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The Impacts of Vermicompost on Tomato Morphological and Physiological Characteristics

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Using of organic matters such as vermicompost in culture bed has been considered widely due to its effect on soil property's modification. Vermicompost increases soil water capacity and supplies plant needed materials resulted in high-yield rate as well as plant quality. To study the effect of vermicompost on tomato morphological and physiological characteristics, experiments were carried out twice in the year 2013 using a complete randomized block design with four treatments and 4 replicates in research fields of agronomy department, faculty of agriculture, Urmia University. Treatments include different vermicompost percentages (0, 25, 50, 75 percent) with garden soil and measuring parameters included root length, stem length, fresh and dried weight, chlorophyl, sugar and prolin contents of the plants. After initial analysis of data, meta-analysis was performed. Results showed that using vermicompost increased all the measuring parameters significantly in general and with the highest rate of vermicompost in particular. In this regard, the paramount effects were pertained to plants root length as well as plant height in comparison to the other treatments.

Key words: Tomato, Vermicompost, Met analysis, Morphological and physiological characteristics.

Development of technology showed the most hazardous effects of chemical residues in agricultural products and their effects on enhancing cancer's rates as well as human and animal nerve systems disorders made paying more attention to supplying products without chemical residues inevitable. Overall, this is also economical concern for growers due to high costs of chemicals, and they prefer to use of biological resources and economical methods as much as possible. Therefore, organic agriculture has been developed rapidly due to social demands, economic aspects as well as ecological importance. In this system, it was tried to eliminate any chemicals and using of organic materials for sustaining environmental quality[20]. It is obvious that in such systems due to improving of soil fertility and plant and soil, biological property's disease and pest's occurrences decreased, and it's no need using any chemicals so natural resources and environmental protection could be obtained[16]. Producing vermicompost as an organic fertilizer has been considered as a valuable, quick and economical alternative. This technology preferred to conventional composting methods since had more nutritional values due to more mineralization and humid contents[13]. Vermicompost is a bio-organic fertilizer, including active biological mixtures of bacteria, enzymes, plant debris; animal dungs as well as earthworm capsules, which degrade soil organic matters and improving of microbial activities in plant beds[8]. Slow and constitutively transferring of these materials in earthworm digestive systems along with crushing and mixing in different parts and adding of various compounds

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such as calcium carbonate, enzymes, mucoses and different microorganism's metabolites and finally a favorable condition for humid acid production makes compounds, which are completely different from initial material . Soil microflora which is digested by earthworms changed both quantitatively as well as qualitatively. Several bacteria such as B. cereus eliminated and other groups, especially heterotrophic bacteria with B12 producing ability as well as ammonium and nitrate producing bacteria were increased. Vermicompost which is an organic matter with regulated pH; abundant in humid materials and mineral plant available nutrients, with different vitamins, inducing plant growth hormones as well as enzymes, which are morphologically granular with a dark color[22]. It has different necessary macro and micro nutrients for plants, but the most important property is that these materials are soluble in water and absorbable. The better nutrient absorption ability by plant in vermicompost is due to its tamponed nature, and its organic acids make soil nutrients soluble and available for plant. Furthermore, vermicompost can fix the soil nutrients and avoid of their excess absorption by plant[14]. Furthermore, induces seed germination and supplies a constitutive and favorable growth for plant in three months[22]. Vermicompost has a high water and nutrient capacity with a suitable aeration and drainage so its application in organic agriculture increases soil efficient microorganism (such as mycorrhizal fungi and phosphate solubilizing microorganisms) as well as supplies plant necessary nutrients such as nitrogen, phosphorous and potassium and improve plant growth and yield[2]. Its process is easier and quicker than bio-compost and rich in nutrients like as phosphorous, potassium, calcium and magnesium, which are available and absorptive for plant[19,3]. Due to more scrutiny on food security, increasing of production in surface area using different sustainable agronomic and breeding methods, which involve correct application of natural resources, especially soil and water without destruction of environments (if any) has been focus of many scholars worldwide in recent years[9].

There is widely held that vermicompost is a useful tool in tomato production. Based on such notion, the main objectives of this study were determination of vermicompost effects on tomato transplant quality, growth and introducing the best applied vermicompost concentration for culturing tomato transplants.

MARERIALS AND METHODS

This study was carried out during the year 2013 in the research field of agronomy department, faculty of agriculture, Urmia University situated 11Km of Urmia northwest (E45º, 5¹ and N37º, 32¹; 1320m). This is a cool and dry region based on amperometric data with a cool winter and dry and hot summers with a mean rainfall of 184mm annually and average annual temperature of 12º C. Experiment was done in a completely randomized design with four treatments, and 3 replications. Each replicate includes eight 4L pots. Treatments and their index listed in table 1. Properties of applied field soil as well as vermicompost also showed in table 2 and table 3. Tomato transplants transferred to pots followed by culture bed preparation. All the transplants were same in morphological characters as well as growing age and their growth condition was similar. Irrigation was done twice in the day, and experiments repeated again after one week.

Plant growth rate (height, stem length, root length, fresh weight) measures weekly during the growing period. Furthermore, at the end of growing period, sugar contents[18], leaf chlorophyll and prolin contents[7] were measured. Data analysis was done separately for each experiment and meta-analysis method used for two experiments results since there was no significant difference between two experiments variances based on Bartlett's test. Data analyzed by SPSS software and mean comparison done based on Duncan's multiple range tests.

RESULTS

Results of both experiments showed that adding vermicompost to field soil increased all growth indexes significantly (Tables 4, 5 and 6).

The mean comparison of growth parameters using meta-analysis method is shown in Table 7. Results show that different levels of vermicompost had various effects on growth parameters. In the root length index, there are no significant effects observed and all the levels grouped each other, so the differences may be randomized. In stem length index, different levels of vermicompost had significant effects and means put in three groups. In the root fresh weight index, increasing levels of vermicompost could increase this index, and mean put in three different groups. It was supposed that there is a linear trend between vermicompost levels and roots fresh weight index. This trend and grouping were also observed in the root dry weight index. For chlorophyll sugar and prolin content's indexes, it was observed that increasing vermicompost levels could increase these indexes and means put in four different groups. It seems that there is a linear trend between vermicompost levels and these parameters.

Table 1. Treatments used in the current study

Index	Vermicompost (V)	Field soil (V)
A	V0-0%	100%
B	V50-25%	75%
C	V75-50%	50%
D	V100-75%	25%

Table 2. Properties of applied field soil

Texture								
Sand%	Silt%	Clay%	K (mg/kg)	P (mg/kg)	N (mg/kg)	C%	pH	EC (ds/m)
28	34	38	197.6	11.6	0.105	1.05	7.5	1

Table 3. Properties of applied vermicompost

pH	EC	OM	OC	C/N	N	P	K
7.64	1.12	8.56	32.9	21.25	1.55	0.4	0.4
Ca	Mg	Fe	Mn	Cu	Zn	Pb	Cd
2.73	0.95	500	275	20	110	19	1

DISCUSSION

Overwhelming scholars believed that vermicompost's impact on high quality tomato production is a key factor. The results of analysis of variances as well as the mean comparison of current study confirmed such assumption and showed that vermicompost had positive effects

Table 4. Results of first experiment analysis of variance

Source of variation	Df	Chlorophyll	Sugar	Prolin	Fresh weight	Dry weight	Stem length	Root length
Treatment	3	1.231**	11.673**	94437.823**	40.217**	1.255*	13.832**	1.023**
Error	8							
CV		22.7%	18%	19%	18.3%	22.2%	9.5%	11.3%

* Difference is significant at the 0.05 level (2-tailed)
** Difference is significant at the 0.01 level (2-tailed)

Table 5. Results of second experiment analysis of variance

Source of variation	Df	Chlorophyll	Sugar	Prolin	Fresh weight	Dry weight	Stem length	Root length
Treatment	3	1.011**	9.753*	80373.242*	86.19**	2.11**	8.61*	1.64*
Error	8							
CV		14.7%	14.3%	17%	7.41%	1.59%	12.94%	15.3%

* Difference is significant at the 0.05 level (2-tailed)
** Difference is significant at the 0.01 level (2-tailed)

on all growth parameters, including root fresh and dry weight, plant height, and chlorophyll, sugar and prolin contents. And vermicompost increased these indices significantly in comparison to control treatment. In most cases, there is a linear positive trend between vermicompost levels and these parameters. However, it should be mentioned that the range of this linearity trend should be compatible with Libek role and would be economic justifiable. Several researchers have studied the effects of different organic resources as well as positive effects of vermicompost on plant yield, quality and micro nutrient absorption.

Increasing of yield components (Leaf number, root number, root length, height and so forth) due to vermicompost application could be the result of more nutrient availability and improving plant growth rate. Other results also showed that favorable effects of vermicompost application are due to physico-chemical as well as microbial and biological changes occurred in culture beds[4]; and also pH regulation and increasing soil water capacity. According to Sahni *et al*. (2008) increasing plant growth related to changes in soil structure differs in water availability, increasing macro and micro nutrients absorption, microbial activity induction, increasing main enzymes activity or production of plant growth promoters by microorganisms. It is possible also that vermicompost could effect of plant growth by changing physic-chemical and microbiological properties of culture beds like the compost[21]. Vermicompost had 40%-60% humid materials more than conventional compost[10]. Acid humid have hormone-like effects and increases root numbers resulted in more nutrient absorption as well as growth and development[1]. According to Krishnamoorthy *et al*. (1986), earthworms can induce plant hormone production from organic wastes. Increasing nitrogen absorption resulted in increasing plant growth and height. In this study increasing of vermicompost levels improved significantly the transplant yield which is a correspondent to other reports[5,6]. In this line, Hu

Table 6. Results of meta-analysis of variance

Source of variation	Df	Chlorophyll	Sugar	Prolin	Fresh weight	Dry weight	Stem length	Root length
Treatment	3	218.86**	289.71**	20987.12**	89.6**	181.16**	4.19**	1.62*
Error	20							
CV		24%	56%	47%	0.37%	13%	7.3%	14.97%

* F is significant at the 0.05 level (2-tailed)
** F is significant at the 0.01 level (2-tailed)

Table 7. Mean grouping of different growth parameters

Parameter	Mean Grouping			
Root length	A	B	C	D
	4.58a	4.68a	5.16a	5.35a
Stem length	A	B	C	D
	21.13a	22.16ab	23.46b	23.68b
Root fresh weight	A	B	C	D
	1.57a	1.99a	5.75b	9.69c
Root dry weight	A	B	C	D
	024a	0.66b	0.75b	1.65c
Chlorophyll content	A	B	C	D
	0.56a	1.21b	1.81c	2.03d
Sugar content	A	B	C	D
	0.56a	2.58b	3.99c	5.09d
Prolin content	A	B	C	D
	127.83a	237.5b	426.83c	518.83d

et al. (1998) stated that earthworms activity could increase some calcium compounds in soil resulted in pH increasing and finally absorption of heavy elements such as Zn and Fe. Whiting *et al* (2001) reported the effects of microorganisms in Zn activity in soil and showed that soil Zn could be activated by chelating agents who produced by soil microbes. Additionally, vermicompost increases Zn, Fe and other nutrients rather than control[11]. In the same line, Moez ardalan *et al*. (2009) also argued that effects of vermicompost in micro nutrient's absorption (Fe and Zn) in Maize shoots rather than control.

CONCLUSION

Considering treatments comparison with each other as well as with control group the best treatment on increasing of transplant quality and yield is 75% vermicompost level. However, other treatments also had more positive effects on plant qualitative and quantitative indices' in comparison to control treatment. Application of organic fertilizer such as vermicompost had positively significant effects on plant's yield as well as decreasing production cost compared to chemical fertilizer's application. Therefore, intensive teaching and training course's producers pertain to application of such organic substances could be key factors for pervasive organic agriculture development and organic yield production as well.

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