1.99	1.95
T_{11} - 75% RDF + 15 t FYM + Azo + PSB	6.07	6.40	6.24	9.70	10.04	9.87	2.05	1.95	2.00
T_{12} - 50% RDF + 30 t FYM	4.77	5.22	4.99	5.74	6.08	5.91	1.95	2.01	1.98
T_{13} - 50% RDF + 30 t FYM + Azo + PSB	5.24	5.52	5.38	6.23	6.92	6.58	2.09	2.15	2.12
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	NS	NS	NS
SE (m) +	0.233	0.260	0.187	0.327	0.319	0.250	0.165	0.171	0.166
CD at 5%	0.680	0.761	0.546	0.955	0.932	0.731	-	-	-

Table 2(b): Effect of nutrient management on flower quality attributes in chrysanthemum

Treatments	Weight of flower (g)			Longevity of intact flower (days)			Shelf life of flower (days)		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1 - 100% RDF	4.16	4.61	4.39	12.46	12.20	12.33	4.20	3.93	4.06
T_2 - 20 t VC	3.29	3.32	3.30	9.80	10.13	9.96	3.20	3.33	3.26
T_3 - 20 t VC + Azo + PSB	3.27	3.42	3.34	9.93	11.00	10.46	3.26	3.46	3.36
T_4 - 60 t FYM	3.05	3.36	3.21	9.46	9.86	9.66	2.53	2.66	2.60
T_5 - 60 t FYM + Azo + PSB	3.17	3.49	3.38	9.60	10.53	10.06	3.13	3.20	3.16
T_6 - 75% RDF + 5 t VC	4.12	4.22	4.17	11.26	12.13	11.70	3.86	4.13	4.00
T_7 -75% RDF + 5 t VC + Azo + PSB	4.61	4.99	4.80	12.86	13.78	13.32	4.66	4.80	4.73
T_8 -50% RDF + 10 t VC	3.56	3.67	3.62	10.06	11.49	10.78	3.46	3.60	3.53
T_9 - 50% RDF + 10 t VC + Azo + PSB	4.40	4.53	4.46	11.50	13.06	12.28	3.66	4.17	3.92
T_{10} - 75% RDF + 15 t FYM	4.07	4.20	4.14	10.33	11.93	11.13	3.73	3.86	3.80
T_{11} - 75% RDF + 15 t FYM + Azo + PSB	4.46	4.87	4.66	12.60	13.40	13.00	3.90	4.33	4.11
T_{12} - 50% RDF + 30 t FYM	3.35	3.54	3.44	9.97	11.13	10.55	3.40	3.53	3.46
T_{13} - 50% RDF + 30 t FYM + Azo + PSB	4.19	4.23	4.21	11.40	12.44	11.92	3.60	4.00	3.80
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) +	0.127	0.241	0.147	0.452	0.455	0.345	0.242	0.226	0.168
CD at 5%	0.372	0.705	0.431	1.321	1.329	1.009	0.706	0.661	0.491

Diameter of peduncle (mm)

The data presented in Table 8 in respect of diameter of peduncle (mm) of chrysanthemum flower was found statistically non-significant during both years of experimentation i.e. in the year 2016-17 and 2017-18 and also in pooled data.

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