Influence of Vermicompost on the Growth of Tomato Transplants

H. Arouiee, B. Dehdashtizade, M. Azizi and G.H. Davarinejad
Ferdowsi University of Mashhad
Mashhad
Iran

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Abstract

An investigation was conducted on the effects of vermicompost on seed germination and some quantitative and qualitative characteristics of tomato (*Lycopersicum esculentum*) transplants under greenhouse conditions. The main aim of this research was to study the influence of different levels of vermicompost on seed germination parameters and the growth of greenhouse tomato. The results indicated that there were significant differences between treatments. The highest seed germination rate was in 25% vermicompost. Tomato seedlings growing in 100% vermicompost had the lowest amount of chlorophyll, the lowest leaf diameter, lowest dry weight and were the shortest seedlings between all treatments. The application of 50% vermicompost increased the inter-node number, root dry weight and N content of tomato seedlings significantly compared to the control plants. Incorporation of 25% vermicompost increased significantly the shoot dry weight and leaf area of tomato seedlings compared to the control.

INTRODUCTION

Vermicompost, in contrast to conventional compost, is the product of accelerated bio-oxidation of organic matter through the use of high densities of earthworms without a thermophilic stage (Dominguez et al., 1997).

Research has shown that different earthworm species are able to consume a wide range of organic residues such as sewage sludge (Mitchell et al., 1980; Dominguze et al., 2000), animal wastes (Edwards, 1998; Atiyeh et al., 2000b), crop residues (Orozco et al., 1996) and industrial wastes (Albanell et al., 1988; Kaushik and Garge, 2003; Maboeta and van Rensburg, 2003).

Several studies have assessed the impact of vermicompost amendments in potting substrates with regard to seedling emergence and the growth of marketable fruit (Arancon et al., 2003, 2004a; Atiyeh et al., 200c, d) and yield (Mba, 1996; Karmegam et al., 1999; Atiyeh et al., 2000a; Arancon et al., 2004b, 2005). The greatest plant growth responses and the largest yield have usually occurred when vermicompost constituted only a relatively small proportion of the compost (20-40%). Larger quantities of vermicompost have not always improved plant growth (Atiyeh et al., 2000a). However, Edwards and Burrows (1988), Wilson and Carlile (1989), Sulber et al. (1998) and Atiyeh et al. (1999) have demonstrated that earthworm-processed organic wastes have a beneficial effect on the growth and development of plant seedlings.

METHODS AND MATERIALS

A plant growth experiment was established in a greenhouse at Ferdowsi University in Mashhad. Vermicompost was applied at five levels, substituting sand at 0, 10, 25, 50 and 100% (v/v).

Five tomato seeds (*Lycopersicum esculentum* var. Super strain B) were sown into pots containing sand (control) and varying proportions of vermicompost. There were 20 pots per mixture. At the transplanting stage, three pots were selected randomly. Pots were placed in the greenhouse with optimum temperature and moisture.

At the transplant stage, the shoot diameter and chlorophyll content were measured along with the leaf area and plant height (distance from the potting medium to the top node), before plants were transplanted into the field.

The biomass accumulated was assessed by drying the plants at 75°C for 48 h and weighing the resultant mass.

The N content was measured by Kejeltek instrument (Digestion methods).

This experiment was done in a complete randomized block design, with 5 treatments and 3 replicates. Each parameter was measured and then analysed with MSTATC and tested for statistical significance using Duncan's multiple range test.

RESULTS AND DISCUSSION

Effect of Vermicompost on Plant Growth

The addition of vermicompost increased plant size significantly in all treatments except 100%. The largest increase in tomato transplant height and internode length was observed in the 50% vermicompost (v/v) treatment. Plants were 4.9 cm higher in this vermicompost mixture than the control and 0.46 and 0.59 mm thicker in 50% and 25% vermicompost respectively than the control plants (Table 1).

The substitution of vermicompost into greenhouse container media has always been associated with increases in germination, seedling growth, flowering of ornamentals and growth and yield of vegetables, even at low substitution rates and independent of nutrient supply (Atiyeh et al., 2000a, b, 2001).

The increased microbial populations resulting from earthworm activity in vermicomposts influence plant growth indirectly. Soils treated with vermicomposts had a significantly greater microbial biomass ($p=0.05$) compared to soils that received inorganic fertilizer only. It has been shown that micro-organisms can produce materials that affect plant growth such as substances acting as plant hormone analogues or growth regulators (Frankenberger and Arshad, 1995; Brown, 1995).

There is a very substantial body of evidence demonstrating that micro-organisms, including bacteria, fungi, yeasts, actinomycetes and algae, are capable of producing plant growth regulators (PGRs) such as auxins, gibberellins, cytokinins, ethylene and abscisic acid in appreciable quantities (Frankenberger and Arshad, 1995). According to Tomati et al. (1983), large quantities of plant hormones such as gibberellins, auxins and cytokinins are produced during vermicomposting.

Muscolo et al. (1999) reported that humic materials extracted from vermicomposts produced auxin-like cell growth and nitrate metabolism of carrots (*Daucus carota*). Masciandaro et al. (1997) reported positive growth responses of plants to the addition of humic material extracted from vermicomposts.

Effect of Vermicompost on Chlorophyll and Leaf Area

The addition of vermicompost increased chlorophyll content significantly. Plants in 50% vermicompost had 14.8 more chlorophyll than the control plants (Fig. 1). The leaf area of transplants was also significantly different: plants in vermicompost at 25 and 100% had the highest and lowest leaf area respectively (Fig. 2).

Effect of Vermicompost on Wet and Dry Weight

Substituting the medium with different concentrations of vermicompost improved the growth of tomato seedlings. The wet shoot and root weight of transplants in 50 and 25% vermicompost was more than the control. In 100% vermicompost, the measures were observed to decrease more than the control plants (Table 2).

The dry shoot and dry root weight of transplants were also significantly different. Those plants growing in vermicompost at 25 and 50% had the highest dry weight, while those growing in 100% vermicompost had the lowest dry weight.

It is well established that changes in allocation patterns largely determine the ability of plants to capture resources. Plants may change their allocation patterns in response to the environment and especially to the availability of soil nutrients. The results of some research indicate that vermicompost influences the rhizosphere microflora (Muscolo et al., 1999), beneficial micro-organisms (Atiyeh et al., 2000d) and plant growth regulators (Tomati et al., 1988).

Effect of Vermicompost on Time of Germination and Transplanting

The germination time and time to transplant was longer in 100% vermicompost than other soil mixtures and the control (Figs. 3 and 4). The results of this study show that vermicompost at the 25% level affected the emergence and growth of tomato seedlings. Seed germination and seedling emergence was faster compared to other vermicompost treatments. The time to transplanting indicated same results.

Studies on the effect of vermicompost amendment to growth media for tomatoes in greenhouses has shown maximum growth at vermicompost proportions of around 20% (Atiyeh et al., 1999, 2000a).

Effect of Vermicompost on N Content

The N content in the potting mixture increased significantly with the increasing quantity of pig manure vermicompost incorporated into the media (Fig. 5). Atiyeh et al. (2001a, b) indicated that combinations of pig manure vermicompost with liquid fertilizers also increased the efficiency of nitrogen uptake by the plants.

CONCLUSION

In this experiment, we observed that seed germination, seedling emergence and the time to transplanting for tomato seedlings were lowest and the LAR and shoot diameter the highest in 25% vermicompost, Chlorophyll and N leaf content were highest in the 50 and 100% vermicompost respectively. The best treatment for application by growers will be 25% vermicompost.

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Tables

Table 1. Means of vermicompost application on tomato transplants.

Vermicompost	Plant height (cm)	Shoot diameter (mm)	Total chlorophyll (Spad)	Leaf area index (LAR)
Control	11.81^{d}	4.19^{b}	32.11^{d}	84.65^{c}
10%	12.41^{c}	4.17^{b}	35.88^{c}	89.31^{c}
25%	12.73^{b}	4.78^{a}	41.57^{b}	148.23^{a}
50%	14.50^{a}	4.83^{a}	46.70^{a}	119.33^{b}
100%	11.35^{e}	3.89^{c}	33.68^{cd}	45.4^{d}

*Those items with the same superscript in each column are not significantly different at $p \leq 0.05$.

Table 2. Mean of vermicompost application on tomato transplants.

	Control	10%	25%	50%	100%
Wet shoot weight	6.47^{d}	9.57^{c}	12.46^{b}	12.86^{a}	5.06^{e}
Wet root weight	4.14^{cd}	4.79^{c}	7.19^{a}	5.89^{b}	3.60^{d}
Dry shoot weight	0.69^{d}	1.00^{c}	1.59^{a}	1.47^{b}	0.41^{e}
Dry root weight	0.25^{d}	0.43^{c}	0.71^{b}	0.82^{a}	0.11^{e}

*Those items with the same superscript in each row are not significantly different at $p \leq 0.05$.

Figures

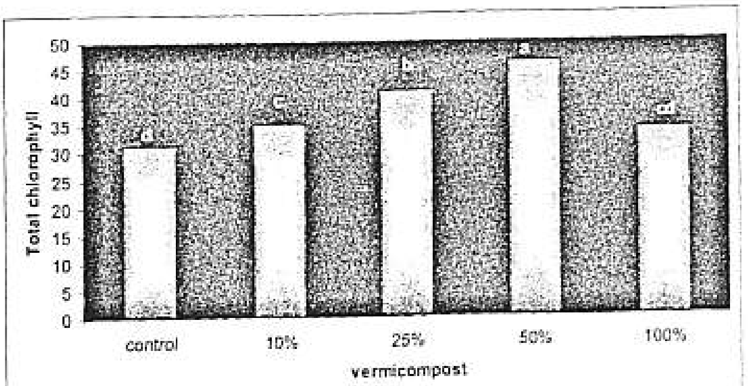

Fig. 1. Effect of vermicompost on total chlorophyll ($p \leq 0.05$).

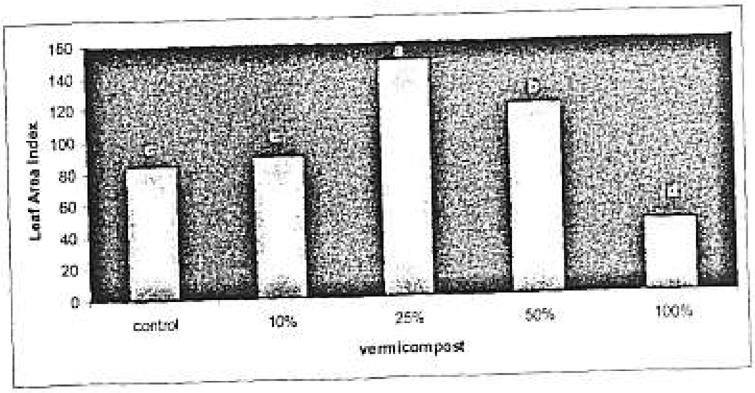

Fig. 2. Effect of vermicompost on Leaf Area Index (p≤0.01).

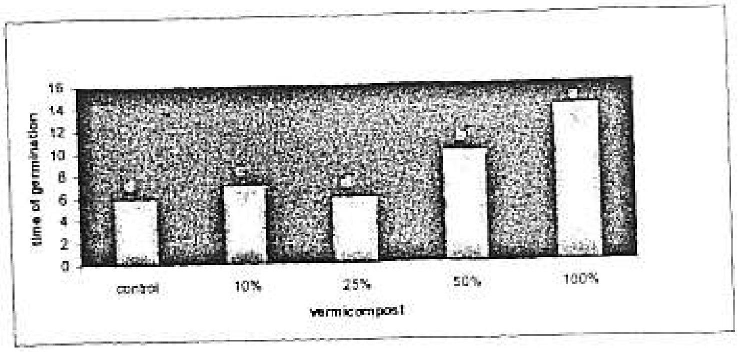

Fig. 3. Effect of vermicompost on time of germination (p≤0.01).

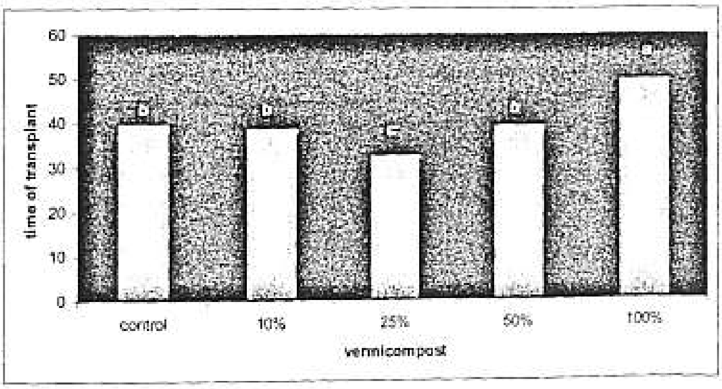

Fig. 4. Effect of vermicompost on time of transplant ($p \leq 0.05$).

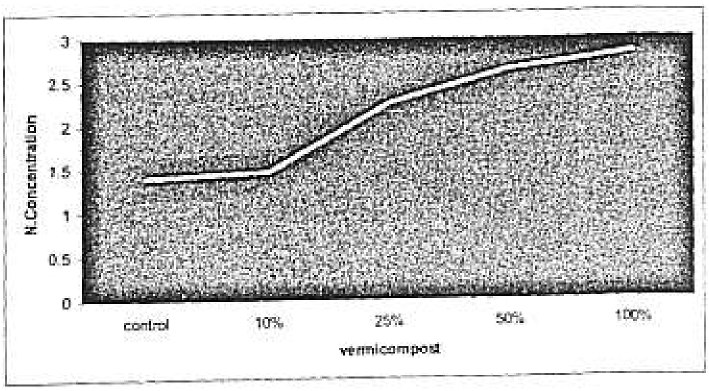

Fig. 5. Effect of vermicompost on N concentration ($p \leq 0.01$).