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Effects of the Biofertilizers Vermicompost and Azotobacter on Qualitative and Quantitative Characteristics of *Petunia hybrida*

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ABSTRACT: *Petunia* belongs to the genus Petunia and family Solanaceae and is a native of South America. An experiment laid out in the factorial arrangement using the completely randomized design with 2 factors and 4 replications was conducted to study the effects of Vermicompost and Azotobacter biofertilizers on qualitative and quantitative characteristics of two cultivars: Persian petunia and Petunia hybrida. The treatments were various application rates of vermicompost (12.5, 23, 37.5, and 50 g/m2) and the various rates of Azotobacter (0, 25, 50, 75, and 100 %). The variety in this experiment was Petunia hybrida. Results of ANOVA indicated the effects of Vermicompost on plant height, stem diameter, number of flowers, fresh and dry weight per plant, dry weight of aerial organs, dry weight of roots, and flower diameter, and the effects of Azotobacter on dry weight of aerial organs were significant at the 1% level. However, Vermicompost had no significant effects on number of leaves. In the Persian cultivar, the effects of Vermicompost on fresh weight per plant and number of leaves were significant at the 1% level. The mutual effects of Vermicompost and Azotobacter were not significant on any of the characteristics, and Vermicompost with 37.5 g/m2 had the maximum effect on flowering in *Petunia hybrida* (which was significantly greater than that of the control).

Keywords: *Petunia hybrida*, Azotobacter, Vermicompost, Organic Fertilizer

INTRODUCTION

Excessive use of fertilizers will cause environmental pollution and will destroy the balance of the ecosystem that is one of the major problems (Mishra, 2004). Thus, biological fertilizers can be considered a suitable solution for overcoming this problem, further by adding beneficial organisms to improve soil fertility and increasing fertilizer planting beds in hydroponic greenhouses and also increase the qualitative and quantitative products. In fact, using organic fertilizers like vermicompost and mycorrhizal fungi can be used in a sustainable agricultural system (Saleh, 2001). The use of organic matter such as animal manures, human waste, food wastes, yard wastes, sewage sludge and composts have long been recognized in agriculture as beneficial for plant growth, yield and in the maintenance of soil fertility. Traditional composting of organic matter wastes have been known for many years. But new methods of thermophilic composting have become much more popular in organic waste treatment recently. Vermicompost has been recognized as a low cost and environmentally sound process for treatment of many organic wastes (Hoitink, 1993). (Edwards and Burrows, 1988) reported that vermicompost, especially those from animal waste sources, usually contained more mineral elements than commercial plant growth media. Many of these elements were changed to forms more that could be readily taken up by the plants, such as nitrates, exchangeable phosphorus and soluble potassium, calcium and magnesium. (Werner and Cuevas, 1996) reported that most vermicompost contained adequate amounts of macro nutrients and trace elements of various kinds but were dependent on the sources of the worm feed stock. Earthworms digested the organic waste and convert to vermicompost with high porosity, water absorption and retention water that improved growth plant and increased of crop yield (Arancon, 2004). Edward and Bätz (1992) found that earthworms were increased significantly plant growth in culture media. Ghosh, *et al.* (1999) observed that integration of vermicompost with inorganic fertilizers tended to increase the yield of crops *viz* potato, rape seed, mulberry and marigold over other traditional composts.

The application of vermicompost rendered better performance in respect of all round growth of mulberry plants in the lateritic soil of South West Bengal (Chakraborty, *et al.,* 2008). One of the unique features of vermicompost is that during the process of conversion of various organic wastes by earthworms, many of the nutrients are changed to their available forms in order to make them easily utilizable by plants. Therefore, vermicomposts have higher level of available nutrients like nitrate or ammonium nitrogen, exchangeable phosphorous and soluble potassium, calcium and magnesium derived from the wastes (Buchanan, *et al.,* 1988). The paper has attempted to evaluate comparative efficacies of vermicompost developed by indigenous method on tomato plants. Nitrogen is the most limiting factor for high crop productivity. There has been an increased interest in biological nitrogen fixation (BNF) in the context of sustainable agriculture. The interest resulted from high cost of mineral fertilizers and their possible harmfulness to the environment. BNF plays an important role in maintaining soil fertility Vance and Graham (Soliman, *et al.,* 1995). Non-symbiotic nitrogen-fixing bacteria that live in the rhizosphere Dobereiner (Dobereiner, 1997) and/or endophytically HECHT-BUCHHOLZ (Hajnal *et al.,* 2004) often increase yields of cereals and other crops. Free-living N-fixing bacteria play an important role in plant development on account of nitrogen fixation and supply of growth activators. Plant growth regulating substances may be produced the bacteria in the root zone, and in some cases there were indications of biological control of plant pathogens OKON (Milosevic, *et al.,* 2005). Azotobacter is a free-living nitrogen-fixing bacterium (Kennedy *et al.,* 2004). which is used as a biofertilizer in the cultivation of most crops. In the local soils, Azotobacter fixes annually about 60-90 kg N/ha and it may be used in crop production as a substitute for a portion of mineral nitrogen fertilizers (Dobereiner, 1997). The purpose of this study was determining the appropriate level of vermicompost and Azotobacter on plant growth for increased yield of *Petunia hybrida*

MATERIALS AND METHODS

This factorial experiment using the completely randomized design with 2 factors and 4 replications was carried out to study the effects of Vermicompost and Azotobacter biofertilizers on qualitative and quantitative characteristics of *Petunia hybrida*. Various rates of Vermicompost (0, 12.5, 25, 37.5, and 50 g/m2) and various rates of Azotobacter (0, 25, 50, 75, and 100%), together with the control (no Vermicompost or Azotobacter) were applied on two petunia cultivars: the Persian cultivar and *Petunia hybrida*. The experiment was performed in a place 6 km from Mashhad (latitude 36°13°N, longitude 59°40°E, and altitude 985m). Based on Amberger's Climate Classification, Mashhad has a dry and cold climate, with average annual rainfall of 214 mm and minimum and maximum absolute temperatures of -27.8 and 43.4°C, respectively. The mean annual temperature is 12.5, and the mean cold and season temperatures -4 and 24.5°C respectively. Seeds were bought from the Pakan Company in Isfahan and, after determining their viability, they were planted in 3 separate plots in late January 2012 to produce seedlings for transplantation in the main farm in late March. Before transplanting, land preparation operations including plowing, two disking operations performed in perpendicular directions, leveling, mixing Vermicompost, and sculpting, were performed in March. Before mixing the Vermicompost and planting, soil samples were taken from various places in the field to perform physical and chemical soil analysis and to determine the main soil nutrients. After soil analysis, about 5 t dry weight/ha of Vermicompost was applied, which was equivalent to 1 kg/plot. Seedlings were planted in plots with 50 cm between rows and 20 cm between plants. Experimental plots were 2 m long and 1m wide. The measured characteristics included plant height, number of leaves, number of flowers, stem and flower diameter, and fresh and dry weight per plant. SAS was employed for statistical analysis of the data, Duncan's test for comparing the means at the 5% probability level, and EXCEL for drawing the diagrams.

RESULTS AND DISCUSSION

A. Plant height at flowering

Table of ANOVA showed the effects of Vermicompost on plant height at flowering were significant at the 5% (Fig. 1). The tallest plants (31.94 cm on average) were achieved at the Vermicompost rate of 12.5g /m^2, and the shortest (23.22 cm on average) at 50 g/m^2.

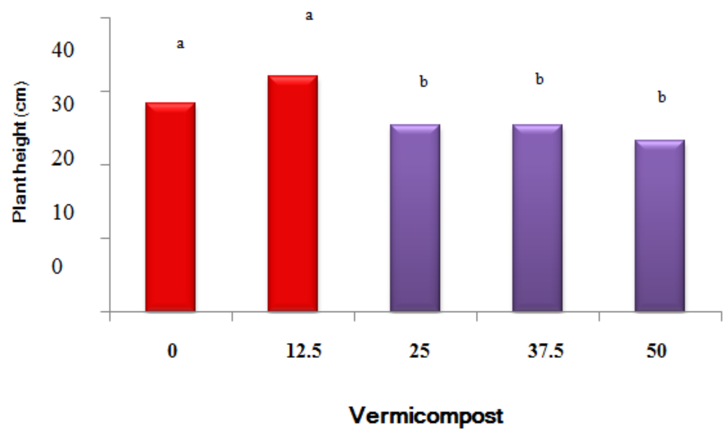

Fig. 1. Average height of *Petunia hybrida* plants under the influence of Vermicompost.

B. Number of flowers

Results of ANOVA indicated that the effects of Vermicompost on number of flowers were significant at the 5% probability level (Fig. 2). The maximum number of flowers (8.4) belonged to Vermicompost application rate of 25 g/m^2, and the minimum (2.83) to no Vermicompost application. However, there were no significant differences between the rates of 12.5 and 50 g/m^2.

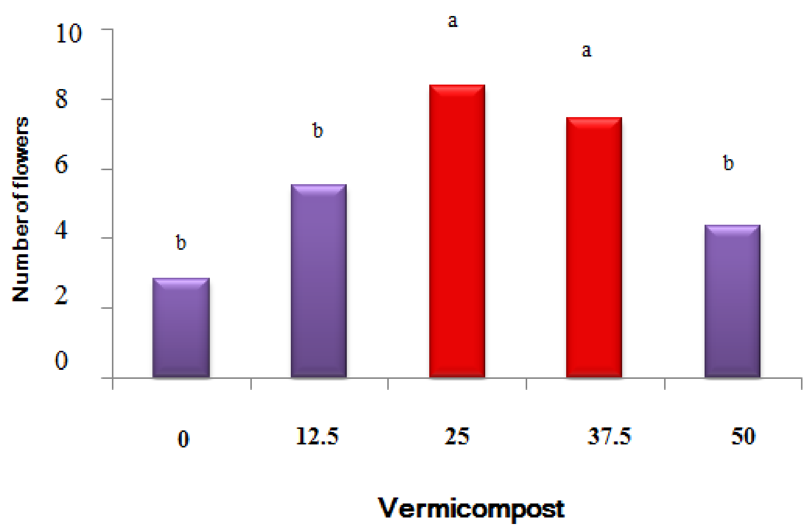

Fig. 2. Mean number of *Petunia hybrida* flowers under the influence of Vermicompost.

C. Stem diameter

Results of ANOVA demonstrated the effects of Vermicompost on stem diameter were significant at the 5% probability level (Fig. 3). The maximum stem lengths were obtained at application rates of 12.5 and 25 g/m^2 (which were significantly different from those of the other rates), and the minimum at the rates of 37.5 and 50 g/m^2.

D. Fresh weight per plant

Comparison of the means showed the effects of Vermicompost on fresh weight per plant were significant at the 5% probability level. The largest average fresh weight per plant (46 g/plant) was observed at the rate of 37.5 g/m^2, and the smallest (37.83 g/plant) at 50 g/m^2.

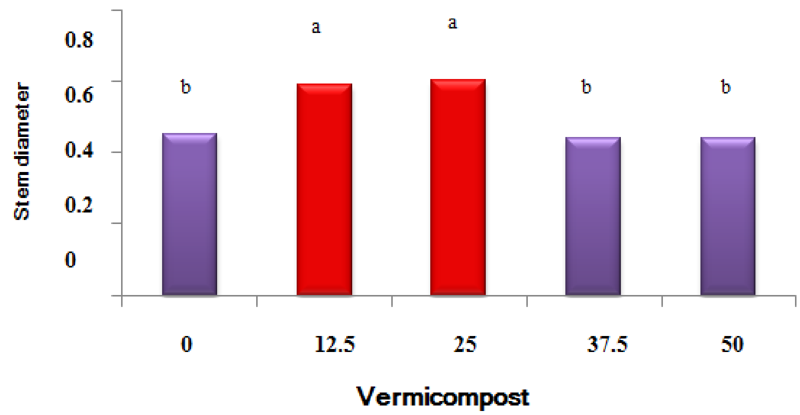

Fig. 3. Mean stem diameter of *Petunia hybrida* flowers under the influence of Vermicompost.

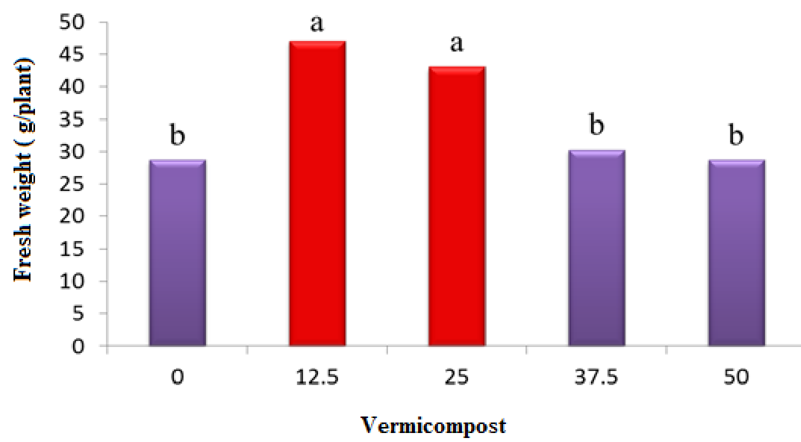

Fig. 4. Average fresh weight of *Petunia hybrida* plants under the influence of Vermicompost.

E. Number of main branches per plant

Results of ANOVA indicated the effects of Vermicompost on number of main branches in Petunia hybrida plants were significant at the 5% level (Table 1). The highest number of main branches (7.5) was obtained at Vermicompost application rate of 37.5g/m^2 (which was not significantly different from those of the 12.5 and 25 g/m^2 rates of application), and the lowest (2.22) in the control (Fig. 5).

F. Number of lateral branches per plant

Results of ANOVA revealed the effects of Vermicompost on number of lateral branches in *Petunia hybrida* were significant at the 5% level. The maximum number of lateral branches was observed at application rates of 25 and 37.5 g/m^2 and the smallest in the control. It seems improving the flowerbed and increased vegetative growth, especially up to flowering, can result in the formation of more lateral branches (Fig. 6).

G. Dry weight of aerial parts

Results of ANOVA demonstrated the effects of Vermicompost on dry weight of the aerial organs were significant at the 5% level. The control had the lowest dry weight of aerial organs among the treatments and the 37.5 g/m^2 application rate the highest (Fig. 7). Results of ANOVA also showed the effects of Azotobacter on dry weight of aerial organs were significant at the 5% level (Table 1). The control had the lowest dry weight of aerial organs and the 50% application rate of Azotobacter the highest (10.9 g) (Fig. 7).

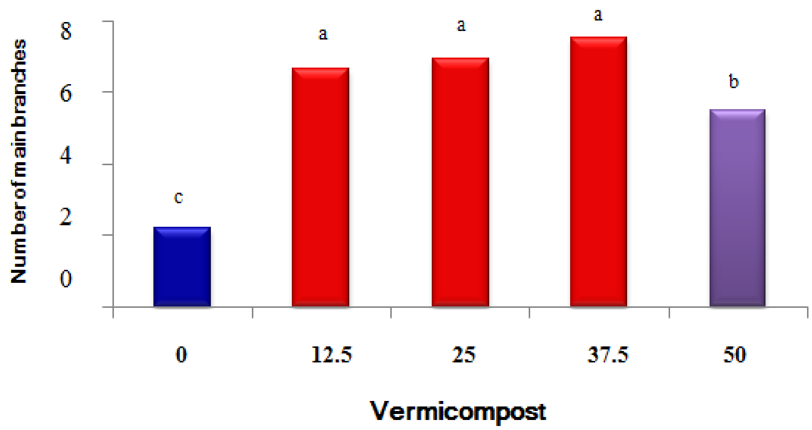

Fig. 5. Average number of main branches in *Petunia hybrida* plants under the influence of Vermicompost.

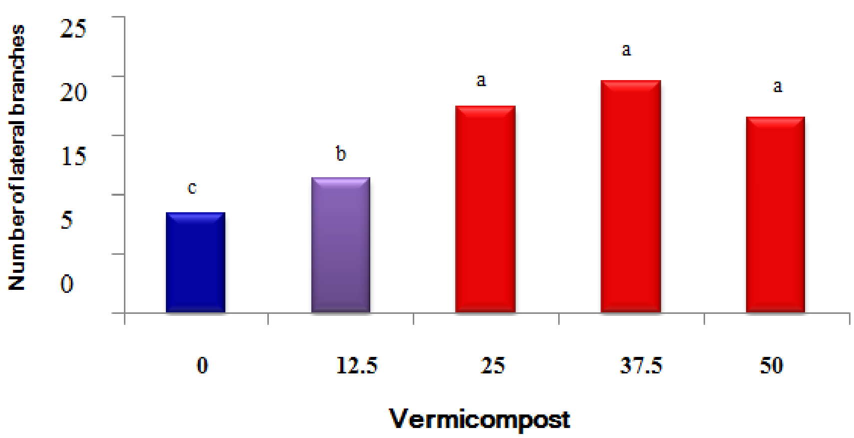

Fig. 6. Average number of lateral branches in *Petunia hybrida* under the influence of Vermicompost.

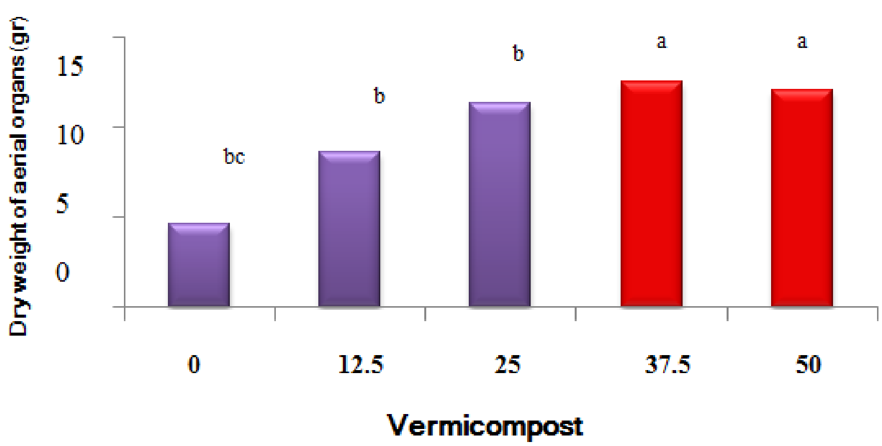

Fig. 7. Average dry weight of aerial organs of *Petunia hybrida* under the influence of Vermicompost.

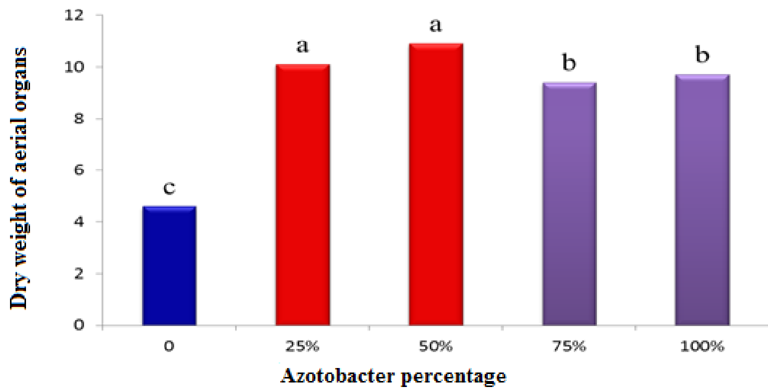

Fig. 8. Average dry weight of the aerial organs of *Petunia hybrida* under the influence of Azotobacter.

Table 1: ANOVA and mean squares of the effects various treatments had on some characteristics of *Petunia hybrid.*

S.O.V	df	Mean squares						
		Plant height	Number of flowers	Stem diameter	Fresh weight per plant	Dry weight of aerial organs	Number of main branches	Number of lateral branches
Nitroxin	4	0.010^{ns}	4.73^{ns}	0.07^{ns}	0.905^{ns}	0.869^{ns}	0.08^{ns}	0.012^{ns}
Vermicompost	4	33.018*	8.185**	1.67*	59.67**	5.932^{ns}	22.18*	27.35*
Nitroxin × Vermicompost	16	16.90^{ns}	4.075^{ns}	0.13^{ns}	8.851^{ns}	0.096^{ns}	13.59^{ns}	24.25^{ns}
Error	72	9.85	2.481	0.59	65.996	2.777	10.59	8.45
CV	-	16.27	20.95	11.33	27.35	28.99	17.35	27.35

*, **, Significantly at the 5% and 1% levels of probability, respectively; ns, non significant.

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