Effects of Split Application of Nitrogen Fertilizer on Furrow Irrigated Tomato Production

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Abstract
Managing soil nutrient under irrigation system production is important for improved yield production. This experiment was conducted with the objective of evaluating the split application of nitrogen fertilizer at various growth stages of tomato under furrow irrigation. The treatments were: 100% (required by soil of the area) of urea at transplanting time (T1), 100% of urea at development period (T2), 50% of urea at transplanting time and 50% at development period (T3), 25% of urea at transplanting time and 75% at development period (T4) and no fertilizer application (T5). These five treatments were arranged in randomized complete block design (RCBD) with three replications. Application of 50% of urea at transplanting time and 50% at development period provides higher yield (39.33 ton/ha). The next higher yield was observed at application of 25% of urea at transplanting time and 75% at development period (33 ton/ha). The minimum yield was observed at no fertilizer treatment. Application of 100% urea at transplanting time or at development period provides lower yield than spilt applied treatments. This result indicated that split application of nitrogen (urea) fertilizer is better system of application in furrow irrigated tomato production.
Keywords: Fertilizer, Tomato, Nutrients, Split application, Yield

1. Introduction

Tomato (Solanum lycopersicum) is the second most important vegetable crop next to potato with world annual production in 2010 was approximately 146 million metric tons of fresh fruit (FAOSTAT, 2012). In Ethiopia a total of 7,255.93 hectares of land was covered by tomato with production of 81,738.05 tones (CSA 2012). Tomato is an essential ingredient in the diet of the people and often used in almost every household. It is used in preparing soups, sauces, stews, salads and other dishes, and used in large quantities as compared to other vegetables (Ellis. 1998)

Tomato is a widely grown plant of great economic importance, especially in warm and rather dry areas (Cuartero and Fernandez-Munoz, 1999). It is widely cultivated in tropical, subtropical and temperate climates (FAO, 2006). The yield and quality of fresh fruit are influenced by many factors, including genetic factors and growing conditions (Viskelis et al., 2008). Irrigation and nutrient supply are considered to be the two environmental inputs that contribute most to crop productivity (Lenka, et al., 2009; Wang et al., 2011). The management of water and nutrients applied in fertilizers are the major factors affecting crop growth and productivity (Bernacchi and VanLoocke, 2015). Root zone nitrogen (N) fertilizer management can lower N fertilizer inputs by 73% for tomato (He et al. 2007). Indeed, crop yield and quality are very sensitive to appropriate water and nutrient contents in the root zone of plants, which can improve the absorbing area and capacity of roots (He et al, 2014).

Vegetable crops differ widely in their macronutrient requirements and in the pattern of uptake over the growing season. Nitrogen (N), Phosphors (P) and potassium (K) uptake by crop follows the same course as the rate of crop biomass accumulation. It is well documented that application of N promotes vegetative growth and fruit yield of tomato. Limitation of nitrogen in any phase of the plant growth stages causes reduction in yield (Mohammadian, 2002). Using nitrogen at the required times even in interval irrigation causes yield increase (Belder, 2005). It is also the most difficult nutrient to manage especially in interval irrigation (Lin et al, 2006). Experiments indicated that application efficiency of nitrogen fertilizer is less in nonsubmerged irrigation comparing to submergence condition (Pirmoradian and Sepaskhah, 2006 and Wang et al., 1998). In addition to these, alternative wetting and drying of the soil increases nitrogen application efficiency in comparison to continually submerged irrigation and increases water productivity (Cabuslay et al, 2002). This experiment was conducted with the objective of evaluating the split application of nitrogen fertilizer at various growth stages of tomato under furrow irrigation.

2. Materials and Methods

2.1 Description of the study area

The study was conducted in Southern Nation Nationalities and peoples Regional State, Gurage Zone, Meskan District, Ethiopia. Meskan District is 133km from capital city of Addis Ababa, 155km from regional capital city of Hawasa and 233km from Zonal capital city Weliqite. It is located at an altitude range of 1501-3500 masl. The mean annual rainfall of the area is 1001-1200mm. The mean annual temperature varies from a minimum of 11.8°C to a maximum of 27.4°C with daily sunshine hour of 10.1hrs. The soil of the experimental area is dominated by black and gray color with clay loam texture.

2.2 Treatment setting

The tomato cultivar used for this experiment was Melka Shola. It is a multipurpose variety released from Melkassa Agricultural Research Center. It has four major growth stages: initial stage, development stage, mid stage and late stage. Treatments used for this experiment were, 100% (required by soil of the area) of urea at transplanting time (T1), 100% of urea at development period (T2), 50% at transplanting time and 50% at development period (T3), 25% at transplanting time and 75% at development period (T4) and no fertilizer application (T5). These five treatments were arranged in randomized complete block design (RCBD) with three replications and made a total of 15 experimental plots. The space between plots and blocks were 1 m and 1.5 m respectively. According to Melkasa Agricultural Research Center, the spacing between tomato plants and planting furrows were 30 cm and 100 cm respectively.

2.3 Data collection and analysis

The field data such as, branch number per plant, fruit number per plant and fruit size were recorded. The data were taken by random selection of six (6) plants from three central rows on each plot by excluding the border rows and border plants. At the end of the season the amount of fruit yield produced was harvested and weighted from each plot.

The data collected for each treatment were subjected to analysis of variance for Randomized Complete Block Design (RCBD). R statistical software package was employed for analysis of variance of the experiment.

3. Results and discussions

3.1 Number of branches per plant

The number of branches per plant was not significantly different among the all treatments except the non fertilized treatment (see table 1). The non fertilized treatment had significantly different branch number from T2 and T3. All the fertilized treatments tried to attain better number of branches per plant than the non fertilized one. The maximum number of branches per plant was accrued in the treatment of 50% of urea at transplanting time and 50% at development period (T3) which is 5.67. Application of 100% of nitrogen (urea) fertilizer at transplanting time or at development period attained less branch number than T3. This might be due to the need of nitrogen by the crop at initial stage as starter of vegetative growth and later at development period for branch development. This result was in close conformity with the findings of Feleafel (2005), who reported that split applications of nitrogen fertilizer significantly increases plant height, number of branches and leaves, leaf area and dry weight per plant of eggplant.

3.2 Number of fruits per plant

The maximum number of fruits per plant was obtained with treatment of 50% of urea at transplanting time and 50% at development period (T3) which is 59.33 followed by treatment of 25% of urea at transplanting time and 75% development period which is 54.67 and the minimum number was observed in treatment of no fertilizer (see table 1). This result is in agreement with research conducted by Ghoneim, (2005) who reported that split applications of nitrogen fertilizer significantly increases total fruit yield, number of green fruits per plant and average fruit weight of sweet pepper. The result showed an increasing tendency in the number of branches per plant with an increase in the fruit number. Applications of 100% of nitrogen (urea) fertilizer at transplanting time or at development period accrued less number of fruits per plant than split application. This might be due to leaching out of nitrogen fertilizer by irrigation water before plant using.

3.3 Fruit size

The maximum fruit size was obtained with treatment of 50% of urea at transplanting time and 50% at development period (T3) (9.16cm) and the minimum size was record at treatment of no fertilizer (6.63cm) (see table 1). Applications of 100% of nitrogen fertilizer at transplanting time or at development period accrued less fruit size than T3. This result was in close agreement with result obtained by (Wilton and Douglas, 1991) who concluded that increasing frequency of nitrogen fertilizer application increase fruit size of tomato.

3.4 Yield

Data presented in table 1 shows a significant effect of split application of nitrogen fertilizer on the fruit yield of tomato. The yield of treatment that was applied 50% of urea at transplanting time and 50% at development period higher than all other treatments. The next higher yield was obtained at treatment of 25% of urea at transplanting time and 75% at development period. Applications of 100% of nitrogen (urea) fertilizer at transplanting time or at development period attained lower yield than all split applied treatments. This might be due to leaching out of nitrogen required by the crop by irrigation water before critical nutrient required stage of the crop and initial requirement for vegetative growth initiator. These result indicated that split application of nitrogen fertilizer increases fruit yield of tomato. Hokam et al., (2011) concluded that later application of nitrogen fertilizer in the growing stages of tomato favors fruit development. Wilton and Douglas, (1991) suggested that increasing the frequency of nitrogen fertilizer application increases fruit yield of tomato. Total fruit yield, number of fruits per plant and average fruit weight of sweet pepper were positively and significantly responded to the split application of nitrogen fertilizer (Ghoneim, 2005). Generally this result indicated that tomato requires enough amount of urea at transplanting time and later at development period to develop high yield.

Conclusion

On the basis of this finding the yield and all other parameters of the treatment that was applied 50% of urea at transplanting time and 50% at development period higher than all other treatments. Application of 25% of urea at transplanting time and 75% at development period attained the next better result. Application of 100% urea at transplanting time or at development period attained lower yield than the split applied treatments. So, split application of nitrogen fertilizer is better system of fertilizer application in furrow irrigated tomato production.

Acknowledgement

The author would like to acknowledge Southern Agricultural Research Institute for providing the research fund and also the author would like acknowledge Worabe Agricultural Research Center for supporting experimental inputs.

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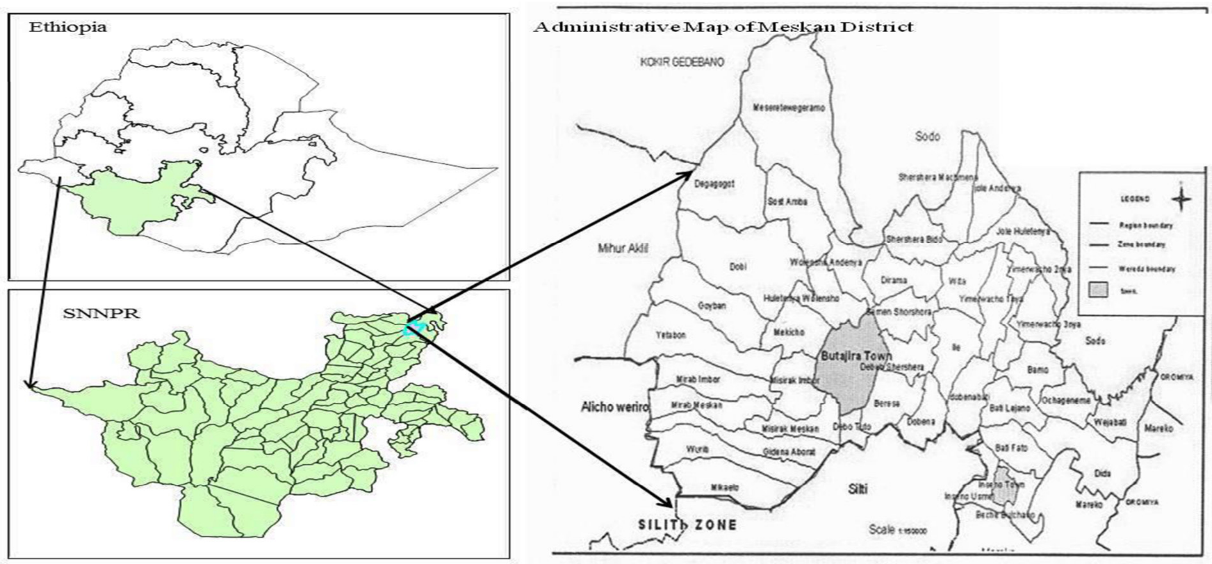

Figure 1. Map of Meskan District

Table1. Results of treatment effect on tomato yield and yield parameters

Treatments	No of branches per plant	No of fruits per plant	Fruit size(cm)	Yield per ha (ton)
100% of urea at transplanting time	4.33ab	46.67bc	7.16bc	27.33bc
100% of urea at development period	5.00a	52.33ab	8.30ab	31.39b
50% of urea at transplanting time and 50% at development period	5.67a	59.33a	9.16a	39.33a
25% of urea at transplanting time and 75% at development period	4.33ab	54.67ab	7.56bc	33.00ab
0 at all(no fertilizer)	2.67b	42.00c	6.63c	23.67c
CV (Coefficient of variation)	22.53	8.44	8.61	12.3
LSD (List significant difference)	1.86	8.10	1.26	7.16