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Vermicompost effects on the growth and flowering of marigold (*Calendula officinalis*)

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ABSTRACT

The effects of vermicompost of an animal manure origin on the growth and flowering of Calendula officinalis 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 total parameter compared to both control amended media. The highest root volume, fresh weight of petal and shoot was achieved in 30% compost treatment. Plant performance was best in the 60% vermicompost medium.

Key words: Animal Manure, *Calendula officinalis*, chlorophyll, Vermicompost.

INTRODUCTION

Calendula officinalis [pot marigold, common marigold, garden marigold, English marigold, or Scottish marigold] is a plant in the genus *Calendula* of the family *Asteraceae*. It is probably native to southern Europe, though its long history of cultivation makes its precise origin unknown, and it may possibly be of garden origin [14]. This plant is an annual plant with yellow to orange flowers and includes a high number of carotenoids such as flavoxanthin, lutein, rubixanthin, b-carotene, g-carotene, and lycopene [21].

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 [9,22]. Vermicomposts are typically finely divided peat-like materials with high porosity, aeration, drainage and waterholding capacity [10]. Atiyeh et al. [5] 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. [3] 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. [15] 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 [13]. Similarly, vermicompost applications increased strawberry plant growth and yield significantly; including increases of up to 37% in leaf area, 37% in shoot biomass, 40% in flower numbers, 36% in plant runner numbers and 35% in marketable fruit weights [1].

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 [4,8]. It has been established that vermicompost contains relatively more amount of nitrogen, carbon and mineral resources [29,6] 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 [10] and to encounter obnoxious chemical substances available in the vicinity of the plants. Such action on plant has been variously mentioned [28, 24, 26, 22, 3]. 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 [17].

While vermicompost effects on growth and productivity of plants have been investigated, there have been relatively few investigations on ornamental flowering plants [5,23] 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 Marigold [*Calendula officinalis*].

MATERIALS AND METHODS

This experiment was conducted to investigate effect of vermicompost on growth, flowering and photosynthetic pigments of medical plant calendula variety yellow. 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 traditional base medium [control] was a mixture of 70% farm soil and 30% sand [v/v]. One irrigation per day was performed during the experiment and was increased to two times per day by increase in air temperature during spring. Results regarding compost analysis are presented in table [1]. the experiment was carried out as completely randomized design with four replications and in each replication, four pot were investigated.

The plant herbage was harvested by cutting above 6cm over 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 petal, shoot, root and total/plant [g], No. of floret and fresh and and Photosynthetic pigments [$\mu g/ml^{-1}$] method according to Lichtenthaler [19] were calculated.

Experimental Design and Statistical Analysis

Experiment was arranged in a complete randomized design with four replications. Analysis of variance was performed on the data collected using the general linear model (GLM) procedure of the SPSS software)Version 16, IBM Inc.). The mean separation was conducted by dancan analysis in the same software (p= 0.05).

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.[illegible]	231.7	61.[illegible]	396.[illegible]	7.[illegible]

RESULTS AND DISCUSSION

The highest number of bud and open floret, root dry weight, root and shoot fresh weight was achieved in 60% vermicompost treatment and the lowest number of bud and open floret was observed in control group, showing a significant difference. Atiyeh et al. [5] investigated the effects of swine manure vermicompost on growth and yield of French tagetes under greenhouse condition. This study showed that the highest rate of vegetative growth was obtained by replacing 30 and 40% of commercial medium with vermicompost and the lowest rate was obtained by

mixing 90 and 100% vermicompost. Maximum number of flower bud was achieved in the medium containing 40% vermicompost and lowest number of flower bud was obtained in the pots containing 100% vermicompost. The lowest number of flower and the smallest flowers were obtained in pots containing 90 and 100% vermicompost. In an experiment conducted by Hashemimajd et al. [16] 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.

Table 2- Effect of vermicompost on growth and flowering parameters of *C. officinalis* L.

Vermicompost (%)	volume root (cm^3)	Plant Height (cm)	Length of lateral shoots (cm)	No. of shoot/plant	Stem Diameter (cm)	number of open flower/plant	No. of floret
0	16.25d	20.62bc	9.10b	8ab	0.21abc	8.50c	
10	23.25bc	23.37abc	9.65b	9.75ab	0.16abc	14b	13.50b
20	24.75bc	26.87a	10.44ab	11.50a	0.20abc	16.25ab	11.50b
30	33.50a	25.37ab	11.54ab	10.25a	0.11c	12.25bc	13.25b
40	19cd	24.12abc	16.06a	6.50b	0.23ab	17ab	12.25b
50	22.75bc	19.12c	10.78ab	8.75ab	0.27a	17.25ab	20.75a
60	25.50b	21.06bc	12.54ab	9ab	0.15bc	20.75a	21.25a

**Means separated by Duncans multiple ranges test at the P< 0.05 level*

Results showed that the largest height of plant and the highest number of shoot were obtained by 20% vermicompost treatment. The lowest height of plants was obtained in 50 and 60% vermicompost suggesting that high levels of vermicompost have negative effect on plant height. 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 [5].

Table 3- Effect of vermicompost on growth and flowering parameters of *C. officinalis* L.

Vermicompost (%)	fresh weight of plant (g)				dry weight of plant (g)			
	petal	shoot	root	total	petal	shoot	root	total
0	0.38cd	22.31b	12.93b	8.70c	0.05a	4.66a	4.04b	35.24c
10	0.61abc	26.24ab	18.11ab	13.83b	0.07a	5.32a	8.51ab	44.35c
20	0.74ab	48.89ab	23.01ab	17.34ab	0.08a	11.30a	6.04ab	71.90b
30	0.81a	47.82ab	29.37a	20.86a	0.09a	13.78a	7.07ab	77.19b
40	0.54bcd	50.20ab	21.46ab	15.92ab	0.07a	12.34a	4.08b	71.66b
50	0.48cd	51.40ab	21.84ab	16.87ab	0.04a	10.83a	6.26ab	73.24b
60	0.34d	85.43a	30.32a	20.42a	0.05a	10.21a	10.21a	115.76a

**Means separated by Duncans 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.

Length of lateral shoots was significantly affected by the treatments so that the highest rate of this trait was achieved in 40% vermicompost and the lowest one was obtained in control group, showing significant difference [$p<0.05$]. Vermicompost has a high special area which provides large porosity for better retention of water and nutrients and activity of microorganisms [25].

The highest root volume, fresh weight of petal and shoot was achieved in 30% compost treatment. The lowest root volume and fresh weight of petal was obtained in control and 60% treatment. Dry weight of shoot and petal was not significantly affected. Application of organic improving material such as thermophilic composts results in amendment of soil structure, soil productivity [12], increased variation of microbial population [7], increased bacterial activity [29] and improvement of water retention capacity of soil and improvement of crop yield.

Stem diameter was not significantly affected. The highest and lowest stem diameter was achieved in 50% and 30% vermicompost respectively, showing significant difference. Vermicompost contains plant growth regulating substances and other substance which are produced by microorganisms and affect plant growth [27]. Krishnamoorthy and Vajrabhiah, [18] 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 [20].

Results indicated that vermicompost had significant effect on photosynthetic pigments [$p<0.05$]. The highest content of chlorophyll a was achieved in 20 and 30% vermicompost and the lowest one was achieved in control [no vermicompost], but these were not significantly difference. The highest content of chlorophyll b was obtained in 40% compost which showed significant difference from control. Chlorophyll b was increased by increase in vermicompost volume up to 40% and reduced by vermicompost increase to 50%. The lowest content of chlorophyll b was obtained in control which was significantly different from other treatments. The highest content of total chlorophyll was achieved in 40% vermicompost which is significantly different from control. The lowest chlorophyll b content was achieved in control group showing significant difference from other treatments.

Table 4- Effect of vermicompost on Photosynthetic pigments of *C. officinalis* L

Vermicompost (%)	[µg/ml^{-1} fresh weight]				
0	Chl. (a)	Chl. (b)	Total Chl. a+b	Carotenoids	sum pigments
10	8.54a	2.19d	10.73b	1.35a	11.72d
20	8.57a	3.79c	12.36ab	1.27a	13.63c
30	9.06a	3.85c	12.92ab	1.13ab	14.79bc
40	9.37a	5.04b	14.41a	0.79c	14.44c
50	9.39a	6.25a	15.14a	1.02b	16.04bc
60	8.95a	3.64c	13.09ab	1.02ab	13.89c

**Means separated by Duncans multiple ranges test at the P< 0.05 level*

Table [4] shows that by increasing vermicompost to 30%, total chlorophyll content was increased. The highest carotenoid and total pigment content was achieved in control [no vermicompost] and 40% vermicompost. 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 [3]. Vermicompost contains available nutrition often in the form of nitrate, pjosphate, exchangeable calcium and soluble potassium [10]. Tomati et al. [27] 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 Marigold; so that for some traits the lowest yield and growth was achieved in control group while the highest one was obtained in 60% vermicompost treatment.

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