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Performance of tomato varieties as affected by different plant density

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Abstract
The management practice, which greatly influences tomato fruit yield, is plant density. Field trial was carried out to determine the suitable plant densities that would give optimum tomato yield. The trial was laid in a randomize complete block design (RCBD) in a split plot arrangement and replicated three times. Tomato varieties were the main plots (Roma VF and Ibadan local) and plant density (17,777, 26,666 and 53,333 plants/ha^{-1}) was the sub plots. Data collected included plant growth parameters and yield component. All data were analyzed using the analysis of variance (ANOVA) and significant means were separated by the least significant difference at 5% probability level ($LSD_{0.05}$). Ibadan local with the density of 53,333 plants/ha^{-1} gave the highest yield. Significant differences among the two varieties for a number of factors confirmed their different genetic background. The growth and yield attribute were affected by the two treatments; variety and plant density. In conclusion, Ibadan local and Roma VF with the density of 53,333 plants/ha^{-1} gave the highest yield.
Keywords: growth parameters, plant densities, yield component

Introduction

Tomato belongs to the family of solanaceae and the genus *lycopersicon* (Vander *et al.,* 2004). Tomato is a very important vegetable cultivated and consumed in most parts of the world, from home gardens and greenhouses to large commercial farms, due to its wider adaptability to various agro-climatic conditions (Agyeman *et al.* 2014). Substantial increase in tomato productivity could be attained through the use of improved varieties and agronomic techniques like population density (Nguyen *et al.,* 2015). It is therefore necessary to develop a technology for Nigerian tomato farmer to improve its production.

Understanding the proper planting pattern and spacing is very important to increase yield and to decrease interference with weeds (Murphy *et al*., 1996). It is one of the production factors which affects light interception by plant canopy (Board, 2001). Optimal plant density can be achieved by establishing appropriate distances both between and within the rows of plants (Victor *et al.,* 2014; Ozer, 2003). Therefore, there is need to determine which plant population will give optimum yield for tomato varieties commonly grown in southwestern Nigeria.

Materials and Methods

The field trial was carried out in early raining season of 2017 at the vegetable research field of the National Horticultural Research Institute (NIHORT), Ibadan (Latitude 7° 22' N and Longitude 3° 50' E at an altitude of 234m above sea level), Oyo State, in the forest agro-ecological zone of Nigeria. The experimental site had been under continuous cultivation for many years. The trial was laid out in a randomized complete block design (RCBD) in a split-plot arrangement and replicated three times on plot size measuring 3 m x 3 m, with an alley of 0.5 m within plots and 1.0 m between replicates. Tomato varieties were the main plot (Roma VF and Ibadan local) while plant population was the subplot (17,777 plants/ha^{-1}, 26,666 plants/ha^{-1} and 53,333 plants/ha^{-1}). Topsoil for the nursery was handled and sterilized by heating to 100^{0}C in a metal drum and was allowed to cool. The sterilized soil was filled into nursery trays after which seeds of tomato were sown. Regular watering and monitoring were carried out in the nursery. The land was ploughed and left for two weeks to allow buried weeds to decay and re-ploughed followed by harrowing. Tomato seedlings were transplanted at 5 weeks after sowing (WAS) at different spacing of 75 cm x 75 cm, 75 cm x 50 cm and 75 cm x 25 cm giving rise to 17,777 plants/ha^{-1}, 26,666 plants/ha^{-1} and 53,333 plants/ha^{-1} respectively.. Uniform fertilizer rate of 90 kg N ha^{-1}, 45 kg P_2ha^{-1} and 45 kg K_2O ha^1 was applied in two split doses at 5 and 7 WAS (Oyinlola and Jinadu, 2012). Weeds were controlled manually, using traditional hoe at 3, 5 and 7 weeks after transplanting. Cypermethrin was applied at 0.4 L/ha was used to control insect pest at 7 WAS and also 1 liter of NIHORT lyptol was mixed with 5litre of water and was applied at 6 and 9 WAS to control diseases. The following data were collected from randomly sampled tagged plants per plot; plant height, number of leaves, leaf area, stem girth (cm), fruit diameter, number of fruit/plant, fruit yield (ton/ha^{-1}), average fruit weight.

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All data collected were subjected to the analysis of variance (ANOVA) using Gen-Stat Discovery Edition 4 (2013). Significant means were separated using the least significant difference (LSD) at five percent (5%) level of probability ($p \leq 0.05$).

Result and Discussion

The result during the early cropping season showed that there were significant varietal differences in terms of plant height of the two tomato varieties used in this study. Roma VF had highest plant height (35.90cm) which was significantly higher than Ibadan local that recorded 32.27cm (Table1). Plant density had significant influenced on the plant height (Table 1). Plot with 53,333 plants/ha^{-1} had significantly higher plant height (Table 1). The number of leaves of tomato evaluated had no significantly effect on the tomato varieties. Roma VF and Ibadan local had the same value (Table 1). Tomato transplanted at 26,666 plants/ha had significantly higher number of leaves at 10WAS. Plots with 26,666 plants/ha had the highest number of leaf (20) leaf (Table1). In early cropping season, leaf area of tomato variety was significantly different among the two varieties (Table1). Roma VF had significantly higher leaf area (12.2cm^2) than Ibadan local. Plant density was significantly affected by the leaf area. Tomato transplanted at 17,777 plants/ha^{-1} gave significantly higher leaf area of 13.89cm^2 (Table 1). The result showed no significant varietal difference on the stem girth of the tomato varieties. Roma VF had the highest stem girth (2.83cm) although not significantly different from stem girth obtained from Ibadan local. Plant density (PD) had no significant effect on stem girth. The highest stem girth (2.89cm) was obtained from tomato transplanted at 17,777plants/ha^{-1} (Table 1).

Interaction of varietal x plant density had no significant effect on plant height. Roma VF planted at 53,333 plants/ha^{-1} gave the tallest plant (39.44cm) although not significantly different from others (Table1). Roma VF within the higher plant density that recorded the tallest plant may be due to Roma VF that exhibits wild survival tendency to grow fast (Joy *et al*.,2015) at higher plant density (53,333 plants/ha^{-1}) which they compete for light and air (Seid *et al*., 2013). Roma VF transplanted at 26,666 plants/ha^{-1} gave significantly higher number of leaves than Ibadan local transplanted at 17,777 plants/ha^{-1} that recorded 20.03 while Roma VF transplanted at 17,777 plants/ha^{-1} gave the least number of leaves. In contrary, Roma VF transplanted at 17,777 plants/ha^{-1} gave significantly higher leaf area. Meanwhile, Ibadan local transplanted at 17,777 plants/ha^{-1} gave significantly higher stem girth of 3.04cm (Table2). The significant higher stem girth gotten at 17, 777 plants/ha^{-1} could be probably because of spacing between the plants. The result of the study for this character in stem girth was in agreement with the findings of Monirul *et al*. (2011) in sweet pepper, which expressed gradual decreased with decreasing plant spacing. Stem girth determines the dimensional attainment of a plant during the growing period.

There was significant varietal effect on the entire yield component except average fruit weight which had no significant effect between the varieties. Ibadan local gave significantly higher yield component, although average fruit weight obtained was not significantly different from that of Roma VF. Ibadan local being a desirable trait commonly grown in south western Nigeria as described by Olosunde *et al*., (2018), could be due to the desirable trait in Ibadan local variety with good performance. This agreed with the report of Adebooye *et al.* (2006) that gave the highest fruit diameter and fruit yield in Ibadan local. Shobo *et al.* (2016) also gave similar report on significant increase on yield component of tomato. Tomato transplanted at 17,777 plants/ha^{-1} gave significantly higher fruit diameter compared to tomato transplanted at 26,666 and 53,333 plants/ha^{-1}. Number of fruit/plants increases at the population of 26,666 and 53,333 plants/ha^{-1} although not significantly different among all the plant population observed. Average fruit weight increases at the increase in plant population per ha. Tomato transplanted at 53,333 plants/ha^{-1} gave significantly higher average fruit weight compared to tomato transplanted at 26,666 plants/ha^{-1} while tomato transplanted at 17,777 plants/ha^{-1} gave significantly lower average fruit weight. Similarly, significant higher yield was obtained from tomato transplanted at 53,333 plants/ha^{-1} while tomato transplanted at the population of 17,777 plants/ha^{-1} gave significantly lower yield (Table 3). The significant increase in fruit weight and fruit yield at 53,333 plants/ha^{-1} could be associated with highest number of plant which produced more fruit. This result is in agreement with Law-Ogbomo and Egharevba (2009) who reported progressive increase in the number of fruits plant, fruit yield ha in tomato as planting density increases.

There were significant differences observed among the interaction of varieties x plant density in all the yield components (Table 4). The significant higher fruit diameter, number of fruit/plant and average fruit weight was obtained from Ibadan local within the plant density of 26,666 plants/ha^{-1} while average fruit weight and

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yield component was significantly higher when Ibadan local was transplanted at 53,333 plants/ha (Table4).

Based on general observation and the result of this study, significant differences among the two varieties for a number of factors confirmed their different genetic backgrounds. The growth and yield attributes were affected by the two treatments: variety and plant density.

In conclusion, Ibadan local and Roma VF within the density of 53,333 plants/ha^{-1} gave the highest yield.

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Table 1: Main effects of transplanting age and plant density on growth parameter of tomato varieties

	10 WAS			
Treatment	**Plant height (cm)**	**Number of leaf**	**Leaf area (cm^2)**	**Stem girth(cm)**
Variety (V)				
Roma VF	35.9	16	12.20	2.83
Ibadan local	32.27	16	9.75	2.82
$L.S.D._{0.05}$	2.35	NS	1.27	NS
Plant density(P)				
17,777 plants/ha	30.15	16	13.89	2.89
26,666 plants/ha	34.51	20	8.99	2.83
53,333 plants/ha	37.59	13	10.05	2.76
$L.S.D._{0.05}$	1.48	1.27	0.83	NS
V X P	NS	*	*	NS

$LSD._{0.05}$: Least Significant Difference at 5% probability, NS: Not Significant, Significant: * , WAS: weeks after sowing

Table 2: Interactive effects of transplanting age and plant density on growth parameter of tomato varieties

	10 WAS				
	Plant density (Plants/ha)	**Plant height (cm)**	**Number of leaf**	**Leaf area (cm^2)**	**Stem girth(cm)**
Roma VF	17,777	32.71	11.68	18.71	2.74
	26,666	35.57	22.36	9.82	2.89
	53,333	39.44	13.14	8.06	2.87
Ibadan local	17,777	27.60	20.03	9.06	3.04
	26,666	33.45	16.77	8.17	2.77
	53,333	35.75	12.02	12.03	2.65
$L.S.D._{0.05}$		2.11	2.72	1.17	0.45
Sig.		NS	**	**	NS

$LSD._{0.05}$: Least Significant Difference at 5% probability, NS: Not Significant, Significant: * , WAS: weeks after sowing

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Table 3: Main effects of transplanting age and plant density on yield component of tomato varieties

	Yield Component			
Treatment	Fruit diameter (ton/ha)	Number of fruit/plant	Average fruit weight	Fruit yield(ton/ha)
Variety (V)				
Roma VF	4.45	2.41	55.2	4.7
Ibadan local	5.36	3.93	66.7	9.78
L.S.D.$_{0.05}$	0.04	1.28	NS	1.91
Plant density(P)				
17,777 plants/ha	4.98	2.94	52.4	2.84
26,666 plants/ha	4.93	3.28	58.6	5.58
53,333 plants/ha	4.79	3.28	71.8	13.3
L.S.D.$_{0.05}$	0.06	NS	8.65	1.09
V X P	**	**	**	**

Table 4: Interactive effects of transplanting age and plant density on yield component of tomato varieties

		Yield component			
Variety	**Plant density (Plants/ha)**	Fruit diameter (cm)	Number of fruit/plant	Average fruit weight	Fruit yield(ton/ha)
Roma VF	17,777	4.62	2.67	61.2	2.87
	26,666	4.46	2	45.9	2.83
	53,333	4.28	2.56	58.6	8.39
Ibadan local	17,777	5.34	3.22	43.7	2.8
	26,666	5.41	4.56	71.4	8.33
	53,333	5.31	4	85	18.21
L.S.D.$_{0.05}$		0.07	0.98	33	1.63
Sig.		**	**	**	**

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