ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24AUG1711

Effect of Pruning on the Growth and Yield of Indeterminate and Determinate Tomato Variety in the Northern Guinea Savanna of Nigeria

[1*]H. Yaro; [2]D. I Adepke; [2]A Ahmed and [3]D.M, Katung
[1]East West Seed, Kaduna, Nigeria
[2]Department of Agronomy, Ahmadu Bello University, Zaria, Nigeria
[3]Department of Plant Science, Ahmadu Bello University, Zaria, Nigeria

Corresponding Author:- [1*]H. Yaro

Abstract:- Pruning is a management practice that helps to increase fruit yield and quality of fruit, better aeration, better exposure of foliage to sunlight and photosynthetic. Pruning is not a common practice among tomato growers in Northern Guinea Savanna of Nigeria and most of the farmers have no idea about it. Field trials were conducted concurrently during the dry season of 2020 on the Research Farms of the Institute for Agricultural Research, Samaru (11º11'N, 07º38'E 686 m above sea level) and Farmers field in Kujama, (9º34'N, 8º18'E 740m above sea level) in the Northern Guinea Savanna Ecological Zones of Nigeria; to determine the effect of pruning on the growth and yield of indeterminate and determinate hybrid tomato varieties. The experiment consisted of 12 treatments comprising of three pruning techniques (no-pruning, pruning on one stem and two stems) and four varieties of tomato (1 indeterminate hybrid tomato; Larisa F_1, 2 determinate hybrid Delta F_1, and Platinum F_1), and one determinate open pollinated variety (UC82B). The four varieties of tomato with three pruning techniques were factorially combined and laid out in a randomized complete block design with three replicates. The result at both locations showed varietal significant differences on growth parameters such as higher plant height, shoot dry weight, leaf area index, crop growth rate, relative crop growth rate, and yield attribute such as fruit diameter, fruits weight per plant, where Larisa F_1 performed better than other varieties. Pruning tomato plant to two-stem and one-stem significantly increased growth parameters where two-stem pruned plants performed best. Variety × pruning interaction on total fresh fruit yield indicated that the combination of Larisa F_1 with two-stem was found suitable for maximum fruit yield though at par with Larisa F_1 one-stem and unpruned.

Keywords:- *Variety, Pruning, Indeterminate, Interactions and Total Fresh Fruit Yield.*

I. INTRODUCTION

Tomato (*Solanum lycopersicum L.*) is one of the most important vegetables worldwide. It belongs to the family Solanaceae, which includes more than 3000 species, occupying a wide variety of habitats [1]. Tomato continues to be the most important vegetable in the world due to increasing commercial and dietary value, widespread production as well as model plant for research [2]. Tomato is utilized as a fresh crop or processed into various forms such as paste, puree and juices. Tomato is a rich source of vitamins (A and C), minerals (iron, phosphorus), lycopene, Beta-carotene, high amount of water and low calories [3]. Tomato is the most popular home garden and the second most consumed vegetable after potato in the world [4]. Tomato plays an important role in human nutrition by providing essential amino acids, vitamins and minerals [5].

Over the years, tomato production in Nigeria has intensified [6], yields, however, have remained low due to impediments, key among them being abiotic (high temperature, erratic rainfall, poor soils, etc.) and biotic factors such as predators and parasites. Biotic factors of notable economic value in tomato production comprise of pest, fungal, bacterial and viral diseases. [7]. Other production constrains include poor agronomic practices like raising good seedlings, correct fertilizer application, irrigation schedule, pruning among others. Tomato cultivation is economically attractive and the area under cultivation is increasing but low yields are obtained due to the use of traditional method of farming. The yield gap between other countries when compared with Nigeria is quite large, an example is the yield obtained in Netherland was 509 t/ha while Nigeria produced 6.7 t/ha [6]. Inadequate education, use of farmer saved seeds, accompanied with traditional methods of farming, use of non-pruning are some of the reasons that contribute to low production in the tomato industry.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24AUG1711

Pruning is a husbandry practice, which increase fruit size. It can provide a helpful antidote to excessive growth, allowing all available leaves to present their faces to the sun. Pruning is not a common practice among tomato growers in Nigeria and most of the farmers have no idea about it. Some farmers are of the opinion that pruning give large-sized and better quality fruits but were reluctant to apply it because they indicated that it is very demanding in terms of labour and the associated costs besides the lack of technical knowhow to practice the pruning hence most farmers do not prune tomato. Pruning tomato plants generally improves the health of the plants and the quality of the fruit they produce, but not every type of tomato plant benefits from pruning. Determinate plants, for example, don't need much pruning to thrive. Tomato is a very important crop therefore it has become increasingly important to employ improve production practices that would increase productivity especially in its off season, when farmers can make more margins. Some advantages of using hybrid seeds includes plant good vigor, better adaptability to stress, and resistance to diseases and gives higher yield. There is the need to adopt pruning and use of hybrids to improve the yield of tomato for our traditional farmers though conventional method may be cheap and easier but might be uneconomically. The objective of this study is to ascertain the effect of pruning on the growth and yield of indeterminate hybrid tomato and determinate tomato varieties.

II. MATERIALS AND METHODS

➢ *Study Area*

The study was conducted concurrently during the dry seasons of 2020 and 2021 on the Research Farms of the Institute for Agricultural Research, Samaru (11º11'N, 07º38'E 686 m above sea level) and Farmers field in Kujama, (9º34'N, 8º18'E 740m above sea level) in the Northern Guinea Savanna Ecological Zones of Nigeria. Data on the relative humidity, temperature and sunshine hours for Samaru and Kajama were collected from the Meteorological Unit of the Institute for Agricultural Research, Samaru, Zaria and Meteorological Department, Kaduna International Airport Kaduna State respectively.

➢ *Soil Sampling and Analysis*

Soil samples were collected from random spots at 9 different points, each at a depth of 0 – 15 cm across the experimental sites of both locations before land preparation using soil auger. The composite of the sampled soil was air dried for laboratory analysis for determination of soil physical and chemical properties, using standard procedures. The particle size distribution of the soil was determined using standard hydrometer method (8) while the textural class was determined using USDA textural triangle. The pH was measured with the aid of pH meter (9) and total nitrogen was determined by Micro Kjeldahl procedure (10), organic carbon was determined using the procedure described by (11). Available phosphorus was extracted by the Bray 1 method (11) and the phosphorus concentration in the extract was determined colorimetrically using the spectronic 70 spectrophotometer. Exchangeable cations were determined using the Reith (12) method. Atomic absorption spectrophotometer was employed to estimate calcium, potassium and magnesium concentrations using Elmers Model 403.

➢ *Experimental Design and Field Layout*

The experiment consisted of 12 treatments comprising of three pruning techniques (no-pruning, pruning on one stem and two stems) and four tomato varieties (three of indeterminate hybrid tomato (Larisa F_1), two of determinate hybrid tomatoes (Delta F_1 and Platinum F_1), one of determinate open pollinated variety (UC82B). The four varieties of tomato with three pruning techniques was factorially combined and laid out in a randomized complete block design with three replicates. Each gross plot consisted of six ridges with a plot size of 4.5 m x 5 m (22.5 m^2) and net plot of two inner ridges with size of 1.5 m x 5 m (7.5 m^2). A spacing of one ridge was maintained between replicates and 0.5 m between plots. The inter and intra row spacing was 0.75 m by 0.5 m. Total plants per plot was sixty plants.

➢ *Nursing and Transplanting of Seedlings*

Seedlings were raised in seedling trays. Coco peat and peat moss were used as planting media and mixed in a 1:1 ratio and cells of the seedling trays were filled. One seed was planted per cell. Seed trays were watered twice daily to ensure good germination. NPK 20:20:20 was diluted in 1:1 ratio of NPK to water. This application was 1 and 2 weeks after planting. Transplanting was carried out 3 weeks after sowing. At 3 weeks after sowing, plants were hardened up and were transplanted. Plants were drenched with calcium nitrate by submerging the seedling trays in a bowl of the solution to allow it to absorb gradually to the top of the planting media in the seedling tray to enhance good root development.

➢ *Land Preparation*

The experimental land was cleared of existing vegetation, ploughed, harrowed to break big clods using tractor mounted equipment after which it was ridged and demarcated into plot and replications.

➢ *Agronomic Practices*

Weeds were managed by hand hoeing at 3, 6 and 9 weeks after transplanting or as when necessary. N: P: k 20:20:20 was applied by side dressing about 2.5cm deep at about 5 cm away from the plant. The actual fertilizer application rate was based on soil test results and water content. Irrigation of the field was carried out, one day before transplanting and after transplanting operations, subsequently irrigation was done daily depending on the ability of soil to retain moisture until harvesting was completed. Pruning of tomato commences at three weeks after transplanting and subsequently was carried out weekly until harvest according to the laid out experimental design with treatments having no pruning, one stem per plant and two stems per plant. Insects and diseases were controlled adequately as the need arises. Tomatoes are susceptible to insect pests, like white flies, Tuta Absoluta, Aphids, nutritional deficiency like Calcium which leads to Blossom end rot. Any incidence of these pests and diseases was

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24AUG1711

sprayed with the appropriate insecticide and chemical. Harvesting was done manually by hand picking at a 5 days interval, at breaker stage (that is when the matured fruit breaks from green to tannish yellow, pink or red). Harvested fruits were sorted out, weighted using a scale and recorded.

➢ *Data Collection*

Data were collected on plant height, shoot dry weight, crop growth rate, relative crop growth rate, leaf area index, fruit diameter, fresh fruit weight per plant, unmarketable yield, marketable yield and total fresh fruit yield. Each of the parameters was measured as indicated below:

- *Plant Height (cm)*

Five plants were tagged from each plot and their height was measured from the base of each plant to the tip of the growing point at vegetative and reproductive stages at 3, 6, 9 and 12 weeks after transplanting using meter rule. Their heights were added and the average per plant was determined and expressed in centimeters.

- *Shoot Dry Matter Weight (g ha^{-1})*

Shoots of five (5) randomly selected plants were separated from their roots, enclosed in brown envelopes and weighed with a top pan balance before being dried in an oven at 70 °C to a constant weight and the mean was recorded.

- *Leaf Area Index (LAI)*

Leaf area index (LAI) was measured at 3, 6, 9 and 12 weeks after sowing. This was done by measuring the leaf area of five tagged plants using leaf area meter model LI-3100C. The values obtained for the five plants were added and divided by the number of plants sampled after which the average leaf area per plant was divided by land area covered by the plant.

- *Crop Growth Rate (CGR)*

Crop growth rate (CGR) is the rate of increase in dry matter per unit ground area. This indicates the dry matter production capacity per unit area and also indicates net primary productivity. This was taken at 3, 6, 9 and 12 WAS. This was calculated using the equation below as described by Radford (13):

$$CGR = \frac{1}{GA} \times \frac{W_2 - W_1}{t_2 - t_1} (gcm^{-1}wk^{-1}) \quad (1)$$

Where:

CGR = Crop Growth Rate

W_1 = Dry matter taken at initial period

t_1 = Time when W_1 was taken

W_2 = Dry matter taken at second sampling period

t_2 = Time when W_2 was taken

GA=Ground Area

- *Relative growth rate ($g^{-1}g^{-1}wk$)*

Relative growth rate (RGR) is the rate of increase in dry matter per unit dry matter. It indicates the proportionate growth of plant independent of their size. This was determined at 6, 9 and 12 WAS using the formula described by Radford (13)

$$RGR = \frac{\log W_2 - \log W_1}{t_2 - t_1} (g^{-1}g^{-1}wk) \quad (2)$$

Where:

RGR = Relative Growth Rate

W_1 = Dry matter taken at initial sampling period

t_1 = Time when W_1 was taken

W_2 = Dry matter taken at second sampling period

t_2 = Time when W_2 was taken

- *Fruit Weight Per Plant Per Kg*

Five plants that were randomly selected from each plot were used to count the fruit setting and will be done at 6, 8, and 10, 12 weeks after transplanting. The number was recorded and expressed as the number of fruits per plant.

- *Fruit Diameter (cm)*

Five fruits from randomly tagged plants were selected at harvest, fruits from the net plot for determination of fruit diameter using vernier caliper and the average was recorded and expressed in centimeters as fruit diameter per plant.

- *Total Fresh Fruit yield per hectare (Kg/ha)*

Fruits were harvested every three days from the net plot, using a spring dials mechanical weighing scale. Records were kept for each plot and at the end of the harvest total fruit yield for each treatment was summed up and converted to yield per hectare to obtain fruit total yield.

➢ *Data Analysis*

Data collected was subjected to statistical analysis of variance (ANOVA) using R-software version 4.2.0. Means was separated at 5 % level of significance; if the results vary significantly, Duncan Multiple Range Test (DMRT) (Duncan, 1955) at 5 % level of probability was used for comparing means.

III. RESULTS

A. Physio-chemical Properties of the Experimental Soil in Kaduna and Samaru

Table 1 shows the physio-chemical properties of the soil at the experimental sites in Kaduna and Samaru. Soils of the study areas were classified as loam in texture. In both locations, soil reaction (pH) was moderately to strongly acidic, organic carbon in the soil was > 15 gkg^{-1}, available P

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24AUG1711

ranged from 10->20 $mgkg^{-1}$, total N was >1.5 gkg^{-1}, exchangeable bases Ca ranged from 2 - 5 $cmolkg^{-1}$, Mg ranged from 0.3 - 1.0, $cmolkg^{-1}$, K ranged from 0.15 - > 0.30 $cmolkg^{-1}$, Na ranged from 0.10 - 0.20 $cmolkg^{-1}$,CEC was >12 $cmolkg^{-1}$, exchangeable soil acidity value ranged from 0.30 - 0.50 $cmolkg^{-1}$.

Table 1 Physio-Chemical Properties of the Experimental Soil during in Kaduna and Samaru

Physical Properties	**Unit**	**Kaduna**	**Samaru**
Sand	g/kg	470	480
Silt	g/kg	360	360
Clay	g/kg	170	160
Textural class		Loam	Loam
Chemical Properties			
pH (H_2O) 1:2.5		6.65	5.65
pH ($CaCl_2$) 0.01M		5.45	4.90
Total Nitrogen	g/kg	2.15	1.75
Organic carbon	g/kg	18.05	15.61
Available Phosphorus	mg/kg	28.95	10.65
Potassium	cmol/kg	0.26	0.21
Calcium	cmol/kg	3.35	2.20
Sodium	cmol/kg	0.18	0.15
Magnesium	cmol/kg	0.55	0.65
AL^{+++}+ H^{+}	cmol/kg	0.30	0.50
Cation exchange capacity (CEC)	cmol/kg	4.64	3.69

B. Effect of Variety and Pruning on Growth Parameters of Tomato in Kaduna and Samaru

➢ *Plant Height*

The effects of variety and pruning of tomato in Kaduna and Samaru are presented in table 2. In both location and all sampling periods, variety Larisa F_1 gave significantly higher plant height compared with all other varieties. Variety UC82B recorded the least plant height in both locations and sampling periods. The two-stem pruned plants recorded significantly higher plant height in both locations and sampling periods except at 6 WAT at Samaru where the two stem and one-stem pruning was at par. The unpruned had the least plant height in both locations and at all sampling periods, except at 3 WAT where it was at par with one-stem plants. Highly significant interaction between variety × pruning at 9 WAT in both locations were recorded (Table 2).

Table 3 presents variety × pruning interaction on plant height at 9 WAT at Kaduna and Samaru. In both locations, combination of Larisa F_1 with two stem and one-stem produced.

Table 2 Effect of Variety and Pruning on Plant Height of Tomato in Kaduna and Samaru

	Plant height (cm)					
	Kaduna			**Samaru**		
Treatments	**3 WAT**	**6 WAT**	**9 WAT**	**3 WAT**	**6 WAT**	**9 WAT**
Variety (V)						
Larisa F_1	17.56a	56.44a	117.22a	16.11a	53.94a	114.94a
Delta F_1	9.83c	38.33b	81.83b	9.17c	37.06b	80.22b
Platinum F_1	13.83b	34.00c	53.11c	13.67b	33.33c	52.06c
UC82B	8.39d	26.39d	32.78d	8.17d	25.33d	31.28d
SE±	0.0735	0.2591	0.6394	0.2642	0.3967	0.7234
Pruning (P)						
Two-stem	12.96a	39.88a	76.08a	12.29a	38.67a	74.58a
One-stem	12.04b	39.00b	70.83b	11.38b	37.97a	69.08b
Unpruned	12.21b	37.50c	66.79c	11.67ab	35.79b	65.21c
SE±	0.0636	0.2244	0.5537	0.2288	0.3436	0.6264
Interactions						
V×P	NS	NS	**	NS	NS	**

WAT= Week after transplanting. Means followed by the same letter(s) within the same column are not significant at 0.05 level of probability using DMRT **= Significant at 0.001 level of probability, NS=Non significant, SE=Standard Error

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24AUG1711

Table 3 Effect of Variety × Pruning Interaction on Plant Height of Tomato in Kaduna and Samaru

Treatments	Plant height (cm) at 9 WAT					
	Kaduna			Samaru		
	Two-stem	One-stem	Unpruned	Two-stem	One-stem	Unpruned
Variety (V)						
	Pruning at 9 WAT					
Larisa F_1	123.33a	118.33ab	110.00b	121.17a	116.00ab	107.67b
Delta F_1	87.50c	80.00c	78.00c	85.00c	79.33c	76.33c
Platinum F_1	62.00d	53.33de	44.00ef	61.83d	51.83de	42.50ef
UC82B	31.50f	31.67f	35.17f	30.33f	29.17f	34.33f
SE±	4.3942			4.4771		

Means followed by the same letter(s) within the same column are not significant at 0.05 level of probability using DMRT statistically similar but significantly taller plants compared with all other combinations. The combination between UC82B with two-stem, one-stem and unpruned the shortest plant heights.

➢ *Shoot Dry Weight*

Table 4 shows the effect of variety and pruning on shoot dry weight of tomato in Kaduna and Samaru. In both locations, response of variety to shoot dry matter was significant at ($p<0.001$) throughout the sampling period. Larisa F_1 produce significantly higher shoot dry weight at all sampling periods in both locations.

Response of shoot dry weight to pruning was significant at 6, 9 and 12 WAT in Samaru whereby two-stem plants produce significantly higher shoot dry weight but were at par with both the one-stem and unpruned plants. One stem pruning produce significantly lower shoot dry weight at all the sampling periods at both locations

Variety × pruning interaction was only significant at 6, 9 and 12 WAT in Samaru (Table 5).

Table 6 shows variety × pruning interactions at various sampling periods in both seasons and locations. In Samaru at 6 WAT, the combination of Larisa F_1 and two-stem plants produced significantly higher shoot dry weight but was statistically similar with the combination of Larisa F_1 and one-stem plants and Platinum F_1 and unpruned plants. The combination of UC82B and all the plant prunings gave the lowest shoot dry weight. At 9 WAT, the result showed that all the combinations of varieties and plant pruning resulted in statistically similar but significantly higher shoot dry weight compared with the combination of UC82B and all the pruned plants. At 12 WAT, combination of Larisa F_1 and the unpruned and two-stem plants recorded similar but significantly higher shoot dry weight compared with all other combinations. Platinum F_1 combined with one and two-stem plants produced statistically similar shoot dry weight with Larisa F_1 and one-stem plants. Variety UC82B in combination with all pruned plants maintained the lowest shoot dry weight (Table 6).

Table 4 Effect of Variety and Pruning on Shoot Dry Weight of Tomato at Kaduna and Samaru

	Shoot dry matter (g/ha^{-1})							
	Kaduna				Samaru			
Treatments	**3 WAT**	**6 WAT**	**9 WAT**	**12 WAT**	**3 WAT**	**6 WAT**	**9 WAT**	**12 WAT**
Variety (V)								
Larisa F_1	27.07a	50.13a	126.37a	435.17a	17.84a	44.92a	120.17a	477.11a
Delta F_1	13.72b	33.08b	113.68b	412.61bc	15.71ab	32.09c	119.39ab	450.67b
Platinum F_1	16.31b	36.13b	120.09ab	426.68ab	18.18a	41.39b	113.61b	421.44c
UC82B	13.85b	32.77b	107.96b	396.97c	13.87b	24.44d	99.28c	387.17d
SE±	1.5427	2.4776	4.0784	5.9121	0.8818	1.0163	2.0578	3.8086
Pruning (P)								
Two-stem	17.78	38.02	118.79	425.74	17.01	37.19a	113.42ab	441.63a
One-stem	17.10	36.59	115.54	417.20	16.35	34.36b	110.08b	426.25b
Unpruned	18.33	39.48	116.75	410.71	15.85	35.59ab	115.83a	434.42ab
SE±	1.336	2.1457	3.532	5.1200	0.7637	0.8801	1.7821	3.2984
Interactions								
V×P	NS	NS	NS	NS	NS	**	**	**

WAT= Week after transplanting. Means followed by the same letter(s) within the same column are not significant at 0.05 level of probability.**= Significant at 0.001 level of probability, NS = Not Significant at 0.05 level of probability, SE=Standard Error

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24AUG1711

Table 5 Effect of Variety × Pruning Interaction on Shoot Dry Weight of Tomato in Kaduna and Samaru during 2020/2021 and 2021/2022 Dry Seasons

Treatments	WAT	Shoot dry weight (g/ha^{-1}) at 6, 9 and 12 WAT		
		Samaru		
		Unpruned	One-stem	Two-stem
Variety (V)	**6 WAT**			
Larisa F_1		41.18bc	44.82ab	48.77a
Delta F_1		35.40de	32.05ef	28.83f
Platinum F_1		44.48ab	38.00cd	41.70bc
UC82B		27.70fg	22.57g	23.07g
SE±		1.766535		
	9 WAT			
Larisa F_1		123.83a	114.50ab	122.17a
Delta F_1		122.50a	116.33a	119.33a
Platinum F_1		103.50bc	114.00ab	123.33a
UC82B		101.83c	95.50c	98.50c
SE±		3.700849		
	12 WAT			
Larisa F_1		752.00a	660.33b	719.00a
Delta F_1		503.00d	495.00d	499.00d
Platinum F_1		558.83c	654.17b	677.50b
UC82B		473.67de	442.50e	448.33e
SE±		14.249569		

Means followed by the same letter(s) within the same column are not significant at 0.05 level of probability using DMRT.

➢ *Crop Growth Rate (CGR)*

Table 6 shows the effect of varieties and pruning on crop growth rate in both locations and all the sampling weeks. Tomato CGR increases with age from 3 WAT and reached maximum at 12 WAT. Variety Larisa F_1 consistently gave significantly higher CGR compared with all other varieties except at 6-9 WAT in Samaru where Delta F_1 gave the highest. Variety UC82B recorded the least CGR in both locations and sampling periods, except in Samaru at 6-9 WAT where Platinum F_1 gave the least CGR.

Two-stem pruned plants recorded significantly higher CGR in both locations at 9-12 WAT. Lowest CGR was observed in one-stem in Samaru at 9-12 WAT, in unpruned at Kaduna respectively.

Variety × pruning interaction was highly significant between at 3-6 WAT and 6-9 WAT at Samaru (Table 8).

Variety × pruning interaction on CGR in Samaru at 3-6 WAT and 6-9 WAT is presented in table 9. In Samaru at 3-6 WAT, combination of Larisa F_1 with two-stem pruned produced significantly highest CGR compared with all other combinations. The combinations between UC82B with one-stem pruned gave the lowest CGR. At 6-9 WAT, combinations of Delta F_1 with two-stem and unpruned plants produced statistically similar but significantly highest CGR compared with all other combinations. The combinations between Platinum F_1 with unpruned plants gave the lowest CGR.

Table 6 Effect of Variety and Pruning on Crop Growth Rate of Tomato in Kaduna and Samaru

Treatments	Crop Growth Rate (CGR) (g.wk^{-1})					
	Kaduna			Samaru		
	3-6 WAT	6-9 WAT	9-12 WAT	3-6 WAT	6-9 WAT	9-12 WAT
Variety (V)						
Larisa F_1	7.69a	25.41	102.93a	9.03a	25.08b	118.98a
Delta F_1	6.45ab	26.868	99.75ab	5.46c	29.09a	110.43b
Platinum F_1	6.61ab	27.99	102.27a	7.73b	24.07b	102.61c
UC82B	6.31b	25.06	96.34b	3.53d	24.94b	96.19d
SE±	0.4438	0.9707	1.5616	0.3055	0.7000	1.2002
Pruning (P)						
Two-stem	6.74	26.93	102.37a	6.73	25.41	109.57a
One-stem	6.49	26.32	100.55ab	6.00	25.24	105.39b
Unpruned	7.05	25.76	98.04b	6.58	26.74	106.19b
SE±	0.3843	0.8407	1.3524	0.2646		1.039
Interactions						
V×P	NS	NS	NS	**	**	NS

WAT= Week after transplanting. Means followed by the same letter(s) within the same column are not significant at 0.05 level of probability.**= Significant at 0.001 level of probability, NS = Not Significant at 0.05 level of probability, SE=Standard Error

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24AUG1711

Table 7 Effect of Variety and Pruning Interaction on Crop Growth Rate of Tomato in Samaru

	Crop Growth Rate (CGR) (g.wk^{-1}) at 3, 6 and 9 WAT			
	Pruning			
Treatments	**WAT**	**Unpruned**	**One-stem**	**Two-stem**
Variety (V)	**3-6 WAT**			
Larisa F_1		7.44cd	8.64bc	10.94a
Delta F_1		5.92de	5.71de	4.76ef
Platinum F_1		9.22b	7.04cd	6.95cd
UC82B		4.32efg	2.63g	3.63fg
SE±		0.5963		
	6-9 WAT			
Larisa F_1		27.55abc	23.23d	24.47cd
Delta F_1		29.03ab	28.09abc	30.17a
Platinum F_1		19.67e	25.33bcd	27.21a-d
UC82B		24.71cd	24.31cd	25.14bcd
SE±		1.2502		

Means followed by the same letter(s) within the same column are not significant at 0.05 level of probability using DMRT

➢ *Relative Growth Rate (RGR)*

Table 8 shows the effect of variety and pruning on RGR in both locations and at all sampling periods. In kaduna at 3-6 WAT and 6-9 WAT, variety Delta F_1, Platinum F_1 and UC82B produced statistically similar but significantly higher RGR compared to Larisa F_1 that gave the least RGR. In Samaru at 3-6 WAT, variety Larisa F_1, Platinum F_1 and Delta F_1 produced statistically similar but significantly higher RGR compared to UC82B that gave the least RGR. At 6-9 WAT, variety UC82B and Delta F_1 produce statistically similar but significantly higher RGR compared to Larisa F_1 and Platinum F_1 that produced least RGR. At 9-12 WAT, Larisa F_1 and UC82B produce statistically similar but significantly higher RGR than other varieties.

Response of RGR to pruning was only significant at 6-9 WAT where two stem pruned was statistically similar and higher than one stem pruned and unpruned.

Variety × pruning interaction was significant at 3-6 WAT and 9-12 WAT in Samaru (Table 8). Table 9 shows variety × pruning interaction at 3-6 WAT and 9-12 WAT in Samaru. At 3-6 WAT, combination of Larisa F_1 and unpruned resulted in significantly higher RGR but was statistically at par with the RGR produced by the combination of Platinum F_1 and two-stem pruned plants. Combination of UC82B and all the pruning techniques recorded the lowest RGR. In the same location at 9-12 WAT, combination of Larisa F_1 and two-stem pruned, Platinum F_1 and two-stem pruned resulted in significantly higher RGR but was statistically at par with the RGR produced by the combination of all other treatment with the exception of the combination of Delta F_1 and two-stem plants, Platinum F_1 and one-stem and unpruned. Combination of Platinum F_1 and unpruned recorded the lowest RGR.

Table 8 Effect of Variety and Pruning on Relative Growth Rate (RGR) of Tomato at Kaduna and Sama

	Relative Growth Rate (RGR) (g.g^{-1}.wk^{-1})					
	Kaduna			Samaru		
Treatments	**3-6 WAT**	**6-9 WAT**	**9-12 WAT**	**3-6 WAT**	**6-9 WAT**	**9-12 WAT**
Variety (V)						
Larisa F_1	0.21b	0.31b	0.41	0.31a	0.33b	0.46a
Delta F_1	0.31a	0.43a	0.43	0.24b	0.44a	0.44bc
Platinum F_1	0.28a	0.41a	0.43	0.29ab	0.34b	0.43c
UC82B	0.29a	0.40a	0.44	0.19c	0.47a	0.45ab
SE±	0.0159	0.0168	0.0061	0.0166	0.0104	0.0054
Pruning (P)						
Un pruned	0.28	0.39	0.43	0.27	0.38b	0.46
One-stem	0.27	0.39	0.43	0.25	0.40ab	0.45
Two-stem	0.28	0.38	0.42	0.27	0.41a	0.44
SE±	0.0138	0.0145	0.008	0.0144	0.0090	0.0046
Interactions						
V×P	NS	NS	NS	**	NS	**

WAT= Week after transplanting. Means followed by the same letter(s) within the same column are not significant at 0.05 level of probability. Significant at 0.001 level of probability, NS = Not Significant at 0.05 level of probability, LOS=Level of significant, SE=Standard Error

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24AUG1711

Table 9 Effect of Variety × Pruning Interaction on Relative Growth Rate (RGR) of Tomato at Samaru

Treatments	Relative Growth Rate (RGR) ($g.g^{-1}.wk^{-1}$) at 3-6 WAT			
	Pruning			
	WAT	Two-stem	One-stem	Unpruned
Variety (V)	**3-6 WAT**			
Larisa F_1		0.26bc	0.29abc	0.38a
Delta F_1		0.24cd	0.23cd	0.233cd
Platinum F_1		0.34ab	0.29abc	0.24cd
UC82B		0.22cd	0.14d	0.22cd
SE±		0.0314		
	9-12 WAT			
Larisa F_1		0.47a	0.46ab	0.45ab
Delta F_1		0.44abc	0.45ab	0.45ab
Platinum F_1		0.47a	0.42bc	0.42c
UC82B		0.45ab	0.46ab	0.46ab
SE±		0.0098		

Means followed by the same letter(s) within the same column are not significant at 0.05 level of probability using DMRT, SE=Standard Error

➢ *Leaf Area Index (LAI)*

Leaf area index (LAI) as influenced by variety and pruning in both locations at all the sampling periods is presented in Table 10. The LAI increased gradually from 3 WAT to 12 WAT. At both locations and all sampling periods, variety Larisa F_1 gave significantly higher LAI compared with all other varieties except in Kaduna at 6 WAT where UC82B gave the highest LAI. Variety Platinum F_1 recorded the least LAI in both locations and sampling periods. The two-stem pruned plants recorded significantly higher LAI in Kaduna at all sampling periods. Variety and pruning interaction was only significant at 6 WAT in Samaru (Table 11).

Table 11 shows variety × pruning interaction between on LAI at 6 WAT at Samaru. Combination of Delta F_1 with two-stem pruned, Delta F_1 unpruned and Larisa F_1 with two-stem pruned and UC82B with one-stem pruned produced statistically similar but significantly higher LAI compared with all other combinations. The combination between Platinum F_1 unpruned gave the lowest LAI.

Table 10 Effect of Variety and Pruning on Leaf Area Index (LAI) of Tomato in Kaduna and Samaru

Treatments	LAI							
	Kaduna				Samaru			
	3 WAT	6 WAT	9 WAT	12 WAT	3 WAT	6 WAT	9 WAT	12 WAT
Variety (V)								
Larisa F_1	0.51a	0.60ab	0.95	1.32a	0.46	0.87a	1.22a	1.67a
Delta F_1	0.42ab	0.56ab	0.90	1.26ab	0.50	0.88a	1.23a	1.57ab
Platinum F_1	0.35b	0.56ab	0.81	1.14b	0.41	0.76b	1.06b	1.37b
UC82B	0.51a	0.67a	0.97	1.22ab	0.45	0.76b	1.02b	1.49ab
SE±	0.0476	0.0527	0.0601	0.0651	0.0284	0.0346	0.0506	0.082
Pruning (P)								
Two-stem	0.59a	0.79a	1.10a	1.48a	0.41	0.79	1.16	1.59
One-stem	0.33b	0.47b	0.83b	1.16b	0.48	0.82	1.12	1.47
Unpruned	0.35b	0.47b	0.79b	1.10b	0.48	0.83	1.12	1.53
SE±	0.0412	0.0456	0.052	0.0564	0.0246	0.03	0.0438	0.071
Interactions								
V×P	NS	NS	NS	NS	NS	*	NS	NS

WAT=Week after transplanting, LAI=Leaf Area Index. Means followed by the same letter(s) within the same column are not significant at 0.05 level of probability.* = Significant at 0.05 level of probability,± NS = Not Significant at 0.05 level of probability, SE=Standard Error

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24AUG1711

Table 11 Effect of Variety × Pruning Interaction on Leaf Area Index (LAI) of Tomato in Samaru

Leaf Area Index (LAI) at 6 WAT			
Treatments	**Pruning**		
	Unpruned	**One-stem**	**Two-stem**
Variety (V)			
Larisa F_1	0.86abc	0.84a-d	0.91ab
Delta F_1	0.91ab	0.79a-d	0.93a
Platinum F_1	0.70cd	0.75a-d	0.81a-d
UC82B	0.72bcd	0.91ab	0.67d
SE±	0.05956		

Means followed by the same letter(s) within the same column are not significant at 0.05 level of probability using DMRT

C. Effect of Variety and Pruning on Yield Parameters and Yield of Tomato in Kaduna and Samaru

➢ *Fruit Diameter*

Table 15 shows the effect of variety and pruning on fruit diameter of tomato in Kaduna and Samaru. Larisa F_1 produced significantly higher fruit diameter followed by Delta F_1 in both locations. Variety UC82B recorded the lowest fruit diameter in both locations Pruning had no significant influenced on fruit diameter of tomato in both location. Interaction between variety and pruning on fruit diameter was not significant at both locations.

➢ *Fresh Fruit Weight Per Plant*

Table 12 presents the fresh fruit weight per plant of all the tomatoes varieties and their responses to pruning in both locations. The results obtained showed that Larisa F_1 produced significantly higher fresh fruit weight per plant compared with all other varieties evaluated in both locations. Fruit fresh weight per plant produced by Delta F_1 and Platinum F_1 were statistically at par but significantly higher than that produced by UC82B. Pruning had significant influence on fresh fruit weight per plant. The result revealed that two-stem pruned plants produced the highest value followed by one-stem which were statistically similar but significantly different from the unpruned that produced the least fresh fruit weight per plant in Kaduna. The same trend was observed in Samaru where two-stem also produced the highest fresh fruit weight per plant followed by one-stem and unpruned plant recorded the lowest fresh fruit weight per plant.

Variety × pruning interaction on fruit fresh weight was significant at Samaru in 2020/2021 dry season (Table 13). Table 14 shows variety × pruning interaction on fruit fresh weight at Samaru. Combination of Larisa F_1 and Platinum F_1 two-stem produced statistically similar but significantly higher fruit fresh weight compared with all other combinations. The combination between UC82B with unpruned, one-stem and two-stem gave the lowest fruit fresh weight.

➢ *Total Fresh Fruit Yield (t/ha)*

Table 15 shows the effect of variety and pruning on total fresh fruit yield per hectare of tomato at Kaduna and Samaru. Variety recorded significant variation on total fresh fruit yield per hectare of tomato at both locations. Larisa F_1 consistently produced significantly higher total fresh fruit yield per hectare followed by Platinum F_1, Delta F_1 which were statistically not similar and lower total fresh fruit yield was obtained in UC82B in both locations. Pruning method had significant influenced on total fresh fruit yield per hectare of tomato locations where two-stem pruned plants consistently resulted in significantly higher total fresh fruit yield per hectare of tomato followed by one-stem pruned and unpruned which were statistically not the same. Unpruned produced significantly lower total fresh fruit yield per hectare of tomato. Variety × pruning interaction was significant at Samaru (Table 14). Table 15 shows variety × pruning interaction on total fresh fruit yield per hectare of tomato in both locations. In Samaru, combination between Larisa F_1 with one stem pruned, two-stem pruned and unpruned produced statistically similar but significantly higher total fresh fruit yield per hectare of tomato compared with all other combinations. The combination between UC82B with unpruned, one-stem pruned and two-stem pruned gave the lowest total fresh fruit yield of tomato.

Table 12 Effect of Variety and Pruning on Fruit Diameter and Fresh Fruit Weight Per Plant of Tomato in Kaduna and Samaru

	Fruit Diameter (cm)		**Fresh Fruit Weight Per Plant (Kg)**	
Treatments	**Kaduna**	**Samaru**	**Kaduna**	**Samaru**
Variety (V)				
Larisa F_1	28.33a	27.17a	36.67a	43.17a
Delta F_1	17.17b	15.83b	33.94b	36.50b
Platinum F_1	13.56c	13.67b	33.17b	32.33c
UC82B	10.33d	10.33c	12.78c	14.00dc
SE±	1.10	0.799	1.61	0.812
Pruning (P)				
Two-stem	16.88	16.88	32.75a	34.00a
One-stem	16.42	16.00	31.17a	31.38b

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24AUG1711

Unpruned	18.75	17.38	25.75b	29.13c
SE±	0.9498	0.6922	1.3979	0.7032
Interactions				
V×P	NS	NS	**	**

WAT=Week after transplanting, LAI=Leaf Area Index. Means followed by the same letter(s) within the same column are not significant at 0.05 level of probability. ** = Significant at 0.001 l level of probability NS = Not Significant at 0.05 level of probability, LOS=Level of significant, SE=Standard Error.

Table 13 Effect of Variety × Pruning Interaction on Fruit Fresh Weight Per Plant of Tomato in Samaru.

Fruit fresh weight per plant (Kg)			
Treatments	**Pruning**		
	Two-stem	**One-stem**	**Two-stem**
Variety (V)			
Larisa F_1	43.00a	44.00a	42.50a
Delta F_1	38.00ab	38.00ab	33.50bc
Platinum F_1	40.00a	29.00c	28.00c
UC82B	15.00d	14.50d	12.50d
SE±	2.0383653		

Means followed by the same letter(s) within the same column are not significant at 0.05 level of probability using DMRT

Table 14 Effect of Variety and Pruning on Total Fresh Fruit Yield of Tomato in Kaduna and Samaru

	Total Fresh Fruit Yield (t/ha)	
Treatments	**Kaduna**	**Samaru**
Variety (V)		
Larisa F1	69.67a	78.67a
Delta F1	40..83b	43.00c
Platinum F1	43.56b	47.67b
UC82B	14.44c	13.00d
SE±	1.57	0.909
Pruning		
Two-stem	45.08a	50.29a
One-stem	41.83b	44.21b
Unpruned	39.46b	42.25b
SE±	1.3638	0.7876
Interactions		
V*P	NS	**

WAT= Week after transplanting. Means followed by the same letter(s) within the same column are not significant at 0.05 level of probability. Significant at 0.001 level of probability, NS = Not Significant at 0.05 level of probability, LOS=Level of significant, SE=Standard Error

Table 15 Effect of Variety × Pruning Interaction of Total Fresh Fruit Yield Per Hectare of Tomato in Samaru

	Pruning		
Treatments	**Two-stem**	**One-stem**	**Unpruned**
Variety (V)			
Larisa F1	81.17a	77.50a	76.17a
Delta F1	37.25c	52.17b	39.33c
Platinum F1	39.00c	56.50b	47.50bc
UC82B	10.50d	14.50d	13.00d
SE±		3.8326	

Means followed by the same letter(s) within the same column are not significant at 0.05 level of probability using DMRT

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24AUG1711

IV. DISCUSSION

➢ *Physiochemical Properties of the Soil Used in the Study*

The texture of the soil was loamy with slight clay content as [14] reported that a loamy soil enhances good water holding capacity with sufficient aeration and contains enough humus. The soil reaction (pH) for both location showed that they were nearly within the pH limit (5.5 to 6.5) set for optimum crop production in the tropics according to [15]. Organic carbon in the soil were generally high, total N and available P were between medium and high, exchangeable bases Ca, was medium, Na was medium, Mg was medium, K was medium to high, CEC was high and exchangeable soil acidity was low according to [16] and [17]. The high values of organic carbon, total nitrogen and available phosphorus would suggest that the soils were rich in essential nutrients and demand little or no application of organic and mineral fertilizers. Furthermore, high level of organic carbon translates to high CEC which would enhance rapid availability of basic cations. The soil pH value in water was above 5.0 (i.e. > 5.8) indicating that exchangeable Al toxicity may not be a problem in the soil. The low exchangeable acidity reflects that crop production of tomato will not be hindered in the ecological zone. These values reported in this study are close to what [18] reported for N (2.50 g kg^{-1}), P (30 mg kg^{-1}) and K (0.20 cmol kg^{-1}) for optimum crop production.

➢ *Effect of Variety on Growth Parameters and Yield of Tomato*

At both locations, the overall performance of tomato plant as exhibited by plant height, shoot dry weight, leaf area index, crop growth rate, relative crop growth rate, fruit weight per plant, fruit diameter might be as a result of favourable weather conditions for the crop. Generally, all the growth attributes in this study at different sampling periods were found higher in Larisa F_1 than other varieties. The superiority of Larisa F_1 to other varieties on the above mentioned growth and yield characters might be attributed to genetic difference between them. It could be the variety Larisa F_1 has better photosynthetic efficiency due to higher leaf area index which resulted to good growth and yield. Differential performance of the different varieties could be attributed to genetic variability and adaptability during the crop growth period. In this study, UC82B was the lowest in the growth attributes of tomato than other varieties evaluated. This report negates the findings by [19] who indicated that UC82B was higher in the growth attributes of tomato than other varieties evaluated. In addition, consistent increased in plant height in Larisa F_1 may also be ascribe to cultivar characteristics or genetic make-up. This assertion was supported by [20] who reported that plant height may vary according to cultivar characteristics or genetic make-up. This may also be that the cultivars response to nutrients utilization depends on genetic make-up of the cultivar. The superiority of Larisa F_1 in plant height compared to other varieties may be their indeterminate nature which does not cease growth at the onset of the reproductive phase. This finding agrees with that of [21] who opined that determinate varieties do not require staking as the indeterminate varieties because they continue to grow and produce fruit year round except they are killed by the harsh weather. The performance of these varieties on all growth parameter could be attributed to the fact that cultivars response to nutrients utilization depends on genetic make- up of the cultivar. Higher values of crop growth rate reported in this study may probably be due to the genetic make-up of the varieties and the management practices given to the plants. The higher values reported corroborate with the findings of [22].

The yield components such as fruit weight per plant, fruit diameter and fresh fruit yield (t/ha) was significant where Larisa F_1 proved superior to other varieties in both locations. This could be attributed to genetic factor as influenced by the favorable environmental factors that allowed the crop to grow vigorously resulting to early fruit setting. These results are in agreement with the findings of [23] who reported that UC82B yielded low when compared with Roma VF 3900 and Roma VF 5-80-285 tomato cultivars evaluated. [24] indicated that early flowering varieties would be beneficial for attaining higher yield of tomato. The highest fresh fruit yield produced by Larisa F_1 could be attributed to the genetic makeup of the variety.

➢ *Effect of Pruning on Growth Parameters and Yield of Tomato*

Pruning is a management practices that help to increase fruit yield and quality of fruit, better aeration, better exposure of foliage to sunlight and photosynthetic activities and also minimize the risk of diseases. The superiority of variety Larisa F_1 with two, one-stem pruned in production of more shoot dry matter than other varieties could be that the physiological processes which is controlled by the interplay of both genetic makeup and the environment might be responsible. More so, differential performance of all the varieties could be attributed to genetic variability adaptability, morphological features, and physiological factors during the crop growth period. This conforms to the report of [25] that varieties differ in their growth potential depending mainly on the physiological process which is controlled by interplay of both genetic make-up and the environment.

In this study, indeterminate tomatoes that were two stem pruned gave highest growth parameters and yield. This concur with the findings of [26; 27; 28] who reported that pruning indeterminate tomatoes helps plant growth to facilitate light penetration throughout the leaf canopy for more efficient interception of light for photosynthesis and to maintain a balance between vegetative and reproductive growth, and that tomato yield occurs when side shoots can develop, because they use nutrients which otherwise would have been used for fruit development. [29] reported a higher marketable yield per unit area when pruning indeterminate field tomatoes to 2 rather than 1 stem.

➢ *Interactions*

- *Variety and Pruning Interaction*

The response of variety to pruning in this study shows the significance of pruning as an important management practice in tomato production. The unique display of Larisa

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24AUG1711

F_1 to all the pruning method may probably be ascribe to the genetic makeup and favourable environmental condition as compared to other varieties. The indeterminate nature of Larisa F_1 might also be responsible for the behaviour. Larisa F_1 when pruned to two-stem recorded the highest total fresh fruit yield compared to other varieties. This supports the findings of [30] who reported that pruning in tomatoes increase yields and quality of fruits.

REFERENCES

[1]. S, Knapp. Solanum section Geminata. FI Neotrop, 2002, 84:1- 405

[2]. S, Kimura and N, Sinha. Tomato (Solanum lycopersicum): A Model Fruit-Bearing Crop. CSH protocols. 2008. pdb.emo105. 10.1101/pdb.emo105.

[3]. W, Joye, C, George and L, Sheryl. Tomatoes and Cardiovascular Health. Critical reviews in food science and nutrition. 2003, 43. 1-18. 10.1080/10408690390826437.

[4]. J, Jr. Benton. Tomato plant culture: In the field, greenhouse, and home garden. CRC Press, London. 2007.

[5]. M.U. Sainju, R, Dris and B, Singh. Mineral nutrition of tomato. Food Agriculture & Environment, vol.1 (2), 176-183, 2003.

[6]. FAO. Green beans integrated pest management. An Ecological Guide Training. Resource Text on Crop Development, Major Agronomic Practice, Disease and Insect Ecology, Insect Pest, Natural Enemies and Diseases of Green Beans. Food and Agriculture Organization, Rome, Italy, 2007.

[7]. O. Anastacia, A. Masinde, T.K. Kwambai, and N.H. Wambani. Evaluation of tomato (Lycopersicon esculentum L.) variety tolerance to foliar diseases at Kenya Agricultural Research Institute Centre-Kitale in North West Kenya Afr. J. Plant Sci. 5 11 1934 1940), 2011.

[8]. G. W. Gee, and J. W. Bauder. Particle-Size analysis. Methods of soil analysis. Part Physical and mineralogical methods, 2nd ed.; American society of agronomy, Madison, WI, 383-411, 1986.

[9]. C. A, Black. Method of Soil Analysis, Agronomy. Part 1, American Society of Agronomy, Madison, Wisconsin USA, 1572p, 1965.

[10]. J. M. Bremner, and C. S. Muvaney. Total nitrogen. In: Methods of soil analysis. Page, A.L., R.H. Miller and D.R. keeping (Eds.) of soil part 2. American Society of Agronomy. Madison Wisconsin. 595-624, 1982.

[11]. Bray and Kurtz. Determination of total, Organic and available forms of phosphorus in soil. Soil science, 59; 39-45, 1945.

[12]. J. M. Anderson, and J. S. I. Ingram. Tropical Soil Biology and Fertility: A Handbook of Methods(2nded.). C.A.B. Intemation Wallingford, U.K. pp. 221, 1989.

[13]. P. J. Radford, Growth Analysis Formulae, their uses and abuse. Crop Science 3: 171- 173, 1967.

[14]. S. O. Agbato, Principles and Practices of Crop Production. (Odumatt Press and Publishers, Oyo, Nigeria). pp 121, 2003.

[15]. I. E. Esu, Soil characterization, classification and survey. HEBN Publishers Plc., Ibadan, Nigeria. 232 pp, 2010.

[16]. FMARD. Fertilizer Use and Management Practices for crops in Nigeria (4th Edition). Edited by Chude, V.O., Olayiwola, S.O., Daudu, C. K. and A. Ekeoma. Produced by Federal Fertilizer Department, Federal Ministry of Agriculture and Rural Development, Abuja. 229pp, 2012.

[17]. Soil Survey Staff. Soil Survey Manual. USDA Handbook 18, US Government Printing office, Wash. Soil Science of America Journal, 58: 123-130, 1999.

[18]. N. Mangale., A. Muriuki., A.N. Kathuku-Gitonga., C.N. Kibunja., J.K. Mutegi., O. Anthony.,A.O. Esilaba., F.O. Ayuke., S.N. Nguluu, and E.W. Gikonyo, Manual for Integrated Soil Fertility Management in Kenya, 107pp, 2016.

[19]. J. O. Olaniyi., W.B. Akanbi., T.A. Adejumo, and O.G. Akande, Growth, fruit yield and nutritional quality of tomato varieties. African Journal of Food Science, 4 (6), 398-402, 2010.

[20]. S. Sinnaduiai, Vegetable cultivation, Accra Asempa publication, Accra, 1992.

[21]. P. Hanson, J. T. Chen., C. G. Kuo., R. Morris, and R.T. Opena, Suggested cultural practice for tomato international cooperators, Guide. Asia Vegetable Research and development, 2000.

[22]. E.N.K. Sowley, and Y. Damba, Influence of staking and pruning on growth and yield of tomato in the Guinea Savannah Zone of Ghana. International Journal of Science and Technology Research. 2:12: 103-107, 2013.

[23]. K. E. Law-Ogbomo, and R. K. A. Egharevba, Effects of Planting Density and NPK Fertilizer Application on Yield and Yield Components of Tomato (Lycospersicon esculentum Mill) in Forest Location. World Journal of Agricultural Sciences 5 (2): 152-158, 2009ISSN 1817-3047© IDOSI Publications, 2009.

[24]. N. Mehta, and B. S. Asati, Genetic relationship of growth and development trait with fruit yield in Tomato (Lycopersicon esculentum Mill.). Karnataka Journal of Agricultural Science. 2 1 (1): 9 2-96, 2008.

[25]. S. Isah., E.B. Amans., E.C. Odion, and A.A. Yusuf, Growth Rate and Yield of Two Tomato Varieties (Lycopersicon esculentum Mill) under Green Manure and NPK Fertilizer Rate Samaru Northern Guinea Savanna, International Journal of Agronomy, 932759, 8-10, 2014. https://doi.org/10.1155/2014/932759.

[26]. E. Jovicich., D. J. Cantliffe, and G. J. Hochmuth, Plant density and shoot pruning on yield and quality of a summer greenhouse sweet pepper crop in North central Florida. Proc. Amer. Soc. Plasticulture, 19-22 May 1999, Tallahassee, FL.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24AUG1711

[27]. M. Navarrete., and B. Jeannequin, Effect of frequency of axillary bud pruning on vegetative growth and fruit yield in greenhouse tomato crops. Sci. Hort. 86:197–210, 2000. doi: 10.1016/S0304-4238(00)00147-3.
[28]. M. M. Maboko., C. P. Du Plooy, and S. Chiloane, Effect of plant population, stem and fruit pruning of hydroponically grown tomato. African Journal of Agricultural Research. 6:5144–5148, 2011
[29]. M. Aung, Effect of pruning and spacing on performance of fresh market tomato. Report of AVRDC, The World Vegetable Center. Pp.1-7, 1999.
[30]. S. Srinivasan., D. Veeraghavathathan, V. Kanthaswamy and S. Thiruvudainambi, The effect of spacing, training and pruning in hybrid tomato. Ed. CAB international, 2001.