Effect of graded levels of Nutrients and Organic amendments on growth and flower yield of African marigold (*Tagetes erecta* L.)

Abstract

Production of marigold can be improved to a large extent by the judicious cultural operations i.e., application of optimum fertilizer at required time and appropriate crop management practices. Marigold petals are one of the common concentrated sources of xanthophylls. Petals taken from deep orange-coloured flowers were found to be the best for extraction of more xanthophylls. The carotenoid content of fresh flower petals ranges from 0.2 to 2.69 mg/g and dried petals content about 1.6%. Hence, marigold is used for commercial and medicinal purposes. Integrated Nutrient Management (INM) provides an excellent opportunity to overcome all the imbalances beside sustaining soil health and enhancing crop production. Hence, an experiment was laid out to find the influence of organic amendments *viz.,* Vermicompost, Humic acid and Arka microbial consortium in addition with graded levels of recommended dose of fertilizers on growth, flowering and yield in African Marigold var. Pusa Narangi Gainda. The effect of thirteen treatments was studied under randomized block design with three replications. Results of the experiment revealed that an application of Vermicompost @ 5 t ha^{-1} + Humic acid @ 5 kg ha^{-1} along with Arka microbial consortium@ 12.5 kg ha^{-1} in addition with 100 % RDF (90:90:75 kg N, P_2O_5 and K_2O kg ha^{-1}) will be effective in increasing the growth, flower yield and xanthophyll content of African marigold.

Introduction

Marigold gained popularity in the ornamental gardens and flower dealers on account of its easy culture and wide spectrum of attractive colours, shape, size and good keeping quality. Extraction of essential oil and carotenoid pigments started very late in our country. Marigold petals are one of the common concentrated sources of xanthophylls. Petals taken from deep orange-coloured flowers were found to be the best for extraction of more xanthophylls. The carotenoid content of fresh flower petals ranges from 0.2 to 2.69 mg/g and dried petals content about 1.6%. Hence, marigold is used for commercial and medicinal purposes. Continuous application of imbalanced and excessive nutrients has led to decline in nutrient-use efficiency making fertilizer consumption uneconomical and producing adverse effects on atmosphere and ground water quality, causing health hazards. Integrated Nutrient Management (INM) provides an excellent opportunity to overcome all the imbalances beside sustaining soil health and

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enhancing crop production. The use of organic manures and bio-fertilizers along with balanced use of chemical fertilizers is known to improve the physio-chemical and biological properties of soil, besides improving the efficiency of applied fertilizers (Verma *et al.*, 2011). Abhinav Kumar and Ashok Kumar (2017) also reported increased yield with the application of bio-fertilizers and nutrients on growth and flower yield of African marigold (*Tagetes erecta* L.). Hence, an experiment was laid out to find the influence of organic amendments *viz.*, Vermicompost, Humic acid and Arka microbial consortium in addition with graded levels of recommended dose of fertilizers on growth, flowering and yield in African Marigold var. Pusa Narangi Gainda.

Materials and Methods

The present investigation entitled "Effect of graded levels of nutrients and organic amendments on growth and yield of African marigold (*Tagetes erecta* L.)" was carried out in the experimental farm of Adhiparasakthi Horticultural College, Kalavai, Vellore district of Tamilnadu during the period of August 2019 to December 2019. The Treatment details are: Control (RDF 100%) (T_1), RDF 75% + Vermicompost (T_2), RDF 100% + Vermicompost (T_3), RDF 75% + Humic acid(T_4), RDF 100% + Humic acid (T_5), RDF 75% + Vermicompost + Humic acid (T_6), RDF 100% + Vermicompost + Humic acid (T_7), RDF 75% + Humic Acid + Arka microbial consortium (T_8), RDF 100% + Humic Acid + Arka microbial consortium (T_9), RDF 75% + Vermicompost + Arka microbial consortium (T_{10}), RDF 100% + Vermicompost + Arka microbial consortium (T_{11}), RDF 75% + Vermicompost + Humic Acid + Arka microbial consortium (T_{12}), RDF 100% + Vermicompost + Humic Acid + Arka microbial consortium (T_{13}).

The effect of thirteen treatments was studied under randomized block design with three replications. Each treatment was applied to a plot of 3 x 3 m size with plants spaced at 45 x 35 cm. Observations on plant height, number of branches, number of leaves, number of flowers, single flower weight, flower yield per plant , flower yield per plot and xanthophyll content were recorded and statistically analyzed.

Results and Discussion

From the data it is evident that significant differences were noticed in all most all the characters due to the application of graded levels of nutrients along with organic amendments**.** There was a significant increase in plant height due to various combinations of treatments. The maximum plant height of 109.28 cm observed in T_{13} (RDF 100% + Vermicompost + Humic

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Acid + AMC) which was found to be significantly high when compared with T_{12} (RDF 75% + Vermicompost + Humic Acid + AMC) which recorded a plant height of 104.90 cm. The lowest plant height of 68.44 cm was observed in T_1 (Control-100% RDF). The maximum number of branches (18.74) were observed in T_{13} (RDF 100% + Vermicompost + Humic Acid + AMC) which was significantly higher than T_{12} (RDF 75% + Vermicompost + Humic Acid + AMC) which recorded 17.73 branches. The least number of 11.69 branches were observed in T_1 (Control-100% RDF). The number of leaves per plant was significantly enhanced due to graded levels of nutrients and organic amendments. The highest number of leaves (136.94) was observed in T_{13} (RDF 100% + Vermicompost + Humic Acid + AMC), was significantly higher than T_{12} (RDF 75% + Vermicompost + Humic Acid + AMC) which recorded 133.39 leaves. The least number of 106.16 leaves were observed in T_1 (Control-100% RDF). From the Table 1, it is evident that significant differences were recorded for number of flowers per plant. Maximum number of flowers (58.42) was recorded under the treatment T_{13} (RDF 100% + Vermicompost + Humic Acid + AMC) which is followed by the treatment T_{12} (RDF 75% + Vermicompost + Humic Acid + AMC) with 57.43 flowers. However, the minimum number of leaves (49.18) were recorded under in T_1 (Control-RDF 100%). The maximum weight of flower (6.95 g) was observed in the treatment T_{13} (RDF 100% + Vermicompost + Humic Acid + AMC) which is followed by T_{12} (RDF 75% + Vermicompost + Humic Acid + AMC) which recorded a flower weight of 6.72 g. The lowest flower weight (4.93 g) was observed in T_1 (Control-RDF 100%). The treatment T_{13} (RDF 100% + Vermicompost + Humic Acid + AMC) recorded the maximum flower yield (312.63 g plant^{-1}). It was followed by T_{12} (RDF 75% + Vermicompost + Humic Acid + AMC) which recorded a flower yield of 297.17 g plant^{-1}. The lowest flower yield of 186.69 g plant^{-1} was observed in T_1 (Control-RDF 100%). The maximum flower yield per plot (10.5 kg) was observed in the treatment T_{13} (RDF 100% + Vermicompost + Humic Acid + AMC) which is followed by T_{12} (RDF 75% + Vermicompost + Humic Acid + AMC) which recorded a flower yield of 9.98 kg. However, the lowest flower yield per plot (6.27 kg) was observed in T_1 (Control-RDF 100%).

The positive influence of N, P and K on growth could be attributed due to the role of N in cell division as well as protein synthesis. This would have ultimately resulted in increased rate of leaf growth and stems. Better availability of nutrients might have increased crop growth and yield components due to optimum level of fertilizer application, which influenced the plant to

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absorb more nutrients. Vermicompost is not only rich in nutrients but also contains certain organic stimulants like auxins and cytokinins, which enhance sufficient quantity of nutrient flow in the plant system (Radha *et al.,* 1986). Vermicompost contains major and minor nutrients in available forms which also contain enzymes, beneficial microorganisms and other growth substances which have definite advantage over other organic manures in respect of quality and shelf life of the produce (Meerabai and Asha Raj, 2001). The results of the experiment revealed that the application of humic acid along with the organic manure had positive effect on growth and flower yield. The influence of humic acid on growth and its ultimate expression (*i.e.*) flower yield and xanthophyll content could be attributed to role in accelerating the enzyme and hormone systems increasing cell communication and coordination, in increasing synthesis of every molecules and inducing cell division and growth (Adani *et al*., 1998). The results of the experiment revealed that the application of Arka microbial consortium along with the organic manure had positive effect on growth and flower yield. This may be due to early breaking of apical dominance followed by easy and better translocation of nutrients to the flowers brought about by inoculation with beneficial microbial inoculants like *Azotobacter tropicalis, Bacillus aryabhattai,* and *Pseudomonas taiwanensis* (Ramesh Koli and R Jayanthi, 2018).

A close observation on the uptake of nutrients from plants stated that, those plants applied with RDF (100%) along with vermicompost, humic acid and Arka microbial consortium (T_{13}) recorded maximum uptake (38.45 kg ha^{-1}, 9.78 kg ha^{-1} and 29.98 kg ha^{-1}) of N, P and K respectively. The data on the uptake of N, P and K shown in Table 1, also corroborates the view that high uptake was responsible for desirable vegetative characters which resulted in increasing the yield in the best treatment T_{13} (Vermicompost + Humic Acid + AMC). Better root proliferation coupled with greater availability of nutrients in the rhizosphere might have helped in higher uptake required to maintain optimum plant growth and development. Moreover, the uptake of the nutrients is primarily a function of production of biomass and nutrient content at cellular level. High availability of nutrients would have enhanced the photosynthetic activity and accumulation of more photosynthates at the sink. The results of the present experiment are in consonance with the findings of Chauhan *et al*. (2005), Maharnor *et al*. (2011) and Singh *et al*. (2015).

From the above experiment, it is concluded that an application of vermicompost @ 5 t ha^{-1} + humic acid @ 5 kg ha^{-1} along with Arka microbial consortium@ 12.5 kg ha^{-1} in addition with

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100 % RDF (90:90:75 kg N, P_2O_5 and K_2O kg ha^{-1}) will be effective in increasing the growth, flower yield and xanthophyll content of African marigold.

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Effect of graded levels of nutrients and organic amendments on growth and flowering in African marigold (*Tagetes erecta* L.)

Treatment details	Plant height (cm)	Number of branches	Number of Leaves	Number of flowers per plant	Single Flower Weight (g)	Flower Yield per plant (g)	Flower Yield per plot (kg)	Xanthophyll content (kg^{-1} of petal meal (g))
T_1- Control (RDF 100%)	68.44	11.69	106.16	49.18	4.93	186.69	6.27	16.37
T_2-RDF 75% + VC	72.59	11.92	110.53	50.16	5.15	198.91	6.68	16.66
T_3-RDF 100%+ VC	73.30	12.01	114.05	50.83	5.39	210.96	7.08	16.87
T_4-RDF 75% + HA	77.41	12.88	117.55	51.81	5.47	218.22	7.33	17.10
T_5-RDF 100% + HA	78.36	13.27	118.63	52.16	5.70	228.93	7.69	17.16
T_6-RDF 75% + VC+ HA	82.58	14.34	122.15	53.14	5.92	242.23	8.14	17.36
T_7-RDF 100%+ VC+ HA	81.75	15.64	127.74	55.29	6.22	264.81	8.89	17.50
T_8-RDF 75% + HA + AMC	100.59	16.83	132.49	56.46	6.51	283.02	9.51	17.88
T_9-RDF 100% + HA + AMC	85.15	14.51	123.17	55.08	5.97	253.20	8.51	17.38
T_{10}-RDF 75% + VC+ AMC	89.18	15.38	126.66	54.12	6.18	257.54	8.65	17.42
T_{11}-RDF 100% + VC+ AMC	96.17	16.41	129.08	55.50	6.31	269.66	9.06	17.71
T_{12}-RDF 75% + VC+ HA + AMC	104.90	17.73	133.39	57.43	6.72	297.17	9.98	18.06
T_{13}-RDF 100% + VC+ HA + AMC	109.28	18.74	136.94	58.42	6.95	312.63	10.5	18.26
S.Ed.	0.73	0.48	1.33	0.43	0.10	4.64	0.09	0.06
CD(p=0.05)	1.48	0.96	2.68	0.88	0.22	9.34	0.18	0.14

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RDF 100%	:	90:90:75 kg N, P_2O_5, K_2O ha^{-1}	Humic Acid - 50% (HA)	:	5 kg ha^{-1}
RDF 75%	:	67.5:67.5:56 kg N, P_2O_5, K_2O ha^{-1}	Arka microbial consortium (AMC)	:	12.5 kg ha^{-1}
Vermicompost (VC)	:	5tonnes ha^{-1}			

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