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Effect of bio-fertilizers and nutrients on growth, yield and economics of summer season African marigold (*Tagetes erecta* L.)

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Abstract

A field experiment was carried out to study the effect of bio-fertilizers and nutrients on growth and flower yield of summer season African marigold (*Tagetes erecta* L.) at the Main Experiment Station, Department of Floriculture & Landscape, Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) during summer season in the year 2016-2017. The experiment was conducted in Randomized Block Design with 11 treatments replicated thrice to assess the effect of bio-fertilizers and nutrients on growth and flower yield of African marigold. Results reveal that the application of bio-fertilizers and nutrients had left significant response on growth and yield of marigold. Azotobacter + PSB + 75% NPK have resulted maximum plant height (72.46), number of branches (26.60), number of flowers per plant (24.84), weight of flower (7.80 g) and yield of flower per plant and per hectare (178.55 g & 257.76 q) was recorded with the application of Azotobacter + PSB + 75% NPK. The maximum gross return (257760 per ha), net return (183534.81 per ha) and benefit cost ratio (2.47:1) was recorded maximum with same treatment i.e. T₉ Azotobacter + PSB + 75% NPK under Main Experiment Station area.

Keywords: Bio-fertilizer, azotobacter, PSB, nutrient, marigold

Introduction

Marigold is an important commercial flower of India belongs to family Asteraceae (Compositae). It was originated in central and South America especially Mexico. It spreads to different parts of the world during early part of 16th century from Mexico. Bailey mentioned that African marigold was put into cultivation in 1596 A.D. in Europe. In India it is thought to be introduced by Portuguese in 1502-1550 A.D. African marigold gained popularity amongst gardeners and flower growers on account of its easy cultivation practices, wider adaptability to grow in different types of soil and climatic condition, long duration of flowering and attractive flower colour with excellent keeping quality. It is an annual plant with hardy vigorous and erect stem, which are bushy and branching towards the apex. Leaves are professed, brilliant green, elegantly divided into dentate lance late segments. The common name 'marigold' derived from 'Mary's Gold' is associated with Virgin Mary of the Christian stories. In India marigold is one of the most commonly grown flowers, sold in the market as loose flower for making garland. Flowers are traditionally used for offerings in churches, temples and in festivals for beautification. It is highly suitable for making flower beds in an herbaceous border and also found ideal for newly planted shrubberies to provide color and fill the space. Both, leaves and flowers possess medicinal values. The petals are an important source of carotenoid, which is used in poultry farm to intensify the colour of egg yolk. It inhibits lung cancer, prostate cancer, ovarian cancer, reduces heart diseases and breast tumors. Leaf extract is a good remedy for eye disease and ulcers. It is mainly grown in India, Tropical Africa, Sri Lanka and Madagascar. In India, marigold is commercially cultivated in different states such as Delhi, Haryana, Karnataka, Punjab, Tamil Nadu, Uttar Pradesh and West Bengal. Marigold can be grown in all seasons i.e., rainy, winter and summer of which rainy and winter season crops are the main crops under eastern U.P. condition. Seedlings are transplanted in the month of July-August and September-October, respectively, while summer season crop is transplanted in the month of February-March. Production of marigold can be improved to a large extent by the judicious cultural operations i.e. application of suitable fertilizer, appropriate planting distance, irrigation practices and use of plant growth regulators.

Bio-fertilizers are the products containing living cells of different types of microorganisms, which are capable of mobilizing nutritive elements from non-usable form to usable form through biological process. Azotobacter and PSB are free living bacteria which help in N₂ fixation and solubilizing phosphorus in the soil. Nitrogen is an important metabolic element for growth and development of plant. It is essentially considered as metabolic activities, transformation of energy, essential for metabolism of protein and other biochemical product such as nucleic acid, chlorophyll and protoplasm. Phosphorus is the essential component of protoplasm and chlorophyll which caused conversion of photosynthesis into phospholipids resulting adequate vegetative growth of plant. Keeping in view the role of bio-fertilizer and nutrients, present investigation was conducted with the objective to assess the effect of bio-fertilizers and nutrients on growth and flower yield of summer season marigold.

Materials and Methods

The present study was under taken at Main Experimental Station, Horticulture, N.D.U.A. & T., Kumarganj, Faizabad (U.P.) India during summer season of 2016- 17. Geographically, it is situated in typical saline alkali belt of Indo-gangetic plains of eastern U.P. at 26.47-0 N latitude, 88.120 E longitudes and at an altitude of 113 meter from mean sea level. The region enjoys sub humid and subtropical climate receiving a mean annual rainfall of about 1215 mm out of which about 85% is concentrated from mid June to end of September. The winter months are cold and dry and occasional frost occurs during this period. Westerly hot wind starts from the month of March and continues up to onset of monsoon. The experiment was laid out in Randomized Block Design (RBD) with three replications and eleven treatments either alone or in combination of bio-fertilizer and nutrients to evaluate the effect on growth and flower yield of African marigold. 30 days seedlings of African marigold, Pusa Narangi Gaiinda variety were transplanted at 30 X 20 cm in well prepared seed bed size 1.5 m×1.00 m in the month of February. The bio-fertilizers were mix with soil at final field preparation before that they were mix with well rotted FYM one week earlier. Nitrogen and phosphorus were applied in the form of urea and single superphosphate. Urea was applied in two split doses as half amount as basal dose at the time of transplanting and half as top dressing 30 days after transplanting, while phosphorus was used in single dose as basal application. Murat of potash (MOP) was applied as recommended dose at the time of final field preparation. Observations were recorded on vegetative characters at bud initiation stage and flowering attribute at different stage of plants. The obtained data had statistically analyzed adopting procedure as given by Fisher and Yates (1949) [4].

Results and Discussion

Crop economics

The cost of cultivation for each treatment was worked out by taking in to consideration of all the expenses incurred. The gross income was worked out by multiplying the fruit yield per hectare under various treatments with prevailing selling price during 2015 -16. The net return was calculated by deducting cost of cultivation from the gross income of the respective treatments and the cost benefit ratio was derived using following formula.

$$\text{Cost benefit ratio} = \frac{\text{Net return (Rs.)}}{\text{Total cost of cultivation (Rs.)}}$$

The economics of the crop cultivation under different treatment combination was worked out on the basis of input-output analysis. And thus the results obtained on various components of crop economics have been presented in Table No. 1.

The statistical analysis of data (Table-1) revealed that plant height at first flower bud initiation stage influenced with different treatments. Maximum plant height (72.46 cm), plant spread (45.26 cm²) and number of branches per plant (26.60) were obtained with treatment combination Azotobacter + PSB + 75% N.P.K. /ha. The better plant growth recorded due to application of NPK along with inoculation of bio-fertilizer proved beneficial may be due to the fix the atmospheric nitrogen in the soil and phosphorus would easily available to the plants. It is now well demonstrated the role and stimulation effects on non-symbiotic N-fixing bacteria (Azotobacter) in combination with N- fertilization, because these nutrient are essential for increasing the microbial activity in soil. Similar findings are reported by Syamal, *et al.* (2006) [9], Kumar Dhiraj *et al.* (2009) [6], Davood Hashemabadi *et al.* (2012) [2], Kaushik Himanshu *et al.* (2013) [5], Ali Jabbar Abdulsada *et al.* (2013) [1] and Manoj Kumar Rolaniya *et al.* (2017) [7] in marigold.

It is clear from the table-1, indicated that bio-fertilizers and nutrients had responded significantly on flowering attributes on marigold. Maximum number of flower per plant (24.84), maximum flower weight (97.80 g) and flower yield per plant and per hectare (178.55g and 257.76 q) were recorded by the application of Azotobacter + PSB + 75% NPK/ha. The advancement in the flowering attributes through the application of bio-fertilizers and nutrients may be favorable response of bio-inoculation which proved the nutrients availability to the plants by edition of atmospheric nitrogen to the soil promoted the more vegetative growth and yield attributing parameter through stimulation of plant growth promoting substances such as Auxins, gibberellins, vitamins and organic acid the conversion of photosynthesis into protein resulted on more production biomass. It also favours the induction of more flower primordial and development of flower buds, attributing to quality flower and higher flowers yield. Similar result was also reported by Ali Jabbar Abdulsada *et al.* (2013) [1], Kaushik Himanshu *et al.* (2013) [5], Kumar Dhiraj *et al.* (2014), Dipal Bhatt (2016) [3], Singh Sastiya Madhu *et al.* (2017) [8] and Manoj Kumar Rolaniya *et al.* (2017) [7] in marigold.

Economics

The maximum gross return (257760 per ha), net return (183534.81 per ha) and cost of benefit cost ratio (2.47:1) was maximum in treatment with T₉-Azotobacter +PSB+ 75% NPK + followed by T₁₀- Azotobacter +PSB + 50% N+ 60kg P₂O₅ ha⁻¹ + 60kg K₂O ha⁻¹. While least BCR value (0.65:1) was found in T₁- 120kg N ha⁻¹ + 60kg P₂O₅ ha⁻¹ + 60kg K₂O ha⁻¹ and T₃- PSB only. On the basis of the experiment as well as economic point of views, an application of bio-fertilizers in combination with chemical fertilizers produced its significant impact on cost benefits ratio. Both these treatments (T₉ and T₁₀) were found economical, profitable and proved highly remunerative under the Faizabad, India conditions for growing the marigold cv. "Pusa Basanti Gaiinda", which also improved the soil health. Similar findings are observed by Jadhav, P. B. *et al.* (2014) in marigold.

Table 1: Economics of bio-fertilizers and nutrients on growth and yield of summer season African marigold (*Tagetes erecta* L.)

Treatments	Plant height (cm)	Number of branches	Number of flower per plant	Weight of flower (g)	Yield of flower per plant (g)	Yield of flower (q/ha)	Flower yield (q./ha.)	Total cost of cultivation (Rs./ha.)	Gross return Rs./ha @ Rs. 1000	Net return (Rs./ha)	C:B Ratio
T ₁ : Control	52.20	23.40	16.21	5.40	87.53	116.46	116.46	70512.19	116460	45947.81	1:0.65
T ₂ : Azotobacter	54.16	24.00	18.84	5.62	105.88	140.61	140.63	71262.19	140630	69368.81	1:0.97
T ₃ : PSB	53.73	23.60	16.32	5.42	88.45	117.66	117.66	71262.19	117660	46398.81	1:0.65
T ₄ : N.P.K	68.46	25.33	19.86	5.54	110.02	137.97	137.97	72936.19	137970	65034.81	1:0.89
T ₅ : Azotobacter + 75 % N+P+K	68.86	26.33	23.18	7.32	169.67	225.81	225.81	73476.19	225810	152334.81	1:2.07
T ₆ : Azotobacter + 50% N+P+K	65.26	25.40	20.32	7.23	146.91	195.26	195.37	73266.19	195370	122104.81	1:1.66
T ₇ : PSB +75 %P+N+K	64.60	25.26	21.98	7.30	160.45	213.62	213.62	73536.19	213620	140084.81	1:1.90
T ₈ : PSB +50% P+N+K	63.60	24.40	20.43	7.23	147.70	196.47	196.44	73386.19	196440	123054.81	1:1.67
T ₉ : Azotobacter + PSB +75 % NP+K	72.46	26.60	24.84	7.80	193.75	257.76	257.76	74226.19	257760	183534.81	1:2.47
T ₁₀ : Azotobacter + PSB +50 % NP+K	69.10	26.40	22.98	7.77	178.55	237.50	237.50	74016.19	237500	163484.81	1:2.22
T ₁₁ : Azotobacter + PSB	60.40	24.06	19.84	6.34	126.48	167.37	167.37	72012.19	167370	95357.81	1:1.32
SEm±	0.81	0.61	0.36	0.01	4.41	5.85	5.85	-	-	-	-
CD at 5%	2.64	1.26	1.07	0.03	13.00	17.27	17.27	-	-	-	-

Does of Nutrients and rate of fertilizers

1. Azotobacter-7.5/ha-100
2. PSB-7.5kg/ha-100,
3. Urea -120/ha- 7Rs/kg
4. Single super phosphate-60kg- 10.00Rs/kg
5. Muriate of potash- 60 kg- 16.40Rs/kg
6. 1 kg flowers selling prize- 20,
7. Labour charge/day-150

Conclusion

As per economics point of view, highest net realization of Rs. 183534.81/ha along with benefit cost ratio of 1:2.47 was recorded with the treatment T₉: Azotobacter + PSB +75 % NP+K followed by T₁₀: Azotobacter + PSB +50 % NP+K (Rs. 163484.81 with CBR 1:2.22) and T₅: Azotobacter + 75 % N+P+K (Rs. 152334.81 with benefit cost ratio 1:2.07). This clearly indicated that T₁₀ and T₅ treatments are also economically viable for gladiolus cultivation besides T₉. In conclusion the response of African marigold varies with application of organic and inorganic manures but the application of Azotobacter +PSB + 75% NPK to African marigold cv. Pusa Narangi Gaiinda gave maximum growth and yield attributes with high cost benefit ratio.

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