Early Pruning Effects on 'Florida-47' and 'Sungard' Tomato

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SUMMARY. The effects of early pruning on the growth and yield of 'Florida-47' and 'Sungard' tomato (*Solanum lycopersicum*) were assessed in west-central Florida. Each cultivar was established in separate experiments. The four pruning treatments consisted of leaving one, two, and three main stems in the tomato plants below the first flower cluster, and a nonpruned control. Pruning shoots had significant effects on the plant height of 'Sungard' and 'Florida-47' at 4 and 3 weeks after transplanting, respectively. Tomato plants with a single stem were 13% and 10% taller than the ones in the nonpruned control, respectively. However, this effect disappeared 1 and 2 weeks later in both cultivars. Regardless of the cultivar, early pruning did not influence foliar disease incidence or early and total tomato marketable yield. This cultural practice did not affect the partitioning to different fruit categories in either cultivars. This data showed that early pruning can temporarily change the plant architecture of 'Sungard' and 'Florida-47' tomato, explaining the perceived increased plant vigor in comparison with the nonpruned control. However, the effect disappeared during the growing season and did not reflect on marketable yields of either tomato cultivars. If no pruning were performed in these cultivars, growers would be able to save an estimated \$40/acre of tomato.

Pruning is a field operation aimed to remove unwanted lateral and basal branches or "suckers" in staked fresh-market tomato. This cultural practice occurs between 2 and 4 weeks after transplanting (WAT), and it could be accomplished once or twice during that period by removing shoots from the ground level up to the primary fork below the first flower cluster (Olson et al., 2006). The effect of pruning on growth and development could vary widely because tomato cultivars may have different plant architecture and growth habits. Short compact tomato cultivars might not require pruning (Kemble et al., 1994) or only minimal pruning (Olson et al., 2006), whereas the opposite might be necessary for vigorous and tall cultivars. 'Sungard' tomato is a heat-resistant cultivar with intermediate growth and 'Florida-47' is a compact determinate plant. Both cultivars are actively planted in the United States.

The literature differs greatly about the effect of pruning on partitioning of vegetative biomass. Tanaka

and Fujita (1974) and Starck (1983), studying source-sink distribution in tomato, observed that photosynthate flow from sources exceeds sink demands and that the partial removal of tomato leaves is compensated with an increase in the net assimilation rate of the remaining leaves; thus, fruit growth is unaffected. However, McGraw et al. (2007) indicated that pruning small basal branches helps to maintain the balance between vegetative and reproductive biomass. Several reports confirm there are considerable differences on the effect of leaf and shoot removal on tomato yield. Logendra et al. (2001), explaining the diverse pruning responses within the same tomato cultivar, indicated that leaving two leaves above fruiting clusters increased fruit yield compared with having no leaves above

clusters. This response could be explained because leaves above floral clusters typically supply photosynthesis products to apical meristems, young leaves, and flower clusters, whereas lower leaves this provide to lower shoots and roots (Khan and Sagar, 1969). Similarly, pruning shoots below floral clusters could have a profound effect on the crop. It has been suggested that side shoots reduced the number of marketable fruit carried on each cluster and increased leaf area index and total fruit yield of determinate cultivars (Burgis and Levins, 1974; Cockshull et al., 2001). Sikes and Coffey (1976) indicated that nonpruned plots produced the largest number of harvestable fruit. However, fruit size was significantly less in the nonpruned than in the pruned system.

Carlton et al. (1994) and Sikes and Coffey (1976) determined that pruning increased early yield, but reduced total yield. Other production practices, such as in-row distances, could interact with pruning on its effects on tomato yields. For instance, net economic returns increased when tomato plants were spaced less than 18 inches apart and were pruned early, or when plants were spaced 18 to 30 inches apart and were not pruned (Davis and Estes, 1993). Frequency of pruning also affects vegetative growth and yield. Navarrete and Jeannequin (2000) found that when pruning was performed every 21 d, tomato stem diameter, vigor, fruit number, and yield decreased.

Two drawbacks of pruning are the current high costs of hand labor and the potential for causing fruit injury and transmitting diseases with cutting implements. It has been estimated that the production costs associated with transplanting, pruning, staking, and tying plants to stakes could account for up to 55% of total tomato production costs (Davis and

Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.4047	acre(s)	ha	2.4711
3.7854	gal	L	0.2642
9.3540	gal/acre	L·ha ⁻¹	0.1069
2.54	inch(es)	cm	0.3937
25.4	inch(es)	mm	0.0394
1.1209	lb/acre	kg·ha ⁻¹	0.8922
0.0254	mil	mm	39.3701
2.2417	ton/acre	t·ha ⁻¹	0.4461

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Estes, 1993). Surveys conducted among Florida growers reflected that the cost of pruning is about \$40/acre. Therefore, determining whether pruning is necessary for current determinate tomato cultivars could save considerable resources for growers.

From the plant protection standpoint, Carlton et al. (1994) indicated that pruning opens up the plant canopy, which could reduce the incidence of foliar diseases as improved air flow dries moisture on leaf surfaces. Pruning also augmented the severity of the mechanically transmitted bacterial canker (*Clavibacter michiganensis*) in tomato plots (Carlton et al., 1994; Damicone and Brandenberger, 2007). Ehret et al. (1993) showed that there was an inverse relationship between pruning and fruits affected with the abiotic cuticle cracking disorder, which could be attributed to reduced foliage protection from sunlight. Pruning could also influence the incidence of the abiotic tomato disorder "catfacing." Sikes and Coffey (1976) indicated that pruning one or two basal tomato stems resulted in a higher percentage of "catfaced" fruit than in nonpruned systems. The majority of open-field tomato growers in Florida use this practice, but the scientific basis for its use needs to be justified for modern cultivars. Therefore, the objective of this study was to determine the effect of early pruning on growth and yield of selected tomato cultivars.

Materials and methods

Field studies were conducted between 2005 and 2006 at the Gulf Coast Research and Education Center of the University of Florida in Balm, FL. The soil was a sandy, siliceous, hyperthermic Oxyaquic Alorthod with 1.5% organic matter and a pH of 7.3. 'Florida-47' and 'Sungard' tomato were established in two separate trials for each cultivar. The studies with 'Florida-47' were conducted from 27 March to 15 June 2006 and between 17 Aug. and 9 Nov. 2006. For 'Sungard', the trials were carried out between 12 Sept. and 11 Dec. 2005 and between 16 March and 5 June 2006.

Planting beds were preformed with a standard bedder and were 32 inches wide on the base, 28 inches wide on top, and 8 inches high. Beds were fumigated with methyl bromide

plus chloropicrin (67:33, by volume) through three chisels spaced 12 inches apart, which delivered fumigant 6 inches deep. Beds were fertilized with 50 lb/acre of a 15N-0P-24.9K granular formula, and planting beds were covered with 0.6-mm-thick silver on black mulch. Drip irrigation tubing (0.45 gal/min per 100 ft of bed; T-Tape Systems International, San Diego, CA) was buried 1 inch deep on the bed center. Transplants in the four-true leaf stage were planted on polyethylene mulched beds, and were established 2 ft apart on single rows on bed centers. Irrigation was supplied through drip and subsurface irrigation at rates of 5000 to 8000 gal/acre per day, respectively. The water table was maintained between 18 and 24 inches deep and was constantly monitored with observation wells located in the fields. Additional N and K were drip-injected daily at rates of 1.5 (from transplanting to 2 WAT), 2.0 (from 3–5 WAT), and 2.5 (from 6–13 WAT) lb/acre per day of each nutrient. The crop was staked at 3 WAT and was tied three times at 3, 5, and 7 WAT. Weekly applications of currently labeled products were performed following current recommendations for insect and disease management (Olson et al., 2006).

Studies with each cultivar were established on a randomized complete block design with four replications. Plots were 30 ft long (15 plants/plot) during all seasons. Four pruning treatments consisted of leaving one, two, and three main stems in the tomato plants below the first flower cluster, and a nonpruned control. Hand shears were used for shoot

removal at 2 WAT. Tomato plant height was measured from the plant base to the newest apical growing point of the tallest stem at 3 and 4 WAT for 'Sungard' and at 4 and 6 WAT for 'Florida-47'. Marketable yields were collected at 10 and 12 WAT, and fruit were classified as extra large, large, and medium, following current market standards (Sargent et al., 2005). The two harvests per season and the planting dates corresponded to normal tomato-producing practices in Florida. The incidence and severity of foliar diseases were monitored biweekly beginning at 2 WAT and ending at 8 WAT. The number of plants with visible foliar injury was counted for disease incidence, whereas for disease severity, a qualitative scale from 1 to 5 was used where 1 = no visible disease injury and 5 = plant death. Disease data were transformed with arc sine square root to normalize the treatment means before analysis of variance ($P = 0.05$). The resulting crop and disease data were analyzed with general linear model procedure to determine treatments effects ($P = 0.05$), and treatment means were separated with the Waller-Duncan test.

Results and discussion

There were no significant treatment $\times$ season interactions for the examined variables of both cultivars. Therefore, data from two seasons for each cultivar were combined for analysis. There were no significant foliar disease effects of the treatments on 'Sungard' and 'Florida-47' tomato (data not shown). Therefore, there was no evidence that early pruning affected the incidence and severity of

Table 1. Response of 'Florida-47' and 'Sungard' tomato plant height to early pruning at Balm, FL, in 2005–06.

Treatment ^a	Florida-47		Sungard	
	Plant ht (inches) ^y			
	4 WAT ^x	6 WAT	3 WAT	4 WAT
One stem	38.0 a	50.4	17.8 a	24.3
Two stems	33.8 b	46.4	14.0 b	27.1
Three stems	32.4 b	50.6	13.4 b	26.3
Nonpruned control	34.4 b	54.0	15.8 b	28.2
Significance (<i>P</i> < 0.05)	*	NS	*	NS

^aPruning treatments were based on the number of stems allowed to continue growing after 2 weeks after transplanting.

^yData combined for two seasons for each cultivar. Treatment means were separated with Waller-Duncan multiple comparison procedure ($P = 0.05$); 1 inch = 2.54 cm.

^xWAT = weeks after transplanting.

^{NS} Nonsignificant or significant at $P < 0.05$, respectively.

Table 2. Response of ‘Florida-47’ and ‘Sungard’ tomato marketable yield and per category to early pruning at Balm, FL, in 2005–06.

Treatment ^z	Florida-47				Sungard			
	Medium ^w	Large	Extra-large	Total	Medium	Large	Extra large	Total
One stem	7.3	4.2	2.7	14.2	4.9	2.0	2.4	9.3
Two stems	6.9	4.0	2.6	13.5	5.7	2.4	2.9	11.0
Three stems	6.8	3.8	2.1	12.7	5.8	2.6	3.2	11.6
Nonpruned control	6.7	3.8	2.2	12.7	5.6	2.8	3.8	12.2
Significance ($P < 0.05$)	NS	NS	NS	NS	NS	NS	NS	NS

^zPruning treatments were based on the number of stems allowed to continue growing after 2 weeks after transplanting.

^w1 ton/acre = 2.2417 t-ha⁻¹.

^zData combined for two seasons for each cultivar.

^wMedium, large, and extra-large fruit were 64, 73, and 88 mm of maximum horizontal diameter, respectively; 1 mm = 0.0394 inch.

^{NS}Nonsignificant or significant at $P < 0.05$, respectively.

foliar diseases such as bacterial leaf spot (*Xanthomonas campestris* pv. *vesicatoria*) or late blight (*Phytophthora infestans*).

Early pruning had significant effects on plant height of ‘Sungard’ and ‘Florida-47’ at 3 and 4 WAT, respectively (Table 1). ‘Florida-47’ tomato plants with a single main stem were the tallest among all treatments 4 WAT, with vines 10% longer than those in the nonpruned control. A similar situation was observed with ‘Sungard’ at 3 WAT. This initial response might be due to the increased allocation of most photosynthates for only a single stem as opposed to distributing them across multiple main stems. However, this growth effect was temporary and it disappeared at 4 and 6 WAT in plots planted with ‘Sungard’ and ‘Florida-47’, respectively. Average ‘Sungard’ plant height at 4 WAT was 26.5 inches, whereas the average height of ‘Florida-47’ plants was 50.3 inches at 6 WAT.

Regardless of the cultivar, early pruning did not influence yield at 10 WAT (data not shown) and total tomato marketable yield. The average marketable yield of ‘Florida-47’ ranged between 12.7 and 14.2 tons/acre, whereas the marketable yield of ‘Sungard’ was between 9.3 and 12.2 tons/acre (Table 2). At the same time, this cultural practice did not affect partitioning among different fruit categories in ‘Sungard’ or ‘Florida-47’ tomato (Table 2). This data showed that early pruning can temporarily change the plant architecture of ‘Sungard’ and ‘Florida-47’ tomato, explaining the perceived increased plant vigor in comparison

with the nonpruned control. However, the effect disappeared during the growing season and did not reflect on marketable yields of either tomato cultivars.

These results differ from those presented by Carlton et al. (1994) and Sikes and Coffey (1976) in which pruning improved early yield, but reduced total yield, as well as the data presented by Burgis and Levins (1974), where additional side shoots increased total fruit yield. It is plausible to believe that the effect of pruning on the crop is highly dependent on timing, frequency, and particular tomato cultivars because of the variety of responses obtained with this practice. If no pruning is used, tomato growers could save in labor costs about \$40/acre planted with ‘Florida-47’ and ‘Sungard’. Nevertheless, the effect of late pruning and in situations of high-foliar disease pressure still needs to be assessed to offer tomato growers a complete recommendation on whether to totally exclude pruning as a cultural practice.

Literature cited

Burgis, D.S. and R.A. Levins. 1974. Pruning determinate tomato plants will increase dollar return. Proc. Florida State Hort. Soc. 87:122–124.

Carlton, W.M., M.L. Gleason, and E.J. Braun. 1994. Effects of pruning on tomato plants supporting epiphytic populations of *Clavibacter michiganensis* subsp. *michiganensis*. Plant Dis. 78:742–745.

Cockshull, K.E., L.C. Ho, and J.S. Fenlon. 2001. The effect of the time of taking side shoots on the regulation of fruit size

in glasshouse-grown tomato crops. J. Hort. Sci. Biotechnol. 76:474–483.

Damicone, J.P. and L. Brandenberger. 2007. Common diseases of tomatoes, Part II: Diseases caused by bacteria, viruses, and nematodes. Oklahoma State Univ., Oklahoma Coop. Ext. Serv. Fact Sheet EPP-7626.

Davis, J.M. and E.A. Estes. 1993. Spacing and pruning affect growth, yield, and economic returns of staked fresh-market tomatoes. J. Amer. Soc. Hort. Sci. 118:719–723.

Ehret, D.L., T. Helmet, and J.W. Hall. 1993. Cuticle cracking in tomato fruit. J. Hort. Sci. 68:195–201.

Kemble, J.M., J.M. Davis, R.G. Gardner, and D.C. Sanders. 1994. Spacing, root cell volume, and age affect production and economics of compact-growth-habit tomato. HortScience 29:1460–1464.

Khan, A.A. and G.R. Sagar. 1969. Alteration of the pattern of distribution of photosynthetic products in the tomato by manipulation of the plant. Ann. Bot. (Lond.) 33:753–762.

Logendra, L.S., T.J. Gianfagna, D.R. Specca, and H.W. Janes. 2001. Greenhouse tomato limited cluster production systems: Crop management practices affect yield. HortScience 36:893–896.

McGraw, D., J. Motes, and R.J. Schatzer. 2007. Commercial production of fresh market tomatoes. Oklahoma State Univ., Oklahoma Coop. Ext. Serv. Fact Sheet F-6019.

Navarrete, M. and B. Jeannequin. 2000. Effect of frequency of axillary bud pruning on vegetative growth and fruit yield in greenhouse tomato crops. Scientia Hort. 86:197–210.

Olson, S.M., W.M. Stall, M.T. Momol, S.E. Webb, T.G. Taylor, S.A. Smith, E.H. Simonne, and E. McAvoy. 2006. Tomato

production in Florida, p. 407–426. In: S.M. Olson and E.H. Simonne (eds.). Vegetable production handbook for Florida, 2006–2007. University of Florida, Institute of Food and Agricultural Science and Vance Publishing, Lincolnshire, IL.

Sargent, S.A., J.K. Brecht, and T. Olczyk. 2005. Handling Florida vegetable series: Round and Roma tomato types. Univ. of

Florida, Inst. Food Agr. Sci. Fact Sheet SS-VEC-928.

Sikes, J. and D.L. Coffey. 1976. Catfacing of tomato fruits as influenced by pruning. HortScience 11:26–27.

Starck, Z. 1983. Photosynthesis and endogenous regulation of the source-sink

relation in tomato plants. Photosynthetica 17:1–11.

Tanaka, A. and K. Fujita. 1974. Nutritional physiological studies on the tomato plant. IV. Source-sink relationship and structure of the source-sink unit. Soil Sci. Plant Nutr. 20:305–315.