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Original Research

Effect of Different Staking Methods on the Growth and yield of Tomato (*Solanum Lycopersicum*) in the Rainforest Agro-ecological Zone

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ABSTRACT: The study was conducted at he teaching and research farm of , Imo State University, Owerri to evaluate the effect of different staking methods on the growth and yield of Roma VF. Tomato. Treatments were arranged in a randomized complete block design and replicated four times. The treatments were unstaked, single, vertical and platform stakings. A total of 64 stands of tomato were used, 16 tomato stands per treatment. A blanket application of decomposed pig dung was used. Data were collected based on growth and yield. Results showed that treatments had significant ($P<0.05$) effect for all the parameters measured. Vertical and platform staking had the best performance in terms of fruit weight, number of fruits, plant height, and number of diseased fruits. Control recorded the highest mean number of days to flowering (59) while platform and vertical staking recorded highest mean number of fruits per stand of 68.50 and 61.50 respectively. Therefore, tomato staking should be adopted by tomato farmers mainly vertical and platform staking methods.

Keywords: Staking, yield, tomato, humid tropics, Agro-ecological
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INTRODUCTION

Tomato *(Solanum lycopersicum.*) is one of the most important fruit vegetable crop in the World. It belongs to the night shade family. The crop is attractive, relatively short lived-with high yield production. They are generally eaten fresh in salad or sauces, soups and meat or fish dishes with other vegetable dishes.Sometimes used in preparing stew.They are major source of antioxidants that helps prevent carcinogens. Tomatoes contains vitamin B and C, iron, potassium, folate, vitamin K and phosphorus. *Solanum lycopersicum* is the second most important vegetable after potato with a global production of 164 million tons of fresh fruit harvested on a 4.7 million hectares surface (FAOSTAT, 2015). Over 120 million metric tons grown annually. The fruit also contains larger amount of water, low protein and fats, vitamins and mineral and some carbohydrates (FAO, 2018). It is grown in most part of the World for vegetable to meet the mineral and vitamins requirement of humans (Hossain *et al.,* 2023; Idikut, *et al.,* 2009). Apart from contributing to food security and supplementary household income for small and medium scale farmers, tomato has currently strong consumer demand because of its wide acceptable nutritional value as source of vitamins and minerals especially vitamin C as well as industrial raw materials (Nyalugwe *et al.,* 2022). According to Food and Agricultural Organization Statistics, estimated total world production for tomato in 2017 was 182,301,395 metric tonnes. The largest tomato producer was China whose production accounted for nearly 33% of global production. India and Turkey produced 20,708,000 and

12,750,000, respectively. United States - 10,910,990; Egypt 7,297,108; Iran 6,177,290; Italy 5,605,868; Spain 5,163,466; Mexico 4,243,058; Brazil 4,230,150 and Nigeria 4,100,000(FAOSAT, 2015). In the South-Eastern Nigeria, the quantity of tomato production was low when compared with the Northern states where bulk of the tomato consumed in the South-East is produced. Staking is a horticultural method of providing support to tomato fruits and branches to ensure clean and unblemished fruits and prevent stem breakage. This practice keeps the fruit off the ground thereby minimizing diseased fruits and increase yield of tomato (Monteiro, 2004; Salem *et al.,* 2023). There are different methods of staking tomato. This research work therefore evaluates the effect of different staking methods on the growth and yield of tomato in therainforest agro-ecological zone of Nigeria with particular reference to Imo state.

MATERIALS AND METHODS

Experimental location and field condition

The field research was conducted in 2021at the Teaching and Research Farm of Imo State University, Owerri (Latitude 05^{o} 26' N, Longitude 07^{o} 02' E and attitude 91m above sea level) located in the rainforest agro – ecological zone. The annual average rainfall is between 2500mm to 3000mm distributed between March and October, relative humidity of 75% and temperature range of 25 to 32^{0}C (NIMET, 2020).

Field layout, treatments and experimental design

The experimental plot was a randomized complete block design with four treatment each replicated four times. The treatments were unstaked, single staking, pyramid staking and platform staking. Seeds of Roma VF were obtained from Imo ADP located at Okigwe road Owerri. A field size measured 4.30 m x 7.50 m (32.25m^{2}) was demarcated. Hoe was used in preparation of the 16 beds, each measuring 1.00 m x 0.70m with spacing of 0.50 m x 0.50 m between plots and 1m between blocks. Seedlings were transplanted on the prepared beds at planting distance of 0.60 m x 0.50 m and watered until all seedlings were established. Each bed contained 4 plants.

Nursing and transplanting of seedlings

A bed measuring 1.0 m x 0.50 m was prepared for the nursing of seedling. Seeds of Roma VF were thinly sown in drills spaced 20.0 cm apart in August, 2020. The beds were mulched with dry grass and watered (when there was no rain) at 3 - day's intervals until germination. 12 days after germination, 1.50 kg of decomposed pig dung was dissolved in 10.0 litres of water and evenly applied on the seed bed for proper growth and development.

Agronomic practices

Tomato seedlings were transplanted to the main field 4 weeks after nursery establishment. 2 weeks after transplanting, weeding, earthing-up and additional manuring with well decomposed pig dung at 200g per stand were carried out. 3 weeks after transplanting, staking commenced as soon as the branches were long enough to be staked. Subsequent weeding were carried out at 2 weeks interval with hand hoe.

Data collection and analysis

Growth and yield data were collected at 2 weeks interval on plant height, number of leaves/plant and number of branches/plant. Also data were collected on number of bent stem/plant, number of diseased fruit/plant, leaf area, days to 50% flowering, number of fruits/plant and weight of fruit/plant. Collected data were subjected to Analysis of variance (ANOVA) using Stagraphic centurion version 19. Significant means were separated using Duncan's New Multiple Range Test (DNMRT).

RESULTS

The result of the soil analysis of the experimental site is shown on (Table 1). The soil was classified as moderately acidic with soil pH of 5.72. The organic carbon content and organic matter status was 2.37% and 3.99% respectively. The concentration of P, N, Ca, Mg, Na, and K levels in the soil at the beginning of the study were 12.63ppm, 0.19%, 3.20, 2.00, 0.21, ad 0.13 Cmol/100g soil.The mean results of analysis of variance for effect of different staking methods on growth and yield of tomato are shown on (Table 2). A great deal of variations and similarities were recorded among the parameters measured. The result on mean number of plant leaves varied significantly at 10 weeks after planting from control. Single staking, vertical staking and platform staking with mean figures of 127.57, 125.67 and 129.25 respectively were statistically ($P<0.05$) the same.

Number of branches

Significant ($P<0.05$) differences were observed among the various staking methods on mean number of branches which ranged from 6.70 to 9.50 at 10 weeks after transplanting. Platform staking with 9.50 mean number of branches were significantly ($P<0.05$) different from control with mean value of 6.70 branches but

Table 1: Soil analysis of the site

pH	Organic Carbon (%)	Organic matter (%)	P (ppm)	N (%)	Ca Cmol/100g	Mg (Cmol/100g)	Na (Cmol/100g)	K (Cmol/100g)
5.72	2.37	3.99	12.63	0.19	3.20	2.00	0.21	0.13

Table 2: Effect of different staking methods on the growth and yield of tomato in Imo State

Treatments	NL	NB	LA	PH	BS	D 50% F	NF	FW	DF
CO	89.50^{b}	6.70^{b}	50.20^{b}	25.80^{c}	7.00^{a}	59.00	27.00^{c}	62.17^{b}	6.50^{a}
SS	127.57^{a}	8.00^{ab}	55.30^{b}	33.23^{bc}	4.75^{a}	56.75	44.75^{b}	108.07^{b}	2.25^{b}
VS	125.67^{a}	8.00^{ab}	56.25^{ab}	37.80^{ab}	1.25^{b}	51.25	61.50^{a}	169.99^{a}	3.25^{a}
PS	129.25^{a}	9.50^{a}	62.79^{a}	44.60^{a}	0.50^{b}	48.50	68.50^{a}	201.74^{a}	1.50^{b}

Means having the same letter(s) are not significantly (P<0.05) different

CO = = Control	NL = Number of Leaf	BS = Bent Stem	DF =Diseased Fruit
SS = Single Staking	NB = Number of Branches	D 50% F = Days to 50 % Flowering	
VS-= Vertical Staking	LA = Leaf Area	NF = Number of Fruits	
PS = Platform Staking	PH = Plant Height	FW = Fruit Weight	

statistically similar with single staking and vertical staking with mean scores of 8.00 (Table 2).

Leaf area

The result obtained on the mean leaf area ten weeks after transplanting showed some similarities. Platform staking and vertical staking with mean values of 56.25 cm^2 and 62.79 cm^2respectively were statistically similar (P<0.05). Also vertical staking, single staking and no staking (control) with mean values of 56.25 cm^2, 55.30 cm^2 and 50.20 cm^2respectively were statistically (P<0.05) the same (table 2).

Plant height

Ten weeks after transplanting, significant (P<0.05) differences were observed on mean plant height among the treatments. The least mean value of 25.80 cm was recorded by unstaked while the highest mean plant height of 44.60 cm was recorded by platform staking. There was no significant (P<0.05) difference in the height of tomato crops with single staking and unstaked. Also no significant (P<0.05) differences were recorded in the height of tomato crops with vertical staking and platform staking. There were significant (P<0.05) differences in the height of tomato crops with vertical staking and platform staking from unstaked (Table 2).

Bent stem

The highest mean number of bent stem was 7.00 and 4.75 recorded by control and single staking respectively but these were statistically the same and significantly different from vertical staking and platform staking with the mean values of 1.25 and 0.50 respectively (Table 2).

Days to 50 % flowering

The number of days it took for the tomato to flower were recorded. Result showed that control or unstaked tomato had the longest number of days (59) to flower. Platform staking had 48.50days. Vertical and single staking recorded 51.25 and 56.75 days respectively.

Number of fruits/plant

Significant (P<0.05) differences were observed on the mean number of fruits among the various treatments. The mean values ranged from 27.00 to 68.50 respectively. The highest and best fruit production was platform staking with mean value of 68.50 and this was followed by vertical staking with 61.50. These were statistically similar but significantly different from single staking and unstaked with mean values of 44.75 and 27.00 which were also significantly (P<0.05) different (table 2).

Fruit weight

Significant (P<0.05) differences were observed among the four treatments evaluated for fruit weight. The least fruit weight was recorded by unstaked while the highest fruit weight was recorded by platform staking with mean values of 62.17 and 201.74 respectively. These mean values were ssignificant (P<0.05) different. On the other hand, vertical staking with mean fruit weight value of 169.99 and platform staking were statistically (P<0.05) similar (table 2).

Number of diseased fruits/plant

Platform staking had the least number of diseased tomato fruits while unstaked had the highest. These were significantly (P<0.05) different. Also, vertical and single

staking were statistically similar in the mean number of diseased fruits with values of 3.25 and 2.25 respectively (Table 2).

DISCUSSION

Staking of tomato in horticulture is done to provide support while the crop grows. In this research, different staking methods were used, results obtained showed that staking had effect on some parameters measured. Diseased fruits were high in unstaked. Staking prevents infestation of diseases and rotting of fruits thereby increasing marketable yield of tomatoes (Nyalugwe, 2022). Interms of number of leaves and number of branches, crops that were staked mainly : platform staking and vertical staking performed better than control and these may be attributed to the exposure given to them to attract sunlight which is necessary for photosynthesis (Hossain *et al.,* 2023). Plant height was highest in staked than unstaked crops, while bent stem was low in staked than unstaked. As a result of these, there was a high number of fruits in staked crops than unstaked. Platform staking and vertical staking recorded the highest number of fruits which were significantly ($P<0.05$) different from control, this can be attributed to the fact that staking positions the crop in a better condition to receive sunlight which is necessary for plant growth and production. This also allows growth of the fruit to continue successfully which agrees with Monteiro (2004) that method of fruit growth in tomato enhances fruit setting and growth.

Conclusion

Staking is an agronomic practice used in the production of some horticultural crops such as tomato, cucumber, etc. Staking of tomato especially by vertical and platform methods enhanced both number of leaves, leaf area, plant height, fruit weight, number of fruits and decreased bent stem, diseased fruit and days to 50 % flowering. Therefore, staking of tomato is essential for tomato farmers for increased fruit set and reduction in disease infestation.

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