Effects of Mycorrhizae as a Substitute for Inorganic Fertilizer on Growth and Yield of Tomato (*Lycopersicon esculentum*), and Soil Microbial Activity

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Abstract

A Greenhouse experiment was conducted to determine the influence of mycorrhizae as a substitute for inorganic fertilizer on growth and yield of Tomato (*Lycopersicon esculentum*) and soil microbial activity. Four doses of inorganic fertilizer [recommended dose (Urea:TSP:MOP=65:325:65kg/ha), 1/2 and 1/4 recommended dose and 0) were applied to soil with standard dose of mycorrhizae (2g/5L water). The above 4 treatments were tested in a Completely Randomized Design (CRD) with five replicates. Results indicated that there was no significant difference in all parameters tested on plants treated with recommended dose and 1/2 of recommended dose of inorganic fertilizer with standard dose of mycorrhizae. Highest fruit wet weight (556g/plant - 69% higher than lowest) in tomato plants treated with ½ recommended dose of inorganic fertilizer, and lowest was recorded in plants treated with standard dose of mycorrhizae without inorganic fertilizer (329g/plant). Highest soil microbial activity was recorded in soil treated with standard dose of mycorrhizae without inorganic fertilizer (462 CO_2 mg/kg of soil - 61% higher as comparing to the recommended dose of inorganic fertilizer) and lowest observed in soil treated with recommended dose of inorganic fertilizer (287 CO_2 mg/kg of soil). The microbial activities of soil micro-organisms were lower in soils treated with inorganic fertilizers. It is concluded that 1/2 recommended dose of inorganic fertilizer with standard dose of mycorrhizae is the best fertilizer mixture for tomato. Addition of mycorrhizae increases the soil microbial activity significantly comparing with field soil.

Keywords: Mycorrhizae, Inorganic fertilizer, Tomato

Introduction

Generally inorganic fertilizer application can enhance plant growth and yield. Inorganic fertilizer can absorb quickly to soil and plants. Therefore maximum amount of inorganic fertilizer is applied to crops order to achieve higher yield. As a result, it prone to leaching and contribute to surface and ground water pollution. Thus it is better to use a combination of inorganic fertilizer and biological ingredients in crop cultivation (Urban Creeks Council, 2001). Mycorrhiza is a type of organic fertilizer (bio fertilizer) that creates mutualistic symbiosis between mycorrhizal fungi and higher plants. It belongs to family Endogone and form a bridge between the roots and the soil. Mycorrhizae improves crop yield and increases the use of inorganic fertilizer (University of Washington, 2006). Further Mycorrhizae enhance the structure of the soil and improves air and water infiltration indirectly.

Tomato (*Lycopersicon esculentum*) is the second most important vegetable crop next to potato. Present world tomato production is about 100 million tons fresh fruit produced on 3.7 million hectares. It is much depended on mycorrhizal symbiosis, classified as mycotropic plant (FAOSTATDatebase, cited in growing tomatoes 2012). At present the tomato is an important cash crop for the Sri Lankan farmer. It is a primary ingredient in many Sri Lankan curries, and is sometimes paired with fish, prawns, or okra.

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The present study was conducted to find the responses of tomato to inorganic fertilizer and mycorrhizae. The objectives of this study were to develop a best fertilizer combination (Inorganic + Mycorrizae) for the growth and yield of Tomato and to compare the soil microbial activity of field and treated soils.

Materials and Method

This study was conducted during six months (July-December 2012) period at Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya. Mapalana is located in the low country wet zone (WL_2) where the annual rainfall is > 1900 mm. The mean monthly temperature is 27.5 °C and relative humidity is around 72%.

Tomato variety Bhathiya seeds were obtained by Department of Agriculture. Nursery tray was filled using 1:1 ratio of compost and sand. Seeds were covered by thin soil layer and watering was done daily. After twenty one days of nursery period healthy, same size (5 cm) seedlings were transplanted to pots and maintained three plants per pot. Weaker plant are thinned out after 10-12 days, leaving two plants in each pot.

Potting media was prepared using 1:1:1:1 ratio of top soil, coir dust, sand and compost. Pots were filled with potting media and sterilized using Topsin fungicide (6g /10 L of water). After sterilization, pots were kept wet for seven days. Inorganic fertilizer recommended level without mycorrhizae (T1), 1/2 Inorganic fertilizer with standard dose of mycorrhizae (T2), 1/4 Inorganic fertilizer with standard dose of mycorrhizae (T3) and Standard dose of mycorrhizae without Inorganic fertilizer (T4) were used. Each treatment was replicated five times. All management practices were conducted according to recommendations of the Department of Agriculture from seed germination to harvesting. Data were analyzed using SAS program (9.1.3).

Results and Discussion

The results revealed that the highest mean number of leaves at 25 days was recorded in inorganic fertilizer recommended dose without mycorrhizae (T1). But it was not significantly different from ½ of the recommended dose of inorganic fertilizer with mycorrhizae standard dose (T2). The lowest number of leaves at 25 days was recorded in mycorrhizae standard dose without inorganic fertilizer (T4). Both

Table 1: Growth parameters of Tomato with inorganic fertilizer and mycorrhizae

Treatment	No of leaves at 25 days	No.of leaves at 45 days	Plant shoot height (cm)	Plant root length (cm)	No.of flowers/plant	No of fruits/plant	Wet weight of fruits/plant (g)	Soil microbial activity
T1	13^{a}	47.6^{a}	95.68^{a}	22^{a}	32.2^{a}	27^{a}	556^{a}	286.5d
T2	12.4^{ab}	43.2^{ab}	92.06^{a}	22.3^{a}	30.2^{ab}	25.2^{a}	548.25^{a}	349.3c
T3	10.8^{bc}	38.6^{b}	81.66^{b}	23.56^{a}	25.6^{bc}	20.6^{ab}	378.82^{b}	372.7c
T4	9^{c}	38.6^{b}	79.42^{b}	26.066^{a}	23.4^{c}	18.4^{b}	328.84^{b}	461.5a
Field soil	-	-	-	-	-	-	-	419b

T1: Inorganic fertilizer without mycorrhizae, T2: 1/2 Inorganic fertilizer with standard dose of mycorrhizae, T3: 1/4 Inorganic fertilizer with standard dose of mycorrhizae, T4: Standard dose of mycorrhizae without Inorganic fertilizer.
Column values followed by the same letter are not significantly different as determined by Duncan's multiple range test (P>0.05).

T1 and T2 treatments were significantly different from T4. The number of leaves at 25 days in T1 was 44.4% higher compared to T4. T2 was not significantly different from ¼ of the recommended dose of inorganic fertilizer with mycorrhizae standard dose (T3). The highest number of leaves at 45 days was recorded in inorganic fertilizer recommended dose without mycorrhizae (T1) and lowest was recorded in mycorrhizae standard dose without fertilizer (T4). According to the results number of leaves at 45 days in T1 was 23.3% higher compared to T4. T1 was not significantly different from ½ of the recommended dose of inorganic fertilizer with mycorrhizae standard dose (T2). Both ¼ of the recommended dose of inorganic fertilizer with mycorrhizae standard dose (T3) and T4 were not significantly different from each other.

As indicated in Table 1, treatment T1 was recorded the highest shoot height and lowest was recorded in T4 Plant height in T1 was 20.4% higher compared to T4. T1 was not significantly different from T2. Both T1 and T2 treatments were significantly different from T3 and T4.

There were no significant ($P>0.05$) difference in plant root length among all the treatments (Table 1). However highest root length was recorded in T4 and lowest recorded in T1. The reason is due to plants for adaptation to adverse soil conditions are an increase in root surface area via mycorrhizae (Seran *et al.*, 2010).

According to the results of Table 1 highest number of flowers per plant recorded in T1 and lowest recorded in T4. T1 had a mean number of flowers that was 37.6% higher than T4. Also there was no significant difference between T1 and T2. There was no significant difference between T3 and T4. Both T1 and T2 treatments were significantly different from T4. T1 was significantly different from T3 ,but T2 was not significantly different from T3 treatment.

As indicated in Table 1 highest number of fruits was recorded in T1. It was not significantly different from T2 and T3. The lowest mean number of fruits was recorded in T4. Number of fruits in T1 is 46.7% high compared to T4.

However highest wet weight of fruits/plant was recorded in T1. It was not significantly different from T2. Both of them were significantly different from T3 and T4. Lowest wet weight was recorded in T4. Wet weight of pods in T1 was 69% higher than T4.

When comparing soil samples, highest microbial activity (emitted Co_2 mg/kg of soil) was recorded in T4 and it was significantly different from all other treatments. St John, cited in Rod, (2005) was observed mycorrhizal fungi constitute the dominant microorganisms in most undisturbed soils estimated at about 70% of microbial biomass. Field soil recorded the next highest microbial activity. Reason for that may be field soil was not sterilized using topsin, but all other soils in T1,T2,T3 and T4 were sterilized using topsin before giving the treatment. T1 recorded the lowest soil microbial activity. Increment of soil microbial activity of T4 was 61.0 % than T1. Seran *et al.* (2010) found that activities of soil micro and macro organisms are reduced with the presence of inorganic fertilizers as compared to organic fertilizers. There was no significant difference between soils T2 (349.3 mg/kg of soil) and T3 (372.7 mg/kg of soil) for soil microbial activity. But both T2 and T3 were significantly different from field soil, T1 and T4 treatments.

Conclusion

T2 (1/2 of the recommended fertilizer + Mycorrhizae standard dose) is the best fertilizer mixture. When adding of mycorrhizae increase the soil microbial activity significantly comparing with field soil.

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