Influence Of Staking And Pruning On Growth And Yield Of Tomato In The Guinea Savannah Zone Of Ghana.

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Abstract: Tomato, an important fruit vegetable used in almost every meal in all homes, chops bars and restaurants to create appetite and taste. It has the potential of becoming a corner stone in alleviating poverty of smallholder farmers in Ghana especially Northern Ghana but its production results in low yield due small size and rotten tomato fruits at harvest. Higher yields can be realized when famers adopt best agronomic practices to enhance yield to match consumption demand of the 'Red Gold'. This research was therefore carried out in the Northern Region of Ghana, the second largest tomato growing region after the Upper East Region, to determine the effect of staking and pruning on the growth and yield of tomato. It is equip tomato farmers in the Savannah Ecological zone of Ghana with best agronomic practices to among other things increase marketable yield of tomato. Three cultivars of tomato namely, local, F1 titao, and Pectomech were used. The experiment was a 2*2*3 factorial with 12 treatments each replicated 3 times. The factors were pruning, staking and variety. These were laid in a randomized complete block design. The study measured seven parameters which included fruit yield, plant height, and number of branches, days to flowering, number of flowers, and number of fruits, dry matter and fruit yield. The results of the experiment showed that the all the parameters were cultivar dependent except fruit yield. Pruning affected plant height negatively and unstaked-unpruned plants were significantly higher than unstaked - pruned and staked – pruned plants. Staking did not show significant differences among treatments. At harvest, unstaked-unpruned and staked-unpruned plants indicated higher number of fruits per plant with small fruit size as compared to the other plants. Stake - prune and unstake - prune plants few number of fruit per plant but fruits size bigger than staked-unpruned and unstaked – unpruned. The local cultivar ripped earlier than F1 titao and pectomech cultivars. Marketable fruit yield was obtained in staked - pruned of local and F1 titao cultivars similar to staked - unpruned. The study concluded that the effect of staking and pruning on growth and yield of tomato was cultivar depended. Staking and pruning gave clean and bigger fruits with an increase in total marketable fruit yield by weight. The study therefore recommends that tomato farmers should adopt staking and pruning to obtain higher marketable yields that will fetch them good prices but must be guided in their cultivar selection.

Index Terms: Cultivar, pruning, staking, tomato and yield

1 INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is one of the most important vegetables worldwide. World tomato production in 2001 was about 105 million tons of fresh fruit from an estimated 3.9 million hectares [17]. It is economically attractive and the area under cultivation is increasing daily but results in low yield due to the use of traditional method of farming. Tomato belongs to the *Solanaceae* family. The yield gap is quite huge in Ghana. While the annual realizable yield for tomatoes in Ghana is 15 metric tonnes per hectare, the actual yield now is 7.5 metric tonnes per hectare. This gives a yield gap of 50% [18]. Production of tomato in Ghana has contributed a lot to the country's economy but inadequate education and the use of traditional methods of farming have contributed to low production in the tomato industry. Tomato which originated from South America specifically Mexico a most popular vegetable crop [16]. It ranks 16th among vegetables in relative concentration of vitamins and minerals [15] and most highly priced and consumed widely [12]. Tomatoes contribute to a healthy, well-balanced diet [17]. It is rich in minerals, vitamins, essential amino acids, sugars and dietary fibers. Tomato contains much vitamin ***B*** and ***C***, iron and phosphorus. Tomato fruits are consumed fresh in salads or cooked in sauces, soup and meat or fish dishes [17]. It can be processed into purées, juices and ketchup. Canned and dried tomatoes are economically important processed products. In Ghana, tomato production is a source of employment for many people especially the youth. Farmers hire labourers for activities like land preparation, watering, transplanting, weeding, earthing-up, staking, pruning, harvesting and loading of tomatoes. Processing industries also provide jobs. It is mainly women who are engaged in the sale of tomatoes which generates income for their households. Tomatoes are sold at a higher rate than cereals and grains. During the rainy season, tomatoes give very good income in comparison to grain and fodder crops. Market gardeners create substantial income from intensive cultivation of limited lands [12]. The medicinal value of tomato cannot be overlooked. Many of the vegetable crops possess high medicinal values. Plant biochemists and pharmacologists are using them to manufacture medicines. It is reported that, people of Northern Italy who ate seven or more servings of raw tomato every week had 60% less chance of developing diabetes [2]. Despite the economic importance of tomato and its contribution to the economy of Ghana, production in the country is low [3]. For instance, the average yield in Nigeria was 10 tonnes per hectare compared to 5.5 tonnes per hectare in Ghana [3]. There is a general problem of poor performance of tomato in Ghana due to non-adoption of improved husbandry practices in tomato production. In 2003 and 2004 Ghana exported 4,368 and 607 metric tonnes of tomato respectively which showed the declared of production [4]. Fruit yield of tomato of 7.5-15 tonnes per hectare have been recorded from farmer's field as average yield of tomato in Ghana [9]. It has been observed that with good cultivation practices the yield of tomato could reach 22,000 - 27,000kg/ha (22 – 27 tonnes per hectare) for a field in the Accra plains [14]. It was further observed that, with good soil management and irrigation, the yield of 33,000 - 38,000kg/ha (33 – 38 tonnes per hectare) could be obtained in the Northern region of Ghana [14]. Also it is asserted that with improved horticultural practices including the use of improved cultivars, yield of over 32.5 – 46.0 tonnes per hectare have been realized in the forest zones of Ghana [8]. There is the need to adopt pruning and staking to improve the yield of tomato for our traditional farmers though conventional method may be cheap and easy but uneconomically. Pruning is a husbandry practice which increase fruit size and total yield of tomato [7]. It has been reported that pruning increased the total yield of two

determinate cultivars but did not alter the peak period of harvesting [1]. Staking is a means of providing supports to ensure clean and unblemished fruits which kept fruits off from the ground, minimizing diseases and rotting of fruits thereby increasing marketable yield [6]. Marketable yield of tomato at Samaru Nigeria under wet condition was significantly increased by staking of tomato plants [11]. Therefore the objective of the study was to assess the influence of staking and pruning of the tomato in Guinea Savannah Ecology.

2.0 MATERIALS AND METHODS

2.1 Study Area

The study was conducted at the research field of University for Development Studies, Nyankpala campus from July – December, 2008. Nyankpala is located on latitude 009° 25' 41" N, longitude 000° 58' 42" W and altitude 183m above sea level. The area has unimodal rainfall distributed from April to October. It has an average annual rainfall of about 1046 mm [13]. The average temperature of the area is 28.3 ^{o}C. The soil type of the study area has been classified under Nyankpala series. These soils are brown in colour, moderately drained sandy loam, developed from Voltarian sandstone. The vegetation is made up of short deciduous fire resistant trees which do not form a close canopy. The ground flora is made up of different species of grasses.

2.2 Experimental Design and Field Layout

The experiment was a 3 x 2 x 2 factorial laid out in a randomized complete block design with 12 treatments each replicated three times. The factors were staking, pruning and variety (local, F1 titao and pectomech). Seeds of a local cultivar, F1 titao and pectomech were obtained from Tamale market, Afrique Link Company at Wenchi and Evans Addo Agro-chemicals, Tamale. A field size of 7.4 m x 29.5 m was demarcated and sprayed with glyphosate to kill weeds. Hoes were used in preparing 36 beds each measuring 2m x 1.8m with spacing of 0.5m between plots and 1m between blocks. Seedlings were transplanted on the prepared beds at planting distance of 0.6m x 0.5m and watered until all seedlings were established. Each bed contained 12 plants of a cultivar.

2.3 Nursing and transplanting of seedlings

Three beds each measuring 1.5 m x 1 m were prepared on a sandy loam soil for the nursing of seedlings. Seeds of each cultivar were thinly sown in drills spaced 20 cm apart in July 2008. The beds were mulched with dry grass and watered at 3 day's intervals until germination. Fourteen days after germination, seedlings were supplied NPK starter solution, made by dissolving 10 g of NPK in a litre of water.

2.4 Agronomic Practices

Weeding and earthing-up were done at third and sixth weeks after transplanting. Plants were staked at three weeks after transplanting (WAT). Pruning was started at 4 WAT and continued for four weeks. Pruning was carried out by heading back and thinning out of branches. The lateral buds become active and formed a bushy and compact crown. Heading back was done at four weeks after transplanting and thinning out at six weeks after transplanting and continues every two weeks. Thinning out is the complete removal of branches from the main truck or its branches. This makes up the crown letting in more light and air to encourage elongation by the terminal buds. It was done every week. At four weeks tomato plants were pruned to two-stemmed per plant by pinching out (thinning out) the lateral branches as they appear in the axis of each leaf at two weeks interval. NPK (15-15-15) fertilizer was applied at 220kg/ha at two weeks after transplanting. At fifth week after transplanting, NPK was applied at the same rate.

2.5 Data collection

Data were collected on plant height, number of branches per plant, days to flowering, number of flowers per plant, fresh shoot weight, shoot dry matter, number of fruits per plant, fruit weight and fruit yield. Each of the parameters was measured as indicated below:

2.5.1 Plant height

Heights of the tomato plants were recorded at 2, 4, 6, and 8 weeks after transplanting. The height of each plant was measured from the base of the plant to the apex with a tape measure.

2.5.2 Number of branches per plant

Number of branches per plant for five randomly selected plants per replication was determined at 2 weeks after heading back and 2 weeks after thinning out and the mean recorded.

2.5.3 Days to flowering

At four weeks after transplanting plants were closely observed for flowering at three day interval.

2.5.4 Number of flowers per plant

Number of flowers per plant of five (5) randomly selected plants was determined at 50% and 100% flowering.

2.5.5 Fresh shoot weight and dry matter

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 82 °C for 24hours. The dry weight was then determined.

2.5.6 Fruit number per plant

Five plants were randomly selected in each plot and fruits were counted at 7, 8, and 9 weeks after transplanting. The numbers were recorded.

2.5.7 Weight of fruits

The fruits were harvested from randomly selected plant in each treatment. The harvested fruits were weighed from each treatment after harvesting and the mean weight was recorded in grams.

2.5.8 Fruit yield

Fruits were harvested every three days from middle rows. Records were kept for each plot in a replication and at the end of the harvest total fruit yield for each treatment were summed up and converted to yield per hectare.

2.6 Data Analysis

The data collected were subjected to Analysis of Variance (ANOVA) using GENSTAT (3rd Edition). The Least Significant Difference (LSD) was used to separate the means.

3.0 RESULTS

3.1 Effect of pruning and staking on plant height

There were significant differences ($p<0.05$) in plant height among treatments. At 2 weeks after transplanting (WAT) plant height was similar among treatments but at 4WAT, 6WAT and 8WAT treatments that were unstaked and unpruned were significantly higher ($p<0.05$) than unstaked- pruned and staked- pruned but similar to staked – unpruned (Figure 1). Plant height was increased with time and affected negatively with pruning.

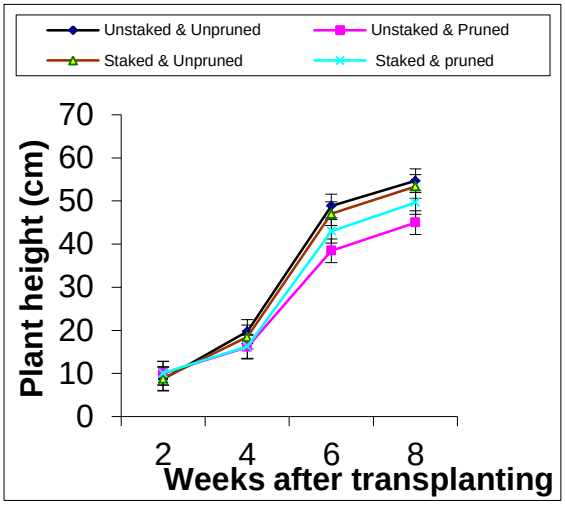

Fig 1: Effect of staking and pruning on plant height. Data points represent means and bars represent S.E.D.

3.2 Effect of staking and pruning branching

The number of branches of local cultivar was significantly higher ($p<0.001$) than other treatments at 6 WAT and 10 WAT (Figure 2).

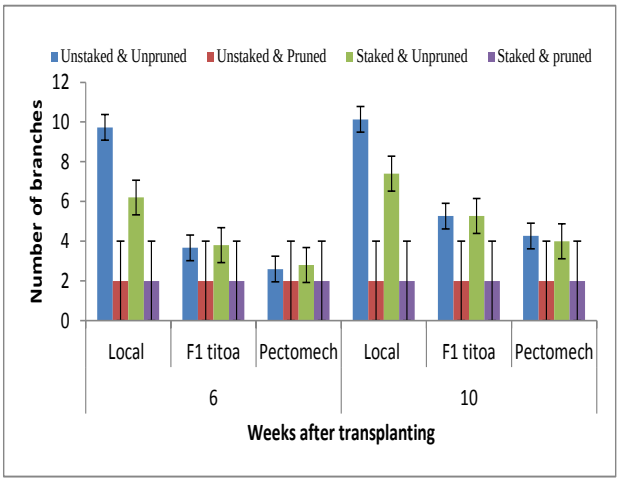

Fig 2: Number of branches as affected by staking and pruning and varieties at 10 WAT. Bars represent S.E.D.

3.3 Effect of staking and pruning on flowering of tomato

Unpruned- staked and unpruned- unstaked plants flowered earlier than those of the other treatments but the differences were not significant (Figure 3). Staking did not have any effect on days to flowering and pruning influenced higher days to flowering.

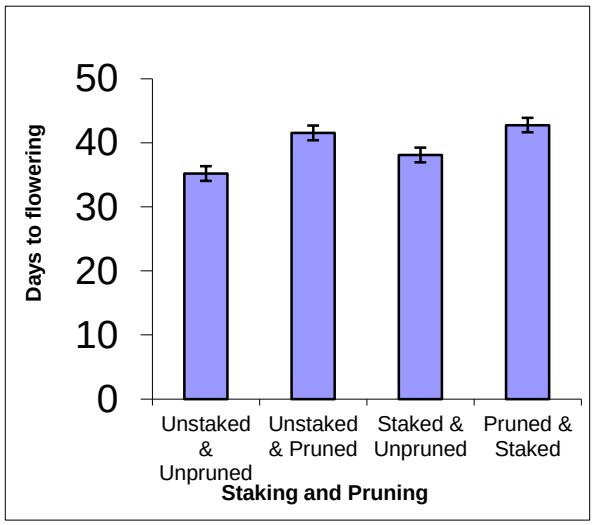

Fig 3: Days to flowering affected by staking and pruning of tomato. Bars represent S.E.D.

3.4 Effect of cultivar on dry matter of tomato

F1 titao plants produced a significantly higher ($p<$) amount of dry matter than other treatments (Figure 4).

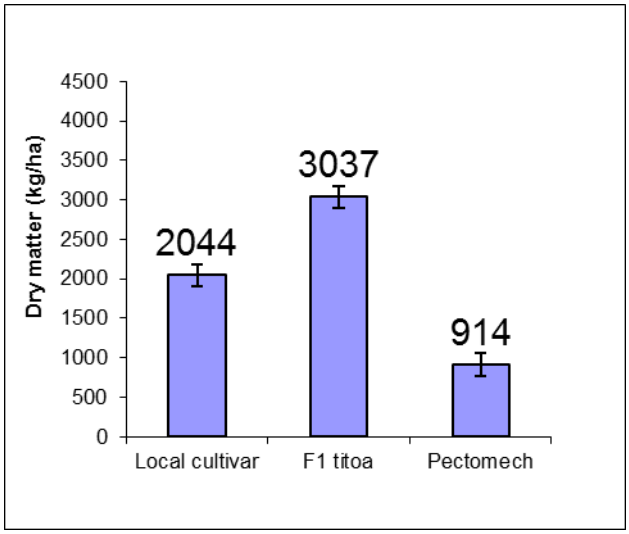

Fig 4: Effect of cultivar on dry matter. Bars represent S.E.D.

3.5 Effect of staking and pruning on number of flowers per plant

Unpruned plants showed significantly higher number of flowers per plant than the other treatments at 50% flowering and 100% flowering (Figure 5).

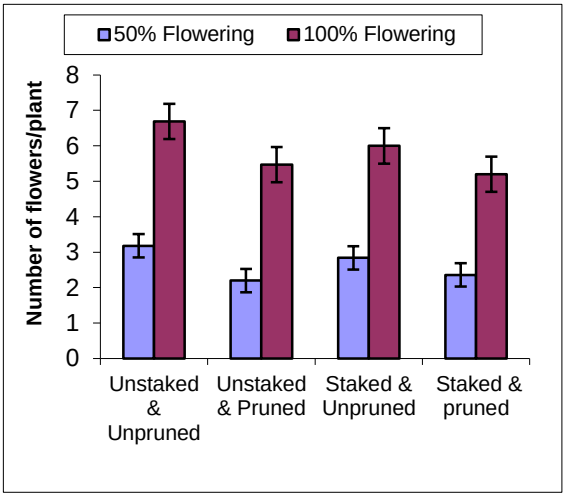

Fig 5: The effects of staking and pruning on number of flowers per plant. Bars represent S.E.D

3.6 Effect of staking and pruning and cultivar on number of fruits per plant

The number of fruits per plant was significantly higher ($p<0.05$) unpruned plants than pruned plants in all cultivars of tomato (Figure 6).

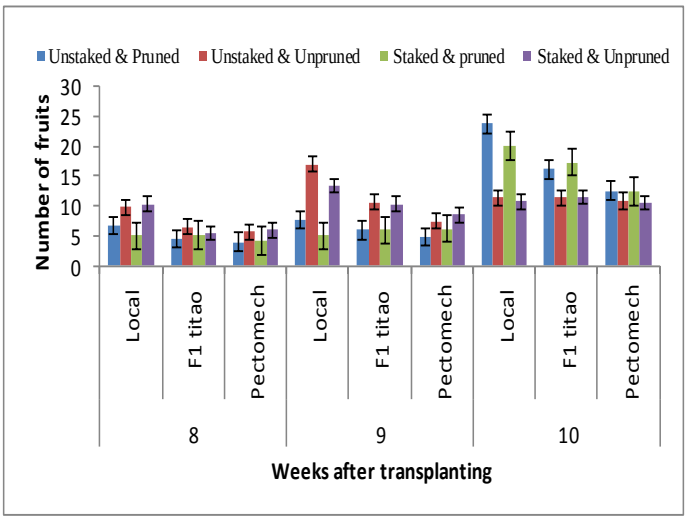

Fig 6: Effect of staking and pruning and variety on number of fruits per plant. Bars represent S.E.D.

3.7 Effect of staking and pruning on fruit weight and fruit yield

Fruit weight was significantly ($p<0.001$) higher in pruned plant than unpruned plants (Figure 7). Fruit yield of tomato was significantly higher ($p<0.001$) in F1 titao with staked – pruned more than the local and pectomech cultivars. However cultivars with unstaked – unpruned and unstaked – pruned showed similar fruit yield in the cultivars (Figure 8).

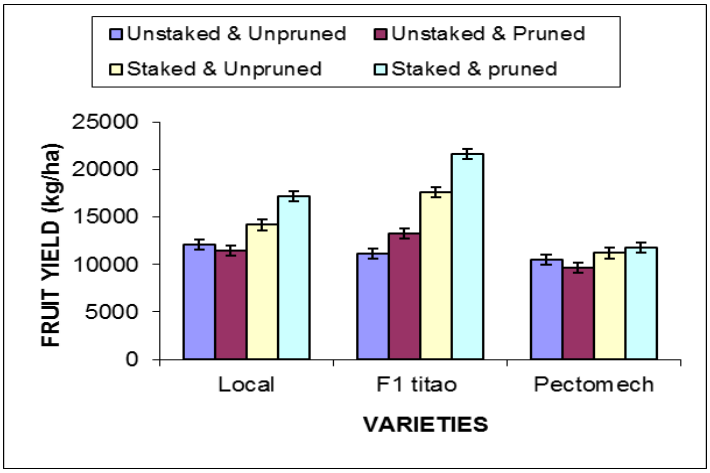

Fig 7: Effect of **staking** and pruning on the fruit weight. Bars represent S.E.D.

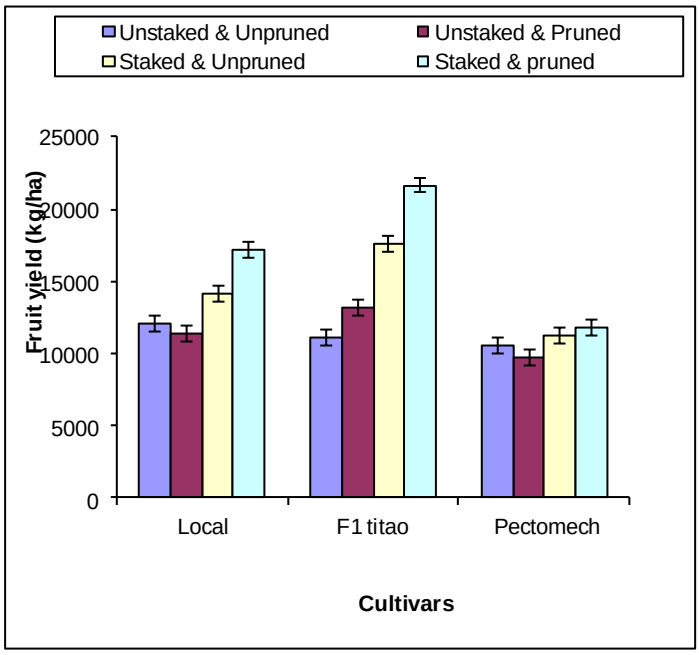

Fig 8: Effect of cultivars and staking and pruning on fruit yield of tomato. Data points represent means and bars represent S.E.D.

4.0 DISCUSSION

4.1 Effect of staking and pruning Plant height

Plant height was affected by pruning and staking. Unstaked - unpruned promoted the parameter similarly to staked - unpruned due to the fact that the terminal bud was left to grow. Unstaked - pruned and staked - pruned did not influence plant height positively due the type of pruning used which inhibited the apical growth of the plants (Figure 1). The pectomech cultivar was significantly different from local but similar to F1 titao in plant height. This could be due to the fact that cultivars response to nutrients utilization depends on genetic make- up of the cultivar. This assertion was supported by [14] who reported that plant height may vary according to cultivar characteristics or genetic make-up. Staking did not

have any positive or negative effect on the plant height. Pruning affected the parameter negatively because the type of pruning used inhibited apical growth of tomato plants.

4.2 Effect of staking and pruning on branching

Staking and pruning influenced the number of branches per plant. The number of branches per plant was higher in unstaked - unpruned similarly to staked - unpruned but lower in unstaked - pruned and staked – pruned (Figure 2). This was due to the fact that pruning type used regulated the branches in pruned plants but unpruned plants were left freely to branch. Number of branches per plant was also affected by cultivar difference in the experiment. The local cultivar was significantly higher number of branches per plant then pectomech but F1 titao and pectomech gave similar number of braches per plant. This variation could also be attributed to the genetic make-up of the cultivars.

4.3 Effect of staking and pruning on number of flowers and fruits

Number of flowers and fruits were affected by pruning and staking (Figure 3). Unstaked - unpruned promoted higher number of flowers and fruits of small size per plant similarly to staked-unpruned but unstaked-pruned and staked-pruned recorded the lower number of flowers and fruits of bigger sizes. The higher number of flowers per plant recorded by unstaked - unpruned as well as staked - unpruned could be attributed to the higher number of branches per plant. Cultivar difference affected the flowering and fruiting of the tomato plant. The local cultivar produced the highest flowers and fruits per plant then F1 titao and pectomech cultivars. This may be due to fact that cultivars used varied in their genetic make-up. Temperature variation during the experiment could have also affected the number of flowers and fruits a plant can produce. Temperature could have caused flower and fruit abortion during data collection. This confirmed [5] and [10] who reported that temperature affected the number of flowers and fruits per plant in tomatoes. Local cultivar ripped earlier than pectomech and F1 titao cultivars which could be attributed to its genetic characteristics of the cultivars.

4.4 Effect of staking and pruning on dry matter

Dry matter of the plants was influenced by cultivar difference (Figure 4). The highest dry matter was recorded by F1 titoa cultivar and pectomech recorded the least. This dry matter difference may be due to the cultivar difference among plants which made it possible to adapt well in the savannah ecology to produce high fresh weight.

4.5 Effect of staking and pruning on fruit weight

Staking and pruning affected fruit weight of tomatoes. Staked - pruned plants produced the highest fruit weight similarly to unstaked - pruned but unstaked - unpruned and staked - unpruned recorded least weight. This was due to the size of fruits produced by pruned plants. This confirmed the findings of [7] who reported that, pruning of tomatoes gave bigger fruits than unpruned. The differences that existed among treatments may be attributed to the effect of pruning and staking.

4.6 Effect of staking and pruning on fruit yield

Variety and staking - pruning affected fruit yield of tomatoes. It was observed that, staked - unpruned and staked - pruned plots of F1 titao cultivar recorded fruit yield similarly to staked - pruned of local cultivar. This could be attributed to the fact that few fruits of staked plants were rotten and bigger fruits were produced by pruned plants. This showed that staking prevented rotting of fruits and pruning increased fruit size there by increasing marketable yield of tomatoes. The fruit yield of staked - unpruned and staked - pruned of F1 titao cultivar were 17611kg/ha and 21667kg/ha and staked - pruned of local cultivar was 17139kg/ha. This findings confirmed by [7] and [1] who reported that, staking and pruning increase marketable yield of tomatoes.

Conclusions

Pruning increased the sizes of tomato fruits which resulted in higher of fruit yield of the tomato. However, better and stable fruit yield of tomato could be obtained with the practice of pruning in combination of staking. The combination of pruning with staking showed synergism by producing comparable yields to that of pruning alone but these fruits were cleaner than pruning without staking. Staking prevented the rotting of the tomato fruits which resulted in high yield of tomatoes in pruned-staked tomatoes.

Recommendations

It recommended that pruning should be carried out together with staking for higher fruit yield and clean fruits of tomato from economic point of view. There is the need to carry out further studies especially cost benefit analysis and multi-locational trials in future studies.

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