HS1180

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Cultural Practices for Vegetable and Small Fruit Crops: Does Shoot Pruning Improve Tomato Yield and Reduce Bacterial Spot Infestation?[1]

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Introduction

Among the many diseases that affect tomato, bacterial spot is one of the most troublesome. This disease is caused by *Xanthomonas perforans*, *X. vesicatoria*, *X. euvesicatoria*, and *X. gardneri* (formerly referred to as *X. campestris* pv. *vesicatoria*) and favored by warm, humid weather conditions, but often initiated by episodes of wind-driven rain.

On the leaves, infection begins when the bacterium enters the plant through natural openings and wounds, where it multiplies within plant tissues (Figure 1). Within three to four days, the first symptoms—water-soaked lesions—are visible on lower leaf surfaces. Lesions can enlarge and coalesce, causing extensive leaf chlorosis and defoliation. All aboveground tissues are susceptible to the disease.

Fruit lesions begin as small, raised blisters on the fruit surface that are a lighter green than the rest of the immature fruit. As the lesions enlarge, they turn brown to black and develop a layer of scablike tissue. Fruit lesions are particularly problematic for growers, since they not only affect fruit appearance but also offer a site for other microbes to enter the fruit.

Figure 1. Bacterial spot lesions on the lower surface of tomato leaves and a view of a severely infected tomato field (Credit: G. E. Vallad)

Control of bacterial spot relies on cultural exclusion of the pathogen from production areas, use of resistant cultivars, and diligent application of copper-based bactericides. Regardless, bacterial spot epidemics occur every season in most tomato production regions. The presence of infected tomato volunteers and weedy hosts are common sources of local inoculum. Infected seed and transplants are also a mechanism of long-distance movement. Copper-based bactericides can offer some level of

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control, except under the most extreme weather conditions. However, the reliance on copper in agriculture has led to widespread copper tolerance among bacterial pathogens in many crops. A dithiocarbamate fungicide (either maneb or mancozeb) is routinely combined with copper-based bactericides to enhance bacterial spot control, but fungicidal activity of the dithiocarbamate is reduced. The overuse of copper-based pesticides in vegetable production can adversely affect crop growth and the environment.

Most growers of round tomatoes in Florida perform shoot pruning on their crops during the early part of the growing season to reduce the number of unwanted lateral branches. This practice involves removing shoots from ground level up to the primary fork below the first flower cluster, usually between 2 and 4 weeks after transplanting (WAT), and it could be accomplished once or twice during that period. Previous research showed that for some tomato cultivars, shoot pruning increased early yield, whereas other studies found either no response or reduced growth and yields. Some growers and scientists think that shoot pruning could potentially reduce bacterial spot infection because a) it reduces the amount of foliage near the soil that could serve as an initial point of entry for the bacterium, and b) it changes the architecture of plant canopies, thus changing air and moisture flow through the leaves.

Shoot pruning costs about $50/acre, which is a significant expense for tomato production. The objective of this study was to determine the effect of early shoot pruning on the severity of bacterial spot and on the growth and yield of different tomato cultivars.

Materials and Methods

Two field trials were conducted in the spring and fall of 2009 at the University of Florida's Gulf Coast Research and Education Center in Balm, Florida, using standard tomato production practices (e.g., soil fumigation, mulching, drip irrigation). Tomato seedlings in the four-true-leaf stage (8 inches tall) were transplanted in single rows 2 inches offset of bed centers and 18 inches apart. The study combined two tomato cultivars, two bacterial spot inoculation regimes, and three shoot pruning programs in a split-split plot design with five replications. The tomato cultivars were 'Tygress' and 'Security-28', which are resistant to the tomato yellow leaf curl virus. Shoot pruning levels were heavy and light, plus a nonpruned control group. Light pruning was defined as carefully removing by hand only two to three lateral buds ("suckers") from the main stems from ground level to 6 inches high, whereas heavy pruning was defined as the removal of all the lateral buds and stems up to 6 inches high. Early shoot pruning occurred between 3 and 4 WAT. Bacterial spot treatments consisted of noninoculated plots and plots inoculated with a suspension of *X. perforans* strain XT4 (1 x 10^6 cfu/mL), which was applied to the foliage with a conventional backpack sprayer at 5 WAT at a volume of approximately 15 mL per plant.

Plant heights were determined at 3 and 6 WAT, and tomato fruits were harvested twice (at 10 and 12 WAT) in the mature green stage and graded following current market standards as extra-large and marketable fruit of all categories. Fruit yields from the first harvest (at 10 WAT) were considered early fruit weight, while the summation of the two harvests (at 10 and 12 WAT) was the seasonal fruit weight.

Plots were monitored for bacterial spot and rated for severity at 7 and 9 WAT in the spring trial and at 9 and 11 WAT in the fall trial using the Horsfall-Barratt scale, a nondimensional 12-point scale, to assess the percentage of canopy affected by bacterial leaf spot. Disease severity values were converted to midpercentages and used to generate the area under the disease progress curve (AUDPC). Means of significant treatment effects and their interactions were separated with a Fisher's protected least significant difference (LSD) procedure at the 5% level.

Results and Discussion

Plant height and bacterial spot severity. Shoot pruning did not affect tomato plant height at 3 and 6 WAT, regardless of cultivars and bacterial spot inoculation (data not shown). Bacterial spot inoculation increased disease severity based on an AUDPC of 1445 (an average disease severity of 41%) in inoculated plots versus an AUDPC of 821 (an average disease severity of 29%) in noninoculated plots averaged across both seasons (data not shown). Disease severity was greater at the end of the spring trial than at the end of the fall 2009 trial (65% and 35%, respectively). Inversely, initial disease severity was much greater in the fall study (24% disease severity in noninoculated plots) than the spring trial (1.5% disease severity in noninoculated plots). 'Tygress' was more susceptible to bacterial spot than 'Security-28', exhibiting 20.4% more disease on average.

Early tomato fruit weight. Early extra-large fruit weight was affected by tomato cultivars and the inoculation of bacterial spot, but not by pruning programs or the interaction among factors. 'Security-28' had the highest early extra-large fruit weight with 5.1 ton/acre, which was more than 2.5 times higher than that obtained with 'Tygress' (Table 1). Tomato plants inoculated with bacterial spot reduced their extra-large fruit weight by 31% in comparison with those plants that were not inoculated with the bacterium. Pruning programs resulted in extra-large yields ranging between 3.4 and 3.6 ton/acre. Early marketable fruit weight was influenced by the interaction between cultivars and pruning programs, and separately by the inoculation of bacterial spot (Table 1). There were no differences in early marketable fruit weight among the combinations of 'Security-28' and the three pruning programs, which averaged 6.9 ton/acre of fruit. At the same time, all pruning programs in plots planted with 'Tygress' did not differ among each other, though they had significantly lower marketable fruit weight at 10 WAT than the 'Security-28' and its pruning combinations. Tomato plants in plots inoculated with bacterial spot decreased their marketable fruit weight at 10 WAT by 25% in comparison with the noninoculated plants.

Seasonal tomato fruit weight. The cultivar by bacterial spot inoculation interaction affected the seasonal extra-large fruit weight. However, other main factors and interactions were not significant. The highest seasonal extra-large fruit weight was obtained in noninoculated plots of 'Security-28' (11.1 ton/acre), followed by inoculated 'Security-28' plots (Table 2). Bacterial spot inoculation did not affect the seasonal extra-large fruit weight obtained in plots planted with 'Tygress'. All three factors individually influenced the seasonal marketable fruit weight of tomato. Noninoculated plots produced 21% higher seasonal yields (18.1 ton/acre) than plants inoculated with bacterial spot (15.0 ton/acre). When comparing pruning programs, there was no difference between lightly pruned plants and the nonpruned control for seasonal marketable fruit weight, regardless of tomato cultivars (Table 2). However, heavy pruning did reduce seasonal yields by 10% in comparison with the nonpruned control.

These results indicate that light shoot pruning does not improve tomato yield of total and extra-large marketable fruit. At the same time, this practice did not reduce bacterial spot severity on 'Security-28' and 'Tygress' tomato leaves. In contrast, heavy pruning reduced seasonal marketable yields in comparison with nonpruned plants. It is possible that other cultivars may benefit from shoot pruning, as the tested cultivars are newer hybrids introduced to the market for their resistance to tomato yellow leaf curl virus. Data also emphasized the impact of bacterial spot on fruit production, especially the production of early extra-large fruit, and the importance of selecting varieties with improved tolerance to bacterial spot when disease pressure is high.

By eliminating light shoot pruning from routine cultural practices, tomato growers can save up to $50/acre, which might translate into nearly $2 million per year in savings for all the planted areas in Florida.

Table 1. Effects of early shoot pruning levels, tomato cultivars, and bacterial spot inoculation on early extra-large and total marketable fruit weight

	Early extra-large fruit weight[z]		Early marketable fruit weight
Pruning		**Pruning x cultivar**	
	Ton/acre		Ton/acre
Nonpruned	3.5	**Nonpruned, 'Security-28'**	7.4 a
Light	3.6	**Light, 'Security-28'**	7.1 a
Heavy	3.4	**Heavy, 'Security-28'**	6.3 a
Significance (*P* < 0.05)	NS	**Heavy, 'Tygress'**	4.4 b
Cultivar		**Light, 'Tygress'**	3.7 b
'Security-28'	5.1 a	**Nonpruned, 'Tygress'**	3.4 b
'Tygress'	1.9 b		
Significance (*P* < 0.05)	*	Significance (*P* < 0.05)	*
Bacterial spot		**Bacterial spot**	
Noninoculated	4.2 a	**Noninoculated**	6.4 a
Inoculated	2.9 b	**Inoculated**	4.8 b
Significance (*P* < 0.05)	*	Significance (*P* < 0.05)	*

[z]Values followed by the same letter in the same column do not differ statistically at the 5% significance level, according to Fisher's protected LSD. NS = *nonsignificant* and * = *significant*.

Table 2. Effects of early shoot pruning levels, tomato cultivars, and bacterial spot inoculation on seasonal extra-large and total marketable fruit weight

	Seasonal extra-large fruit weight[z]		Seasonal marketable fruit weight
Cultivar x bacterial spot		**Pruning**	
	Ton/acre		Ton/acre
Noninoculated, 'Security-28'	11.1 a	**Nonpruned**	18.2 a
Inoculated, 'Security-28'	8.1 b	**Light**	17.4 ab
Noninoculated, 'Tygress'	7.0 c	**Heavy**	16.3 b
Inoculated, 'Tygress'	7.5 c	Significance (*P* < 0.05)	*
Significance (*P* < 0.05)	*	**Cultivar**	
		'Security-28'	18.3 a
		'Tygress'	15.0 b
Pruning		Significance (*P* < 0.05)	*
Nonpruned	8.4	**Bacterial spot**	
Light	8.3	**Noninoculated**	18.1 a
Heavy	8.4	**Inoculated**	15.2 b
Significance (*P* < 0.05)	NS	Significance (*P* < 0.05)	*

[z]Values followed by the same letter in the same column do not differ statistically at the 5% significance level, according to Fisher's protected LSD. NS = *nonsignificant* and * = *significant*.