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INFLUENCE OF PLANT SPACING ON THE GROWTH AND YIELD OF TOMATO (*Lycopersicon esculentum Mill*.) VARIETIES

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ABSTRACT

Field studies on the effect of plant spacing on three varieties of tomato (*Lycopersicon esculentum Mill.)* was carried out at the Experimental Farm of the Department of Crop Science, Faculty of Agriculture, University of Benin, Benin City. Three varieties of tomato and three spacing regimes were used. The experiments were laid out in 3x3 factorial combination in a randomized complete block design (RCBD) in three replications. The treatments had three varieties of tomato (Roma savanna, UC 82, and Roma VF) and three plant spacing regimes (75 cm x 40 cm, 75 cm x 50 cm, and 75 cm x 60 cm). The results obtained showed that the effect of variety on the vegetative characters was significant ($p \leq 0.05$) but did not follow a particular order. The narrowest spacing of 75 cm x 40 cm showed superiority in plant height and leaf area compared with the wider plant spacing of 75 cm x 50 cm and 75 cm x 60 cm. Roma savanna attained 50% flowering earlier and had the highest number of fruits per plant (10.01) and fruit yield (10.87 t/ha) compared with UC 82 (6.73 and 8.73 t/ha) and Roma VF varieties (7.66 and 8.28 t/ha). Significant yield differences were recorded in tomato plants spaced at 75 cm x 40 cm and 75 cm x 50 cm which produced statistically similar fruit yield of (10.41 t/ha) and (9.76 t/ha) respectively above the yield of (7.72 t/ha) obtained from plants spaced at 75 cm x 60 cm.

Keywords: Flowering, plants, Roma savanna, UC82, yield

INTRODUCTION

Tomato (*Lycopersicon esculentum)* production in Nigeria is constrained by many factors. These include shortage of improved varieties, disease and pest infestation, poor agronomic practices and poor postharvest handling. Although traditional agriculture was based on the use of low yielding varieties and low planting densities, attitudes moved in modern agriculture towards dense planting populations and use of varieties with high yield potential. Obtaining maximum yield depends on optimum planting density, cropping systems and the cultivar used (Dong *et al.,* 2013). Plant spacing is the most important factor that affects yield and fruit quality of tomato (Tesfaye, 2008). Khan *et al.,* (2002) also stated that plant population is one of the management practices that greatly influence tomato yield. The distance between row and plant depend on the production purpose, soil fertility and plant structure. According to Ibrahim (2012), plant density per unit area determines the optimal above the ground conditions that allow the plant to be affected by the growth factors, light, water, temperature, nutrition. These influence productivity and hence the final yield. Space is needed for weeding along and between rows, to create good air circulation and to allow each crop to grow to its determined size.

This study was therefore carried out to evaluate the growth and yield responses of three varieties of tomato (*Lycopersicon esculentum)* to plant spacing.

MATERIALS AND METHODS

Description of Experimental Area

The study was conducted during the dry cropping seasons of (October-February) 2015/16 and 2016/17 in the Experimental Farm of the Department of Crop Science, Faculty of Agriculture, University of Benin, Benin City, Nigeria. The location lies between latitude 6° 14'N and 7° 34' N and longitude 5° 40' E and 6° 43' E. Meteorological data during the experimental period was obtained from Nigerian Institute for Oil Palm Research (NIFOR). The portion of land for the experiment had previously been cultivated with leafy

vegetables but was left fallow for one year and was over grown with mainly spear grass (*Imperata cylindrica*) and sensitive plant (*Mimosa pudica).*

Source of Seeds

Tomato seeds of three varieties, Roma Savanna, UC 82 and Roma VF were obtained from National Institute for Horticulture and Research (NIHORT).

Soil Sampling and Analysis

Before planting and after harvest, composite soil samples were collected from a depth of 0 – 30 cm using soil auger, air-dried and were crushed to pass through a 2 mm sieve and packaged for routine soil physical and chemical analysis according to standard laboratory procedures. Soil pH was determined using a pH meter. Organic carbon was determined by (Walkley and Black, 1962) wet oxidation method as modified by Jackson (1969). Total nitrogen was obtained by macro Kjeldahl method as modified by Jackson (1969). Available P was extracted by Bray I method (Bray and Kurtz, 1945) and P was estimated by the blue colour method of Murphy and Riley (1962). Exchangeable K and Na were determined using flame photometer, and Ca and Mg using the Atomic Absorption Spectrophotometer.

Treatments and Experimental Design

The experiment was a factorial combination of 3 × 3 in randomized complete block design (RCBD) with nine treatments in three replications. The treatments used for the trial were three varieties of tomato (Roma savanna, UC 82 and Roma VF) and three spacing regimes. (75 cm x 40 cm, 75 cm x 50 cm and 75 cm x 60 cm) which corresponded to 33,333, 25,925 and 22,222 plants ha^{-1} respectively. Each replicate had nine plots for a total of 27 plots in this experiment.

Cultural Practices

The land was cleared with the debris worked into the soil with a hoe. Beds for planting were prepared and tomato seeds were sown in the nursery. Plots were mulched to conserve soil moisture and suppress weeds. Two weeks before transplanting, the field was marked out and beds of 3 m x 1.8 m were prepared with 20 t/ha poultry manure as basal application applied thereafter, three weeks old tomato seedlings were transplanted to the field depending on the treatment and maintained till harvest.

Sampling and Measurements

Data collection commences four weeks after transplanting. Four plants were randomly selected from each plot and tagged for the purpose of collecting data. Vegetative growth, and yield components of tomato were evaluated. Vegetative growth parameters measured included plant height (cm), number of leaves, stem diameter (cm), leaf area $(cm)^2$ and number of branches while the yield components measured number of days to 50% flowering, number of flowers, number of fruits, fruit weight per plant (g) and fruit yield (t/ha).

Statistical Analysis

The data obtained were subjected to statistical Analysis of Variance (ANOVA) using Statistical Analysis System (SAS) version 1998, following the model for factorial experiment in a randomized complete block design and differences among treatments means were separated using the Least Significant Difference (LSD) at ($p \leq 0.05$).

RESULTS

The meteorological data during the experimental period showed that the rainfall was sparse throughout the experimental period with no rain in December and January, 2015/16 and in January, 2017 which necessitated the need for irrigation (Table 1).

Table 1: Weather condition during the period of the experiment

Year	Weather condition	October	November	December	January	February	March
2015/16	Rainfall (mm)	247.80	62.80	0.00	0.00	126.10	80.45
	Temperature(°C)	25.36	27.40	26.75	26.05	25.75	24.70
	Relative humidity (%)	78.95	74.1	63.65	53.35	69.90	72.3
2016/17	Rainfall (mm)	157.70	58.80	31.10	0.00	7.00	155.10
	Temperature(°C)	39.00	33.60	33.60	34.90	34.70	33.50
	Relative humidity (%)	83.00	75.1	61.80	44.30	48.20	66.3

Source: Nigerian Institute for Oil Palm Research (NIFOR)

In Table 2, the physical and chemical properties of the soil used for the experiment gave the textural class as sandy loam. The organic carbon (0.40) g g^{-1}, total nitrogen (0.04)%, available phosphorus (3.33) mg/kg, were all below recommended critical levels of 0.15% N, 10 – 16 mg/kg P and 0.34 cmol/kg K for crop production. Hence the need for additional nutrient amendments to the soil. The effect of variety on plant height was significant ($p \leq 0.05$). Roma Savanna had the highest plant height though it was statistically same with the UC 82 variety while Roma VF variety had the lowest plant height (Table 3). Plant spacing increased plant height significantly as spacing decreased. The narrowest spacing of 75cm x 40 cm produced significantly highest plant height. The number of leaves were significantly increased by the varieties used, Roma savanna produced significantly higher number of leaves (191.87) above Roma VF (147.64) while the narrower spacing of 75cm x 40 cm and 75cm x 50 cm increased number of leaves (214.12 and 171.37) respectively above the wider spacing of which produced (132.61). The effect of variety on stem

diameter was not significant but it ranged from 1.59 cm - 2.85 cm for varieties and 1.66 cm - 3.01 cm for plant spacing (Table 3). However, the effect of variety was significant for the number of branches and leaf area and these followed a similar trend UC82, produced the least number of branches (12.51) and leaf area (133.13 cm^2). Leaf area of tomato decreased with increase in spacing. The highest value (145.94 cm^2) for leaf area was recorded for the narrowest spacing of 75 cm x 40 cm while wider spacing of 75cm x 60 cm produced the least number of branches (11.26) and leaf area (129.15 cm^2). There were significant differences among treatments for effect of varieties on number of days to 50% flowering. Roma savanna variety attained 50% flowering (21.56) earlier than UC82 (28.00) and Roma VF (28.77). However, 50 % flowering, number of flowers per plant and fruit yield (t/ha) decreased with increase in spacing (Table 4). The highest fruit yield (10.87 t/ha) was produced by Roma savanna followed by UC 82 (8.73 t/ha) and then Roma VF (8.28 t/ha) which were statistically similar. The 75 cm x 40 cm spacing produced the highest fruit yield (10.41 t/ha) but was statistically similar to 75cm x 50cm spacing whose fruit yield was (9.76 t/ha). The lowest fruit yield (7.72 t/ha) was produced by the widest spacing of 75 cm x 60 cm.

Table 2: Physical and chemical properties of the experimental soils before planting and after planting

Soil properties	Before Planting	After Planting
pH (H_2O)	5.16	5.23
Organic Matter (g $100g^{-1}$)	0.40	0.79
Total N ($g100g^{-1}$)	0.04	0.03
Total P (mg kg^{-1})	3.33	20.69
K (cmol kg^{-1})	0.14	0.16
Ca (cmol kg^{-1})	1.30	1.20
Mg(cmol kg^{-1})	0.70	0.60
Sand (%)	66.43	66.87
Clay (%)	25.20	18.65
Silt (%)	8.00	8.12
Textural class	Sandy loam	

TABLE 3: Effect of varieties and spacing on some vegetative growth components of tomato (*Lycopersicon esculentum*) **per plant**

Treatment	Plant height (cm)	No. of leaves	No. of branches	Stem diameter (cm)	Leaf area (cm^2)
Varieties					
Roma savanna	57.24[a]	191.87[a]	12.17[ab]	1.59[a]	138.91[ab]
UC82	56.68[a]	172.59[ab]	11.56[b]	2.85[a]	133.13[b]
Roma VF	51.11[b]	147.64[b]	12.51[a]	2.02[a]	140.14[a]
Significance	*	*	*	N.S	*
LSD	3.52	49.36	0.83	1.87	6.42
Spacing(cm)					
75 x 40	59.89[a]	214.12[a]	12.58[a]	3.01[a]	145.94[a]
75 x 50	55.32[b]	171.37[ab]	12.39[a]	1.79[a]	137.08[b]
75 x 60	49.83[c]	132.61[b]	11.26[b]	1.66[a]	129.15[c]
Significance	*	*	*	NS	*
LSD	3.52	49.36	0.83	1.87	6.42

Means followed by the same letter in a column are not significantly different at 5% level of probability.

* Significant at 5% level of probability,

TABLE 4: Effects of varieties and spacing on yield and yield components of tomato (*Lycopersicon esculentum*)

Treatment	No of days to 50% flowering	No of flowers per plant	No of fruit per plant	Fruit wt per plant (g)	Fruit yield (t/ha)
Varieties					
Roma	21.56[b]	20.25[a]	10.01[a]	404.88[a]	10.87[a]
savanna					
UC82	28.00[a]	20.11[a]	6.73[b]	322.59[b]	8.73[b]
Roma VF	28.77[a]	18.33[a]	7.66[b]	310.32[b]	8.28[b]
Significance	*	NS	*	*	*
LSD	1.28	3.11	1.06	60.78	1.64
Spacing(cm)					
75 x 40	28.22[a]	23.44[a]	8.17[a]	324.63[a]	10.41[a]
75 x 50	26.22[b]	20.39[a]	7.98 [a]	383.24[a]	9.76 [a]
75 x 60	23.89[c]	14.85[b]	8.14 [a]	329.93[a]	7.72 [b]
Significance	*	*	NS	NS	*
LSD	1.28	3.11	1.06	60.78	1.64

Means followed by the same letter in a column are not significantly different at 5% level of probability.

* Significant at 5% level of probability,

DISCUSSION

The soil of the experimental site gave the textural class as sandy loam. The organic carbon, total nitrogen, available phosphorus, were all below recommended critical levels of 0.15% N, 10 – 16mg/kg P and 0.34 cmol/kg K for crop production (Aduayi *et al;* 2002). Fertilizer or manure application is required for optimum growth and yield of any crop in a nutrient deficient soil, hence the need for additional nutrient amendments to the soil. Previous findings revealed that tropical soils are usually deficient in one or more of the essential elements needed for crop growth (Adeoye and Agboola, 1985). The increase in plant height, number of leaves and most of the vegetative characters observed with the narrower spacing of 75 cm x 40 cm and 75 cm x 50 cm suggest that it could probably be the best spacings for these varieties of tomato plants. Plants under the closer spacings had adequate ground cover due to the tendency of plants to form canopy thereby conserving soil moisture, nutrients and regulating the soil temperature which could have resulted in a greater number of leaves and increase in plants height. The superiority observed in Roma savanna compared with the other two varieties in most of the yield and yield attributes is in accordance with the findings of (Law-Ogbomo and Egharevba, 2008) who reported that UC82 yielded low when compared with other varieties evaluated. The significant early flowering and subsequent highest fruit yield observed in Roma savanna is in agreement with the findings of Mehta and Asati (2008) and Sharma *et al.* (2009) who indicated that early flowering varieties would be beneficial for attaining higher yield of tomato. The decrease in the number of flowers per plant and in the fruit yield (t/ha) observed with the widest spacing suggests that the widest spacing of 75 cm x 60 cm would not be favourable and economical for these tomato varieties in this locality. The highest fruit yield obtained at the narrower spacing of 75 cm x 40 cm could also be attributed to the higher number of plants per unit area. Consequently, producing a greater number of fruits and fruit yield per hectare. Wider spacing reduced yield due to total reduction in plants per hectare and consequently spacing is not fully utilized. These results are evidently in accordance with those of Khan *et al.,* (2002) and Aliyu *et al*., (2008).

CONCLUSION AND RECOMMENDATION

This study shows that early flowering varieties have a beneficial effect for attaining higher yield of tomato. It was also observed that Roma savanna was superior to the other varieties in terms of the yield attributes. Increase in plant spacing from 75 cm x 40 cm to 75 cm x 60 cm resulted in decrease in some vegetative characters and fruit yield per hectare of tomato plant. Highest fruit yield was recorded with 75 cm x 40 cm though not statistically different from 75 cm x 50 cm for most parameters measured. In conclusion, Roma savanna variety produces the highest fruit yield (t/ha) at either 75 cm x 40 cm or 75 cm x 50 cm plant spacing and therefore should be recommended to farmers in this locality.

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