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Vermicompost Effects on the Growth and Flowering of *Petunia hybrida* 'Dream Neon Rose'

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Abstract: The effects of vermicompost of an animal manure origin on the growth and flowering of *Petunia hybrida* 'Dream Neon Rose' grown under glasshouse conditions were determined. Petunia 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 20, 40 and 60% or sphagnum peat incorporated at 30 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 and peat amended media. Plant performance was best in the 20% vermicompost medium. Further increasing the vermicompost content in the base media decreased flower numbers, leaf growth rates and shoot fresh and dry weights. Plant performance was poorest in the 60% sphagnum peat medium. Plant tissue analysis revealed that total extractable N, P and K were highest in petunia plants grown in the 60% vermicompost medium and were lowest in plants grown in the 60% peat medium. Use of vermicompost tended to increase tissue Ca and Mg concentrations compared to the control. However, these trends were generally not significant at $P<0.05$. Fe was also highest in plants grown in the 60% vermicompost medium and was lowest in plants grown in the control medium. Zn concentrations were highest in plants grown in 60% peat medium and lowest in plants grown in the control medium. Cu and Mn concentrations in petunia plants grown in vermicompost media were significantly ($P<0.05$) lower than for those grown in the control medium. Thus, the beneficial effects of vermicompost were associated with elevated tissue concentrations of the macronutrients.

Key words: Vermicompost . animal manure . *Petunia hybrida* . sphagnum peat

INTRODUCTION

Petunia (*Petunia*×*hybrida*) belongs to the Solanaceae family [1]. Petunias are perennials in warm climates and are used mainly as annual bedding and container plants in temperate zones [2]. Sphagnum peat moss is derived from dead organic material that accumulates in the lower levels of a sphagnum bog and is used as a soil conditioner and/or replacement by gardeners [3]. There is increasing interest in the potential use of vermicomposts as plant growth media and soil amendments. These are products of a non-thermophilic 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 [4, 5]. Vermicomposts are typically finely divided peat-like materials with high porosity, aeration, drainage and waterholding capacity [6].

Atiyeh *et al*. [7] 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*. [8] 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*. [9] reported that incorporation of earthworm castings increased plant

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(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 [10]. 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 [11].

Nutrients in vermicompost are present in readily available forms for plant uptake; e.g. nitrates, exchangeable P, K, Ca and Mg [6]. Senthilkumar *et al*. [12] found that vermicompost ± NPK fertilizers significantly enhanced rose growth, yield and quality over the untreated control, especially when used in combination. Application of 75% RFR (recommended fertilizer rates) + 200 g vermicompost and 100% RFR + 200 g vermicompost per plant resulted in greater plant heights, leaf areas, shoot and root dry weights and numbers of laterals per plant. Plant available N, P and K were higher in plots supplied with both vermicompost and NPK fertilizers [12]. Premuzic *et al*. [13] reported that for tomatoes grown on organic substrates, such as vermicompost, the fruit contained significantly more Ca and vitamin C (but less Fe) than those grown in a hydroponics medium. No differences were found in P and K concentrations. Sainz *et al*. [14] reported that addition of vermicompost to soil resulted in increased mineral contents in the substrate and higher concentrations P, Ca, Mg, Cu, Mn and Zn in shoot tissues of red clover and cucumber. Kumari and Ushakumari [15] reported that treatment with enriched vermicompost was superior to other treatments for the uptake of N, P, K, Ca and Mg by cowpea.

Vermicomposts are comprised of large amounts of humic substances, some of the effects of which on plant growth are similar to those of soil-applied plant growth regulators [16]. For peppers, an improvement of the physical structure of the potting medium, increases in populations of beneficial microorganisms and enhanced availability of plant growth influencing substances produced by microorganisms in vermicomposts were factors considered to have contributed to increased fruit yields [17].

While vermicompost effects on growth and productivity of plants have been investigated, there have been relatively few investigations on ornamental flowering plants [7, 12] 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 *Petunia hybrida* 'Dream Neon Rose' compared to traditional media and sphagnum peat amendments.

MATERIALS AND METHODS

Petunia plants were grown in the greenhouse of Horticulture Department at the Mohaghegh Ardebil University, Iran. Seeds were germinated in small trays with the same medium for each treatment, transplanted into final pots (treatment media) and grown-on for 150 days. There was one plant per pot during the growing on phase. The traditional base medium (control) was a mixture of 70% farm soil and 30% sand. The farm soil was a clay classification. Other treatment media were either vermicompost incorporated at 20, 40 and 60% or more conventional sphagnum peat incorporated at 30 and 60%.

Time to flowering was recorded as time from seeding to first open flowers. Total leaf numbers per pot were determined each 10 days from seed germination up to 70 days, when leaf number counting was stopped because of high leaf density. Flower numbers per pot were counted each 10 days from 80 days after seeding. Finally, petunia plants were removed from their pots and shoot (leaf + flower + stems) fresh weights were recorded. The shoot material was then dried in an oven (60°C) for 2 days. Dry weights were recorded and the tissue used for nutrient analyses.

Chemical properties of soil, cattle manure vermicompost and peat were determined prior to seeding (Table 1). Soil and vermicompost pH were measured in deionised water (solids/solution ratio of

Table 1: Chemical properties of the base media (farm soil plus sand) and vermicompost and sphagnum peat used to amend the base media. Data are means for three replications

	%		mg/kg						(1:2.5)	mmho/cm	meq/l	
Media	OC	N	P	K	Fe	Mn	Zn	Cu	pH	EC	Ca	Mg
Soil	2.02	0.079	24.480	232.60	3.65	7.08	2.83	1.86	7.64	1.04	7.6	4.4
Vermicompost	12.87	2.100	66.500	371.00	22.49	28.68	32.75	2.71	7.84	6.50	16.0	11.0
Peat	20.28	1.120	0.018	0.84	11.53	0.74	0.29	0.36	3.50	0.74	5.0	2.0

1: 2.5) using a pH meter. Electrical conductivity (EC) was measured in the effluent and in a saturated solution extract of the vermicompost [18]. Organic carbon was determined by the Walkley-Black method [19]. Methods of measuring N, P, K, Ca and Mg in soil and plants are described below. Diethentriaminpentaacetic acid (DTPA) extractable Zn, Fe, Cu and Mn were determined in soil samples by atomic absorption spectroscopy (Perkin Elmer, type 3041, series 3000) [20].

Nutrient concentrations in plant samples were determined on shoot material rinsed with distilled water before being dried in an oven (see above) and then ground by a Wiley mill, mixed well and stored in air tight containers. Total N was determined in dried tissue samples of 1 g d.w. by the Kjeldhal method using concentrated H_2SO_4, K_2SO_4 and selenium to digest the sample and in soil was determined according to Bremner and Mulvaney [21]. For other nutrients, each ground sample (2 g) was ashed in a muffle furnace at 550°C. The white ash was dissolved in 2 N HCl and made up to 100 ml with distilled water. P was determined by the colourimetric method of Olsen *et al*. [22]. A flame photometer type JENWAY PFP 7 was used for determination of K. Ca and Mg were measured according to Houba *et al*. [23]. Zn, Fe, Cu and Mn were determined by atomic absorption spectroscopy [24].

The experiment was a completely randomized design with 9 replicates of each treatment. Data were analyzed by one way ANOVA (Minitab Version 13.1). Least significant difference (LSD; P = 0.05) values were calculated for comparisons of treatment means.

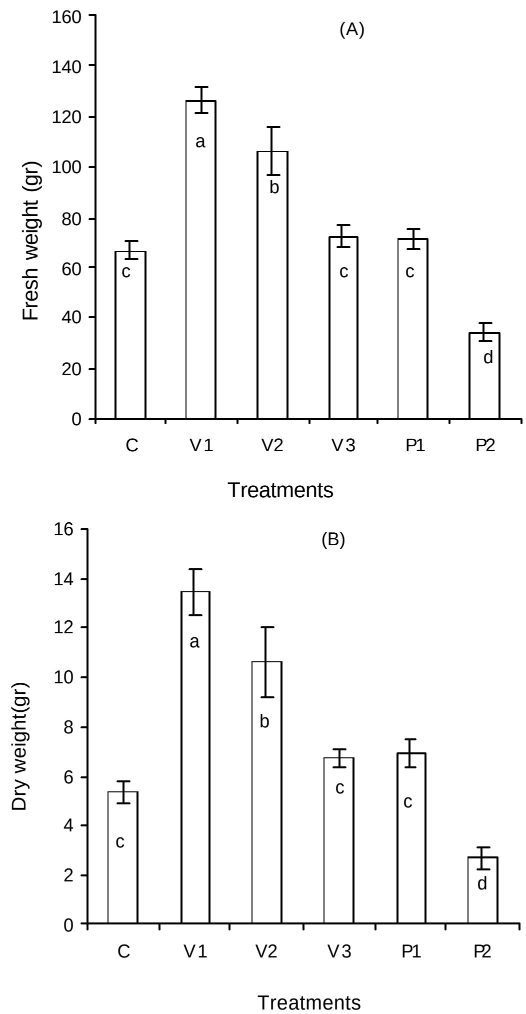

Fig. 1: Fresh (A) and dry (B) weights of petunia shoot tissues produced in media substituted with various volumes of either vermicompost (V1 = vermicompost 20%; V2 = vermicompost 40% and V3= vermicompost 60%) or sphagnum peat (P1 = peat 30% and P2 = peat 60%) versus the base control medium (C). Data are means of 9 replications

RESULTS AND DISCUSSION

Shoot fresh and dry weights: Media with 20 and 40% vermicompost incorporated significantly ($P<0.05$) increased fresh and dry weights of petunia shoots compared to both the control and peat amended media (Fig. 1). No significant differences were found among media amended with 60% vermicompost, 30% peat and the control. Fresh and dry weights of plants grown in the 60% peat medium were the lowest ($P<0.05$) compared to all other treatments.

Leaf numbers: Total leaf numbers per pot for media with 20 and 40% vermicompost incorporated, were significantly ($P<0.05$) higher than for all other treatments during the experiment (Fig. 2). Vermicompost at 60% gave more leaves than did control and peat amended media. The lowest leaf numbers were from 60% peat amended media and the control. Significant differences for the 30% peat media compared to control were apparent on days 50, 60 and 70.

Flower numbers: Media with 20 and 40% vermicompost incorporated produced significantly ($P<0.05$) higher flower numbers compared to the control (Fig. 2). No significant difference was found between 20 and 40% vermicompost, except on day 1 (i.e. at 80 days after seeding). Media with 60% vermicompost gave significantly ($P<0.05$) increased

Table 2: Nutrient concentrations in shoot tissues of petunia plants grown in media with either 20, 40 and 60% vermicompost (V1 = vermicompost 20%; V2 = vermicompost 40% and V3 = vermicompost 60%) or 30 and 60% peat (P1 = peat 30% and P2 = peat 60%) incorporated versus the base media control (C) at 150 days after seeding. Data are means for three replications

	%			meq/l		mg/kg			
Treatments	TN	P	K	Ca	Mg	Fe	Mn	Zn	Cu
V1	2.906c	0.285c	4.36c	13.66a	2.66bc	166.34bc	30.22b	13.86d	9.90c
V2	3.046b	0.313b	5.26b	15.33a	3.33bc	216.14b	26.04b	15.32cd	10.54c
V3	3.430a	0.356a	6.45a	16.00a	6.66a	323.96a	26.04b	17.58bc	10.51c
C	2.530d	0.209 d	3.90cd	13.33a	2.33c	91.14 d	42.60a	12.21d	15.90a
P1	2.430 d	0.114 e	3.77 d	14.00a	3.50bc	115.00cd	30.41b	20.37bc	14.25ab
P2	1.870 e	0.122 e	3.57 d	13.00a	3.00bc	135.89cd	24.04b	23.79a	13.11b

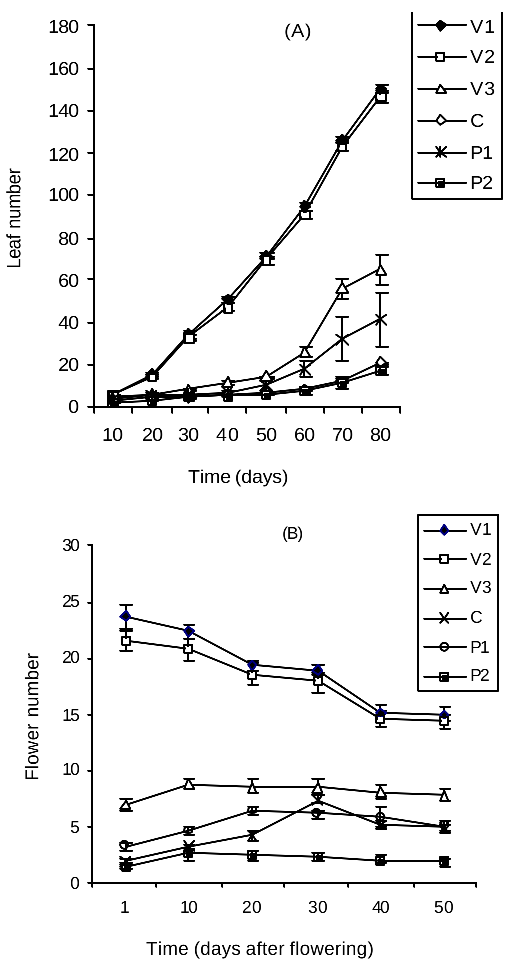

Fig. 2: Leaf (A) and flower (B) numbers for petunia shoots produced in media substituted with various volumes of either vermicompost (V1 = vermicompost 20%; V2 = vermicompost 40% and V3= vermicompost 60%) or sphagnum peat (P1 = peat 30% and P2 = peat 60%) versus the base control medium (C). Data are means of 9 replications. Day 1 for flower numbers represents 80 days after seeding

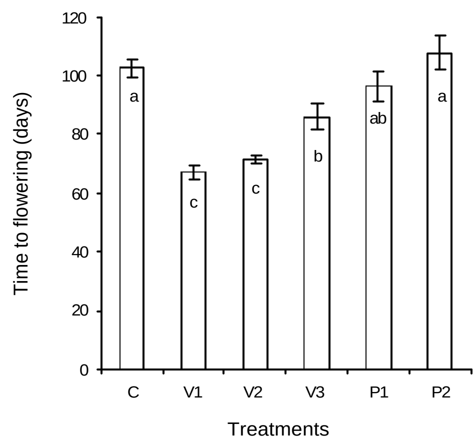

Fig. 3: Time to flowering of petunia plants produced in media substituted with various volumes of either vermicompost (V1 = vermicompost 20%; V2 = vermicompost 40% and V3 = vermicompost 60%) or sphagnum peat (P1 = peat 30% and P2 = peat 60%) versus the base control medium (C). Data are means of 9 replications

flower production compared to control, except on day 30. Media amended with 60% peat significantly (P<0.05) decreased flower numbers after days 20 compared to the control.

Times to flowering: Plants potted in media with 20, 40 and 60% vermicompost incorporated produced flowers significantly (P<0.05) sooner than other treatments (Fig. 3). Significant differences were found between the 60% and the 20 and 40% vermicompost treatments. No significant differences (P<0.05) were found among the 30 and 60% peat amended media and the control.

Nutrients in shoot tissues: N concentrations in petunia shoot tissues increased significantly (P<0.05) with increasing of vermicompost volumes in the base media compared to the control (Table 2). No significant difference was found between the 30% peat amended media and the control. The N concentration in shoot tissues was decreased significantly (P<0.05) in 60% peat media compared to the control. P concentrations in plant tissues increased significantly (P<0.05) with increasing of vermicompost volumes in the media compared to the control. Plants grown in the 30 and 60% peat amended media had significantly (P<0.05) lower P concentrations in shoot tissue compared to the control. Plants grown in the media with 40 and 60% vermicompost incorporated had significantly (P<0.05) higher K concentrations compared to the control. No significant difference in K was found between plants grown in the media with 20% vermicompost and the control. N, P and K contents of base media would be increased by addition of vermicompost (Table 1).

Similarly, addition of vermicompost to the base media tended to increase concentrations of total Ca and Mg compared to the control (Table 2). However, this response was not significant at P<0.05, except for Mg at 60% vermicompost. The Fe content of plant tissues increased significantly (P<0.05) with increasing vermicompost volume in the base media compared to the control. No significant difference was found, however, between plants grown in the peat amended media and the control. Addition of either vermicompost or peat to base media significantly (P<0.05) decreased Mn concentrations in petunia shoot tissues compared to the control. The Zn concentrations in plant tissues tended to increase with increasing of vermicompost and peat incorporation in the base media compared to the control, but the effect was significant (P<0.05) only for plants grown in 60% vermicompost and 30 and 60% peat amended media. Addition of vermicompost to media significantly (P<0.05) decreased the Cu concentrations in petunia shoot tissues compared to the control. No significant difference in Cu concentration was found between plants grown in the 30% peat amended media and the control.

DISSCUSSION

Incorporation of vermicompost had significant (P<0.05) positive effects on flower numbers, leaf growth and fresh and dry weights compared to both the base control and peat amended potting media. Similarly, Atiyeh *et al*. [7] found that fresh weights of marigold plant shoots at 121 days after seeding were greatest in potting mixtures containing 30% and 40% pig manure vermicompost. However, they were least in potting mixtures of 90% and 100% vermicompost. Bugbee and Frink [25] reported that when a greenhouse container medium was amended with 10, 20, 30, 40 and 50% sewage sludge compost, the shoot dry weights of marigold plants improved significantly. Maximum marigold growth occurred in the 30% compost containing mixture. Growth of tomato seedlings was greatest after substitution of commercial Metro-Mix 360 with between 25% and 50% pig manure vermicompost [26]. Substituting Metro-Mix 360 with 5, 10, 25 and 50% pig manure vermicompost progressively increased leaf numbers, shoot lengths and shoot dry weights at 14 and 21 days after germination of tomato seedlings with no fertilizer treatment compared with the Metro-Mix control. Subler *et al*. [5] reported that the incorporation of small amount (10%) of pig manure vermicompost into a commercial bedding plant potting media was sufficient to produce a significant increase in the total biomass of tomato seedlings after 3 weeks of growth in the greenhouse. Increasing of flower numbers by vermicompost amendments is also in agreement with a report by Gajalakshmi and Abbasi [10], where use of vermicompost led to significant improvements in both growth and flowering of crossandra compared to untreated control plants. Substituting Metro-Mix 360 with pig manure vermicompost not only improved the growth of marigold seedlings, but it also significantly (*P*<0.05) increased the numbers of flower buds produced [7]. The greatest numbers of flower buds were in the potting mixture containing 40% pig manure vermicompost and 60% Metro Mix 360; viz. 19% more than in the Metro-Mix 360 only control. Substitution of vermicomposts into greenhouse container media has been associated with increased germination, seedling growth and flowering of ornamentals and growth and yield of vegetables even at low substitution rates and independent of nutrient supply [7, 26].

N, P, K, Fe and Zn (only at 60% vermicompost) concentrations in petunia plant shoot tissues increased significantly (P<0.05) with increasing vermicompost volumes in the base media compared to the control (Table 2). Atiyeh *et al*. [7] reported significant increases in N concentrations in the leaves of 121 days marigold plants grown in the vermicompost / Metro-Mix 360 mixtures, which evidently resulted in greater root and shoot growth. However, there were no significant differences (*P*>0.05) at 28 days after seeding in either nitrate-N concentrations or total N concentrations in marigold between the Metro-Mix 360 control and this media substituted with 40% pig manure vermicompost. This lack of difference could possibly be explained by the significant increases in shoot weights of marigold seedlings after substitution of Metro-Mix 360 with 40% vermicompost. The tissue N concentrations of tomato seedlings grown without fertilizer in media with 10, 25, 50 and 100% pig manure vermicompost amendments and harvested 14 days after germination were significantly greater than those of plants grown with 5% and no vermicompost incorporated [26]. Decreased plant growth when the volume of pig manure vermicompost approached 100% could possibly be attributed to high concentrations of soluble salts in the pig manure vermicompost, poor porosity and / or poor aeration. For roses, available N, P and K were higher in plots supplied with both vermicompost and NPK fertilizers [12]. Sainz *et al*. [14] reported that addition of vermicompost to soil increased nutrient contents in the substrate and gave higher concentrations of P, Ca, Mg, Cu, Mn and Zn in shoot tissues of red clover and cucumber. Kumari and Ushakumari [15] reported that enriched vermicompost was a superior treatment for enhancing uptake of N, P, K, Ca and Mg by cowpea.

Considered collectively, the results of this study indicate that incorporation of vermicompost of animal origin into a traditional base medium of farm soil and sand enhanced growth and flowering of potted petunia plants through, at least in part, improved mineral nutrition. In this context, verimicompost proved to be a superior soil amendment to sphagnum peat moss.

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