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Effects of different ratios of vermicompost produced from municipal solid waste on emergence and seedling growth of okra (*Abelmoschus esculentus* (L.) Moench)

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Abstract

To evaluate the applicability of vermicompost produced form municipal solid waste on the emergence and seedling growth of okra under greenhouse condition an experiment was conducted in a completely randomized design with four replications. Four treatments based on the mixing ratios of vermicompost with soil in the ratio of 1 to 2.5, 1 to 5, 1 to 7.5 and 1 to 10 were compared with the control (garden soil). The results showed that the greatest rate of germination, seedling growth and dry weight of shoots and roots was observed at the mixing ratio of 1 to 5 soil: vermicompost. Mixing ratio of 1 to 2.5 soil:vermicompost had the least germination and seedling growth of okra among other treatments. Toxic compounds and nutrient imbalances may be responsible for the inhibitory effect of vermicompost on seedlings growth at this treatment. Application of large quantities of vermicompost produced from municipal solid waste may have harmful influence on crops.

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Introduction

Urban waste production has increased due to increasing population and expansion of cities. Populous cities such as Mashhad in Iran produce more than 1200 tons of waste every day. (Bahmani, 2005). Dense urban waste, particularly in populous areas, has forced urban planners to proper management of waste disposal. One of the appropriate methods of waste disposal management is recycling it into compost manure (Khoshgoftarmanesh, 2003).

Commercial production of compost from municipal waste is a useful method for getting rid of too much waste produced in large cities. Compost, as an effective mulch surface to increase the amount of soil organic matter, improves the soil structure and the water storage capacity of the soil, controls the growth and spread of weeds and provides a long-term source for nutrient supply of the farm (Aoumare, *et al.*, 2003; Chodak, *et al.*, 2001; Gonzales, *et al.* 1990, He, *et al.*, 2000; Levy and Tylor, 2003, Sikora and Enkiri, 1999). In comparison with chemical fertilizers, compost produced from urban waste often contains relatively low amounts of mineral elements (Sikora and Enkiri, 1999; Asgharipour, 2012; Asgharipour and Rafiei, 2010); this, along with its low-speed mineralization process, may cause (Hornik *et al.*, 1984). Heavy metals with urban waste compost may permeate groundwater or increase heavy metals content of plants and soil, will be harmful for germination, growth and yield. Therefore, researchers should study the effects of urban waste compost on germination, emergence and early stages of plant growth.

A large number of previous studies are about the crop response to compost based on assessment of its positive effects on growth and yield in an attempt to determine the appropriate amount of compost used for different products (Hornik, *et al.*, 1984; Levy and Tylor, 2003), and few reports are available about the negative effects of compost in the early stages of germination and growth. More studies are essential on the effects of compost, especially in plants such as cress or many of those which are sensitive to toxic substances (Hoekestra *et al.*, 2002). The present experiment was performed for this purpose through testing the possible effects of compost on growth and dry weight of okra seedlings in the greenhouse to determine the appropriate amount of compost and prepare the seed bed for germination and emergence of okra.

Materials and methods

Compost and soil characterization

Compost used in this study was purchased from the compost factory in Mashhad, Iran. Table 1 shows some Physiochemical characteristics of the soil and compost.

Okra was selected for this bioassay due to having a good response to soil nutrients and also its rapid and easy growth. The effects of nutrient deficiency and inhibitory toxic substances in the compost on okra are more evident in the early stages of growth. Therefore, in this study seedling growth rate to determine the beneficial effects and germination percentage to determine the negative effects of compost were determined.

Seeds of okra were planted in plastic pots with 15 cm in diameter and 12 cm in height. Compost and garden soil (loamy texture) were mixed (volume basis) at mixing ratios of 1 to 2.5, 1 to 5, 1 to 7.5, and 1 to 10 compost and soil.

Experimental design used in this study was a completely randomized design with four replications. Eight pots filled with soil were tested as a control. Five okra seeds were planted in each pot and the pots were irrigated with distilled water during the experiment. The minimum and maximum greenhouse temperature during the test was 11 and 28 °C.

The number of emerged seedlings in each pot was recorded for each treatment one and two weeks after planting. At the beginning of the second week and followed by nine consecutive weeks, stem heights were measured from the soil surface to the upper leaves. The last height measurement was performed after nine weeks and the length of largest leaf was determined for each plant. Then, plants were harvested from the soil and separated into leaf, stem and root. The mean weight of stalks, leaves and roots was determined for each pot after drying at 60 °C.

Finally, analysis of data obtained using packaged software SAS was performed and comparison test with Duncan's multiple range.

Results and discussion

Emergence of okra seedlings

There was no significant difference in the number of emerged seedlings between different amounts of added compost to soil. Mixing ratio of 1:2.5 compost and soil had a powerful inhibitory effect on seed germination; in this treatment only an average of 26% of seeds planted and germinated after a week in each pot (Figure 1). Mixing ratio of 1:5 compost and soil caused highest percentage of emergence of okra seedlings; in this treatment an average of 60% of seeds germinated after a week. At the end of the second week, germination completed in all treatments except for the mixing ratio of 1:7.5 compost and soil (Figure 1). The difference at the end of the second week remained the same as the first week. Almost all seedlings (90%) at mixing ratio of 1:5 compost and soil and more than 70% of seedlings at mixing ratio of 1:7.5 compost and soil emerged at the end of the second week. Mixing ratio of 1:2.5 compost and soil at the end of the third weeks was less than other mixing ratios. At the end of the third week no seedlings in any of the treatments was emerged.

Table 1. Physiochemical characteristics of soil and compost.

	Sand	Silt	Clay	Co	Cr	Cd	Ni	Pb	Zn	Cu	Fe	Na	K	P	C/N ratio	Total N	pH	EC
	(%)			(mg kg^{-1})											(g kg^{-1})			dSm^{-1}
Soil	45	30	25	3	1.4	0.3	3	2	23	16	21	1.40	0.6	1.7	0.01	0.2	7.2	2.0
Compost				15	30.4	3.6	19	80	634	139	788	2.49	2.7	28.9	2.67	58.3	7.5	8.0

Growth of okra seedlings

Growth of okra seedlings was at first rapid in all treatments, but approaching the end of experiment, seedling growth slowed down probably due to the limited size of pot (Fig 2). Table of analysis of variance divided okra seedling growth into two separate groups ($P< 0.05$). Growth rate at mixing ratios of 1:5 and 1:7.5 compost and soil was equal and significantly higher than growth rate at mixing ratios of 1:2.5 and 1:10 compost and soil and control (Fig 2). There is significant difference in growth rate within each one of these two groups. Differences in growth rate between treatments in both groups were clear from the beginning of the experiment and remained more or less constant during the whole test period. Differences in growth rate between seedlings resulted in difference in seedlings weight between treatments.

Weight of aerial organs (stem and leaf) in the mixing ratio of 1 to 5 compost and soil were significantly higher compared to other treatments (Figure 3). Comparison test of Duncan multiple range divided the remaining treatments into two separate groups. Stem weight at mixing ratio of 1:2.5 compost and soil and control was less than mixing ratios of 1:7.5 and 1:10 compost and soil. Weight of aerial organs at control was almost half the weight of the aerial organs at mixing ratio of 1:5 compost and soil. Differences in root weight of okra seedlings after 9 weeks of planting seeds in all treatments had similar results to the aerial organs (Figure 3). But differences were less evident between treatments in root weight.

Duncan test divided the treatments into two separate groups. Okra seedlings that had the lowest aerial organs weight in mixing ratio of 1:10 and control, also showed the lowest root weight between the treatments, but the difference between the two treatments was not significant. Root weight in the other treatments were significantly (P<0.05) more than the two mentioned treatments.

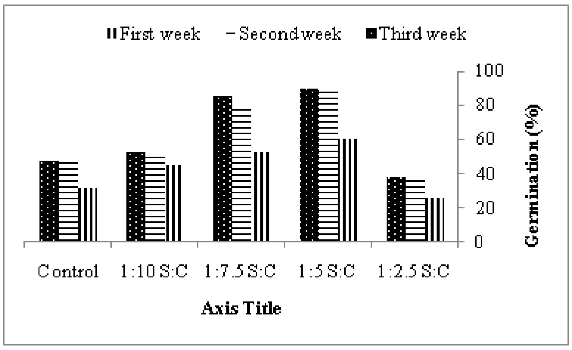

Fig. 1. Percent germination of okra seeds in different treatments (compost to soil ratio) one week, two weeks and three weeks after soaking the seeds.

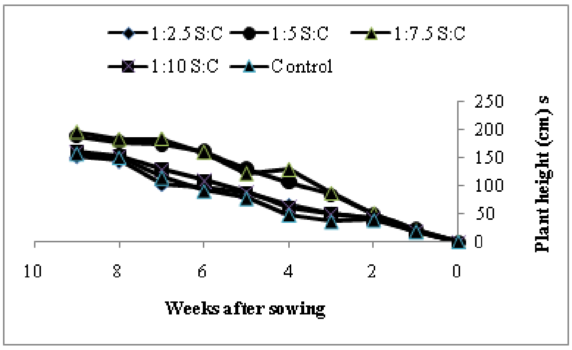

Fig. 2. Increase the height of okra seedlings during the 9 weeks after the start of the experiment in different growth environments (compost to soil ratio).

Differences in the number of leaves per plant and length of largest leaf (Data not provided) were low between different treatments. Okra seedlings at mixing ratio of 1 to 7:5 had the largest and most leaves, whereas seedlings grown in control pots were having the lowest number of leaves and the smallest leaves. The other treatments were between these two. Similar effect of compost on growth media has also been reported by other researchers (Garcia-Gomez, *et al.*, 2002, Pinamonti and Zorzi, 1996; Asgharipour and Armin, 2010; Asgharipour and Rafiei, 2011). This impact is mainly due to the role of nutrients, especially nitrogen and potassium in the compost. Sanchez-Monedero, *et al.*, (1997) in their experiment using different growth media obtained from mixture of different types of compost and garden soil found that compost can be used up to 66% without any negative effect on plant growth. In a similar experiment Pinamonti and Zorzi (1996) reported an increase of respectively 15 and 48 percent in the growth of cucumber and okra grown in the growth media produced from 50 percent of sewage sludge compost.

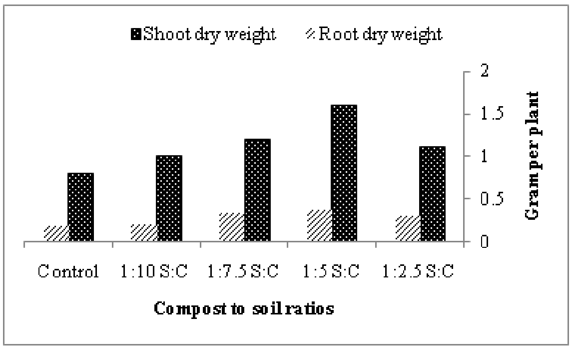

Fig. 3. Shoot and root dry weight of single plant okra seedlings 9 weeks after the start of the experiment at different substrates.

Conclusions

Application of compost produced from urban waste for agricultural purposes is economical and most efficient method for municipal waste disposal. However, heavy metals and other toxic substances in the compost may permeate the soil and be absorbed by the crops and affect germination and growth of crops. The results of this experiment cannot be completely generalized to field conditions, because the mixing ratios of soil and compost used in this study are much more than the usual amount of compost used for crops in the field. The highest percentage of germination and dry weight of okra plants were obtained in the mixing ratio of 1 to 5 compost and soil. But, the mixing ratio of 1 to 2.5 result the highest value of macro and micro nutrients at plant tissues.

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