International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Effect of Intra-row Spacing on Growth and Development of Tomato (*Lycopersicum esculentum* Mill) Var. Roma VF, at the experimental site of Wollo University, South Wollo, Ethiopia

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Abstract

A field experiment was conducted at Wollo University experimental site during March to June 2013 cropping season. The objective of this study was to determine the effect of intra-row spacing on the growth and development of tomato. The experiment was conducted on a randomized complete block design with three replication. Only one variety Roma VF was used on the experiment. The treatment used are 20, 25, 30,35cms spacing between plants with an inter-row spacing of 70cm. Growth and development parameters were recorded and analyzed by using ANOVA. The result revealed that tomato plants planted at 30 and 35cms had higher branch number, flower and fruit number per plant but shorter in plant height. In general this research indicated that high plant density (narrow) spacing greatly affected plant. Significant effects ($p \leq 0.05$) of intra row spacing were observed for number of flower per plant.. The wider spacing (30cm,35cm) had the highest flower per plant (53 and 56) and the lower spacing (20cm an 25cm) had lowest flower per plant (21 and 26). Significant effect ($p \leq 0.05$) of in the intra-row spacing was observed for number of branches per plant. A significant effect ($p \leq 0.05$) of intra row spacing was observed for plant height. The maximum height was recorded from lower spacing (20cm, 25cm) i.e. 51 and 44 and the minimum plant height were recorded from wider spacing i.e. 40 and 39. Highly significant effects ($p \leq 0.01$) of intra row spacing were observed for number of fruit and leaf area. The wider spacing (30cm and 35cm) had the highest fruit per plant (43 and 44) and the lower spacing (20cm an 25cm) had lowest fruit per plant (10 and 12cms).

Keywords: intra-row; tomato; Roma VF; growth; development

1. Introduction

Tomato (*Lycopersicon esculentum* Mill.) belongs to the *Solanaceae* family and self crossing annual crop. This family also includes other well known species such as potato, tobacco, hot pepper and egg plant (aubergine). The center of origin of the world tomato is considered to be Andean Zone, whereas it is considered that the tomato was domesticated in Mexico [1].

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Presently the tomato is one of the vegetables with the highest production in the world and its production is increasing all over the world, primarily, in Asia. The production area in Europe, North and Latin America, tends to stop increasing of yield per hectare, probably using high yielding varieties.

Tomato is the third most important vegetable in the world next to potato and sweet potato [2]. In 2009 the world's total cultivated area under tomato was 4.89 million ha, with a production quantity of 141.14 million tons [3]. China is the world leading tomato producer with a production of 34.12 million tons followed by the united state and Turkey [3]. China is not only the world's largest fresh tomato producer, but also the world largest tomato paste producer, followed to EU and united state. In 2008, the export quantity reached 818,512 tones a sharp increase from 106,667ton in the previous year [4]

In the tropics, tomato is mostly produced by transplanting. Good quality of seedling usually leads to better growth, higher yields and earlier maturity tomato is among the most important vegetable crops in Ethiopia. Both fresh and processed tomato varieties are popular and economically important vegetable crops produced in the country [5]. [6] indicated that the total production of tomato in the country has shown as a marked increase since it become the most profitable crop providing higher income to small scale farmers' compared to other vegetable crops. However the production and productivity of the crop in the country is influenced by different factors among which improper plant spacing is the notable reasons of the low productivity of this crop.

The national average of tomato yield under farmer's condition is very low as compared to demonstration and experimental research plot. Increasing production of the crop has a great role to strengthen the growing vegetable industries in the country. Plant spacing greatly influences growth and yield of tomato. Typically, the farmers produce tomato on the method of broadcasting and inter closing in which this type of sowing method has many problems such as high plant population due to high seed rate, difficult to management, increasing competition to water and nutrient, harbor to disease and pest, low quality and small size fruits and reduce the yield of tomato. Thus the aim of research is to investigate the effect of pant density on yield and yield components of tomato for ecologies similar to the study area.

2. Research Methodology

2.1 Description of the Experimental site

The experiment was conducted in south Wollo Zone, Dessie town Wollo university at Kelem meda which has an altitude of 2600 m.a.s.l, annual rain fall ranging from 900 – 1000 mm and the average temperature of the area is ranging from $12^{o}c$ – $26^{o}c$. The soil type of the experimental site is heavy clay soil and the weather condition of the area is under "Dega".

2.2 Experimental design

The experiment was conducted to RCBD (random complete block design) with three replication and four treatments. The total treatment plots of the experimental design were 12 plots. The size of each treatment plot is 2mx1.7m =3.4m^2. The total area of experimental plots would be 12x3.4m^2 =40.8m^2. The spacing between two consecutive plots would be 0.5m, and the spacing between two consecutive replication would be 0.7m. Generally the total area of the experimental site is 10.50mx7.9m=82.95m^2. Thus the experiment was only a single factor treatment.

2.3 Treatments

Table 1. Treatments of the experiment

No	Treatment	Space b/n plant	Nº of plant on each plot	No of plant on each plot times replication (total plant on each treatment)
1	T1	20cm	30	30x3 =90
2	T2	25	24	24x3=72
3	T3	30	21	21x3= 63
4	T4	35	18	18x3= 54

2.4 Data collected

Data were collected from randomly selected and tagged plants from the central row excluding, the border rows. The parameters that were considered during data collection are: plant height, number of branches, number of fruit per plant and number of flowers per plant.

3. Results and Discussion

Data on growth and development were recorded during the study period. Significant differences between intra row spacing were observed for most of the parameters tested. The result of the experiment are presented and discussed as follows.

3.1 Number of branches per plant

Significant effect ($p \leq 0.05$) of in the intra-row spacing was observed for number of branches per plant (Table 2). T4 and T3 planted at all tested spacing gave the highest branch per plant. The branch number obtained under this factor was statistically similar and varied from 10 and 13 branches per plant were the least branch number (4 and 5) Was obtained from T1 and T2 at intra row spacing of 20cm and 25cm respectively (Table1), the maximum branch number per plant could be due to different type of spacing. Treatment (35cm, 30cm, 25cm and, 20cm), 30cm intra row plant spacing could be recommended for better branch number per plant. This result in agreement with [7]who reported that increase in planting density resulted in reduction in number of branches per plant. When intra row spacing increase, the number of branches per plants per unit area becomes less. More mineral nutrients highly

moisture and space become available for the vegetative growth to the efficiency of photosynthesis than in dense plantation. It is also demonstrated decreased number of branches per plant in determinate type as a result of plant density.

Table 2. ANOVA for Number of branches

Source	Df	ss	ms	Fcal	Ftab
Block	2	3	1.5		
Treatment	3	31.52	10.5	17.797**	4.76
Error	6	3.55	0.59		
Total	11	38.07			

df=degree of freedom, ss= sum of square, ms=mean sum of square

**=highly significant at p≤0.01

3.2 Plant height

A highly significant effect (p≤0.01) of intra row spacing was observed for plant height (table 3). The maximum height was recorded from lower spacing (20cm, 25cm) i.e. 51 and 44 and the minimum plant height were recorded from wider spacing i.e. 40 and 39. The result of this experiment indicates that lower intra row spacing resulted in maximum plant height. This could be due to maximum competition of light, and air T1&T2 (Table 1).

Table 3 ANOVA for plant height

Source	Df	ss	ms	Fcal	Ftab
Block	2	169.238	84.619		
Treatment	3	1801.97	600.66	16.45**	4.76
Error	6	217.92	36.32		
Total	11	2189.12			

df=degree of freedom, ss= sum of square, ms=mean sum of square

**= highly significant at p≤0.01

3.3 Flower number per plant

Significant effects (p≤0.05) of intra row spacing were observed for number of flower per plant (Table 4). The wider spacing (30cm,35cm) had the highest flower per plant (53 and 56) and the lower spacing (20cm an 25cm) had lowest flower per plant (21 and 26) This result indicates that increasing plant spacing more than 30cm for determinate types had little addition of flower number per plant. So increasing intra row spacing greater than 30cm is not needed.

Table 4 ANOVA for Nº of flowers per plant

Source	Df	Ss	ms	Fcal	Ftab
Block	2	838.49	419.24		
Treatment	3	2835.74	945.24	8.97*	4.76
Error	6	631.83	105.30		
Total	11	4036.06			

df=degree of freedom, ss= sum of square, ms=mean sum of square *= significant at p≤0.05

3.4 Fruit number

Highly significant effects (p≤0.01) of intra row spacing were observed for number of fruit and leaf area (Table 5). The wider spacing (30cm and 35cm) had the highest fruit per plant (43 and 44) and the lower spacing (20cm an 25cm) had lowest fruit per plant (10 and 12). This result indicates that increasing plant spacing more than 30cm for determinate types had little addition of fruit number per plant. So increasing intra row spacing greater than 30cm is not needed.

Table 5. ANOVA for number of fruit

Source	Df	Ss	Ms	Fcal	Ftab
Block	2	24	12		
Treatment	3	350.2	116.73	33.35**	4.76
Error	6	21.1	3.5		
Total	11	395.3			

df=degree of freedom, ss= sum of square, ms=mean sum of square

**=highly significant at p≤0.01

4. Conclusion and Recommendation

Tomato is the most important vegetable crops in Ethiopia, providing a higher income to small-scale farmers compared to other vegetable crops. However, tomato production in Ethiopia is highly constrained by several factors. Farmers get lower yields mainly due to disease, pests and inappropriate agronomic practice and lack of improved variety. Improper plant spacing is among the notable reason of low productivity of this crop.

The study was conducted to investigate the effect of different levels of intra row spacing on growth and development of the tomato under kelemeda condition. It was carried out under open field of Wollo University College of Agriculture department of plant science research site in 2013. The experiment is a one factor and four treatments (20cm, 25cm, 30cm, and 35cm) by 70cm intra-row spacing on Roma VF variety arranged in RCBD with three replication.

Data on plant growth and development parameter including plant height, branch number, flower number and fruit number per plant, were recorded before harvest. From the study conducted intra-raw spacing had valid effect on growth and development of tomato. Plants at 30cm and 35cm cm x 70cm had higher branch number, flower and fruit number while the plant at 20cm, 25 cm x 70cm had higher plant height than 30cm and 35 cm x 70cm.

In general this research indicates that high plant density (narrow spacing) greatly affected plant growth and development and since it affect the growth and development of the plant, it also affect final yield of tomato plant. Most resource poor farmers use cultural practice in their tomato production system. Thus to produce higher fruit yield tomato growers in the study area should be encouraged to use intra raw spacing 30cm cm x 70 cm with the Roma VF variety.

Acknowledgement

Above all we would like to prostrate for God, who gave patient and made our work successful. Our great appreciation is also to Wollo University, Department of plant sciences, who materialized us all inputs necessary for the research.

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