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RESEARCH ARTICLE

EFFECT OF COMBINATION OF PLANT NUTRIENTS ON FLOWERING AND YIELD OF MARIGOLD (*TAGETES ERECTA* L.)

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ABSTRACT

The present investigation was under taken during two consecutive years on periodical observations (30, 60 and 90 DAT) on vegetative growth at C.S. Azad University of Agriculture and Technology, Kanpur. Results indicated that all the growth parameters such as number of leaves, plant spread, diameter of plant stem, increased to the maximum upto the 75 % nitrogen level with or without biofertilizers. 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 biofertilizers (*Azotobacter* + PSB) along with 75 % nitrogen (T_8) in both the years. While, Application of 100 % nitrogen along with biofertilizer inoculation delayed both the parameters. However, the maximum days were required under control (T_{14}).

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INTRODUCTION

Marigold is native of Central and South America, especially Mexico (Randhawa and Mukhopadhyaya, 1986). Marigold *(Tagetes erecta* L.), the most popular and commercial flower, apart from their aesthetic and industrial values, marigold is also 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.

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Thus, keeping in view the above facts, this experiment was undertaken to obtaining higher and quality flower yield.

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 twelve treatments was tested in three replicated trail under RBD. 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 splits 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 data recorded were analyzed as per method described by Fisher (1937).

RESULTS AND DISCUSSION

It may be observed from the Table 1 that all the treatments exerted significant effect on size of flower except T_{13} and T_9 as compared to control. However, the maximum size of flower was observed with T_8 (7.98 and 8.16 cm) followed by T_4 (7.68 and 7.82 cm), T_7 (7.44 and 7.60 cm) and T_3. T_4, T_7 and T_3 were found to be at par with T_8 during both the years.

The enhanced levels of auxins and other phytohormones due to the biofertilizers could have diverted the photoassimilates to the developing flower buds which resulted in increased size and weight of flower as also reported by Yadav *et al.* (2004) in marigold and Joshi *et al.* (2008) in chrysanthemum.. It is evident from the data presented in Table 2 that different treatments exerted a striking effect on flower yield per plant in comparison to control except T_{13} & T_9 during both the years of experimentation. The highest flower yield was obtained with T_8 treatment (553.64 and 577.15 g) and (273.40 and 285.01 q/ha) followed by T_4,((143.29 and 152.46 q/ha), T_3 and T_7 in 2008-09 and 2009-10, respectively. T_4, T_7, T_3 T_6, T_2 and T_5 were observed to be at par with treatment T_8.

Table 1. Effect of integrated nutrient management on weight of flower (g) and size of flower (cm) of African marigold

S. No.	Treatment		Size of flower (cm)		Weight of flower (cm)	
			2008-09	2009-10	2008-09	2009-10
1.	T_1	100% N	6.48	6.92	9.60	10.00
2.	T_2	100% N + *Azotobacter*	7.20	7.68	9.76	10.05
3.	T_3	100% N + PSB	6.70	7.02	9.00	9.46
4.	T_4	100% N + *Azotobacter* + PSB	7.44	7.98	8.50	9.79
5.	T_5	75% N	5.44	5.74	10.18	9.96
6.	T_6	75% N + *Azotobacter*	6.04	6.36	10.27	9.21
7.	T_7	75% N + PSB	5.04	4.70	9.65	8.74
8.	T_8	75% N + *Azotobacter* + PSB	6.60	7.06	9.83	10.26
9.	T_9	50% N	7.34	7.82	9.94	10.30
10.	T_{10}	50% N + *Azotobacter*	6.86	7.18	9.22	9.80
11.	T_{11}	50% N + PSB	7.60	8.16	8.34	1.02
12.	T_{12}	50% N + *Azotobacter* + PSB	5.48	5.90	10.42	10.15
13.	T_{13}	*Azotobacter* + PSB alone	6.20	6.50	10.50	9.43
14.	T_{14}	Control	5.22	4.83	9.98	8.55
	SE(d) ±		0.50	0.44	0.35	0.73
	CD 5%		0.44	0.90	0.36	0.74

Table 2. Effect of integrated nutrient management on flower yield per plant (g) and flower yield (q/ha) of African marigold

S. No.	Treatment		Flower yield per plant (g)		Flower yield (q/ha)	
			2008-09	2009-10	2008-09	2009-10
1.	T_1	100% N	439.14	460.01	216.85	232.59
2.	T_2	100% N + *zotobacter*	471.00	492.55	250.11	264.30
3.	T_3	100% N + PSB	506.48	528.17	229.88	243.89
4.	T_4	100% N + *Azotobacter* + PSB	535.22	556.42	255.55	273.40
5.	T_5	75% N	465.47	487.38	179.59	194.55
6.	T_6	75% N + *Azotobacter*	493.88	517.42	206.76	219.53
7.	T_7	75% N + PSB	517.50	542.01	152.96	143.29
8.	T_8	75% N + *Azotobacter* + PSB	553.64	577.15	227.17	143.23
9.	T_9	50% N	363.68	383.56	260.82	274.77
10.	T_{10}	50% N + *Azotobacter*	393.97	415.30	240.68	255.51
11.	T_{11}	50% N + PSB	418.69	439.71	267.65	285.01
12.	T_{12}	50% N + *Azotobacter* + PSB	444.56	485.83	189.41	205.08
13.	T_{13}	*Azotobacter* + PSB alone	309.74	329.62	217.14	229.94
14.	T_{14}	Control	290.23	308.74	162.77	152.46
	SE(d) ±		46.78	52.02	23.18	47.66
	CD 5%		96.16	106.94	25.69	52.89

The minimum size of flower was observed with control i.e.T_{14} (4.70 and 4.83cm). However, T_9 and T_{13} did not exhibit any significant variation with control. The maximum average flower weight was obtained in T_8 (10.30 and 10.50 g) as against control (8.34 and 8.55 g) during the years 2008-09 and 2009-10, respectively. The treatments T_{13} and T_9 did not bring any significant change in average flower weight as compared to control (T_{14}).The average flower size and weight increased significantly due to different N levels alone or in association of biofertilizers. The maximum growth, flowering and yield were recorded with the treatment of 75% N + *Azotobacter* +PSB (T_8) during both the years. This might be due to favourable action of biofertilizers in soil, which compensated the requirement of chemical fertilizers upto certain extent. Improvement in the size and weight of flower might to due to increased availability of nutrients during the flower development.

It would be further evident that treatment i.e. *Azotobacter* and PSB alone (T_{13}) did not give any significant increase in yield as compared to control (290.23 and 308.74g) which is observed as lowest. However, *Azotobacter* or PSB in combination with graded level of nitrogen, proved more effective in increasing the flower yield per plant. The present findings revealed that there was an increase in the number of flowers per plant and flower yield per hectare due to combination of biofertilizers and 75% of chemical nitrogen. 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 like auxins, gibberellins, vitamins and organic acid like acetic, formic, propionic, lactic, glycolic, fumaric and succinic which helped to enhance growth attributes like number of primary and secondary branches, plant spread resulting in more flower and flower attributes, yield per plant and per hectare.

Table 3. Cost of cultivation & B:C ratio for African marigold cv. Pusa Narangi as influenced by application of different treatments

Treatment Notation	Cost of Production * (Rs.)				Total Cost of Production (Rs.)		Interest** (Rs.)		Marketing*** (Rs.)		Total Expenditure (Rs.)	
	Common Cost (Rs.)	Variable Cost (Rs.)										
		Fertilizer & Bio-fertilizer (Rs.)	Packaging & Transportation (Rs.)									
			2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
T_1	74840	3637.68	7589.75	7950.95	86067.43	86428.63	12049.44	12100.01	16263.75	17037.75	114380.62	115566.39
T_2	74840	3777.68	8140.65	8513.05	86758.33	87130.73	12146.17	12198.30	17444.25	18242.25	116348.75	117571.28
T_3	74840	3777.68	8753.85	9128.70	87371.53	87746.38	12232.01	12284.49	18758.25	19561.50	118361.79	119592.37
T_4	74840	3917.68	9250.50	9616.95	88008.18	88374.63	12321.15	12372.45	19822.50	20607.75	120151.83	121354.83
T_5	74840	3472.23	8045.80	8423.80	86358.03	86736.03	12090.12	12143.04	17241.00	18051.00	115689.15	116930.07
T_6	74840	3612.23	8536.15	8942.85	86988.38	87395.08	12178.37	12235.31	18291.75	19163.25	117458.50	118793.64
T_7	74840	3612.23	8944.25	9367.75	87396.48	87819.98	12235.51	12294.80	19166.25	20073.75	118798.24	120188.53
T_8	74840	3752.23	9569.00	9975.35	88161.23	88567.58	12342.57	12399.46	20505.00	21375.75	121008.80	122342.79
T_9	74840	3306.63	6285.65	6629.35	84432.28	84775.98	11820.52	11868.64	13469.25	14205.75	109722.05	110850.37
T_{10}	74840	3446.63	6809.25	7177.80	85095.88	85464.43	11913.42	11965.02	14591.25	15381.00	111600.55	112810.45
T_{11}	74840	3446.63	7236.60	7599.90	85523.23	85886.53	11973.25	12024.11	15507.00	16285.50	113003.48	114196.14
T_{12}	74840	3586.63	7683.55	8047.90	86110.18	86474.53	12055.43	12106.43	16464.75	17245.50	114630.36	115826.46
T_{13}	74840	280.00	5353.60	5696.95	80473.60	80816.95	11266.30	11314.37	11472.00	12207.75	103211.90	104339.07
T_{14}	74840	–	5015.15	5336.10	79855.15	80176.10	11179.72	11224.65	10746.75	11434.50	101781.62	102835.25

**Interest on capital investment @ 14 per cent per annum. ***Marketing/Commission agent fees @ 5 per cent of total sale of flowers.

Treatment Notation	Net flower yield (q/ha)		Gross Income (Rs.)		Net Profit (Rs.)		B : C Ratio	
	2008-2009	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
T_1	216.85	227.17	325275.00	340755.00	210894.38	225188.61	1.84	1.95
T_2	232.59	243.23	348885.00	364845.00	232536.25	247273.72	2.00	2.10
T_3	250.11	260.82	375165.00	391230.00	256803.21	271637.63	2.17	2.27
T_4	264.30	274.77	396450.00	412155.00	276298.17	290800.17	2.30	2.40
T_5	229.88	240.68	344820.00	361020.00	229130.85	244089.93	1.98	2.09
T_6	243.89	255.51	365835.00	383265.00	248376.50	264471.36	2.11	2.23
T_7	255.55	267.65	383325.00	401475.00	264526.76	281286.47	2.23	2.34
T_8	273.40	285.01	410100.00	427515.00	289091.20	305172.21	2.39	2.49
T_9	179.59	189.41	269385.00	284115.00	159662.95	173264.63	1.46	1.56
T_{10}	194.55	205.08	291825.00	307620.00	180224.45	194809.55	1.61	1.73
T_{11}	206.76	217.14	310140.00	325710.00	197136.52	211513.86	1.74	1.85
T_{12}	219.53	229.94	329295.00	344910.00	214664.64	229083.54	1.87	1.98
T_{13}	152.96	162.77	229440.00	244155.00	126228.10	139815.93	1.22	1.34
T_{14}	143.29	152.46	214935.00	228690.00	113153.38	125854.75	1.11	1.22

Similar findings have been reported earlier by Deshmukh *et al.* (2008) and Yadav (2010) in different flower and fruit crops. Economics of different treatments revealed that combined application of biofertilizer alongwith 75% of N (T_8) gave highest gross and net return (Rs 4,10,100.00, Rs 2,89,091.20, and Rs. 4,27,515.00, 3,05,172.21) per hectare followed by T_4 i.e. 100% dose of N along with biofertilizers (Rs. 3,96,450.00, Rs. 2,76,298.17 and 4,12,155.00, 2,90,800.17) and it was found least in control (Rs. 2,14,935.00, Rs. 1,13,153.38 and Rs. 2,28,690.00, Rs.1,25,854.75) during the year 2008-09 and 2009-10, respectively. Benefit cost ratio was also observed maximum in T_8 (2.39 and 2.49) followed by T_4 (2.30 and 2.40) and it was minimum (1.11 and 1.22) in control (T_{14}) during the respective years of study. Further, it may be concluded that application of 75% N + AZB + PSB (T_8) proved to be the most effective and economic treatment for cultivation of marigold cv. Pusa Narangi to achieve sustainable crop and soil productivity.

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