

THE EFFECTS OF PRUNING VERSUS NON-PRUNING ON QUALITY AND YIELD OF STAKED FRESH-MARKET TOMATOES

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September 2012

ABSTRACT

A field experiment was conducted at the Gladstone Road Agricultural Centre from November 2011 to February 2012. This study examined the effects of pruning on yield and quality of four staked tomato varieties: 'BHN543', 'Finishline', 'Rocky Top' and 'Soraya'. The trial was set out in a completely randomised design with three replications. Results showed an increase in tomato yield per plant with pruning. Also with pruning, the number of fruit per plant increased with the varieties 'Rocky Top' and 'Soraya', but decreased with 'BHN543' and 'Finishline'. The potential yield of marketable fruit per hectare was higher in pruned 'Soraya' (10.5 tonnes/ha), followed by 'Rocky Top' (7.8 tonnes/ha), 'Finishline' (6.9 tonnes/ha), and 'BHN543' (5.8 tonnes/ha).



Staked tomato plants growing at the Gladstone Road Agricultural Centre during 2012.

Introduction:

The tomato (*Solanum lycopersicum*, *syn. Lycopersicon lycopersicum*) is one of the most important vegetable crops in the world. Its total production of more than 150 million tons of fresh fruit, produced on 3.7 million hectares, exceeds all other crops, with the exception of the potato and sweet potato (FAOSTAT, 2010). The tomato is cultivated in both temperate and tropical regions of the world. It is a very attractive and tasty fruit with a bright red colour that makes it even more appetising to the consumer. It is consumed in a variety of ways: fresh in salads and sandwiches, cooked, or processed in ketchup, sauces, juices or dried powder.

The tomato plays an important role in human nutrition by providing essential amino acids, vitamins and minerals (Sainju *et al.*, 2003). Its vitamin C content is particularly high (Kanyomeka and Shivute, 2005). It also contains lycopene, a very potent antioxidant that may be an important contributor to the prevention of cancers (Agarwal and Rao, 2000).



Staked 'Soraya' variety ready for harvest at the Gladstone Road Agricultural Centre during 2012.

Tomatoes are usually staked and supported off the ground, in an effort to minimise losses from rots when the fruit is in contact with the soil. The pruning of staked tomatoes is a cultural practice that greatly influences yield, according to Davis and Esters (1993). Pruning is practised by farmers to enhance quality and increase yield of tomato. Pruning involves the selective removal of side shoots to limit plant growth and to divert nutrients to the flower clusters of the main stem (Chen and Lal, 1999). Ahmad and Singh (2005) demonstrated that yield increases can be obtained in tomatoes with the use of staking, while Navarrete and Jeannequin (2000) established that fruit quality is enhanced with pruning. In an earlier study, Wurster and Nganga (1971) demonstrated that the quality and size of tomato fruit improved with pruning. They also emphasised that, when properly staked and pruned, tomato plants produced earlier fruit that were larger and higher in yield than non-pruned and non-staked plants of the same variety. Muhammad and Singh (2007b) have also reported a significant increase in quality and yield of tomatoes with pruning.

Staking and pruning have also proven to be effective in reducing the incidence of pest problems, thereby increasing yields (Saunyama and Knapp, 2003). Chen and Lal (1999) demonstrated that staking allowed for better coverage of chemical sprays and prevented fruit clusters from touching the soil, resulting in a reduction of rots and soil-borne diseases. According to Kanyomeka and Shivute (2005), pruned tomatoes are less prone to pest attack than those which were not pruned.

There have been conflicting reports, however, on the effects of pruning and staking practices on the quality and yield of tomatoes. The research of Kanyomeka and Shivute (2005) show that pruning results in low quality production and yield losses, while the only benefits obtained from this practice were increased fruit quality and plant health. Other researchers have recorded earlier yields from pruning, but with a reduction in total yields (Sikes and Coffey 1976). Olson (1989) also recorded a significant reduction in yields with heavy pruning, but fruit size increased as the degree of pruning increased. Reducing the fruit number from six to three fruits per truss increased the fruit weight by 42%, while the marketable yield was reduced by 15 to 25% (Fanasca *et al.*, 2007).

Tomatoes are one of the traditional crops of The Bahamas, where they enjoy a long history of cultivation, under various farming conditions. It is probably the most popular vegetable crop cultivated in The Bahamas. Bahamian farmers produce approximately 3,800 tonnes of tomato annually, on approximately 400 hectares of farmland (FAOSTAT, 2010), scattered throughout the various islands. Eleuthera, where tomatoes have been grown for processing, once had a thriving local canning industry. Andros has exported fresh-market tomatoes to the United States and Canada during the winter vegetable growing season of October to March. Very little documented studies exist on the cultivation of tomato under growing conditions of The Bahamas. The tomato industry of The Bahamas can benefit from the application of improved agronomic practices that can enhance production and increase yields.

Challenges faced by Bahamian farmers in their attempts to produce high yielding tomatoes in quantities to satisfy the local market include, poor agronomic practices, adverse climatic conditions, pests and diseases, and varieties unsuited to the growing conditions. This trial was initiated to determine the effects of pruning on the performance of four improved varieties of staked fresh-market tomato plants.



Field plot of staked tomatoes under cultivation at the Gladstone Road Agricultural Centre during 2012.

Objective:

The objective of this present study was to determine the effects of pruning on the quality and yield of four staked fresh-market tomato varieties.

Materials and Methods:

The variety trial was conducted at the Gladstone Road Agricultural Centre from November 2011 to February 2012. The four varieties were ‘BHN 543’, ‘Finishline’, ‘Rocky Top’ and ‘Soraya’. These

varieties are products of the Seedway seed company. The experiment was set out in a completely randomised design with three replications. Each replicated plot consisted of ten plants. Treatments consisted of two levels of pruning: pruned and unpruned. The four varieties were grown in single row ridged plots under drip irrigation, which supplied water throughout the experimental period.

Tomato seeds were planted in a field seedbed on the 10th November, 2011. After six days, close to 100% germination was achieved. Healthy tomato plantlets were selected from the seedbed and planted to field plots on the 12th December, 2011. Inter-row spacing was 1.5 m (5.0 ft), while within row spacing was 60 cm (2 ft) between plants. The usual cultural practices were observed to ensure that an even stand of plants was maintained in the field plots. Control measures were applied to protect the tomato plots against pest and disease problems. A weekly regime of Bravo[®] fungicide, alternated with the insecticides Pounce[®] and Endosulfan[®], added to Nutrileaf[®] liquid fertiliser in a 20-20-20 formulation, was applied on a regular schedule throughout the growing season.

The pruning of the tomato plants was initiated on the 9th January, 2012. At this time, plants were tied to stakes of approximately 1 m in length, placed at the side of each plant. The pruning treatment consisted of removing the lateral branches to retain a single stem and allowing it to climb along the stake support. For the unpruned tomato plants, the main and lateral stems were left in place. Flowering started on the 24th January, 43 days after transplanting to the field.

Tomatoes were harvested on the 6th February 2012, when the first mature tomatoes, or crown set, were green ripened and of a marketable size. For this study, all observations and measurements were made on the initial harvest of marketable tomatoes. A total of 15 plants, five plants for each of the three replications, were sampled for each variety-treatment combination. Fruit displaying catfacing, surface defects, uneven ripening, disease or insect damage were discarded.

The mean daily maximum and minimum temperatures for the trial period were 27.1°C (80.8°F) and 19.6°C (67.3°F), respectively. The total rainfall for the period was 93.8 mm (3.69 in). Mean monthly sunshine duration for the period was 7.8 h. Weather information (Table 1) was obtained from the Meteorological Department of The Bahamas.

Table 1. Weather data on rainfall, hours of sunshine and mean maximum and minimum temperatures for New Providence for the period of November 2011 to February 2012, courtesy of the Meteorological Department of The Bahamas.

Month	Total rainfall (mm/inches)	Mean monthly radiation (h)	Mean maximum temperature (°C/°F)	Mean minimum temperature (°C/°F)
November 2011	20.1/0.79	8.1	28.2/82.7	21.6/70.8
December 2011	22.9/0.9	7.0	26.9/80.4	19.8/67.6
January 2012	6.6/0.26	8.0	26.1/78.9	17.8/64.0
February 2012	44.2/1.74	8.1	27.2/81.0	19.2/66.6

Note: Monthly mean values have been rounded up to the nearest tenth.

Statistical Analyses:

All experimental results were analysed using Instat+TM v3.36 and ASSISTAT. Instat is an interactive statistical package, copyright © 2006, Statistical Services Centre, University of Reading,

UK. All rights reserved. ASSISTAT, Version 7.6 beta (2012), website – <http://www.assistat.com>, by Fransisco de Assis Santos e Silva, Federal University of Campina-Grande City, Campina Grande, Brazil.

Results:

Results were based on a single harvest of the tomato varieties. Significant differences were observed between the pruned and unpruned tomato plants, as revealed by the analysis of variance (Table 2). The pruning treatment had a significant effect on the number of fruit per plant, weight of fruit per plant and weight of a single tomato fruit. There was no significant difference among varieties for weight of a single tomato fruit. No significant interaction was established between variety and treatment for this same yield response.

Table 2. Analysis of variance (ANOVA) for number of fruit per plant, weight of fruit per plant and weight per tomato among four tomato varieties. Std Err is for each treatment mean. Error mean square has 119 df. *, ** and *** denote statistical significance at 5, 1 and 0.1% level of confidence, respectively. df, degrees of freedom; std err, standard error; ns indicates differences between means not significant.

Source	df	-----Significance levels-----		
		Number of fruit/plant	Weight per plant (g)	Weight of single fruit (g)
Variety	3	**	**	ns
Treatment	1	**	**	**
Variety x Treatment	3	**	**	ns
Error	112			
Std. Err		0.07	16.6	3.66

Mean values for number of fruit per plant, weight per plant and weight of a single tomato, for the pruned and unpruned treatments, are shown in Table 3. There was no significant interaction between variety and pruning treatment for the weight per tomato, so no comparison of means was done for this yield component. The interactive effect of variety and pruning treatment for the other two yield components indicate significant variation between treatments. Mean values for the pruned varieties appear to be more uniform when compared to the unpruned varieties.

Table 3. Mean values of yield responses for four tomato varieties assessed during February, 2012

Pruning Treatment	Pruned			Unpruned		
	Variety	Number of fruit/plant	Weight per plant (g)	*Weight of single fruit (g)	Number of fruit/plant	Weight per plant (g)
BHN 543	2.0cA	522.1cA	261.0	2.1bA	471.7bA	219.9
Finishline	2.4bA	621.3bA	259.2	2.5abA	580.2aA	239.0
Rocky Top	2.7bA	701.8bA	267.2	2.3bB	554.6abB	250.0
Soraya	3.7aA	945.7aA	260.4	2.8aB	638.8aB	235.5

The t-test at a level of 5% probability was applied. For each tomato variety, means within rows bearing different uppercase letters differ significantly at 5% level of confidence. For each variety, means within columns bearing different lowercase letters differ significantly at 5% level of confidence. *The t-test of comparison of means was not applied for the weights per single tomato fruit, as there was no significant interaction between variety and pruning treatment for this yield component.

For the tomato varieties ‘Rocky Top’ and ‘Soraya’, significant differences were observed between the pruned and unpruned treatments in the number of fruit per plant and weight per plant. ‘Rocky

Top' and 'Soraya' produced a significantly larger number of fruit per plant and a higher weight per plant when pruned, compared to unpruned plants. No significant differences were observed for the varieties 'BHN 543' and 'Finishline' for these same yield components. The number of fruit for these two varieties was lower than for the pruned treatments, in contrast to 'Rocky Top' and 'Soraya', in which the pruned plants produced a significantly higher number of fruit. The variety 'Soraya' produced a higher number and weight of fruit per plant than any other variety, whether pruned or unpruned.

The four tomato varieties in this study exhibited acceptable post-harvest quality characteristics (Table 4), consistent with the basic requirements for the USDA standards for grades of fresh tomatoes (USDA-AMS, 1997). The tomatoes were large in size, generally well formed and free of disease or defects, except for the catfacing disorder which was seen only on the variety 'Soraya'. The actual number of days to maturity for the four varieties was between thirteen and twenty-four days earlier than the stated number of days to maturity.

Table 4. Post-harvest quality characteristics of four tomato varieties evaluated at the Gladstone Road Agricultural Centre during 2012.

Variety	Stated number of days to maturity from transplanted seedlings	Actual number of days to maturity from transplanted seedlings	Fruit size	General appearance	Fruit shape	Flesh and skin colour	Visible signs of disease or disorder
BHN 543	72	56	Large to extra large fruit	Well formed, smooth, clean	Flattened globe	Red flesh and red skin	TYLCV
Finishline	69-80	56	Large to extra large fruit	Well formed, smooth, clean	Globe	Red flesh and red skin	TYLCV
Rocky Top	74	56	Large to extra large fruit	Well formed, smooth, clean	Globe	Red flesh and red skin	TYLCV
Soraya	69-80	56	Large to extra large fruit	Well formed, smooth, clean	Globe	Red flesh and red skin	Catfacing, TYLCV

Plates 1 and 2 give some indications of the problems encountered in the field with the cultivation of the tomato crop. The experimental plots were relatively free of problems, with the exception of the catfacing disorder, prevalent only in the tomato variety 'Soraya', and the tomato yellow leaf curl virus (TYLCV), which affected all four varieties.



Plate 1. Two views of catfacing on the tomato variety 'Soraya'.

Catfacing is a distortion that appears as a scarring and malformation at the blossom end of the tomato fruit (Stevenson and Heimann, 1981). It is found most commonly in the first formed fruit and is more prevalent in large to extra large fresh-market tomatoes. Pruning has been shown to influence the incidence of this abiotic tomato disorder (Sikes and Coffey 1976). Sikes and Coffey

(1976) further suggested that pruning one or two basal tomato stems resulted in a higher percentage of catfaced fruit than in non-pruned systems. Barten *et al.* (1992) found that low temperatures induced catfacing of tomato fruit during flower development. It should be noted that the lowest temperatures recorded during this experimental period (Table 1) occurred during the time of flower initiation.

Tomato plants infected by the tomato yellow leaf curl virus (Plate 2) exhibit symptoms such as a reduction in leaf size, the curling upward of leaves, severe stunting and the interveinal chlorosis of leaves (Martinez-Culebras *et al.*, 2001; Salati *et al.*, 2002). None of the four tomato varieties showed resistance to the tomato yellow leaf curl virus. The tomato yellow leaf curl virus is not transmitted from plant to plant by handling, but is spread from infected solanaceous weed species to cultivated tomato plants by whiteflies (Ajlan, *et al.*, 2006; Al-Ani, *et al.*, 2011). Increased whitefly populations are associated with the tomato yellow leaf curl virus. This insect vector is controlled by limiting its numbers. Agronomic practices, such as weeding, the removal of vegetative matter and periodic spraying with insecticides are measures used to prevent the spread of the virus.

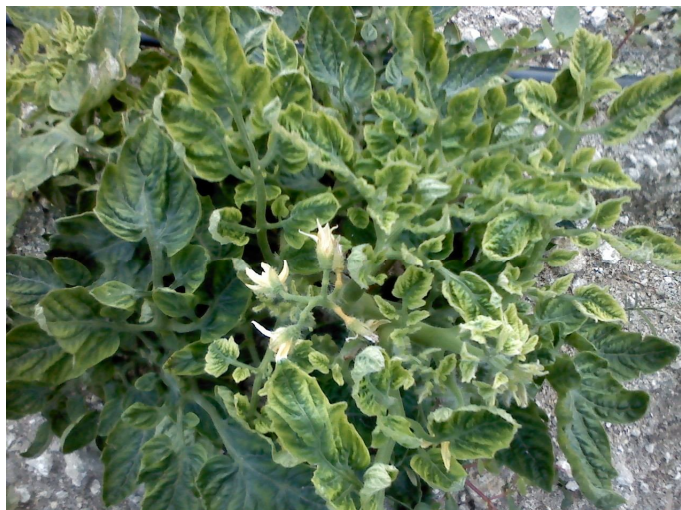


Plate 2. Tomato yellow leaf curl (TYLCV), observed in experimental plots at the Gladstone Road Agricultural Centre during 2012.

Discussion:

The four tomato varieties all matured at an earlier date than expected for these varieties, with the pruned tomatoes being significantly larger in weight per plant than the unpruned tomatoes. Burgis and Crill (1972) made this same observation, in which pruning resulted in the production of larger sized grades of fruit, which increased the value of the crop.

For the varieties ‘BHN 543’ and ‘Finishline’ pruning reduced the number of marketable fruit per plant but increased the weight of marketable fruit per plant. This corroborates the research of Muhammad and Singh (2007a; 2007b) who reported a reduction in the number of tomato fruit accompanied by an increase in weight per plant. This increased weight per plant in pruned plants, however, could be the result of a larger portion of the products of photosynthesis being partitioned to the fruits, compared to unpruned plants, where most of the photosynthates would be used by the

leaves and shoots for respiration (Brown, 1984). The lower number of fruit per plant is to be expected, as the removal of the lateral branches greatly reduces the number of blossoms per plant.

The varieties ‘Rocky Top’ and ‘Soraya’, on the other hand, experienced an increase, though not significant, in the number of fruit per plant with pruning. Similar results were reported by Franco *et al.*, (2009) who demonstrated that pruning of tomatoes resulted in significant increases of the number and total weight of commercial fruit.

Results, on a tonnes per hectare basis, were extrapolated from the mean weights expressed as g per plant and are displayed graphically (Figure 1). The potential yields for tomato ranged from 5.8 to 10.5 tonnes per hectare for the pruned tomatoes and 5.2 to 7.1 tonnes per hectare for the unpruned tomato plants. The potential yields for each of the four varieties were significantly higher for the pruned tomato varieties than the unpruned varieties. Yield estimates for pruned ‘Soraya’ tomatoes compared favourably to FAO yield estimates for The Bahamas for 2010.

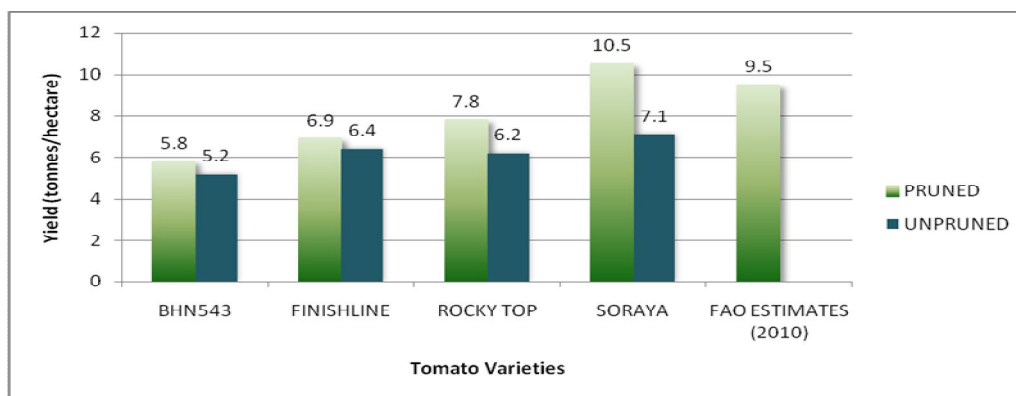


Fig. 1. Potential yields of four tomato varieties evaluated at the Gladstone Road Agricultural Centre during 2012. FAO yield estimates for The Bahamas in 2010 are found in the column at far right.

General Comments:

This experiment demonstrates that pruning can significantly improve the quality and yield of fresh-market tomatoes. Pruned plants gave higher yields than unpruned plants. Pruning of staked fresh-market tomatoes of the varieties promoted earlier ripening of fruit and resulted in an increase in fruit size.

Acknowledgements:

Much appreciation is extended to Jetta Rolle, Geareace Gordon and Valdarene Daxon of the Crops Section at the Gladstone Road Agricultural Centre for their assistance and cooperation in the planting, managing and harvesting of field plots, and the collection of data for this trial.

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