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RESEARCH ARTICLE

GROWTH CHARACTERS OF MARIGOLD (*TAGETES ERECTA* L.) AS INFLUENCED BY INTEGRATED NUTRIENT MANAGEMENT

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ABSTRACT

The present investigation on periodical observations (30, 60 and 90 DAT) on vegetative growth AT c.s. Azad University of Agriculture and Technology, Kanpur during two consecutive years. The results displayed that all the growth parameters increased to the maximum up to the 75 % nitrogen level with or without biofertilizers. However, maximum plant height was attained with 100% N with or without any combination of biofertilizers. During the second year, effect of biofertilizers was more prominent and promising. As regard the flowering characters there was a significant reduction in days taken to first flower bud initiation and days taken to first flower bud opening under the combined application of bio fertilizers (*Azotobacter* + PSB) along with 75 % nitrogen in both the experimental years.

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INTRODUCTION

Marigold *(Tagetes erecta* L.), the most popular and commercial flower, apart from their aesthetic and industrial values, marigold is also equally important from the medicinal point of view, its leaf extract is a good remedy for earache, while its flower extract is considered as blood purifier, a cure for bleeding piles, eye disease, ulcers, wounds etc. (Arora, 1989). Marigold oil has a pronounced odour and acts as a repellent to flies. Marigold has got a wide range of application such as a trap crop and as a biopesticide in various horticultural and field crops. The main period for growing marigold in plains during winter season is from August to January. It is also grown in other seasons, like winter (November–April), summer (February-July) and rainy (May-October). As a result of continuous use of chemical fertilizers, the soil gets depleted year by year and there is pollution of soil and water bodies through leaching, volatilization, dentrification and fixation of phosphorous in soil. Nitrogen being highly mobile in soil can pollute soil and ground water, therefore, management of nitrogenous fertilizer such as rate, type of nitrogen fertilizer, application time is very important. Combination of *Azotobacter* + PSB + Phytoincremin with 75% N was found most effective in increasing the flower yield of marigold (Gupta *et al.,* 1999). However, the detailed scientific information regarding up to what extent nitrogenous fertilizers can be reduced with the use of different bio-inoculants is not available. Thus, keeping in view the above facts, this experiment was undertaken.

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MATERIALS AND METHODS

The present investigation was carried out on African marigold cv. "Pusa Narangi" in the Garden of the Department of Horticulture, Chandra Shekhar Azad university of Agriculture and Technology, Kanpur, U.P., during the winter season of two consecutive years i.e. 2008-09 and 2009-10. The experiment was carried out in sandy loam, well drained soil, having average fertility conditions. The soil samples were collected during October, November, January and February with the help of soil auger from different places of the experimental field at 0-15 cm depth, and were mixed together, air dried and were finally made into powder after proper grinding. The population of various types of the soil micro-organisms was enumerated by dilution planting method. A well rotten FYM @ 250 q $ha^{-1}$was incorporated and mixed well in experimental plots, two weeks before the transplanting. Full dose of phosphorus and potassium was applied as basal dose in soil at the time of transplanting, with all the graded nitrogen treatments except control and AZB + PSB alone.

Nitrogen was applied in two split doses first half (100 kg) at the time of transplanting and rest half (100kg) after 30 days of transplanting as top dressing. The bio-fertilizers namely *Azotobacter* and Phosphate Solublizing Bacteria (PSB) were used. The irrigations were given as and when required. The data recorded were analyzed as per method described by Fisher (1937).

RESULTS AND DISCUSSION

It may be observed that height was observed more under the influenced of N + AZB while branching and other growth attributes were better affected by N + PSB. The maximum plant height (26.47, 27.51 cm at 30 DAT, 61.85, 63.38 cm at 60 DAT and 73.32, 74.89 at 90 DAT) was observed with T_4 treatment followed by T_2 (25.98, 26.97 cm at 30 DAT, 61.48, 63.00 cm at 60 DAT and 72.91, 74.46 cm at 90 DAT), The minimum plant height was recorded with T_{14} (control) in both the respective years i.e. 2008-09 and 2009-10.

The highest number of primary branches was observed in treatment T_8 (13.26, 15.28 at 30 DAT, 17.53, 18.60 at 60 DAT and 18.46, 19.80 at 90 DAT), followed by T_4. The number of primary branches was found to be minimum with T_{14} (control) in both the respective years i.e. 2008-09 Similar effects on height and branching were also reported by Dhami (2008) in marigold. Thus, an increase in the growth parameters may be due to the stimulating and beneficial effects of biofertilizers in solubilizing and utilization of nutrients and biosynthesis of plant growth regulators like IAA, GA and cytokinins as well as vitamins and organic acids. The highest increase in respective fresh and dry weight of plant was found in treatment T_8 (276.34, 76.44 g and 286.55, 78.31 g) during both the years, followed by T_4 (271.04, 74.97 g and 282.32, 77.15 g) and T_7 respectively. The lowest fresh and dry weight (204.15, 57.15 g and 211.82, 57.18 g) was found in control during the Ist and IInd year, respectively. The longest duration of flowering was observed with T_8 (74.13 and 76.00 days) followed by T_7 and T_4 in 2008-09 and 2009-10, respectively against the minimum duration of flowering of 58.27 and 60.13 days in control (Table 4).

Table 1. Effect of integrated nutrient management on plant height (cm) of African marigold

S. No.	Treatment		Plant height (cm)					
			2008-09			2009-10		
			30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
1.	T_1	100% N	24.55	60.32	72.07	25.27	62.14	73.55
2.	T_2	100% N + *Azotobacter*	25.98	61.48	72.91	26.97	63.00	74.46
3.	T_3	100% N + PSB	25.02	60.92	72.26	25.90	62.77	73.95
4.	T_4	100% N + *Azotobacter* + PSB	26.47	61.85	73.32	27.51	63.38	74.89
5.	T_5	75% N	21.20	56.53	68.32	22.10	57.56	69.35
6.	T_6	75% N + *Azotobacter*	22.26	57.16	69.21	23.26	58.48	70.16
7.	T_7	75% N + PSB	21.88	56.71	68.78	22.78	57.73	69.71
8.	T_8	75% N + *Azotobacter* + PSB	22.97	57.54	69.45	23.84	59.12	70.48
9.	T_9	50% N	19.10	45.57	59.37	19.69	47.33	61.03
10.	T_{10}	50% N + *Azotobacter*	20.10	47.53	60.16	20.74	48.27	61.81
11.	T_{11}	50% N + PSB	19.85	47.06	59.77	20.28	47.88	61.37
12.	T_{12}	50% N + *Azotobacter* + PSB	20.76	48.00	60.58	21.32	48.73	62.18
13.	T_{13}	*Azotobacter* + PSB alone	18.56	39.71	56.77	19.14	41.09	57.23
14.	T_{14}	Control	17.81	36.39	55.26	18.40	38.87	56.21
	SE(d) ±		1.07	1.24	1.25	0.85	1.58	1.29
	CD 5%		2.21	2.55	2.58	1.35	3.26	2.66

Table 2. Effect of integrated nutrient management on number of primary branches in African marigold

S. No.	Treatment		Number of primary branches					
			2008-09			2009-10		
			30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
1.	T_1	100% N	9.53	14.00	16.26	9.93	15.00	16.66
2.	T_2	100% N + *Azotobacter*	10.46	14.86	16.80	11.60	15.86	17.26
3.	T_3	100% N + PSB	11.13	15.73	17.40	12.06	16.40	18.20
4.	T_4	100% N + *Azotobacter* + PSB	12.48	17.20	18.06	14.46	17.80	19.13
5.	T_5	75% N	10.00	15.80	16.46	10.28	15.40	17.13
6.	T_6	75% N + *Azotobacter*	11.06	15.93	17.20	11.88	16.06	18.06
7.	T_7	75% N + PSB	11.73	16.33	17.73	12.48	16.46	19.00
8.	T_8	75% N + *Azotobacter* + PSB	13.26	17.53	18.46	15.28	18.60	19.80
9.	T_9	50% N	6.73	10.40	13.20	6.88	11.73	14.33
10.	T_{10}	50% N + *Azotobacter*	7.80	1.1.93	14.20	7.93	13.00	15.26
11.	T_{11}	50% N + PSB	8.80	12.26	15.46	8.73	13.60	16.00
12.	T_{12}	50% N + *Azotobacter* + PSB	9.20	13.06	15.86	9.46	14.26	16.46
13.	T_{13}	*Azotobacter* + PSB alone	6.06	9.26	12.00	6.26	10.33	12.80
14.	T_{14}	Control	5.66	8.66	11.26	5.66	9.60	11.93
	SE(d) ±		1.07	0.93	1.71	0.84	0.86	0.62
	CD 5%		2.20	1.92	1.46	1.74	1.78	1.28

Table 3. Effect of integrated nutrient management on fresh and dry weight of plant (g) of African marigold

S. No.	Treatments		Fresh weight of plant (g)		Dry weight of plant (g)	
			2008-09	2009-10	2008-09	2009-10
1.	T_1	100% N	245.51	252.68	67.92	69.08
2.	T_2	100% N + *Azotobacter*	255.67	263.08	70.72	71.91
3.	T_3	100% N + PSB	263.22	273.48	73.15	74.74
4.	T_4	100% N + *Azotobacter* + PSB	271.04	282.32	74.97	77.15
5.	T_5	75% N	250.00	258.00	69.18	70.51
6.	T_6	75% N + *Azotobacter*	259.16	265.36	71.70	72.52
7.	T_7	75% N + PSB	267.27	276.61	73.93	75.55
8.	T_8	75% N + *Azotobacter* + PSB	276.34	286.55	76.44	78.31
9.	T_9	50% N	214.20	223.15	59.97	60.24
10.	T_{10}	50% N + *Azotobacter*	223.45	231.76	62.56	62.57
11.	T_{11}	50% N + PSB	232.57	240.10	65.11	64.79
12.	T_{12}	50% N + *Azotobacter* + PSB	240.10	249.23	67.22	67.25
13.	T_{13}	*Azotobacter* + PSB alone	211.76	219.50	59.28	59.29
14.	T_{14}	Control	204.15	211.82	57.15	57.18
	SE(d) ±		5.46	4.07	1.81	1.49
	CD 5%		11.23	8.37	3.74	3.07

Table 4: Effect of integrated nutrient management on duration of flowering (days) and average no. of flowers/plant in African marigold

S. No.	Treatment		Duration of flowering (days)		No. of flowers/Plant	
			2008-09	2009-10	2008-09	2009-10
1.	T_1	100% N	66.27	68.40	45.60	46.80
2.	T_2	100% N + *Azotobacter*	68.53	70.33	47.73	49.00
3.	T_3	100% N + PSB	71.40	73.13	50.46	51.73
4.	T_4	100% N + *Azotobacter* + PSB	72.26	74.20	52.00	53.26
5.	T_5	75% N	67.37	69.13	47.60	48.80
6.	T_6	75% N + *Azotobacter*	70.40	72.20	49.60	50.86
7.	T_7	75% N + PSB	73.33	75.07	51.40	52.66
8.	T_8	75% N + *Azotobacter* + PSB	74.13	76.00	53.66	54.86
9.	T_9	50% N	61.20	63.07	40.33	41.53
10.	T_{10}	50% N + *Azotobacter*	63.00	65.00	42.66	43.93
11.	T_{11}	50% N + PSB	65.06	67.00	44.20	45.46
12.	T_{12}	50% N + *Azotobacter* + PSB	66.13	68.00	45.26	46.53
13.	T_{13}	*Azotobacter* + PSB alone	60.00	62.06	36.40	37.66
14.	T_{14}	Control	58.27	60.13	34.80	36.06
	SE(d) ±		0.888	0.728	3.17	6.52
	CD 5%		1.627	1.497	3.54	7.28

Further, T_7, T_4 and T_3 significantly increased the duration of flowering as compared to that in control. The observations recorded on average number of flowers per plant have been given in Table 4. The maximum number of flower was noted in T_8 (53.66 and 54.86) followed by T_4 (52.00 and 53.26), T_7 and T_3. Further, it may be observed that T_4, T_7, T_3, T_6, T_2 and T_5 were found at par with T_8 during both the years. The minimum number of flowers (34.80 and 36.06) was found in T_{14} (control), while T_9 and T_{13} were found at par with control during 2008-09 and 2009-10, respectively as also reported by Yadav *et al.* (2004) in marigold and Joshi *et al.* (2008) in chrysanthemum. Early flowering so observed may be due to the synergistic effect of chemical fertilizer and biofertilizers (*Azotobacter* and PSB). The possibility of an increase in the synthesis of cytokinins in the root tissues and its simultaneous transport to auxiliary buds would have resulted in better sink for mobilization of photoassimilates at a rapid rate. This might have helped in the early transformation phase. Such results have also been corroborated by Kumar *et al.* (2006), in marigold. This might be due to favourable action of biofertilizers in soil, which compensated the requirement of chemical fertilizers upto certain extent. This might be explained in the light of the fact that due to favourable action of bioinoculants which provided nutrients in proportion and availability of growth promoting substances which helped to enhance growth attributes like plant height, number of primary branches, plant fresh and dry weight, duration of flowering and number of flowers. Similar findings have been reported earlier by Yadav (2010) in different flower and fruit crops.

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