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EFFECT OF VERMICOMPOST OBTAINED FROM KITCHEN WASTES ON CORN GROWTH AND MINERAL NUTRITION

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Abstract

In this study, it was aimed to invesitigate the effect of vermicompost obtained from home originated organic wastes on plant growth and mineral nutriton of corn plant under green house condition. Vermicompost were given to the soil at the rates of 0, 5, 10, 20 and 40 t.ha^{-1}. Study was planned according to the randomized parcels with 4 replicates and study lasted two months. At and of the experiment, plant dry weights, N, P, K, Ca, Mg, Fe, Cu, Zn and Mn concentrations were determined. Depending on the applied vermicompost application, plant dry weights increased up to 20 t ha^{-1} vermicompot doses but then decreased. Plant nutrient concentrations such as N, P, Fe, Mn and Cu did not change but Ca concentration decreased. However, K, Mg and Zn concentrations in leaves increased with vermicompost doses. Although, most of the leaf nutrient concentrations were not affected positively with vermicompost doses, about all nutrient uptakes showed increases with the doses of vermicompost.

Key words: *kitchen wastes, plant nutrition, soil fertility, vermicompost.*

INTRODUCTION

Keeping soil fertility is one of the most important subjects for high yield with high quality plant production. Fertile soils are the soils that contain sufficient amount of nutrient ready for plant uptake when they need. Nutrient supplying capacity of the soils can decrease with the time depending on nutrient uptakes by the plants.

Furthermore, soil nutrient concentrations diminish due to the factors such as leaching, fixation, and denitrification.

Plant nutrient requirement changes depending on the plant varieties. While in the fertile soils, nutrient requirement of the plants can be met from the soils, in unfertile soils, these requirements should be met with fertilizers.

Soil organic matter with positive role on soil physical, chemical and biological properties is an important soil component (Doan et al., 2013; Doan et al., 2014; Uz et al., 2016). Additionally, soil organic matter being a main source of N and some other nutrients has an irreplaceable importance for soil fertility. The amount and properties of organic matter are important soil characters.

Chemical fertilizers are the most effective sources to compensate nutrient deficiency in the soils. However, uncontrolled and unconscious use of chemical fertilizers gave rise to some environmental problems. Therefore, nowadays, increasing interest for environmentally friendly sources to increase soil fertility properties as soil amenders or direct nutrient suppliers has been recorded. Some alternative sources such as compost, vermicompost, biochar etc. are being used to increase plant nutritional status (Aggelides and Londra, 2000; Aynacı and Erdal, 2016). These sources may play role in soil fertility directly as nutrient sources or indirectly as soil amenders. This study aimed to determine the effects of vermicompost made of kitchen wastes on plant growth and mineral nutrition of corn plant under greenhouse condition.

MATERIALS AND METHODS

Vermicomposts were given to the soil at the rates of 0,5, 10, 20 and 40 t.da^{-1}. Study was planned according to the randomized parcels with 4 replicates under greenhouse conditions during two months. Corn plant was used as plant material. Before sowing, 200 ppm N (as ammonium nitrate),100 ppm P (as triple super phosphate) and 100 ppm K (as potassium sulphate) were added as basal fertilization and mixed to the soil with vermicompost. During the experiment, plants were irrigated with tap water. Physical and chemical properties of the experimental soils are given in Table 1.

In order to determine soil available nutrients, P extracted with $NaHCO_3$ (Olsen et al., 1954), K, Ca, and Mg extracted with NH_4AOC (Jackson, 1967) and Mn, Zn, Fe, and Cu extracted with DTPA (Lindsay and Norvell, 1969). P measurement was done using spectrophotometer; others were measured with Atomic Absorption Spectrophotometer. Soil texture was determined using hydrometer (Bouyoucos, 1954) and $CaCO_3$ content was measured with calcimeter (Allison and Moodie, 1965). pH was determined using pH meter in suspension of soil and water at the rates of 1/2.5. Soil organic matter (OM) was determined based on Walkley and Black (1934).

Plants were harvested above ground the soil after the experiment period. Then, they were washed toughly with tap water, dilute acid (0.2 N HCl) and distilled water. Afterwards samples were dried, grounded and wet digested with microwave oven. Total nitrogen was analyzed according to Kjeldahl method. Phosphorus concentrations of samples were determined with a spectrophotometer (Shimadzu UV-1208) at 430 nm according to the vanadomolybdo phosphoric acid method. Potassium, Ca, Mg, Fe, Cu, Zn, and Mn concentrations were determined using atomic absorption spectrophotometer.

All data concerning the growth, nutrient concentrations and nutrient uptakes of corn plant were submitted for statistical analyses using MSTAT program for one-way analysis of variance applied to determine any significant difference at 0.05%.

Table 1. Characteristics of the experimental soils

Texture	pH	OM (%)	$CaCO_3$ (%)	Plant available nutrients (mg kg^{-1})							
				P	K	Ca	Mg	Mn	Zn	Fe	Cu
Loam	7.8	3.7	25	108	443	7445	185	6.2	1.3	10.4	2.7

RESULTS AND DISCUSSIONS

Effect of vermicompost obtained from kitchen wastes on plant growth and nutrient concentrations

Vermicompost application doses increased plant dry weight significantly. As it seen from Figure 1, plant dry weights increased from 7.93 g pot^{-1} to 23.43 g pot^{-1} with 20 t ha^{1} **vermicompost** doses (VC doses).

Increase of VC doses levels up to 40 t ha^{-1} resulted in a sharp decrease of plant dry weight. Leaf N levels varied between 2.27% and 2.42%, but leaf N concentrations of corn were not affected from the VC doses.

Leaf K and Mg concentrations of leaves significantly varied with the doses. While all doses had the same effect on leaf K concentrations comparing to control, only the highest VC doses significantly varied from other doses in terms of Mg concentrations.

Leaf Ca concentrations decreased with the VC doses. As indicated in Figure 2, leaf micro element concentrations such as Fe, Mn and Cu were not affected from VC doses.

But leaf Zn concentrations showed significantly increment at the highest vermicompost dose comparing to other application levels.

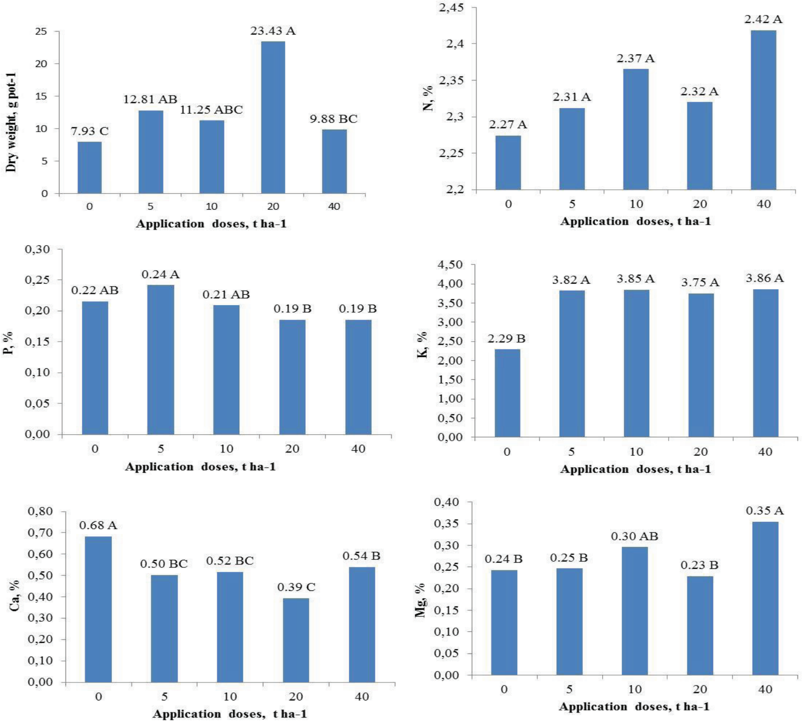

Figure 1. Effects of vermicompost on dry weight and N, P, K, Ca, and Mg concentrations of corn

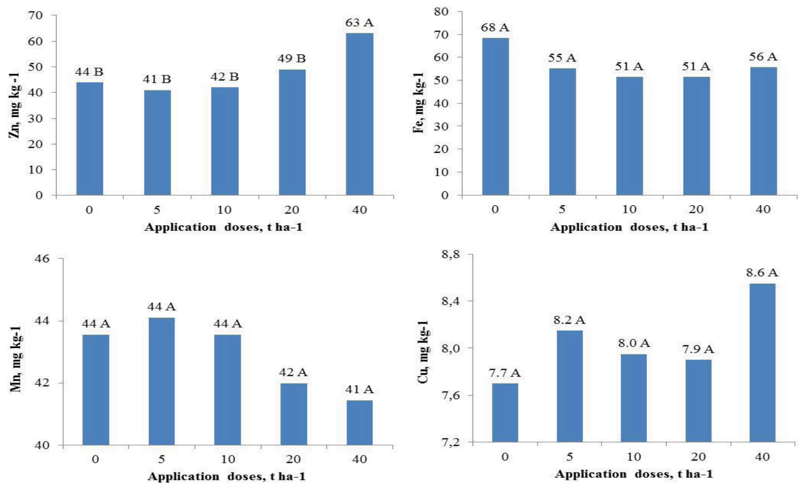

Figure 2. Effects of vermicompost on Zn, Fe, Mn, and Cu concentrations of corn

Effect of vermicompost obtained from kitchen wastes on nutrient uptake of corn plant

Plant N, P, K and Mg uptakes from the soils increased with the VC doses. But the nutrients such as N, P and K showed decrease after the dose of 20 t ha^{-1}. Ca uptake of corn did not show any changes depending on the vermicompost application doses (Figure 3). All micro element uptakes significantly varied with the doses of vermicompost. However, as in macro element uptakes, Fe, Mn, and Cu uptakes began to decrease with the increase of application levels to the 40 t ha^{-1} (Figure 4).

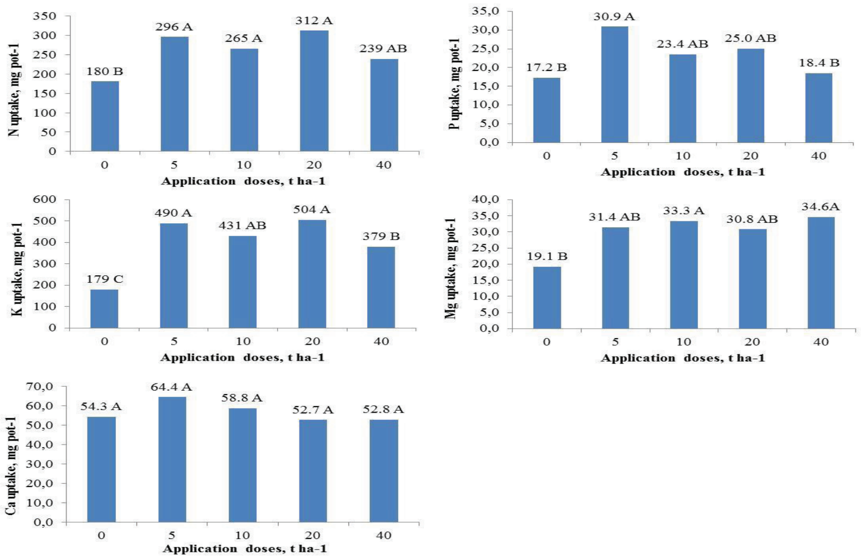

Figure 3. Effects of vermicompost on N, P, K, Ca, and Mg uptakes of corn plant

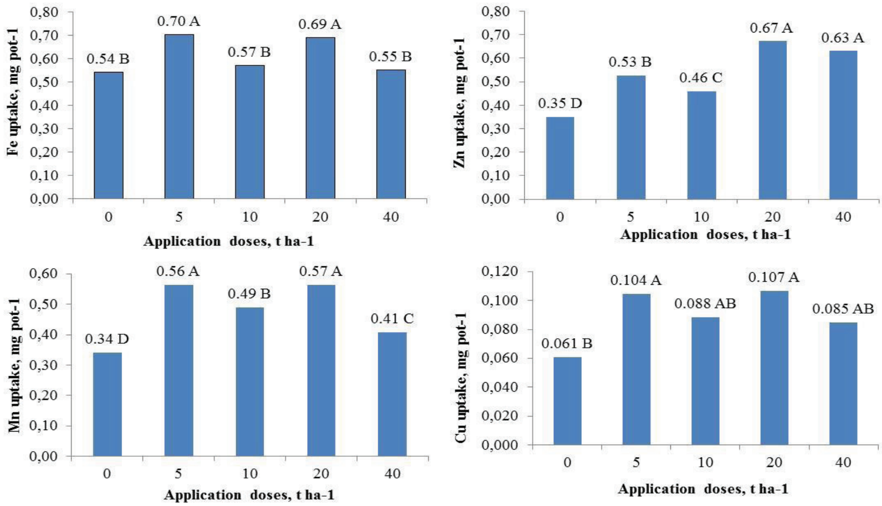

Figure 4. Effects of vermicompost on Fe Zn, Mn, and Cu uptakes of corn plant

Increases in plant dry weight with compost or vermicompost applications are common findings (Loecke et al., 2004; Sardoei, 2014; Aynacı and Erdal, 2016). This situation was expressed with directly or indirectly positive effect of organic matter on plant growth with vermicompost application. As indicated previous studies, vermicompost can increase soil fertility by means of different ways and thus plant growth and dry matter increase (Nagavallemma et al., 2004; Gutiérrez-Miceli et al., 2007; Joshi and Vig, 2010). On increase yield, slow release of nutrients during the plant growth and decreasing of nutrient loss by means of leakage may have effect as indicated by Cantanazaro et al. (1998). In the other study, it was found that vermicompost application led to pH decrease resulting in corn plant dry matter increase (Sharma et al., 2005). However, increase of vermicompost over the 20 t ha^{-1} resulted in dry matter decrease. This may be due to the negative effect of over organic matter and its products such as humic materials (Leventoglu and Erdal, 2014). As indicated in previous studies, higher levels of organic matters can bind soil nutrients as unavailable forms, thus plants cannot grow better (Leventoglu and Erdal, 2014). Vermicomposts have large particulate surface areas that provide many microsites for microbial activity and for the strong retention of nutrients (Shi-wei and Fu-zhen, 1991). Some researchers recorded that there had been some growth improving products such as hormone like substances, cytokinins, auxins and humates produced with some microorganism and earthworms (Krishnamoorthy and Vajrabhiah, 1986; Tomati et al., 1988; Tomati et al., 1990; Atiyeh et al., 2002). Vermicompost contains most nutrients in plant-available forms such as nitrates, phosphates, and exchangeable calcium and soluble potassium (Edwards, 1998). These properties of vermicomposts might be the reason of leaf nutrient increase. Also, increasing effect of vermicompost on soil nutrient availability might lead to increase in plant mineral nutrition.

Nutrient uptake of corn is closely related with plant dry weight and plant nutrient concentrations. As known, nutrient uptakes by plants increase with the increase of dry weight and plant nutrient concentrations. However, nutrient uptakes decreases with the decrease of dry weight and plant nutrient concentrations. Therefore, the factors leading to increase in dry weight and nutrient concentrations increase plant nutrient uptakes; on the contrary, the factors leading to decrease in dry weight and nutrient concentrations decrease plant nutrient uptakes.

CONCLUSIONS

In conclusion, plant growth and mineral nutrition of corn plant positively affected by vermicompost obtained from kitchen wastes generally. But the 40 t ha^{-1} dose of vermicompost had negative effect of corn growth on the soil used for this experiment. Futhermore, effects of the doseges, between 20 t ha^{-1} and 40 t ha^{-1}, on plants growth and mineral nutritions need to be examined.

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