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Full Length Research Paper

The effect of compost and vermicompost of yard leaf manure on growth of corn

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Yard leaf manure vermicompost (V) and compost (C) of 0,1,3,6 and 9% of pot weight and corn (*Zea mays* L.) seeds were grown in pots. Root and shoot dry matters (DM) were greatest in 1 and 3% vermicompost, respectively. Although a decrease in shoot DM was observed in pots containing 3, 6 and 9% compost in comparison with V and control (0%). Macro (N, P, K, Ca, Mg) and micronutrients (Fe, Zn, Cu, Mn) concentrations in the aerial parts of the corn were significantly ($P < 0.01$) affected by the treatments. The concentrations of N, P, K, Ca and Mg in the treatments were higher than in control (only soil). Fe and Mn concentrations in all treatments were significantly ($P < 0.01$) higher than control but the concentration of Cu was not affected by the treatments. Zn concentration in treatments having vermicompost was lower than in control. Physical properties of soil were affected by the application of compost and vermicompost.

Key words: Compost, growth of corn, nutrients, physical properties, vermicompost.

INTRODUCTION

Vermicomposting, or composting with earthworms, is an excellent technique for recycling food waste in the apartment as well as composting yard wastes in the backyard (Bowen, 1969). Earthworm castings contain abundant essential elements that plants need for healthy growth (http://www.louisvillehydroponics. com/organic.html). Analysis of earthworm castings reveal that they are richer in nutrients than surrounding soils, often having 3 times more calcium, and several times more nitrogen , phosphorus, and potassium (http://www.earthwormvietnam. com/ index.html). Application of both compost and vermicompost decreased soil bulk density and increased in water-holding capacity of media and this was also significant and proportional to the rate of compost application (Smith et al., 2000). There is a close relationship between the nutrient status of soil and organic matter content. Researches have shown that the addition of farm yard manure raises soil fertility and yields to levels greater than those under synthetic fertilizer treatments. In addition to directly supplying nutrients from the mineralization of organic matter, the mechanisms of higher availability of nutrients with soils of higher organic matter contents are multiple (Chong, 2005). Orozco et al. (1996) reported that, in addition to increased N availability, C, P, K, Ca and Mg availability in the casts is also greater than in the starting feed material. Domiguez et al. (1997) reported that solid wastes may be converted into useful products by composting and/or vermicom-posting. Chaoui et al. (2003) defines vermicomposting as the digestion of organic materials by earthworms known as casts. Cook et al. (1994) showed that the addition of compost to soil generally improves tilth, soil structure, infiltration, drainage, and water-holding capacity. Perz-Murcia et al. (2006) observed significant increases in N, P and K contents in cucumber, tomato and strawberry grown in peat-sewage sludge compost media. Renato et al. (2003) reported that the supply of cattle manure vermicompost has become a profitable activity for many producers. The contents of available P and exchangeable K, Ca and Mg increased linearly as the vermicompost rates increased,

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Table 1. Chemical properties of compost and vermicompost.

Properties	Compost	Vermicompost
pH	7.16	7.72
EC (dSm^{-1})	3.65	6.88
OC (%)	20.5	17.3
Total N (%)	2.42	3.5
Total P (%)	0.88	0.71
Total K($mgkg^{-1}$)	653.5	950.5
Total Ca (%)	2.9	3.5
Total Mg (%)	1.5	2.8
Total Fe ($mg\ kg^{-1}$)	4467	6045
Total Zn ($mg\ kg^{-1}$)	115.5	189.5
Total Cu ($mg\ kg^{-1}$)	59	38
Total Mn ($mg\ kg^{-1}$)	221.25	344.15
C:N	8.47	5.51

regardless of liming. Subler et al. (1998) showed that the best plant growth responses with all essential mineral nutrients supplied occurred when vermicomposts constituted a relatively small proportion (10 - 20%) of the total volume of container medium mixture.

MATERIAL AND METHODS

Compost and vermicompost

Compost and vermicompost were provided by the biology group of the Department of Soil Science Engineering, University of Tehran. The pH was measured in 1:5 (w/v) suspension of compost and vermicompost in de-ionized water (Thomas, 1996) and electrical conductivity in 1:5 (w/v) of H_2O extract (Rhoades, 1996). Total N was measured by the Kjeldahl method. Total organic carbon content was determined by the Walky and Blank method Nelson and Sommers (1996), total K by flame photometer and total Ca and Mg by the complexometry method. Total Fe, Zn, Mn, and Cu were determined by atomic absorption (Wright and Stuezynski, 1996). Selected chemical properties of compost and vermicompost are shown in Table 1.

Characterization of soil

Selected characteristics of the soil used for the potting mixture were determined and are shown in Table 2. The pH and EC in saturated extract were determined, total N by the regular Kjeldahl method (Miller, 1954). Available P was determined by the Olsen method; available K by flame photometer (Jones, 2001); and available Fe, Mn, Zn and Cu in AB-DTPA entract by atomic absorption (Jones, 2001).

Determination of potting mixes physical properties

Some physical properties of potting mixes used in the study were determined; bulk density (BD) by measuring the weight of 100 cm^3 of mixes; particle density (PD) by the pycnometer method (Agnew and Leonard, 2003); total porosity (%) v/v = (1-B.D/P.D) × 100; water holding capacity (WHC) by measuring the water content of mixes at 1/3 bar potential using a pressure plate apparatus Agnew and Leonard (2003).

Greenhouse trial

A pot experiment was conducted in the greenhouse at the Department of Soil Science Engineering of Tehran University in Iran. 5 - 6 corn seeds (single cross 704) were put in 3 kg pots filled with 4 rates of compost and vermicompost (0, 1, 3, 6 and 9% of pot weight). A total of 9 treatments in 3 replicates were used in a randomized complete design. Pots were watered to keep moisture close to field capacity (FC) level based on pot weight. Plants (shoots and roots) were harvested after 2 months, dried at 65°C for 72 h, weighed, ground and sieved through a 40 mm mesh screen (Jones, 2001). Total content of macro and micronutrients (N, P, K, Ca, Mg Fe, Zn, Cu and Mn) in plants (total aerial parts) were determined. Data were analyzed by one way ANOVA in a general linear model, using Duncan's Multiple Range Test and SAS statistical software.

RESULTS AND DISCUSSION

Table 1 shows that compost had a lower pH, EC, P and Cu, compared to vermicompost (V) but other soluble nutrients were higher in V. The vermicompost contained high concentrations of organic material, silt and clay and was also rich in many soil nutrients such as, nitrogen, sulphur, potash, phosphorus, calcium, magnesium, e.t.c. Vermicompost was also rich in growth hormones and vitamins and thus acts as a powerful biocide against diseases and nematodes (http://www.tribuneindia.com/20010305/ agro.html). Addition of C and V caused a decrease in bulk and particle densities and as a result, caused an increase in the total porosity of potting mixes. The changes were significant as compared to the control (Figures 1, 2 and 3). Decrease in BD was highest at 9% C and lowest at 1% C and 1% V treatments. Hashemimajd et al. (2004) showed that the application of both compost and vermicompost decreased soil bulk density and particle density. Increase in water-holding capacity of media was also significant. The highest increase was observed at 9% C and lowest at 1% V treatments (Figure 4). The analysis of the physical properties of the potting mixes was significantly different at the 1% level (Table 2). The analysis of shoot and root dry matter production, were significant at the 1% level (Table 2). Treatments that received V had significantly greater biomass than the treatments containing C and control. Very low DM production of compost was probably due to lower levels of available plant N in these treatments (Figures 5 and 6).

Nitrogen plays an important role in growth and increase of plant yields. Lui et al. (1991) reported that earthworm cast amendment has been shown to increase plant dry weight. Atiyeh et al. (2000a) reported that the greatest plant growth responses and largest yields have usually occurred when vermicomposts constituted only a volume of a greenhouse container medium mixture. The 3% mixing proportion of vermicompost generally produced

Table 2. Analysis of variance of physical properties of potting mixes, shoot and root dry matter.

Dependent variable	Model		Error	
	DF	**Mean square**	**DF**	Mean square
Bulk density	8	0.098 [a]	18	0.0021 [a]
Particle density	8	0.097 [a]	18	0.0016 [a]
Porosity	8	37.97 [a]	18	4.93 [a]
Waterholding capacity	8	41.52 [a]	18	0.0027 [a]
Shoot dry matter	8	10.22 [a]	18	0.2 [a]
Root dry matter	8	4.81 [a]	18	0.15 [a]

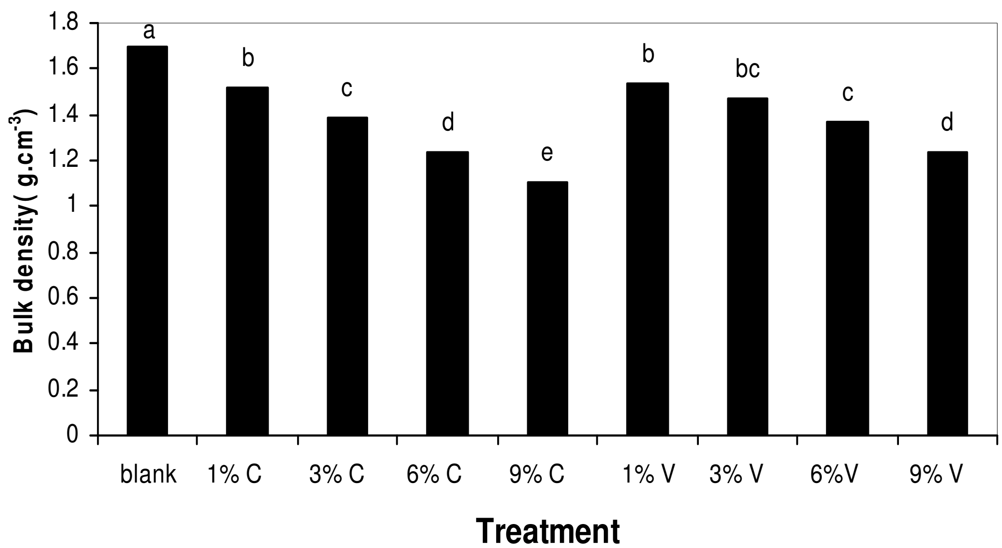

Figure 1. The effect of compost and vermicompost on Bulk density; C = compost; V = vermicompost). Means with the same letter are not significantly different.

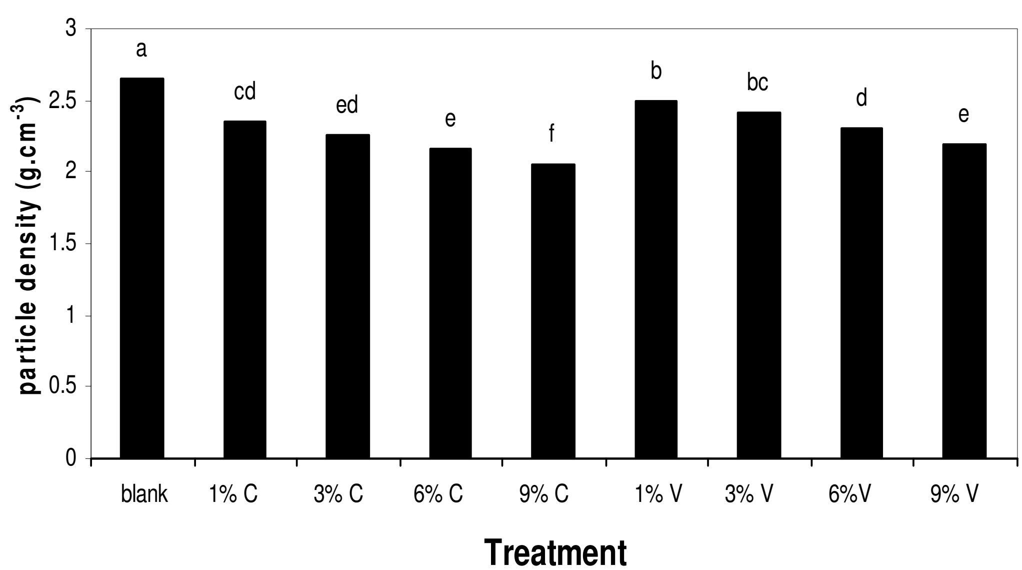

Figure 2. The effect of compost and vermicompost on particle density; C = compost; V = vermicompost. Means with the same letter are not significantly different.

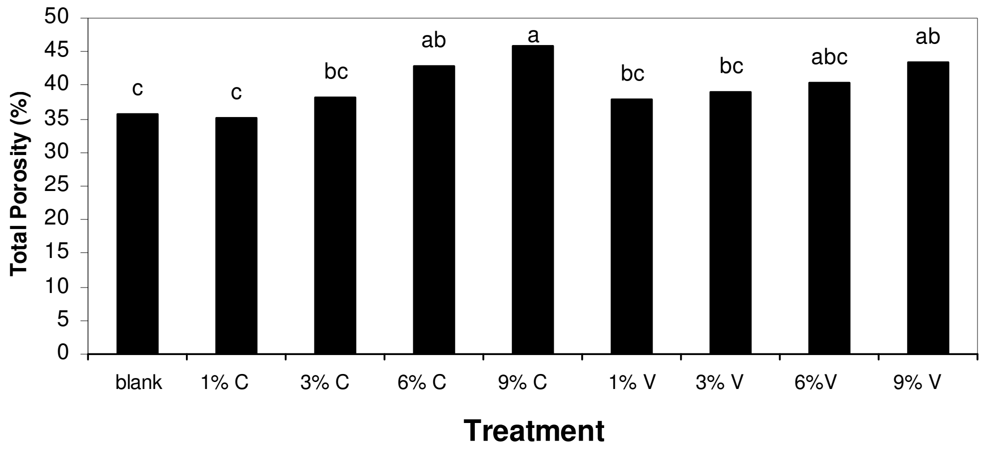

Figure 3. The effect of compost and vermicompost on total porosity; C = compost; V = vermicompost. Means with the same letter are not significantly different.

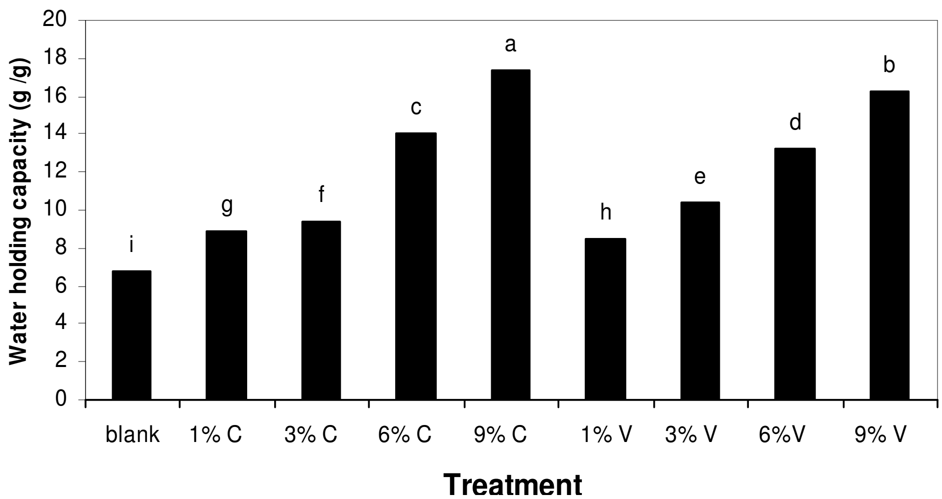

Figure 4. The effect of compost and vermicompost on water holding capacity; C = compost V = vermicompost. Means with the same letter are not significantly different.

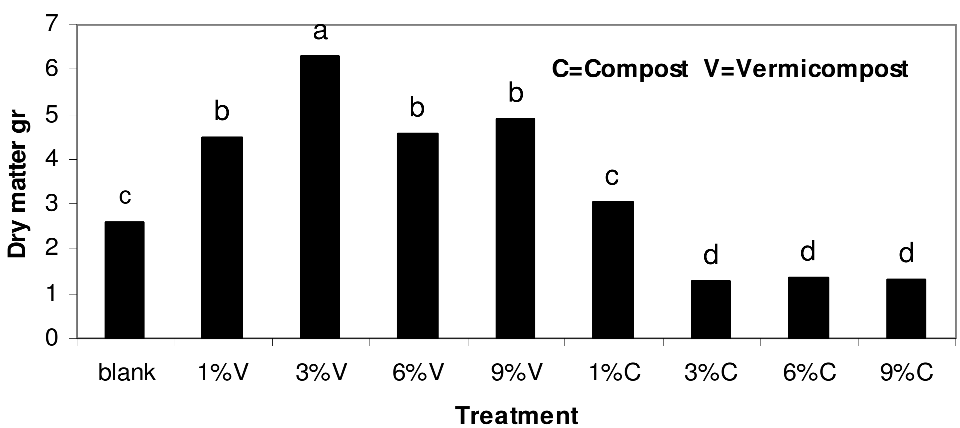

Figure 5. The effect of compost and vermicompost on plant yield and growth; C = compost; V = vermicompost. Means with the same letter are not significantly different.

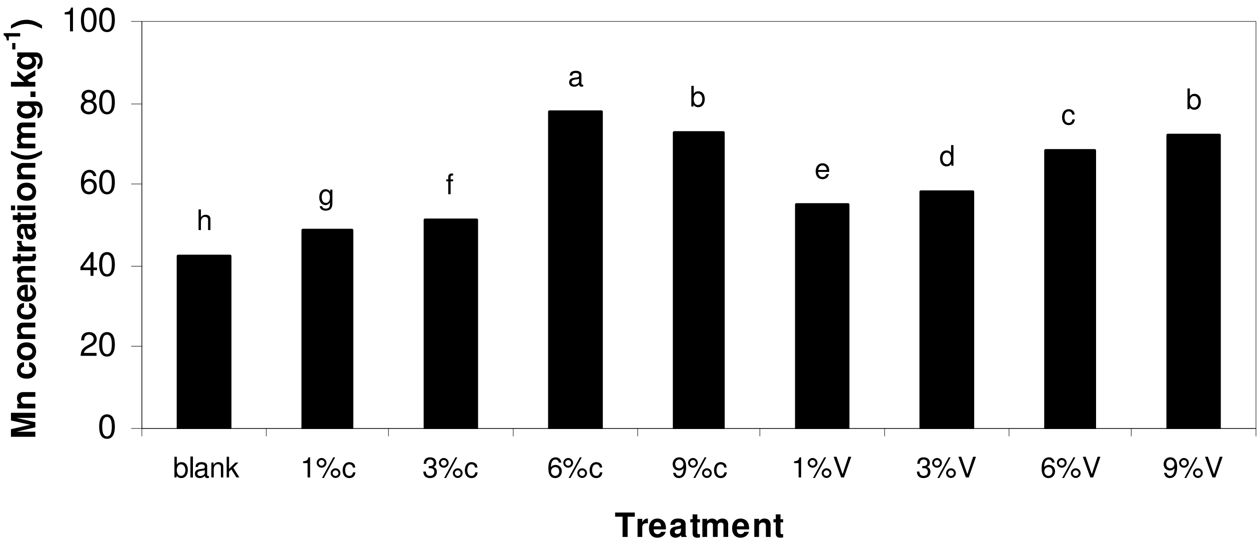

Figure 6. The effect of compost and vermicompost on root growth; C = compost; V = vermicompost. Means with the same letter are not significantly different.

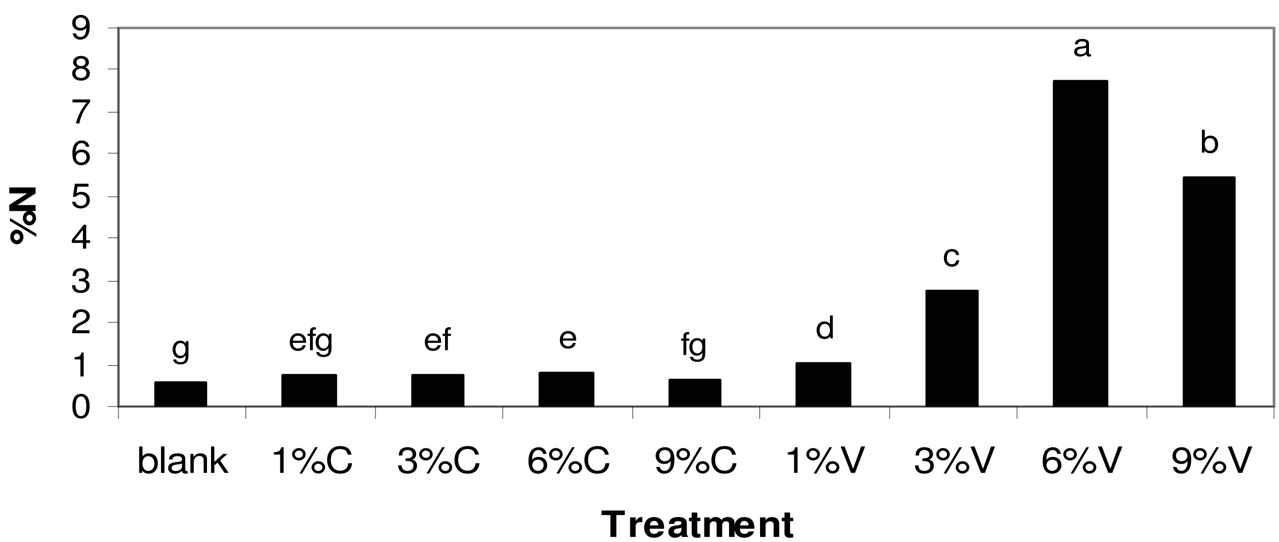

Figure 7. The effect of compost and vermicompost on the concentration N in the shoot of plants; C = compost; V = vermicompost. Means with the same letter are not significantly different.

the highest DM; the differences were not significant among rates in most treatments. The 1% mixture of V produced significantly greater root dry matter as compared to other treatments. Atiyeh et al. (2002) reported that the dry weights of the shoot of tomato seedlings soil was the only substrate. N concentration in pots treated with V was higher as compared with other grown in mixtures containing 200, 250 and 500 $mgkg^{-1}$ humates were 47, 37.4 and 43.4% greater than those of seedlings grown in metro-mix 360 controls. Atiyeh et al. (2001) reported there was accumulating scientific evidence that vermicomposting can influence the growth and productivity of plants significantly. Saniz et al. (2004) reported that the amendment of soil with 10 or 50% vermicompost significantly increased dry matter yields of red clover and cucumber plants, compared to treatments where composts, indicating the need for supplementary application of inorganic N fertilizer. In pots containing 6% V, N concentration was highest as compared to other treatments (Figure 7). Application of compost and vermicompost increased the concentrations of P, K, Ca, Mg (Figures 8, 9, 10 and 11) in the shoot.

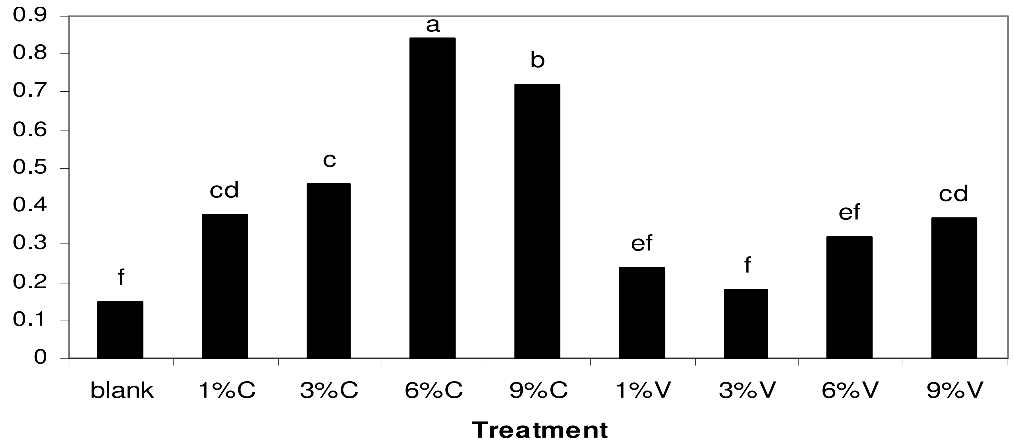

Figure 8. The effect of compost and vermicompost on the concentration of P in the shoot of plants; C = compost; V = vermicompost. Means with the same letter are not significantly different.

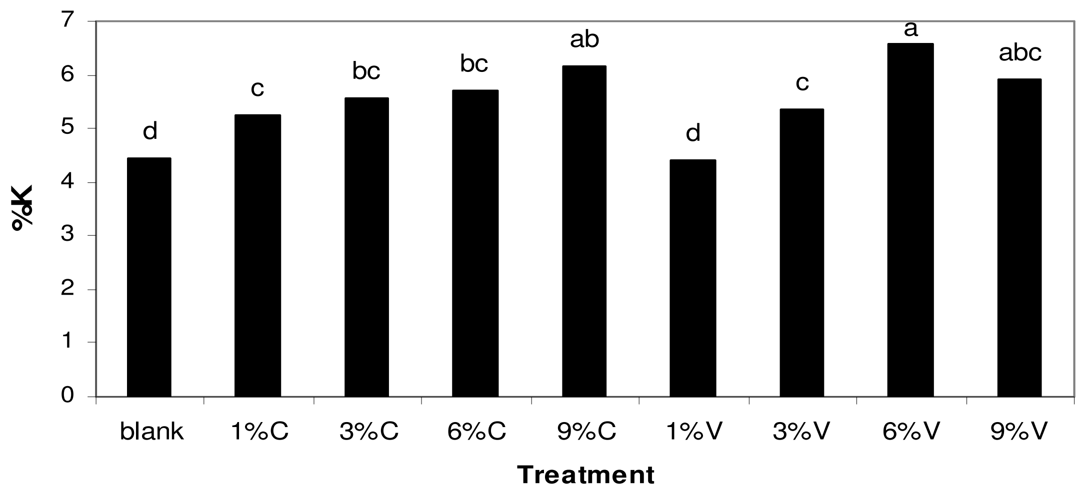

Figure 9. The effect of compost and vermicompost on the concentration of K in the shoot of plants; C = compost; V = vermicompost). Means with the same letter are not significantly different.

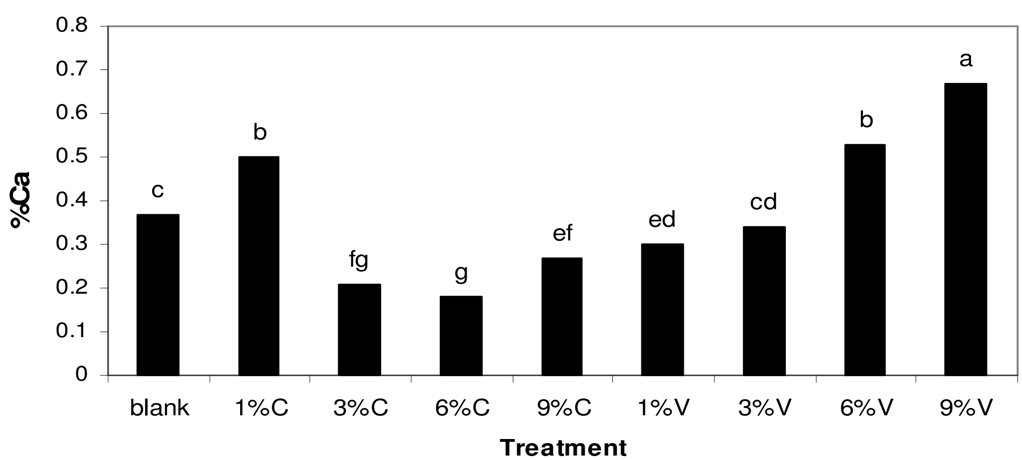

Figure 10. The effect of compost and vermicompost on the concentration Ca in the shoot of plants; C = compost; V = vermicompost. Means with the same letter are not significantly different.

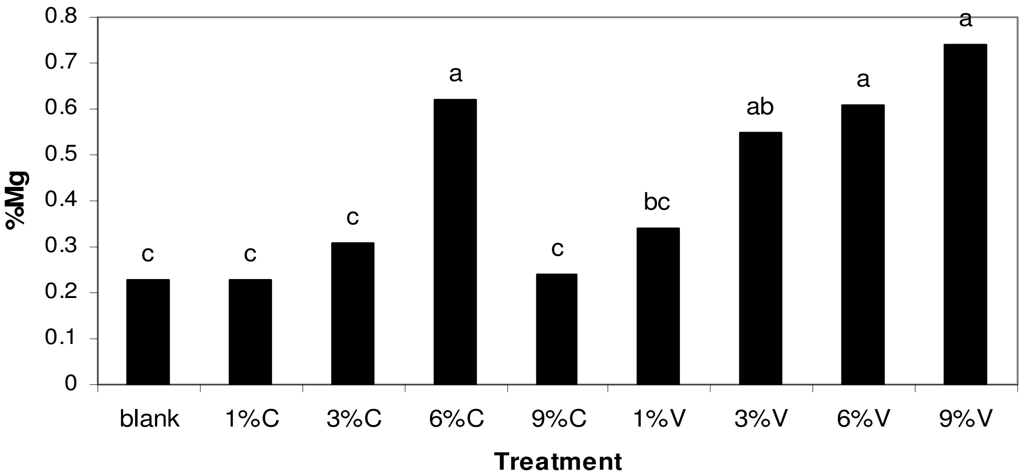

Figure 11. The effect of compost and vermicompost on the concentration Mg in the shoot of plants; C = compost; V = vermicompost). Means with the same letter are not significantly different.

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