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Influence of Effective Microorganisms on Qualities of Tomatoes (Lycopersicon esculentum) Grown on Tropical Loam Soil

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Abstract
The use of Effective Microorganism (EM) consortium along with compost may overcome the harmful effects caused by chemical fertilizer while improving the nutritional quality of crops. The study aimed to determining the influence of compost inoculated with EM on the nutritional qualities of tomatoes (*Lycopersicon esculentum*) grown in tropical loam soil. Four sets of treated loamy soils was experimented. The treatments were the compost without EM (C); compost containing effective microorganisms (EM); compost containing effective microorganisms with chicken manure (CEM) and urea as mineral fertilizer (M). Tomatoes were harvested randomly after matured and kept in plastic bag and immediately transferred to the laboratory for analysis of beta-carotene, vitamin C and brix contents. The results shows that tomatoes planted with EM inoculated compost have relatively higher level of β-Carotene (7.76µg/100g), Brix (4.9%), and vitamin C (77.55mg/100g) compared with those from mineral 4.01µg/100g, 4.8%, and 3.83mg/100g respectively. This is likely reflect the efficiency of organic nature decomposition of EM compost over mineral fertilizers. We may therefore conclude that EM compost can be applied to supersede chemical fertilizer to promote sustainable and environmentally friendly tomatoes agriculture.

Keywords: Beta-carotene, Brix, Compost, Effective microorganisms, Vitamin C.

1. Introduction

The uses of synthetic chemical fertilizer in agriculture have been associated with improving the quantity and qualities of crops (Megali *et al*., 2014). Regrettably, excessive and misuse of chemical fertilizer has been related to many effects such as soil degradation, water pollution, toxic algae blooms, and death of soil organisms like earthworms and insects leading to the reduction of soil fertility and plant yield (Raja, 2012).

Effectives microorganism's technology (EM) has been adopted as an alternative method to synthetic chemical fertilizer. The EM technology is a mixed culture of beneficial microorganisms from a group of photosynthetic microbes, lactic acid bacteria (LAB), yeast, fermenting fungi and actinomycetes (Lindani, 2012). It has been widely applied to agricultural production with over 80 different types of beneficial microorganisms (Zhou *et al*., 2008). Application of EM technology help to decreases crop defenses against insect pests, positive effect on plant growth, and increases overall qualities and quantities of crops (Simeamelak *et al*., 2012).

The potential benefits of EM technology relied on the activities of microorganisms isolated from natural sources, mixed, cultured and inoculated into the soil where they can enhance the decomposition of organic matter and the release of nutrients (Mwegoha, 2012). Rapid breakdown of organic matter is considered a major advantage of EM technology. Moreover, EM is associated with greater nutrient availability from the various organic amendments, such as animal and green manures and municipal wastes (Raja, 2012).

Application of EM as a base fertilizer or as a component of base fertilizer have been reported in many studies (Yang *et al*., 2002; Simeamelak *et al*., 2012). However, the potential of EM for influence on qualities of tomatoes (*Lycopersicon esculentum*) has been little assessed. Thus, the objective of this study was to evaluate the effect of EM on qualities of tomatoes (*Lycopersicon esculentum*) grown on loam soil.

2. Materials and Methods

2.1. Location of the Study Area

The study was conducted in Zanzibar, Tanzania. The plot farm is located at longitude 39.26474° S and latitude -6.26870° E with elevation 113-ft. The experiment was conducted on the loam soil under tropical condition during the summer season. The average temperature of the region was about 29 ° C and precipitation of around 62 mm per day.

2.2. Preparation of EM and Compost

EM was prepared according to Takashi et al., (1999) with a ratio of 1:1:18, EM, molasses and water respectively, and fermented for seven days until reach pH of 3.5. Mineral fertilizer (M) was obtained from local agricultural store. Other three sets of compost were (i) compost containing effective microorganisms (EM), (ii) control or compost without effective microorganisms (C) and (iii) compost composed of effective microorganisms and poultry manure (CEM). The first set was prepared by mixing 1 litre of activated EM with 100 kg of biodegradable waste and covered with a plastic sheet for 40 days. CEM was prepared by mixing 1 litre of activated EM with about 10 kg of poultry manure and then covered with a plastic sheet for 50 days. The composition of compost is shown in the Table 1.

Table 1: The physicochemical property of the compost

Parameter	pH	EC (mS/cm)	PO_4 (%)	K (%)	N (%)	C (%)	OM (%)	Ca (%)	Mg (%)	Na (%)
Values	9.1	6.21	0.005	0.06	0.16	2.4	9.08	9.1	0.5	0.18

2.3. Research Design and Data Analysis

In this experiment, the treatments were arranged in a randomized block design with four plots (C, CEM, EM, M). The dimension each plot was 2 x 2 m (length x witdh). The experiment was conducted at three different location (Dimani, Kiembe Samaki and Shakani). The plots were irrigated twice day (morning and afternoon). When matured, the tomatoes were harvested randomly and kept in plastic bag and immediately transferred to the laboratory and analyzed for three parameters (beta-carotene, vitamin C and brix contents). Beta-carotene was determined according to Siong and LAM (1992). Vitamin C contents of tomatoes was determined using method recommended by (Bailey,1974; Brody, 1994; Pauling,1976; Kalluer,1986). The brix content of tomato was determined using refractometer RFM-340BS22-40, TFDA/DLS/SOP. The collected data were analyzed using SPSS 20

3. Results and Discussion

3.1 Effects of Beta Carotene on Tomatoes

The highest amount of beta carotene (59.9 ± 11.0 µg/100) was obtained in tomatoes grown with EM as shown in Table 2. A significant different was observed for tomatoes grown with EM compared with other fertilizers (Table 2). The results of this study is consistent with others finding, it has been reported by Piyadasa *et al*. (1995) that compost prepared by EM has the ability to effectively mineralize soil organic matter and consequently improve nutrient availability, soil health and crop growth. The bio-augmented compost is also interrelated with improved soil structure and enhanced soil fertility, increased soil microbial activity and improved moisture holding a capacity of the soil (Arancon *et al*., 2004). The EM compost applied in tomato field was endowed with high humus content (7.55%), which in general influences the microbial diversity in soil and helps the plant to improve their physiological processes for mineralization of nutrients in the soil.

Table 2. Results of statistical analysis of tomatoes grown with EM and other fertilizers[+]

Treatments	Beta (µg/100g)	Brix (%)	Vit C (mg/100g)
Control	35.0 ± 35.4[b]	4.4 ± 0.6[a]	82.6 ± 8.5[a]
Minerals	31.1 ± 6.8[b]	4.1 ± 0.6[a]	53.7± 12.0[b]
EM	59.9 ± 11.0[a]	4.6 ± 0.4[a]	90.8 ± 20.7[a]
CEM	30.3 ± 3.9[b]	4.5 ± 0.4[a]	90.8 ± 20.7[a]

[+]*The values in the table are mean ± standard deviation. Values with the same letter for a given property are not significantly different (P < 0.05). EM= effective microorganisms, CEM= effective microorganisms and manure.*

Moreover, it is reported by Riahi and Hdider (2013) that compost fertilizers influence the lycopene content and antioxidant properties in different cultivars of tomato. The increasing of antioxidant might be due to nutrient contents upon EM-compost treatment (Verma *et al*., 2014).

3.2. Effects of Brix on Tomatoes Treatment

The brix value ranged from 4.1 to 4.6% (Table 2). Tomatoes grown in EM contained high brix values compared to others, although no significant difference was observed between fertilizers. The high brix values indicate a sweeter taste and that the fruit or vegetable will keep for longer (Kruss, 2014). So, EM might increase the value of sweetness due to its organic nature decomposition efficiency. According to Hasegawa (1989) the total sugar level (brix) content in tomato fruits was the highest with adding organic fertilizer. Since EM is organic fertilizer maybe is the reason to influences an increase of sweetness in tomatoes due to its organic nature decomposition efficiency.

3.3. Effects on Vitamin C of Tomatoes Treatment

The vitamin C contents of tomatoes is shown in Table 2. A significant difference was observed between tomatoes grown in compost and mineral fertilizers. The same amount of vitamin C was observed in tomatoes grown in EM and CEM. The lowest amount of vitamin C was detected in tomatoes grown with mineral fertilizers (Table 2). The same results were reported by Xu *et al.* (2000) who found higher vitamin C contents in EM-treated tomatoes. Organically grown fruits and vegetables have high levels of vitamin C, iron, magnesium, phosphorus and antioxidant activity (SOD, GR, APO, PO, phenols) and less lipid peroxidation level than conventional grown products (Worthington, 2001; Barron, 2010; Montalba *et al*., 2010;Verma *et al*., 2014)

4. Summary and Conclusion

The study determines the effects of effective microorganisms in tomatoes, four different types of fertilizers were used, EM, CEM, M and controls, then three parameters (beta carotene, brix and vitamin C) were determined. The results the tomatoes grown in EM has significant higher values of beta carotene, brix values and vitamin C contents. Hence, EM compost can be applied to supersede the use chemical fertilizer in crop production and thus minimizing both ecological and environmental effects caused using agrochemical. Also, EM solution contains beneficial microbes that can easily be multiplied very rapidly. Therefore, the application of EM might improve the nutritional contents of tomatoes and other vegetables.

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