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Evaluation of appropriate type and rate of new organic fertilizers with inorganic fertilizers for growth and yield of tomato at east Shewa, Ethiopia

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Abstract
Tomato is one of the most important and widely grown vegetables in the World. It is important in a variety of dishes as raw, cooked or processed products more than any other vegetables. In Ethiopia, tomato is an important cash crop widely produced by smallholder farmers and commercial growers under irrigated conditions.
The experiment was conducted at Adami Tulu on station under irrigation during 2016. All study districts are located in the mid rift valley of Oromia where ATARC is located and characterized with the same agro-ecology.
The experiment was laid out as a Randomized Complete Block Design (RCBD) with three replications. The size of a plot was 12 m2 (4 m x 3 m). Each plot accommodated 4 rows and each row contained 10 plants. A spacing of 30 cm and 70 cm between plants and rows were used, respectively.
The result of the present study showed that the application of NPS, Eco-green and urea improved the growth and yield of tomato crop and enhanced the soil chemical parameters.
Therefore, NPS 200KG/ha, urea 300kg/ha and eco-green 400L/ha can be suggested for tomato crops production for soil nutrient management system in the studied area, however, since the experiment was done once and only at one location, the research should be repeated involving several other varieties at different locations and over various seasons to reach a conclusive recommendation.

Keywords: tomato, fertilizers, urea, eco-green, orga

Introduction
Background and Justification
Tomato is one of the most important and widely grown vegetables in the World. It is important in a variety of dishes as raw, cooked or processed products more than any other vegetables (Lemma Desalegne, 2002) [7]. In Ethiopia, tomato is an important cash crop widely produced by smallholder farmers and commercial growers under irrigated conditions. It is extensively produced in the Rift Valley and lakes region both for fresh market and processing industries and is also expanding in different production belts for its diverse economic benefits (SelamawitKetema and Lemma Desalegne, 2008) [9].
According to Dawit Alemu (2008) [4], the productivity of tomato under research and research managed farmers field is about 60 t ha-1. However, the current productivity of the crop under farmers' conditions is only 10.4 t ha-1, which is very low compared to the yields obtained under research. Despite the fact that tomato has great potential of high productivity in Ethiopia, the current productivity in the country is very low even by the African standard (Ambecha *et al.,* 2012). Increasing productivity of the crop has a great role to strengthen the export potential and growing processing tomato production industries in the country (Dawit Alemu, 2008) [4]. Tomatoes are heavy feeders because of their rapid growth and long production season. Tomatoes need about 84 to 112 kg of nitrogen (N) per ha and moderate to high levels of phosphorus (P) and potassium (K) for maximum yields (Ren *et al.,* 2010) [8]. Commercial tomato production requires optimal fertilizer and water management for high yield and maximum profits. In many cases, N is the element that most limits tomato crop growth, especially on coarse-textured, low organic-matter soils (Scholberg *et al.,* 2000) [10].
Even though specific location information availability is scanty, generally fertilizer use in vegetable production is high in the Rift Valley Region of Ethiopia. In combination with inefficient flush irrigation method, a major share of the fertilizer nutrient may be lost to the environment mainly through run-off and leaching. As a consequence, farmers overuse fertilizers in vegetables to compensate for these losses. Concerning N fertilizer management

for tomato production, little research has been conducted so far in Ethiopia. Lemma Desalegne (2002) [7] reported 105 kg N ha-1 as the optimum rate for tomato production in the Rift Valley region of Ethiopia whereas Tesfaye Balemi (2008) [13] reported a maximum yield when 110 kg N ha-1 was applied in the central highland of the country.

According to preliminary survey conducted in the Rift Valley of Ethiopia by Adami Tulu Agricultural Research Centre during the 2010/11 cropping year, farmers applied up to 400 kgN ha-1; which approximates the quantities of N fertilizer recommended in different part of the world (Tie *et al.,* 2002; Ren *et al.*, 2010 [8]; Ahmed *et al.*, 2012; Elia and Conversa, 2012) [5]. This shows that little systematic studies have been conducted so far in Ethiopia to elucidate the influence of type and rate of different fertilizer on growth, yield and quality parameters of tomato. Therefore, this research was initiated with the following objectives.

1. To identify the effect of different fertilizer types and rate on growth, yield, and quality of tomato plant.
2. To select the appropriate type and rate of fertilizer for tomato production in the area.

Material and Methods

Description of the study area

The experimentwas conducted at Adami Tulu on station under irrigation during 2016. All study districts are located in the mid rift valley of Oromia where ATARC is located and characterized with the same agro-ecology. Adami Tulu Agricultural Research Center (ATARC) is located in the mid rift valley of Ethiopia 167km south of Addis Ababa on the road to Hawassa town. It lies at a latitude of 7° 9'N and longitude of 38° 7'E. It has an altitude of 1650 m.a.s.l. and it receives a bimodal unevenly distributed average annual rainfall of 760.9 mm per annum. Rain fall extends from February to September with a dry period in May to June, which separates the preceding ''short'' rains from the following ``long'' rains. The long-term mean minimum and maximum temperature is 12.6 ^{0}C and 27 ^{0}C respectively. The PH of soil is 7.88. The soil is fine sandy loam in texture with sand, clay and silt in proportion of 34, 48 and 18% respectively (Adami Tulu Agricultural Research Center profile, 1998) [1].

Treatments and experimental design

The experiment was laid out as a Randomized Complete Block Design (RCBD) with three replications. The size of a plot was 12 m2 (4 m x 3 m). Each plot accommodated 4 rows and each row contained 10 plants. A spacing of 30 cm and 70 cm between plants and rows were used, respectively. Seedlings which failed to establish were replaced by replanting within a week of transplanting to maintain the appropriate plant population.

Table 1: Treatment combinations

No	Treatments	rate qu/ha	frequency	time of application
1	orga+Urea	4qu orga and 4qu urea	1orga and 2 urea	at planting orga and urea, ahoeing only urea application
2	NPS and urea	2qu and 3qu urea	1orga and 2 urea	at planting orga and urea, at hoeing urea application.
3	eco-green	400L/ha	3	1st, 2nd hoeing andat fruit setting
4	Ecogreen+Urea	300L eco-green, 200Kg NPS& 150Kg urea	NPS and urea once, 2tim eco green	at planting NPS and urea, eco-green at 1st and 2nd hoeing
5	orga+NPS+Urea	100kg NPS, 200Kg orga and 300kg urea	NPS and orga once, 3 times urea	at planting NPS and orga, at 1st and 2nd hoeing urea application.

Data collection and measurement

Crop phonological, growth, yield and yield component, and quality parameters were considered in this study. All parameters to be considered are listed below with descriptions.

A. Growth parameters

Number of clusters per plant

This was recorded by counting the total number of clusters per plant from 10 randomly selected plants at full maturity.

Stem diameter

Stem diameter was measured in cm using a caliper 10 cm up from the root collar of 10 randomly selected plants from the middle rows.

Plant height

Height of the plants was measured from the ground level to the tip of upper most part of 10 randomly selected plants at flowering, fruit setting, at first harvest and at final harvest.

Number of primary branches

Number of branches extended from the main stem were counted and recorded on 10 randomly selected plants in harvestable rows at flowering stage.

Number of secondary branches

Number of branches extended from the primary branches was recorded on 10 randomly selected plants in harvestable rows at flowering stage.

B. Yield and yield related parameters

Three inner rows leaving one plant from the boarder at each side were used to asses yield related traits. All parameters to be considered are listed below with descriptions.

Number of fruits per cluster: It was recorded by counting the total number of fruits per cluster from ten randomly selected plants at red ripening stage of the fruit earlier used for flower count.

Number of marketable and unmarketable fruits per plant: All fruits produced on plants in the three inner rows of each experimental plot were counted and damaged fruits due to disease, insect, cracking and blossom end rot sorted and counted as unmarketable fruits.

Marketable fruit yield (t ha-1): was recorded by weighing all harvests of marketable fruits from the three inner rows of each plot and calculated in tonnes per hectare.

Unmarketable fruit yield (t ha-1): was recorded by weighing all harvests of unmarketable fruits from the three inner rows of each plot and calculated in tones per hectare.

Total fruit yield (TFY) (t ha-1): was recorded as the sum of the weight of marketable and unmarketable fruit yields and converted to tones per hectare.

Statistical analysis
The mean value of the recorded data's was subjected to analysis of variance (ANOVA) as per the method of Gomez and Gomez (1984) using SAS statistical package. For the significance difference among the treatments, mean separation wascarried out using Duncan multiple range test (DMRT) at 5% levels of significance.

Result and Discussion
A. Growth parameters
Number of clusters per plant
The number of cluster per plant were nonsignificant differences ($p > 0.05$) among treatments (table 2). Even though statistically nonsignificant, tomato plant treated with orga, NPS and Urea had larger number of cluster than other treatments.

Stem diameter
The number of cluster per plant were nonsignificant differences ($p > 0.05$) among treatments (table 2). Even though statistically nonsignificant, tomato plant treated witheco-green had longer stem diameter than other treatments.

Plant height
There was significant difference ($P<0.05$) among treatments in affecting plant height (Table 8). Plot applied with either NPS and Urea or orga +NPS+urea produced the tallest plants. Medium plant height was measured from tomato treated with other plots. However, plot applied with with eco-green and orga+ureal had the shortest plants height.

Number of primary and secondary branches
The number of primary and secondary branches was non-significantly influenced by organic and inorganic fertilizers.

Table 2: the mean of agronomic parameters

Treatments	Plant height(cm)	Number of cluster per plant	Stem diameter(cm)per plant	Number of branches per plant	
				1st branch	2nd branch
orga+Urea	64.66b	20a	57a	2a	3a
NPS and urea	74.33a	22a	63a	2a	3a
eco-green	63.66b	21a	65a	2a	4a
Ecogreen+Urea	70a	21a	59a	2a	3a
orga+NPS+Urea	71.33a	24a	56a	2a	3a
Cv	12	27	15	17	13

B. Yield and yield related parameters
Fruit number per plants
Significant differences ($p < 0.05$) were observed among treatments in the fruit number per plants
(Table 3). Plot treated with NPS and eco-green, in decreasing order respectively formed greater number of fruit than those plot treated with other fertilizers. The least number of plants with fruit was recorded from orga + urea treated plots.
These results are in agreement with the finding of Balemi (2008) who indicated that fruit number per plant was also significantly influenced by plant density, the low plant density resulting in significantly more fruit number as compared to high plant density.

Marketable fruit yield and **Unmarketable fruit yield (t ha-1**
There were significant differences ($P< 0.05$) among treatments in marketable yield of tomato crop (Table 3). Marketable yield of cabbage ranged from 22 to 39 ton/ha. The highest level of marketable cabbage yield was obtained from plots treated with eco-green +urea, followed by NPS+urea treated plot. Moreover, plot treated with NPS, urea and eco-green gave comparable yield with the aforementioned plot. The plot (orga+nps+urea) had the lowest marketable yields.
There were nonsignificant differences ($p > 0.05$) among treatments Unmarketable fruit yield (table 3). Even though statistically nonsignificant, cabbages treated with turmeric, neem and lantana had larger diameter than cabbages treated with diazinon, which had relatively more number of plants per plot.
Corroborating the results of this study, Warner *et al*., (2004) reported that N fertilizer above
100 kg ha-1 increased yields of green fruit, but had little effect on increasing marketable yield with the N rates above 270 kg ha-1. A high level of available N, which promotes vigorous plant growth and fruit.

Table 3: the mean of yield and yield components

Treatments	Fruit number per plant	Total yields tone/ha	Yield of the crop	
			Marketable tone/ha	Unmarketable tone/ha
orga+Urea	65b	28b	23b	10a
NPS and urea	75a	42a	36ab	14a
eco-green	65b	22b	34ab	14a
Ecogreen+Urea	70a	41a	39a	14a
orga+NPS+Urea	66b	29b	22b	10a
Cv	12	23	26	32

Conclusion and Recommendation

The result of the present study showed that the application of NPS, Eco-green and urea improved the growth and yield of tomato crop and enhanced the soil chemical parameters.

Therefore, NPS 200KG/ha, urea 300kg/ha and eco-green 400L/ha can be suggested for tomato crops production for soil nutrient management system in the studied area, however, since the experiment was done once and only at one location, the research should be repeated involving several other varieties at different locations and over various seasons to reach a conclusive recommendation.

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