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Effect of Integrated Nutrient Management on Growth, Flowering and Yield of African Marigold (*Tagetes erecta* L.)

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ABSTRACT

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The present investigation was carried out during *rabi* season 2009-10 to study the effect of integrated nutrient management on growth and yield of African marigold. The treatment consisted of four levels of FYM and inorganic fertilizers and four biofertilizers (control, *Azotobacter*, PSB and *Azotobacter* + PSB). Application of 75% RDF + FYM @ 20 t ha⁻¹ along with inoculation of seedlings with *Azotobacter* + PSB produced significantly higher plant height, number of primary branches plant⁻¹, weight of flower, number of flowers plant⁻¹, yield of flowers plot⁻¹ as well as ha⁻¹. These parameters were statistically at par with the application of 50% RDF + FYM @ 20 t ha⁻¹ along with inoculation of seedlings with *Azotobacter* + PSB.

Introduction

African marigold (*Tagetes erecta* L.), is one of the most important hardy flower crops grown commercially in different parts of the world. Marigold gained popularity among gardens and flower dealers on account of its easy cultivation, wide adaptability of diverse soil and climatic conditions, habit of profuse flowering, short duration to produce marketable flowers, wide spectrum of attractive colours, shape and good keeping quality. In India, it is one of the most

commonly grown loose flowers and extensively used on religious and social functions, in one form or another.

Application of N, P and K through inorganic fertilizers can enhance the growth and yield to considerable. FYM provide a variety of plant nutrients and improve soil structure by providing binding effect to soil aggregates. It increases cation exchange capacity of the soil, water holding capacity and phosphate

availability. The fertilizer use efficiency and microbial quality of the soil is also improved through FYM. It is rich in organic matter and can be supplemented with NPK fertilizers. Biofertilizers play an important role in increasing availability of nutrients and productivity in sustainable manner. *Azotobacter* is free living bacteria which may add 25-30 kg N ha⁻¹ year⁻¹ in a field of non-legume crop under favourable condition and also secretes some growth promoting substances. Inoculation of seeds with PSB culture increase nodulation, crop growth, nitrogenase activity, nutrient uptake and crop yield. Indiscriminate use of fertilizers and other agrochemicals has resulted in the depletion of beneficial micro-organism from the soil and has caused infertile and unproductive soil.

In this respect biofertilizers play multifaceted role by not only enriching the soil micro-organism but also as nutrients, stabilizers, hormones and insulators (Bihari *et al.*, 2009). The advantages of integrated nutrients management generally superior over use of each component separately. Integration of chemical fertilizers with organic manures and biofertilizers had maintained long term fertility and sustains higher productivity (Pillai *et al.*, 1985). The lack of information on these aspects made as impetus to undertake the present study.

Materials and Methods

Field experiment was conducted at Experimental Farm, Department of Horticulture, S.K.N. College of Agriculture, Jobner during *rabi* season 2009-10. The treatment combinations comprised four levels of FYM and inorganic fertilizers (100% RDF, FYM @ 20 t ha⁻¹, 75% RDF and FYM @ 20 t ha⁻¹ and 50% RDF and FYM @ 20 t ha⁻¹) and four biofertilizers (control, *Azotobacter*, PSB and *Azotobacter* + PSB inoculation), thereby, made 16 treatment combinations, which were

replicated thrice in the Factorial Randomized Block Design. Where, RDF represents recommended dose of N, P and K (120- 60- 60 kg ha⁻¹) through inorganic fertilizers. Recommended dose of fertilizer (RDF) was applied as per treatment through DAP and urea as a basal dose. Five weeks old seedlings brought out from nursery bed and treated by dipping of roots into the prepared culture of biofertilizer as per treatments for 30 minutes and then transplanted into plots of 2.4 m x 1.8 m at spacing of 60 x 45 cm. The different growth and yield observations were recorded from five randomly selected plants from each plot. The other cultural operations were done as per recommendation and crop requirement.

Results and Discussion

Growth attributes

Effect of integrated nutrient management

The various combinations of integrated nutrient management significantly affect plant height and number of primary branches plant⁻¹. Maximum plant height (64.58 cm) and number of primary branches plant⁻¹ (13.51) were recorded with the application of 75% RDF + FYM @ 20 t ha⁻¹ which was significantly superior to rest of the treatments.

This might be due to the fact that nitrogen is a constituent of protein which helps in division and enlargement of cell, thereby, enhancing plant growth. The above results are in accordance with the finding of Chandha *et al.*, (1999) and Acharya and Dashora (2004).

Effect of biofertilizers

Significantly higher values of plant height (64.17 cm) and number of primary branches plant⁻¹ (13.48) were recorded with inoculation of seedling with *Azotobacter* + PSB culture whereas, least plant height (49.64 cm) and number of primary branches plant⁻¹ (10.37

cm) were recorded with no inoculation. This treatment (*Azotobacter* + PSB) increased the plant height and number of primary branches plant⁻¹ by 10.44 and 4.39 per cent over no inoculation, respectively. This could be explained by the activities of the inoculants *viz.* nitrogen fixation, release of Pi from insoluble phosphate, production of phytohormones etc. with simultaneous uptake of nutrients. Increase cell elongation and cell multiplication due to enhanced nutrient uptake following inoculation of *Azotobacter* and PSB might have caused plant height (Preethi *et al.*, 1999).

Interaction effect

It was observed that integrated nutrient management along with biofertilizers leaves every possibility of interactions among their different levels thereby reflecting effect on the vegetative growth of plants. Application of 75% RDF + FYM @ 20 t ha⁻¹ along with inoculation of seedlings with *Azotobacter* + PSB culture recorded maximum plant height (68.74 cm) and number of primary branches plant⁻¹ (14.44), while this treatment was statistically at par with 50% RDF + FYM @ 20 t ha⁻¹ along with inoculation of seedlings with *Azotobacter* + PSB (F₄B₃) and 75% RDF + FYM @ 20 t ha⁻¹ along with inoculation of seedlings with *Azotobacter* (F₃B₁) (Table 2). The favourable influence of applied RDF and FYM along with biofertilizers on these characters may be ascribed in the light of balanced nutrition. It is an established fact that balanced nutrition cause great expression in term of crop growth. Striking influence of RDF and FYM along with *Azotobacter* + PSB probably increased availability of nutrients specially nitrogen and phosphorus in the soil and augmented to increase plant height and number of primary branches. These results are also experimentally substantiated with the findings of earlier workers Singh (2006) in rose and Bhalla *et al.*, (2007) in carnation.

Floral attributes

Effect of FYM and inorganic fertilizer

Data presented in table 1 showed that application of different integrated nutrient sources had significant effect on average weight of flower and number of flowers plant⁻¹. Maximum average weight of flower (8.24g) and number of flowers plant⁻¹ (64.33) were observed under the treatment 75% RDF + FYM @ 20t ha⁻¹ (F₃) which was significantly superior to other treatments. 75% RDF + FYM @ 20 t ha⁻¹ registered an increase average weight of flower and number of flowers plant⁻¹ to the tune of 13.49 per cent and 13.53 per cent over application of 100% RDF. It could also be attributed due to fact that after proper decomposition and mineralization, the organic manure supplied available nutrient directly to the plant and also had solublizing effect on fixed form of nutrients in soil and thus improvement in physical and biological properties of the soil (Sinha *et al.*, 1981).

Effect of biofertilizers

Similarly, average weight of flower and number of flowers plant⁻¹ were significantly influenced with the inoculation of seedling with biofertilizers. Maximum weight of flower (8.22 g) and number of flowers plant⁻¹ (67.17) were recorded with inoculation with *Azotobacter* + PSB (B₃). This treatment (*Azotobacter* + PSB) registered an enhancement of average weight of flower to the tune of 36.45 per cent and number of flowers plant⁻¹ to the extent of 30.24 per cent over no inoculation. The earliness of bud initiation in biofertilizer inoculated plants may be ascribed 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. The results are in line with findings in Marigold (Chandrikapure *et al.*, 1999) and Limonium (Gayathri *et al.*, 2004).

Table.1 Effect of FYM, inorganic fertilizers and biofertilizers on different growth and Yield attributes in African marigold

Treatments	Plant height (cm)	No. of primary branches	Weight of flower (g)	Number of flowers plant ⁻¹	Yield of flowers (kg plot ⁻¹)	Yield of flowers (q ha ⁻¹)
A. FYM and inorganic fertilizers						
F ₁ (100% RDF)	56.16	11.90	7.26	56.66	7.12	164.67
F ₂ (FYM @ 20 t ha ⁻¹)	49.08	10.29	6.26	49.92	6.14	142.12
F ₃ (75% RDF and FYM @ 20 t ha ⁻¹)	64.58	13.51	8.24	64.33	8.16	188.69
F ₄ (50% RDF and FYM @ 20 t ha ⁻¹)	61.37	12.84	7.83	61.12	7.76	179.58
SEm _±	0.90	0.18	0.11	0.88	0.11	2.58
CD at 5%	2.61	0.51	0.33	2.55	0.32	7.45
B. Bio-fertilizers						
B ₀ (No inoculation)	49.94	10.37	6.31	49.27	6.23	144.06
B ₁ (<i>Azotobacter</i>)	12.75	7.78	60.73	7.67	7.67	177.58
B ₂ (PSB)	56.60	11.94	7.28	56.85	7.17	165.89
B ₃ (<i>Azotobacter</i> + PSB inoculation)	64.17	13.48	8.22	64.17	8.11	187.53
SEm _±	0.90	0.18	0.11	0.88	0.11	2.58
CD at 5%	2.61	0.51	0.33	2.55	0.32	7.45

Table.2 Interactive effect of FYM, inorganic fertilizers and biofertilizers on different growth and Yield attributes in African marigold

Treatments	Plant height (cm)	No. of primary branches	Weight of flower (g)	Number of flowers per plant ⁻¹	Yield of flowers per plot (kg)	Yield of flowers per hectare (q)
F ₁ B ₀	49.64	10.42	6.36	49.64	6.23	144.16
F ₁ B ₁	58.10	12.41	7.57	59.10	7.45	172.36
F ₁ B ₂	53.94	11.54	7.04	54.94	6.87	159.01
F ₁ B ₃	62.96	13.22	8.07	62.96	7.92	183.15
F ₂ B ₀	35.24	7.35	4.41	34.57	4.34	100.42
F ₂ B ₁	53.80	11.30	6.89	53.80	6.75	156.26
F ₂ B ₂	49.53	10.40	6.34	49.53	6.21	143.67
F ₂ B ₃	57.76	12.13	7.40	57.76	7.27	168.11
F ₃ B ₀	59.56	12.30	7.50	58.56	7.42	171.72
F ₃ B ₁	66.54	13.97	8.52	66.54	8.44	195.37
F ₃ B ₂	63.49	13.33	8.13	63.49	8.06	186.57
F ₃ B ₃	68.74	14.44	8.81	68.74	8.72	201.11
F ₄ B ₀	55.32	11.41	6.96	54.32	6.91	159.94
F ₄ B ₁	63.49	13.33	8.13	63.49	8.05	186.34
F ₄ B ₂	59.44	12.48	7.61	59.44	7.53	174.29
F ₄ B ₃	67.23	14.12	8.61	67.23	8.53	197.74
SEm ₊	1.81	0.35	0.23	1.76	0.22	5.16
CD at 5%	5.23	1.02	0.66	5.10	0.64	14.90

Interaction effect

The application of 75% RDF + FYM @ 20 t ha⁻¹ + inoculation of seedlings with *Azotobacter* + PSB culture significantly enhanced floral characters.

This treatment combination (F₃B₃) was found best for number of flowers plant⁻¹ (68.74) and weight of flower (8.81 g), it was statistically at par with 50% RDF + FYM @ 20 t ha⁻¹ along with inoculation of seedlings with *Azotobacter* + PSB (F₄B₃) and 75% RDF + FYM @ 20 t ha⁻¹ along with inoculation of seedlings with *Azotobacter* (F₃B₁) (Table 2).

The enhancement in flowering attributes *i.e.* number of flowers and weight of flower was possibly due to better nutrients uptake, photosynthesis, source to sink relationship, besides excellent physiological and biochemical activities due to presence of FYM, chemical fertilizers, *Azotobacter* + PSB.

Similar, effect was reported by Swaminathan *et al.*, (1999) in tuberose and Gayithri *et al.*, (2004) in statice.

Yield attributes

Effect of FYM and inorganic fertilizer

Application of FYM along with inorganic fertilizers significantly enhanced the yield characters and yield of marigold. Maximum yield of flower (8.16 kg plot⁻¹ and 188.69 q ha⁻¹) were recorded with application of 75% RDF + FYM @ 20 t ha⁻¹ which was significantly higher over rest of the treatments.

Application of 75% RDF + FYM @ 20 t ha⁻¹ increased the yield of flowers by 14.60 per cent plot⁻¹ and 14.58 per cent ha⁻¹ over 100% RDF. The increase in yield with increasing

levels of nitrogen application (could be attributed to the increase in vegetative growth). These results are in conformity with Agrawal *et al.*, (2002) who reported significantly higher yield with higher levels of nitrogen application in African marigold.

The similar effects were given by Singh (2005) in Rose might due to additional supply of plant nutrients at proper time as well as sources of fertilizer application.

Effect of biofertilizers

Yield of flowers plot⁻¹ and ha⁻¹ were significantly increased with inoculation of seedling with biofertilizers as compared to no inoculation. Inoculation of seedling with *Azotobacter* + PSB exerted maximum yield of flowers (8.11 kg plot⁻¹ and 187.53 q ha⁻¹). Treatment, inoculation of seedling with *Azotobacter* + PSB culture increased the yield of flowers plot⁻¹ 30.17 per cent and yield of flower ha⁻¹ by 30.17 per cent over no inoculation.

Interaction effect

Yield of flowers (8.53 kg plot⁻¹ and 197.74 q ha⁻¹) were exhibited maximum with application of 50% RDF + FYM @ 20 t ha⁻¹ along with inoculation of seedling with *Azotobacter* + PSB. The increase in flowers yield might be due to the possible role of organic, inorganic fertilizers and *Azotobacter* through atmospheric nitrogen fixation, better root proliferation, uptake of nutrients and water, higher photosynthetic activity and enhanced food accumulation which might have resulted in better plant growth and subsequently higher yield. Besides this the increased yield might be attributed to the increased availability of phosphorus through PSB. The present result was also similar to the findings of Chandrikapure *et al.*, 1999 and Gayithri *et al.*, 2004.

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