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Effect of Vermicompost on the Growth and Flowering of African Marigold (*Tagetes erecta*)

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Abstract: The effects of vermicompost of an animal manure origin on the growth and flowering of *Tagetes erecta* grown under glasshouse conditions were determined. Marigold seeds were germinated, transplanted into media and grown-on for 150 days. The traditional base medium (control) was a mixture of 70% farm soil and 30% sand (v/v). Treatments were either vermicompost incorporated at 10, 20, 30, 40, 50 and 60% into the base medium. Vermicompost had significant ($P<0.05$) positive effects on flower numbers, leaf growth and shoot fresh and dry weights compared to both control amended media. Plant performance was the best at the 60% vermicompost medium. Results indicated that vermicompost had significant effect on photosynthetic pigments ($p<0.05$). The highest content of Chl. (a), total Chl. a+b, Carotenoids and total pigments was achieved in 60% vermicompost.

Key words: Animal Manure · *Tagetes erecta* · Photosynthetic Pigments · Vermicompost

INTRODUCTION

There is increasing interest in the potential use of vermicomposts as plant growth media and soil amendments. These are products of a nonthermophilic bio-degradation of organic materials through interactions between earthworms and microorganisms. In vermicompost, compared to conventional compost, accelerated bio-oxidation of organic matter is achieved mostly by high density earthworm populations [1, 2]. Vermicomposts are typically finely divided peat-like materials with high porosity, aeration, drainage and waterholding capacity [3]. Atiyeh *et al*., [4] reported that amendment of Metro-Mix 360, a standard commercial greenhouse container medium, with various volumes of pig manure vermicompost [e.g. 40%] significantly improved growth and productivity of marigold plants.

Atiyeh *et al*., [5] showed that 10-20% vermicompost in Metro-Mix 360 medium significantly increased the weight of tomato seedlings and fruit yields compared to the Metro-Mix 360 control. However, total numbers of flower buds, shoot and root weights and plant heights were decreased at vermicompost concentrations >40%. Hidlago *et al*., [6] reported that incorporation of earthworm castings increased plant (including root) growth, stem diameters and flower numbers of marigold grown in PP [7 peat moss: 3 perlite], commercial Sunshine Mix 1 and PBS (4 pine bark : 1 sand). Application of vermicompost obtained from water hyacinth [*Eichhornia crassipes*] significantly enhanced growth and flowering of *Crossandra udulaefolia* compared to untreated control plants [7]. Similarly, vermicompost applications increased strawberry plant growth and yield significantly; including increases of up to 37% in leaf area,

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37% in shoot biomass, 40% in flower numbers, 36% in plant runner numbers and 35% in marketable fruit weights [8]. The highest number of buds and open floret, root dry weight, root and shoot fresh weight was achieved in 60% vermicompost treatment and the lowest number of buds and open floret was observed in control group, showing a significant difference [9].

Vermicompost which is a product of fragmentation of organic waste of earthworm has been established to be a potential source of nutrient for growth of plants [10, 11]. It has been established that vermicompost contains relatively more amount of nitrogen, carbon and mineral resources [12, 13] befitting the requirement of the recipient plant. Use of such nutrient provide resources essential for building up of molecules in plants to induce better growth, greater capacity to fight disease [14] and to encounter obnoxious chemical substances available in the vicinity of the plants. Such action on plant has been variously mentioned [5, 2, 15-17]. One aspect of such study is also remediation of substance of undesirable nature by plant from the soil, where the role of vermicompost in remediation of metals has been cited [18]. While, vermicompost effects on growth and productivity of plants have been investigated, there have been relatively few investigations on ornamental flowering plants [4, 19] and none on petunia, a widely grown and economically important potted colour crop.

The aim of this study was to determine the effects of different rates of vermicompost of an animal manure origin on the growth and flowering of African marigold (*Tagetes erecta*).

MATERIALS AND METHODS

Plant Material and Cultivation Conditions: This experiment was conducted to investigate effect of vermicompost on growth, flowering and photosynthetic pigments of Ornamental plant *Tagetes erecta*. African marigold seeds were cultured in nursery and transplanted in to culture media containing 10, 20, 30, 40, 50 and 60% [v/v] of vermicompost and cow manure. The seedlings were cultured in 3L pots and the control treatment was composed of three parts of soil, one part of sand and one part of cow rotten manure. One irrigation per day was performed during the experiment and was increased to two times per day by increase in air temperature during spring. Growth indices including growth and development rate, dry and fresh weight of aerial parts, flowering time, plant height, the number of shoots of African marigold between treatment and control group [50% soil: 50% sand] were compared and the best mixing ratio of vermicompost was determined in pot culture media. Results regarding compost analysis are presented in table [20]. The experiment was carried out as completely randomized design with four replications and in each replication, four pot were investigated.

Plant-Growth Parameters: The plant herbage was harvested by cutting above 6 cm above the soil surface and the following data were recorded, plant height [cm], number of open flower/plant, number of shoot/plant, length of lateral shoots [cm], stem diameter [cm], volume root [cm^3], fresh and dry weight of shoot, root and total/plant [g], number of floret and fresh and photosynthetic pigments [mg/ml^{-1}] method according to Lichtenthaler, [21] were calculated.

Estimation of Chlorophyll and Carotenoids: Photosynthetic pigments were measured using Lichtentaller method [21]. 0.2 g of fresh leaf tissue was weight by laboratory balance with accuracy of 0.0001gr and pulverized with mortar in the presence of 10ml of 80% acetone. The resulted solution was filtered through wattman filter paper mounted in glass funnel. The solution volume was increased to 15ml by addition of 80% acetone. 3ml of the solution containing chlorophyll a and b and carotenoids was poured in cuvet and its absorbance was measured in wavelengths of 663.3 nm (chlorophyll a), 646.8 nm (chlorophyll b) and 470 nm (carotenoids) using spectrophotometer device; concentration of the pigments were calculated using.

$$Chl_a\ (mg.ml^{-1}) = (12.5 * A_{663.2}) - (2.79 * A_{646.8})$$

$$Chl_b\ (mg.ml^{-1}) = (21.51 * A_{646.8}) - (5.1 * A_{663.2})$$

$$Chl\ T\ (mg.ml^{-1}) = Chl.a + Chl.b$$

$$Car\ (mg.ml^{-1}) = (1000 * A_{470}) - (1.8 * Chl.a) - (85.02 * Chl.b)/198$$

Table 1: Chemical properties of the vermicompost used to amend the base media. Data are means for four replications

%					ppm				
N	P	K	Mg	Ca	Fe	Zn	Cu	Mn	B
3.3	0.41	2.3	1.8	7.2	325.5	231.7	61.8	396.5	7.3

Where chl.a, chl.b, ch1 total and car are concentration of chlorophyll a, chlorophyll b and carotenoids (carotene and xanthophyll); and $A_{663.2}$, $A_{646.8}$ and A_{470} stand for absorbance in 663.2 nm (chlorophyll a), 646.8 nm (chlorophyll b) and 470 nm (carotenoids), respectively.

Data Analysis: Analysis was performed on data using SPSS ver 16. Comparisons were made using one-way analysis of variance and Duncan's multiple range tests. Differences were considered to be significant at $P < 0.05$.

RESULTS AND DISCUSSION

The highest volume root and number of open floret was achieved in 60% vermicompost treatment and the lowest volume root and number of open floret was observed in 30% and control treatment, showing a significant difference. Atiyeh *et al.,* [4] investigated the effects of swine manure vermicompost on growth and yield of French tagetes under greenhouse condition. Maximum plant height and length of lateral shoots was achieved in the medium containing 50% vermicompost. In an experiment conducted by Hashemimajd *et al.,* [22] on the effects of different vermicomposts on growth and nutrition uptake by tomato, it was observed that addition of vermicompost in to the pot culture media had more dry matter yield compared to compost. Moreover, addition of vermicompost improved physical and chemical properties of pot culture media; this is in agreement with the results we obtained in the present study.

Results showed that the stem diameter and number of open flower/plant were obtained by 40% vermicompost treatment. For example, addition of small quantity of vermicompost to soil-free culture media increased seed germination and growth of tagetes, tomato and pepper in greenhouse condition when all the necessary elements were available [4].

Table 2: Effect of vermicompost on growth and flowering parameters of *Tagetes erecta*.

Vermicompost (%)	volume root (cm^3)	Plant height (cm)	Length of lateral shoots (cm)	No. of shoot/plant	Stem diameter (cm)	No. of open flower/plant	No. of floret
0	18.50ab	24.35a	14.25bc	5.75a	0.14cd	18bc	13b
10	14.50ab	19.50b	15.10ab	6a	0.12d	15c	13b
20	12.50b	19.85b	13.61bcd	5a	0.23b	13c	15.50b
30	9b	20.45b	12.05cd	5a	0.15cd	19abc	12.50b
40	19ab	19.7b	11.73d	5a	0.26a	25.50a	15b
50	19ab	26.65a	17.15a	4a	0.22b	25a	16b
60	25a	19.20b	13.45bcd	4a	0.19bc	23ab	26.50a

*Means separated by Duncan's multiple ranges test at the P< 0.05 level

Table 3: Effect of vermicompost on fresh and dry weight of plant parameters of *Tagetes erecta*.

	Fresh weight of plant (g)			Dry weight of plant (g)		
Vermicompost (%)	shoot	root	total	shoot	root	total
0	5.97b	6.92ab	12.89b	1.10b	2.26bc	3.36de
10	5.99b	3.79b	9.78b	1.15b	0.80c	1.95e
20	12.50ab	7.51ab	20.02ab	1.76b	2.11bc	3.88cde
30	12.89ab	6.76ab	19.66ab	2.46ab	2.69b	5.16cd
40	12.02ab	10.25ab	22.27ab	2.05ab	3.39ab	5.44bc
50	10.29ab	11.98ab	22.27ab	2.64ab	4.65a	7.29ab
60	16.40a	15.75a	32.15a	3.44a	4.52a	7.96a

*Means separated by Duncan's multiple ranges test at the P< 0.05 level

Table 4: Effect of vermicompost on Photosynthetic pigments of *Tagetes erecta*.

	[mg/ml^{-1} fresh weight]				
Vermicompost (%)	Chl. (a)	Chl. (b)	Total Chl. a+b	Carotenoids	Total pigments
0	7.80b	3.74b	11.54bc	2.50c	14.05c
10	7.78b	3.27b	11.06c	2.83bc	13.89c
20	8.02b	4.17ab	12.19bc	2.60c	14.79bc
30	8.11b	3.46b	11.57bc	2.87bc	14.46bc
40	8.36b	5.24a	13.61b	3.33b	16.94b
50	8.36b	4.80ab	13.16bc	2.87bc	16.04bc
60	12.65a	4.85ab	17.50a	3.89a	21.39a

*Means separated by Duncan's multiple ranges test at the P< 0.05 level

By application of vermicomposts resulted from paper and food residues on strawberry, Aracnon *et al.,* [2006] showed that application of vermicomposts increased yield and improved nitrogen and phosphorus uptake. The lowest number of shoots was achieved in 40% vermicompost which shows statistically significant difference [$p<0.05$]. Atiyeh *et al.,* [4] evaluated addition of swine manure vermicompost as 0, 10, 25, 50 and 100% in to metro-mix 360 commercial culture medium and showed that concentrations of 25 to 50% significantly increased growth and yield of the plants. Their investigation indicated that even in tomato and pepper, the highest rate of growth and yield was achieved by application of vermicompost [35-50%] and liquid fertilizer.

Number of shoots/plant was or non significantly affected by the treatments so that the highest rate of this trait was achieved in 10% vermicompost. Vermicompost has a high special area which provides large porosity for better retention of water and nutrients and activity of microorganisms [23].

The fresh and dry weight of plant was achieved in 60% compost treatment. Application of organic improving material such as thermophilic composts results in amendment of soil structure, soil productivity [24], increased variation of microbial population [25], increased bacterial activity [13] and improvement of water retention capacity of soil and improvement of crop yield. Vermicompost contains plant growth regulating substances and other substance which are produced by microorganisms and affect plant growth [26]. Krishnamoorthy and Vajrabhiah, [27] reported that cytokinins and auxines are produced from organic residues processed by earth worms. Vermicompost has been reported to have effects similar to plant growth regulating substances and hormones [28].

Results indicated that vermicompost had significant effect on photosynthetic pigments [$p<0.05$]. The highest content of Chl. (a), Total Chl. a+b, Carotenoids and Sum Pigments was achieved in 60% vermicompost. The highest content of Chl. (b) was obtained in 40% compost which showed significant difference from control treatment. Investigations show that vermicompost permanently enhances biological activity and can be used for improvement of seed germination, flowering, growth and yield compared to commercial culture media which lack applicable nutrition [4]. Vermicompost contains available nutrition often in the form of nitrate, phosphate, exchangeable calcium and soluble potassium [3]. Tomati *et al.,* [26] showed that has significant effect on seed germination via water retention, nutrition supply and production of plant hormones; so can have positive effect on growth of ornamental plants.

CONCLUSION

According to the results obtained in this experiment, application of vermicompost can be useful for *Tagetes erecta*; so that for some traitsthe lowest yield and growth was achieved in control treatment while the highest one was obtained in 40, 50 and 60% vermicompost treatment.

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