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Influence of integrated plant nutrition on growth and flower yield of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. IIHR-6 under Saurashtra condition

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ABSTRACT : The experiment entitled effect of integrated nutrient management on growth and flower yield of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. IIHR-6 was carried out in polyhouse at Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh during 2011-12. The experiment was laid out in a Completely Randomized Design (CRD) with three repetitions and ten treatment combinations comprising of inorganic fertilizers, organic manures and bio fertilizers. The treatment receiving 75 per cent N + 75 per cent P + 100 per cent K + VC@1.25t/ha + CC@0.875t/ha + *Azotobacter* @2kg/ha + PSB@2kg/ha recorded the highest plant height, plant spread (NS, EW), number of branches, number of suckers, fresh weight and dry weight accumulation; flowering parameters like early flower bud initiation, first flower opening, 50 per cent flowering and longest flowering duration; yield attributes such as number of flowers per plant, flower weight per plant, and flower yield per ha, quality parameters like stalk length, shelf life of loose flowers, vase life of cut flowers and *in situ* longevity. Flower diameter was found maximum with the treatment 100 per cent N + 75 per cent P + 100 per cent K + PSB @2kg/ha.

KEY WORDS : Chrysanthemum, Polyhouse, Bio fertilizer, Growth, Quality, Yield

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Chrysanthemum (*Chrysanthemum morifolium* Ramat.), which occupies a prominent place in ornamental horticulture, is one of the commercially exploited flower crops belongs to the family 'Asteraceae' and is known as "queen of east". In many countries, including the United States and Japan, it is considered as the number one crop. While in other countries, it ranks next to rose in value of the crop produced. The plant grows erect and tall making it suitable for border planting, loose flower, or as cut flowers. It is also grown in pots for flower shows. The utility and popularity of the chrysanthemum have increased greatly with the technique of year-round blooming habit based on the research in the field of photoperiodism and genetics.

Though the chrysanthemum is one of the important commercial flower crops of India, its yield levels are low and hence, there is a need to standardize the optimum dose of nutrients particularly the integrated nutrient management for improving the soil structure, physico-chemical properties and flower yield. Chrysanthemum is a heavy feeder of nutrients specially nitrogen and phosphorus (Nalawadi, 1982). At present, these nutrients are supplied through chemical fertilizers. The indiscriminate and continuous use of chemical fertilizers has led to an imbalance of nutrient in soil which has adversely affected the soil health, affecting the yield and quality of the produce. Therefore, the integrated use of nutrient is the need of hour. The use of organic manures and bio fertilizers along the balance use of chemical fertilizers is known to improve physico-chemical and biological properties of soil, besides improving the

efficiency of applied fertilizers.

RESEARCH METHODS

The experiment was carried out in polyhouse at Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh during the year 2011-12. The experiment was laid out in a Completely Randomized Design with three repetitions and ten treatments comprising of combination of organic manures, bio fertilizers and chemical fertilizers mentioned as under.

T_1- RDF, T_2-75 per cent N + 100 per cent P +100 per cent K + VC @2.5 t/ha, T_3-75 per cent N + 100 per cent P + 100 per cent K + CC @1.75t/ha, T_4-75 per cent N + 100 per cent P + 100 per cent K + *Azotobacter* @2kg/ha, T_5-100 per cent N + 75 per cent P + 100 per cent K + PSB @2kg/ha, T_6-75 per cent N + 75 per cent P + 100 per cent K + VC@2.5t/ha + PSB@2kg/ha, T_7-75 per cent N + 75 per cent P + 100 per cent K + CC@1.75t/ha + PSB@2kg/ha, T_8-75 per cent N + 75 per cent P +100 per cent K + *Azotobacter* @2kg/ha + PSB@2kg/ha, T_9-75 per cent N + 100 per cent P + 100 per cent K + VC@1.25t/ha + CC@0.875t/ha + *Azotobacter* @2kg/ha, T_{10}-75 per cent N + 75 per cent P + 100 per cent K + VC@1.25t/ha + CC@0.875t/ha +*Azotobacter* @2kg/ha + PSB@2kg/ha. The organic manures like vermicompost and castor cake were applied 7 days prior to transplanting for proper decomposition. Whereas, the bio fertilizers were applied as seedling drench at the time of transplanting. A slurry of 200 g of lignite based culture of *Azotobacter* and PSB were prepared 10 l of water separately and drenched the soil. Nitrogen, phosphorus and potassium were applied in the form of urea, DAP and muriate of potash, respectively, before transplanting, half of the dose of nitrogen and full dose of phosphorus and potassium were applied in circular band of about 3-4 cm around each plant. The remaining half dose of nitrogen was given as a top dress at 45 days after transplanting.

The data on vegetative parameters *viz.*, plant height (cm), number of primary branches per plant, plant spread (cm), number of suckers per plant, fresh weight of plant (g), dry weight of plant (g) and the flowering parameters like days taken to first bud initiation, first flower open, no. of days taken for 50 per cent flowering, flowering duration, number of flowers per plant, flower yield per plant (g), flower yield per ha (q ha^{-1}). Quality parameters *viz.*, shelf life of flower (days), vase life of flower (days), *in situ* longevity (days), stalk length (cm) and diameter of flower (cm) were recorded at respective stages of growth and their mean data and their analysis of variance have been furnished with the levels of significance.

RESEARCH FINDINGS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarised under following heads:

Growth characters:

Among different treatment combinations T_{10} had positive influence on the vegetative growth parameters (Table 1). The treatment T_{10} (75%N + 75%P + 100%K + VC@1.25t/ha + CC @0.875t/ha + *Azotobacter* @2kg/ha + PSB@2kg/ha) recorded maximum plant height among all other treatments tried. The increase in the plant height in the treatment T_{10} might be due to the beneficial effect of vermicompost and bio fertilizers in combination with recommended dose of inorganic fertilizers. This increase in plant height might be due to macronutrients supplied through optimum dose of inorganic fertilizers, availability of micronutrients from vermicompost and production of growth promoting substances from *Azotobacter* and PSB application. Similar findings were reported by Ajit Kumar

Table 1: Growth parameters of chrysanthemum cv. IIHR-6 as influenced by INM

Treatments	Plant height(cm)	Plant spread(cm)		Number of branches/plant	Number of suckers/plant	Fresh weight (g/plant)	Dry weight (g/plant)
		NS	EW				
T_1	68.33	33.46	28.73	19.00	16.20	294.26	32.59
T_2	73.00	30.66	26.46	21.66	18.13	244.93	31.67
T_3	74.73	27.86	25.33	16.00	11.00	235.06	27.05
T_4	70.06	32.26	27.40	22.33	13.86	266.80	32.60
T_5	70.00	32.46	25.26	20.33	10.00	246.86	30.53
T_6	73.13	32.20	29.73	23.33	15.66	253.46	32.97
T_7	73.46	26.33	24.33	17.33	15.13	227.53	25.90
T_8	75.93	33.30	29.66	26.66	18.80	283.53	33.02
T_9	76.46	35.66	29.20	29.00	19.00	303.93	35.42
T_{10}	78.00	38.20	30.86	32.66	22.86	318.86	37.27
S.E. $\pm$	1.50	1.0	1.0	0.55	0.74	6.16	0.40
C.D. (P=0.05)	4.44	3.02	2.95	1.64	2.20	18.17	1.19
CV%	3.56	5.51	6.27	4.23	8.04	3.99	2.2

(2002) in marigold and Chaitra and Patil (2007) in China aster. The same treatment resulted in marked increase in plant spread. The branches are the skeletal structure of the plant and these were significantly influenced by T_{10}. This could be attributed to better flow of various micro and macro nutrients along plant growth substances into the plant system when applied with vermicompost and biofertilizers in combination with inorganic fertilizers. The growth regulators like NAA and cytokinins released by *Azotobacter* and PSB might have resulted in breaking of apical dominance and accelerated higher number of branches. The increased nitrogen nutrition may also have accelerated the process of cell division and differentiation. The above results are in agreement with the findings of Ajit Kumar (2002) in marigold and Sunitha *et al.* (2007) in African marigold. Significantly highest number of suckers, highest total fresh and dry weight (22.86, 318.86 and 37.27 g/plant, respectively) was recorded in T_{10} (75%N + 75%P +100%K + VC@1.25t/ha + CC@0.875t/ha + *Azotobacter* @2kg/ha + PSB @ 2kg/ha) among to other treatments tried. The treatments clearly showed the beneficial effects of *Azotobacter*, PSB and vermicompost. This increase in dry weight may be ascribed due to effects of plant growth regulators, high rate of photosynthates from vegetative parts to the reproductive parts which subsequently might have resulted in higher fresh weight and dry matter accumulation. These findings are in line with the results reported in marigold (Kumar *et al.*, 2006), chrysanthemum (Chandra *et al.*, 2007), and China aster (Chaitra and Patil, 2007).

Flowering characters:

The plants receiving 75 per cent N + 75 per cent P + 100 per cent K + VC @ 1.25 t/ha + CC@0.875t/ha + *Azotobacter* @2kg/ha + PSB@2kg/ha in combination had taken significantly less number of days for bud initiation (52.73 days), flower opening (72.66 days), 50 per cent flowering (91.32 days) and more flowering duration (54.93 days) among other treatment combinations (Table 2). The

Table 2: Flowering parameters of chrysanthemum cv. IIHR-6 as influenced by INM

Treatments	Days to flower bud initiation	Days to first flower open	Days to 50% flowering	Flowering duration (days)
T_1	60.80	75.66	96.70	50.80
T_2	69.46	82.58	101.20	48.80
T_3	61.40	78.65	106.38	45.53
T_4	65.93	81.79	99.83	45.00
T_5	55.73	72.70	92.37	50.66
T_6	61.00	81.83	100.58	47.06
T_7	72.33	84.89	105.05	43.53
T_8	59.40	75.48	95.90	51.00
T_9	56.00	74.75	94.60	53.86
T_{10}	52.73	72.66	91.32	54.93
S.E. $\pm$	1.49	0.20	0.53	0.74
C.D. (P=0.05)	4.41	0.6	1.56	2.19
CV%	4.21	0.45	0.93	2.63

Table 3: Yield of chrysanthemum cv. IIHR-6 as influenced by INM

Treatments	Number of flowers per plant	Yield per plant (g)	Yield per ha (t)
T_1	58.16	80.92	8.37
T_2	59.23	83.63	10.87
T_3	57.54	86.70	7.40
T_4	57.73	112.33	9.59
T_5	63.33	127.26	10.08
T_6	70.53	105.33	9.07
T_7	47.44	83.48	6.95
T_8	68.03	131.83	10.34
T_9	71.06	136.60	11.70
T_{10}	71.47	152.33	13.50
S.E. $\pm$	0.48	1.54	0.14
C.D. (P=0.05)	1.42	4.55	0..42
CV%	1.34	2.43	2.64

Table 4: Quality parameters of chrysanthemum cv. IIHR-6 as influenced by INM

Treatments	Shelf life (days)	Vase life (days)	*In situ* longevity (days)	Stalk length (cm)	Diameter (cm)
T_1	3.00	4.66	6.06	12.38	2.82
T_2	3.00	5.33	7.33	12.17	2.43
T_3	2.33	4.66	7.40	11.47	2.10
T_4	2.66	5.33	7.80	11.33	2.23
T_5	4.00	8.66	11.86	13.12	3.43
T_6	3.00	5.33	6.46	11.26	2.95
T_7	2.00	3.33	5.73	10.78	2.09
T_8	4.00	8.33	10.20	11.92	2.56
T_9	4.00	8.66	10.26	14.01	3.28
T_{10}	5.00	9.33	12.20	14.56	3.42
S.E. $\pm$	0.14	0.33	0.28	0.42	0.12
C.D. (P=0.05)	0.43	0.98	0.83	1.24	0.38
CV%	7.82	9.07	5.74	5.93	8.17

earliness of flowering may be attributed to the presence of biofertilizers especially inoculation with *Azotobacter* and PSB which consequently lead to flower initiation and more flower duration. This may be ascribed to easy uptake of nutrients and simultaneous transport of growth promoting substances like cytokinins to the axillary buds resulting in breakage of apical dominance. Ultimately, they resulted in better sink for faster mobilization of photosynthates and early transformation of plant parts from vegetative to reproductive phase. This might be due to combine application of inorganic fertilizer, organic fertilizer and bio fertilizer. The beneficial effect of combined application of castor cake and inorganic fertilizer was possible as because the castor oil cake not only supply the NPK but also contained micronutrients and amino acid. Castor oil cake contains some percentage of oil, which prevents rapid conversion of organic nitrogen into available form. It also protects the plant from nematodes and trace elements (Purohit and Gehlot, 2006). These results are similar to the findings of Padaganur *et al.* (2005) in tuberose.

Yield characters:

Significantly highest number of flowers per plant (71.47) were recorded in T_{10}, similarly, highest yield per plant (152.33 g) and yield per hectare (13.50 tonnes) were also recorded in T_{10} (75%N + 75%P + 100%K + VC@1.25t/ha + CC@0.875t/ha + *Azotobacter* @2kg/ha + PSB@2kg/ha) followed by T_9 (75%N + 100%P + 100%K + VC@1.25t/ha + CC@0.875t/ha + *Azotobacter* @2kg/ha) over remaining treatments (Table 3). The increase in number of flowers may be due to possible role of *Azotobacter* through atmospheric nitrogen fixation, better root proliferation, uptake of nutrients and water, higher leaf number and branches. More photosynthesis enhanced food accumulation which might have resulted in better plant growth and subsequently higher number of flowers per plant and hence, more flower yield per ha. Beside this, increase in flower yield may be attributed to increased availability of phosphorus and its greater uptake. Vermicompost being the source of macro and micro nutrients like Fe and Zn, enzymes, growth hormones and presence of micro flora might have played a secondary role in increasing the flower yield.

Quality characters:

The maximum vase life (9.33 days) was recorded in T_{10} (75%N + 100%P +100%K + VC@1.25t/ha + CC@0.875t/ha + *Azotobacter* @2kg/ha + PSB@2kg/ha) (Table 4). This can be ascribed to the development of water conducting tissues facilitated by bio fertilizers. Similar beneficial effects of bio fertilizers and vermicompost on vase life have been also reported by Mogal *et al.* (2006) in China aster and Parmar (2006) in rose. There was a significant difference in shelf life of loose flowers as influenced by different treatments. The maximum shelf life of loose flowers and *in situ* longevity of flowers were also recorded in the same treatment. The extension in shelf life and *in situ* longevity of flowers may be due to bio fertilizers application. Similar beneficial effect of biofertilizers and vermicompost has been reported in chrysanthemum (Verma *et al.*, 2011).

The maximum diameter was observed in plants treated with 100 per cent N + 75 per cent P + 100 per cent K + PSB @2kg/ha (T_5), followed by 75 per cent N + 75 per cent P + 100 per cent K + VC@1.25t/ha + CC@0.875t/ha + *Azotobacter* @2kg/ha + PSB@2kg/ha (T_{10}) among other treatments. Plants which receive 75 per cent N + 75 per cent P + 100 per cent K + VC @1.25 t/ha + CC@ 0.875t/ha + *Azotobacter* @2kg/ha + PSB@2kg/ha (T_{10}) gave maximum length of stalk (14.56 cm). 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 plant in healthy growing condition resulting into

the production of flower having more diameter and stalk length. The positive effect of vermicompost on flower diameter has been reported in marigold by Mashaldi (2000).

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