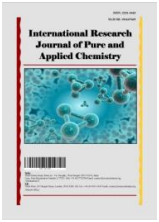

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Effect of Integrated Nutrient Management on Flower Quality of French Marigold (*Tagetes patula* L.) *cv*. Pusa Arpita

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Authors' contributions

This work was carried out in collaboration among all authors. Author VCG designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author SM managed the analyses of the study. Authors MA, SPS, MC and AK managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was carried out with the aim to find out the effect of integrated nutrient management on flower quality of French marigold (*Tagetes patula* L.) cv. Pusa Arpita at the Horticultural Research Centre, Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, U. P., India, during the year 2019-2020. The study consisted of organic manures (FYM and Vermicompost), Bio-fertilizers (PSB and *Azotobacter*), and the recommended dose of inorganic fertilizer (RDF) (150:60:60 kg NPK/ha). The combined application of ½ RDF + ½ PSB+ ½ Vermicompost showed significant influence on quality parameters that include; maximum flowering duration (60.66 days), circumference of flower (22.51 cm), number of florets per flower (136.55), length of flower stalk (6.44 cm), and the vase life of flowers were enhanced by up to 7.47 days over the control that was recorded in the same treatment. The study

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concluded that there was a significant influence of the combined application of organic manure, bio-fertilizer and inorganic fertilizer on French marigold to enhance the flowering quality and their characters.

Keywords: Azotobacter; PSB; Vermicompost; RDF; FYM.

1. INTRODUCTION

French Marigold (*Tagetes patula* L.) originated from South America and belongs to the family Compositeae or Asteraceae. Marigolds are commonly used for loose flowers in India, because of their easy cultivation, adaptability to varying soil and climatic conditions long duration of flowering and excellent keeping quality. In India, marigold was introduced by the Portuguese between 1502-1550 A.D; there are two species, which are commercially grown viz., *Tagetes erecta* L. (African marigold) and *Tagetes patula* L. (French marigold), because of their easy availability under a vast range of agro-climatic conditions. Commercial cultivation of marigold is gaining momentum day-by-day in many states including Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, Delhi, West Bengal, and Rajasthan.

The main growing period for marigold in plains is the winter season (August-January). It can be cultivated in other seasons like spring (November-April), summer (February-July) and the rainy season (May-October). Recently, marigold is grown commercially for carotenoid pigment. The major source of pigment in the plant is xanthophyll particularly lutein extracted from petals. The marigold pigment of major source is the pigment for the poultry industry used as a feed additive to intensify the yellow colour of egg and broiler skin of chickens. The oil extracted from all part of *T. patula* has pronounced odours used as a fly repellent [1]. The oil of *T. minuta* was reported to possess tranquilizing, spasmolytic and anti-inflammatory properties [2].

The plantation of marigold has also found beneficial reducing the population of nematodes especially *Meloidogyne* spp. Husain et al. [3] reported that the nematocidal activity in marigold plant was extremely beneficial for both plants and humans. No single source of nutrient is capable of supplying plant nutrients in adequate amount and balanced proportion. Integrated Nutrient Management (INM) practices involved judicious combination of all organic manure, chemical fertilizer, and bio fertilizers. It can be feasible and viable for sustainable agriculture on a commercial and profitable scale. In addition, they are eco-friendly, easily available such as farmyard manure, vermicompost, and bio fertilizers, like; *Azotobacter* on African marigold. Therefore, the application of organic and inorganic source of nutrients is a strategy for advocating judicious and cost-effective use of chemical fertilizers with matching addition of organic manure and bio- fertilizers. Bio-fertilizers play a critical role of chemical transformation in the soil and thus influence the availability of major nutrient like, Nitrogen, Phosphorus, Potassium and Sulphur inside the plants. *Azotobacter* are Gram negative, free living, aerobic soil dwelling [4] *Azotobacter* is a non symbiotic bacterium which fixes atmospheric nitrogen in to soil [5]. *Azotobacter* also accelerated the production of antifungal and antibacterial compounds in the soil. Vermicompost is a rich source of macro and micro-nutrients which enhances the micro flora and enzymatic activity of the plant. Phosphate solublizing organism are not only able to solubilize insoluble forms of inorganic P but are also capable to mineralize organic forms of P, thus improving the availability of native soil P. Keeping the above facts in view, the present investigation was conducted with the objectives of to see the effect of integrated nutrient source and its combinations and to find out appropriate dose of organic, inorganic and bio-fertilizers on quality parameters of French marigold respectively.

2. MATERIALS AND METHODS

The present investigation was carried out at the Horticultural Research Centre, Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India, during the year 2019-2020. The study consisted of a total eleven treatment combinations comprising recommended dose of fertilizer (RDF), Farmyard Manure (FYM), Vermicompost (VC), Phosphorus Solubilizing Bacteria (PSB) and *Azotobacter* (AZO). The detail of the treatments are : T_1 - Control, T_2- RDF-150:60:60 kg/ha N:P:K, T_3- FYM @ 30 t/ha, T_4- Vermicompost @ 10 (quintals per hectare),

T_5-*Azotobacter* @ 700 ml/ha, T_6-PSB @ 500 ml/ha, T_7-½ RDF + ½ FYM, T_8-½ RDF + ½ Vermicompost,T_9- ½ RDF + ½ *Azotobacter*, T_{10}- ½ RDF + ½ PSB and T_{11}- ½ RDF + ½ PSB + ½ Vermicompost. For yearly crop healthy, strong seedlings of marigold cv. Pusa Arpita were transplanted in the month of November. The soil at the experimental site was a sandy loam with of a pH of 7.83. The soil had a good water holding capacity. Well decomposed FYM @ 30 tons per hectare and Vermicompost @ 1.0 tons per hectare were applied at the time of land preparation. The recommended dose of 150:60:60kg NPK /ha was applied in the form of urea, single super phosphate and muriate of potash, respectively.

Bio-fertilizer like; PSB (500 ml/ha), and *Azotobacter* (700 ml/ha) were applied to the seedlings immediately after transplanting. After the second week of transplanting, 50 per cent N_2 and full dose of P_2O_5 and K_2O were applied in a circular band about 10 cm around each plant at a depth of 3 to 4cm and the remaining 50 per cent 'N_2' was applied at 30 days after transplanting as a top dressing.

3. RESULTS AND DISCUSSION

The data recorded during the course of the investigation were statistically analyzed and are presented below. It was found that yield and quality attributes are significantly affected by the integrated application of nutrients. Data pertaining to flowering duration of marigold as affected by different levels of integrated management of nutrients is shown in (Table 1). According to the statistical analysis, the circumference of flower was significantly affected by different manure, bio-fertilizer and inorganic fertilizer levels. Maximum flowering duration (60.66 days) was recorded with the application of ½ RDF + ½ PSB + ½ Vermicompost, while minimum flowering duration (39.57 days) was obtained in the control treatment.

Data regarding circumference of flower as affected by different levels of manure and fertilizer source is shown in (Table 1). Maximum circumference (22.51cm) was recorded with the application of ½ RDF + ½ PSB + ½ Vermicompost, while minimum circumference (9.92 cm) was recorded in the control treatment. It might be due to uptake of more nitrogen through PSB and vermicompost. Vermicompost increased microbial activity and enhanced the availability of soil phosphorus and nitrogen, hence; increase the flowering duration as well as circumference of flower. Similar findings were reported by Ahmad et al. [6].

Table 1. Effect of integrated nutrient management on various qualities attributes of French marigold

Treatment	Flowering duration (days)	Circumference of flower (cm)	Number of florets per flower	Length of flower stalk (cm)	Vase life (days)
Control	39.57	9.92	56.88	3.40	3.60
RDF-150:60:60 kg/ha N:P:K	43.58	12.21	78.69	4.51	4.80
FYM @ 30t/ha	45.80	13.48	89.15	4.83	5.81
Vermicompost @ 10 q/h	56.74	14.83	97.52	4.55	5.84
Azotobacter@ 700 ml/ha	48.48	15.34	109.50	4.66	6.33
PSB @ 500 ml/ha	52.65	15.62	112.72	4.09	5.80
½ RDF + ½ FYM	53.40	15.98	124.68	4.45	5.74
½ RDF + ½ Vermicompost	55.76	18.84	126.65	5.53	6.44
½ RDF + ½ *Azotobacter*	57.55	18.47	121.42	5.41	6.54
½ RDF + ½ PSB	58.41	20.73	122.46	5.30	6.82
½ RDF + ½ PSB + ½ Vermicompost	60.66	22.51	136.55	6.44	7.47
S.E.(m)±	0.25	0.39	0.49	0.49	0.34
C D at 5%	0.77	1.16	1.46	1.45	1.03

Data pertaining to the numbers florets per flower are shown in (Table 1). Statistical analysis shows that the numbers of florets per flower was significantly affected by various nutrient source levels. Maximum number of florets per flower (136.55) was recorded with the application of ½ RDF + ½ PSB + ½ Vermicompost, and minimum number of florets per flower (56.88) was recorded with the control treatment. Thesignificant enhancement in number of florets per flower might be due to the application of nitrogen in combination with PSB and vermicompost. Both were found to be valuable in the initiation of flower primordial formation leading to the increased number of florets per flower in marigold Verma et al. [7].

Data regarding length of flower stalk of marigold as affected by different level of integrated nutrient source is shown in (Table 1). According to the statistical analysis, length of flower stalk was significantly affected by different nutrient source. Maximum length of flower stalk (6.44 cm) was recorded with the application of (½ RDF + ½ PSB + ½ Vermicompost) and the minimum length of flower stalk (3.70 cm) was recorded with the control treatment. This may be due to high nitrogen assimilation from PSB, Vermicompost and 50% RDF with more nitrogen fixing and phosphorus solubilizing proficiency coupled with section of hormones by the vermicompost culture. The present findings are in accordance with [8] in marigold.

The vase life of marigold flower was influenced by various integrated nutrient sources. The results clearly (Table 1) revealed that the maximum vase life (7.47 days) of flower was recorded with the application of ½ RDF + ½ PSB + ½ Vermicompost, while the minimum vase life (3.60 days) was recorded in the control treatment. Increased vase life might be due to the reduced physiological (weight loss and lesser water uptake by flowers. Restricted respiration due to the unavailability action of these nutrient sources might increase the vase life. This findings was in agreement with the findings of Lodhi et al. [9].

4. CONCLUSION

It can be concluded from the present experiment that the nutrient sources play an important role for the quality of French marigold. The application of ½ RDF + ½ PSB + ½ Vermicompost was found to be the best with respect to most of the parameters examined in this investigation *i.e*. flowering duration (days), circumference of flower, number of florets per flower and length of flower stalk with respect to vase life of flowers. The best results were recorded with ½ RDF + ½ PSB + ½ Vermicompost, in French Marigold (*Tagetes patula* L.) *cv*. Pusa Arpita.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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