

EFFECT OF STAKING, PRUNING AND FERTILIZER APPLICATION ON THE GROWTH AND YIELD OF TOMATO

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Abstract

Field experiments were conducted during the rainy seasons of 2010 and 2011 at Oyo State College of Agriculture, Research farm, Igboora, Nigeria to evaluate the effect of some cultural practices management options on the performance of tomato. The treatments were; staking (S), pruning (P) and fertilizer (F) application only, S+ P, S+ F, P +F, S+ P + F combined and control. The eight treatments were laid out in a randomized complete block design in three replications (2x2x2x3). Agronomic data collected includes; Plant girth, plant height, Number of leaves and leaf area index while the fruit yield were also taken biweekly. All the growth characters evaluated at the ages of 6, 8 and 10 weeks after planting were significantly affected by all the three factors. The higher values of growth parameters (plant girth, plant height, Number of leaves count and leaf area index) were associated with effective staking, pruning and fertilization practise enhanced crop growth rate with corresponding effects resulting in higher fruit yield for the plants. Highest fruit yield was recorded from the effective integration of the three operations compared with either sole or combination of any two. Plants pruned, staked and fertilized produced 690% more fruits than the control. A combination of the three cultural practices was the most efficient in terms of fruit parameter examined.

Key words: Staking, Pruning, Fertilizer, Growth, Yield.

Introduction

Tomato is one of the most widely grown vegetables in the world. The popularity of the crop among consumers was due to its important as source of vitamins A and C diets (Rai and Yadau, 2005). Tomato was also considered to be the world's largest vegetable crops after potato and sweet potato but it tops the list of canned vegetables (Olaniyi *et al.*, 2009). Similarly, Fawusi (1978) had earlier reported it as one of the most important vegetables after onions and pepper in Nigeria. Findings have confirmed that large scale tomato production can be possible in the northern Guinea and Sudan Savannah zones of Nigeria, where relatively high yield could be realized by planting between June and December (Bodunde *et al.*, 1996).

The total cultivated area in Nigeria for the production of tomato was 12700hectares and the quantity produced was 889000tonnes giving an average of 7 tonnes per hectare (Padwick, 1983). However, tomato production in Nigeria is low when compared to other major producing Countries like Niger (22.22 t ha⁻¹), South Asia Countries (18.88 t ha⁻¹), China (27.01 t ha⁻¹), United State (69.40 t ha⁻¹) and (210.

28 t ha⁻¹) for United Kingdom (Law –Ogbomo and Egharevba, 2008). To ascertain the observation, FAO, (2003) had earlier concluded that tomato production in Nigeria is below Africa average of 20.51t ha⁻¹. The major factors responsible for the low productivity in Nigeria compared with other African Countries are the inadequate use of some vital cultural practices which include effective pruning, adequate staking and the use of fertilizer in the management of the crop under degraded soil situation.

Fertilizer application is one major farming operation needed to correct deficiencies in the soil in order to ensure proper growth and functioning of crops with regards to yield optimization (Srivastava *et al.*, 2006). Thus, adequate fertilizer application is crucial in successful production of tomato for maximum profit.

Pruning of the stem above certain fruit cluster is one of the basic applications in green house tomato production carried out to accomplish a desired purpose. It entails removing excessive and undesirable growth or parts and structures. Pruning in tomatoes has been reported to increase yields and quality

(Srivivason *et al.*, 2001) while other researchers gave conflicting results that pruning either reduces tomato yield and/or quality has no effect on its production (Resh, 1997; Ferrandino, 1999). Similarly, Kanyomeka and Shivute, (2005) concluded that tomato pruning could reduce tomatoes yield but when not pruned appear to be more prone to pest attack. It is therefore, essential to ascertain whether tomato pruning is worthwhile or not.

Staking plants has proved to be beneficial in the cultivation of tomato. Scholars had earlier advocates staking of plants in the field for the control of disease and this was also reported by Hazarika, (2001). In staking, sticks are inserted into the ground near the plants and are loosely tied with Jute strings to keep the plant straight. This practise would provide support for the crop and thus allows free air movement and reduces moisture accumulation thereby reducing disease incidence. However, the information available on this agronomic practice on tomato production is very scanty and there is need for its evaluation for proper documentation in the study area.

Most studies fail to acknowledge the effects of staking on small holder farm while those that considered the application of mineral fertilizers, pruning and staking do so separately. Therefore, it is imperative that concerted efforts be put together to evaluate the effect of these three agronomic practices on tomato production. The study therefore, aimed at investigating the effect of staking, pruning and fertilizer application on growth and yield of tomato.

Materials and method

Experiment was conducted at the Teaching and Research farm of Oyo State College of Agriculture, Igboora (OYSCATECH). Igbo-ora town is located in Ibarapa Central Local Government, the northern part and derived Savannah Zone of Oyo State Nigeria. The region has two rainy periods and had between 1000 to 1600mm of rainfall and temperature between 22°C and 38°C.

Prior to Land preparation, soil samples (0- 15cm) were collected randomly from 120 spots in the experimental site with the use of an auger. Samples were bulked, air dried and ground to pass through a 2mm sieve. The soil samples were analysed for physico-chemical properties as follows: soil particle size were evaluated by Bouyoucos method (Bouyoucos,

1962). Soil PH in H₂O(1:1) was determined using the standard laboratory apparatus as specified by (I.I.T.A, 1982). Soil organic carbon was determined by Walkley black modified method (Black, 1965) . Available phosphorus and total nitrogen were determined separately by Technicon method while exchangeable Ca, Mg, K, Na and effective C.E.C in soils by use of atomic absorption spectrophotometer (Tel and Hargerty, 1984).

The tomato seed varieties were obtained from seed life Agric Enterprise, Ibadan, Oyo State Nigeria. From information it is an hybrid with early maturity. The beds were prepared with top soils and watered regularly using a watering can. The nursery boxes were kept under a shade to minimize evapo-transpiration and other water loss in the soil. Tomato seeds were planted in the nursery by broadcasting the seeds in the seed boxes. Transplanting of tomatoes seedlings into their respective plots in the field were carried out four weeks after sowing (WAS).

The treatments area was laid out in a randomized complete block design (RCBD). The treatments were; staking (S), pruning (P) and fertilizer (F) application only, S+P, S+ F, P +F, S+ P + F combined and control. The total plot area was 13.1m by 10m with three replicates and 0.5m space in between each block. Each plot size was 1.2m by 3.0m. The tomato was spaced at 60cm by 60cm given ten stands of tomato plants per plot. Staking was done two (2) weeks after transplanting (WAT) with a strong stick of about 1.5m to keep the tomato plant from spreading on the ground or getting in- contact with soil and diseases. Pruning was also done at two weeks after planting with small knife to cut off dead leaves and branches to make plant sanitation and improve productivity.

N.P.K. (15-15-15) fertilizer was applied at the rate of 60kg/ha three weeks after transplanting (WATP) to enhance the growth of the crops. The fertilizer was applied by ring placement into drills 5cm deep and 7.5cm away from the plant and covered with soil. Each of the treatment (staking, pruning and fertilizer application) was applied at two levels and replicated three times (2x 2 x2 x 3) = 24 plots. Weeding was carried out three times after transplanting biweekly with the use of hoe to

reduce weed competition. Other crop management practices includes; spraying with Cymbush at 2, 4 and 6 weeks after transplanting against defoliating pests (Vimala, 1978).

Data collected were on growth parameters (plant girth, plant height, number of leaves and leaf area) while the yield and yield components includes number of fruit per plant, fruit weight per plot and fruit yield per hectare. The tomato plant height was measured with the

Result and Discussion

Table 1 shows the chemical and physical properties of the soil at the experimental site. The soil is moderately acidic and with low organic matter content. The total N and Ca value is below the critical level of

use of meter rulers from the base to the tip of the main shoots while the number of leaves were counted and recorded at 2, 4 and 8WAT. At harvest, the number of fruit per plant and plot were counted while fruit weight was also taken per plant and hectare. All data collected were subjected to analysis of variance and significant means separated by Duncan Multiple Range Test at 5% level of probability (SAS, 1999).

0.2% while the K status fell above the critical level of 0.2cmol/kg (Adeoye, 1986). The available P, K and Mg all fell within critical range. The lower values of N% and Ca justify the need for fertilizer application.

Table1: Physico-chemical properties of the soil in the experimental site at Igboora- oyo State.

Parameter	Value
pH	6.78
Organic matter	1.68%
Total Nitrogen	0.18%
Available P	18.9mg/kg
Exchangeable K	1.16cmol/kg
Calcium	0.18cmol/kg
Magnesium	0.16cmol/kg
Physical particle size	
Sand	68.4
Silt	16.6%
Clay	15.0%

The plant height increased as the plant aged (Table 2). There were statistically significant differences among the treatments. Staking, pruning and NPK fertilizer application significantly influenced plant height ($P < 0.05$). While staking+ pruning + fertilizer application increase plant height (94.6cm) followed by the use of staking + fertilization (86.66cm) with control the least value (51.6cm) at six weeks after transplanting (WAT). Differences in the main effect on stem diameter were also

significant with the treatments application. The increase in stem diameter was well pronounced S+P + F (11.2cm) compared with other treatments. The use of S + F (7.3cm) gave higher value while the control gave the lowest (1.5cm) result. Although, there were no significant differences between the use of Staking only compared with the use of Pruning only 6 weeks after transplanting (WAT) respectively.

Table2: Effect of staking, pruning and fertilizer application on the plant girth and height of Tomato at 2, 4 and 6 weeks after transplanting (WAT).

Treatment	Plant girth (cm)			Plant height (cm)		
	2WAT	4WAT	6WAT	2WAT	4WAT	6WAT
SPF	3.0a	10.1a	11.2a	49.3a	73.0a	94.6a
S	2.8ab	1.6d	2.7c	46.5b	49.0d	63.3e
PF	2.8ab	4.7bc	5.3bc	40.0c	60.0bc	79.6c
Control	3.0a	1.3d	1.5d	40.0c	39.1e	51.6f
SP	2.8ab	1.7cd	3.4c	41.0c	52.3cd	68.6d
SF	2.5b	6.3d	7.3b	40.3c	65.6ab	86.6b
P	2.4c	1.6d	2.7c	38.3d	45.3de	59.0e
F	2.6bc	3.6bcd	4.7bc	41.3e	61.0b	71.0d

S = staking, P = pruning and F = NPK fertilizer application

Means followed by the same letter in the same columns are not significantly different at 5% level of probability by DMRT

At 2WAT SPF recorded significantly more leaves than all other treatments except SP. Tomato in SP and SF plots were comparable, but recorded significantly more leaves than S, PF, F or control. The mean number of leaves of tomato is presented in Table 3. The number of leaves increased as the plant mature. The statistical analysis showed significant difference among the

various treatments except with SP and F treated plots at 6WAT. The highest number of leaves was recorded from SPF (127cm) untreated plot gave the least value (47cm). The tomato plants growth patterns show a slow growth increase initially after the establishment of the plant after transplanting with time.

Table 3: Effect of staking, pruning and fertilizer application on number of leaves and total leaf area of Tomato at 2, 4 and 6 weeks after transplanting (WAT)

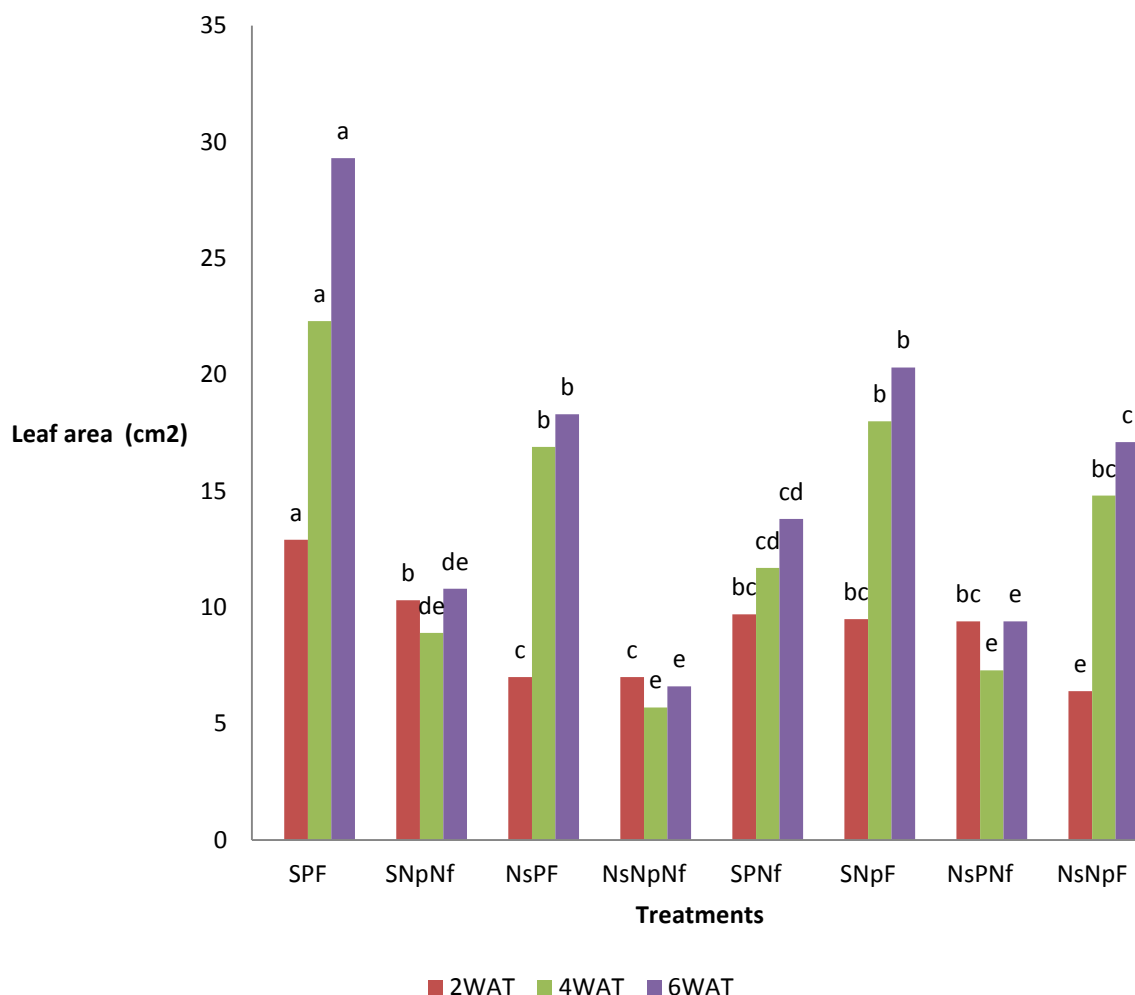
Treatment	Number of leaves			Total leaf area (cm ²)		
	2WAT	4WAT	6WAT	2WAT	4WAT	6WAT
SPF	55.0a	91.3a	127.0a	557.6a	1535.9a	3194.1a
S	35.8d	60.8e	70.3e	359.2cd	623.7e	1292.1c
PF	28.0e	72.6c	92.6c	195.2cd	991.3c	1433.7c
Control	36.7d	38.6f	47.0g	258.0e	400.5f	741.5d
SP	53.7ab	66.6d	77.0d	538.7b	845.1d	1306.6c
SF	51.7b	82.3b	98.2b	533.6b	1132.5b	2000.7b
P	45.0c	61.0e	63.2f	503.5c	547.3e	1258.0c
F	46.7bc	69.9cd	80.6d	304.3de	941.4cd	1350.0c

S = staking, P = pruning and F = NPK fertilizer application

Means followed by the same letter in the same columns are not significantly different at 5% level of probability by DMRT

Similar trend was observed for the total leaf area (Fig. 1). The highest total leaf area was produced by SPF plots (3194.1cm²), followed by staking + No pruning + NPK 15-15-15 application (2000.7cm²) while the

control gave the least value (741.5cm²) at 6WAT. Although, significant effect occurs with SPF, SF and untreated plots while others were not significant at 6WAT.



SPF (staking + pruning + fertilizer application), Np (no pruning), Ns (no staking) and Nf (no fertilizer application).

Fig. 1: Effect of staking, pruning and NPK fertilizer application on the leaf area of tomato

The differences between the treatments application have been found significant at $p=0.05$ in terms of fruit yield (t/ha) (Table 4). The highest yield 15.8t/ha was obtained from

SPF followed by SF plots (10.4t/ha) while control had the lowest (2.0t/ha) during the last harvesting period.

Table 4: Effect of staking, pruning and fertilizer application on the yield of tomato in t/ha.

Treatment	Yield of tomato (t/ha)		
	i	ii	iii
SPF	5.2a	13.2a	15.8a
S	3.7b	2.8d	3.3d
PF	3.3bc	6.6bc	8.2bc
Control	1.7d	1.8d	2.0d
SP	3.7b	2.9cd	3.4d
SF	5.0ab	7.9b	10.4b
P	2.9c	2.6d	2.9d
F	3.6b	4.1bcd	5.3cd

S = staking, P = pruning and F = NPK fertilizer application

Means followed by the same letter in the same columns are not significantly different at 5% level of probability by DMRT

The trend of growth pattern observed in the tomato and increase in fruit yield with time is similar with the findings of Olaniyi and Fagbayide, (1999). The researchers had earlier confirmed that height increase commences slowly and with gradual rise to a maximum which later slow down again. The higher vegetative growth and marketable yield in fertilizer treated plots may be attributed to increased soil nutrients associated with the use of chemical fertilizer. This finding corroborated the work of Akanbi *et al.*, (2000) who reported that fertilizers enhanced vegetative growth and marketable yield of vegetables. The result obtained from SPF treated plots is similar to the result of Ara *et al.*, (2007) who affirmed that one stem pruned plants produced the highest number of flower per cluster while the unpruned plant produced the lowest number of flower per cluster. The effectiveness of the pruning further ascertain the findings of Uddin *et al.*, (1997) who confirmed that in case of stem pruning, one stem pruning gave the tallest plant and shortest plant height was obtained in no pruning. The result is also in agreement with the previous results of (Maboko and Plooy, 2009) who concluded that plants pruned resulted in a significant increase in total and

marketable yield, with a decrease in unmarketable yield. Staking in combination with pruning and fertilizer application might have aided a very high yield and this could have prevented rotting of fruit. Staking tomato plant could have increased fruit yield and size; reduced fruit rot and ease spraying and harvesting may improve the productivity. The results clearly indicated that staking, pruning and fertilizer application are essential cultural practices that are required for good performance of tomato.

Conclusion and Recommendations

The combined application of staking, pruning and NPK fertilizer resulted in better performance of vegetative growth and fruit yield of tomato. Therefore, staking, pruning and fertilization of tomato are recommended for both wet and dry seasons but to reduce cost of production staking + fertilizer application may be considered during the dry season when the incidence of pest and diseases are minimal. The study further, stressed that yield and fruit size weight can be effectively manipulated by staking, stem pruning and NPK fertilization while pruning has a limited effect. Results need to be clarified with other cultivars and cultural operations for future investigations

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