Levels of Tomato Anthracnose Resistance Measured by Reduction of Fungicide Use

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ABSTRACT

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Chlorothalonil was applied one, two, three, four and eight times during the growing season to five anthracnose-resistant tomato breeding lines and two susceptible check cultivars. Yields of resistant lines, and of cultivars were comparable and were increased by fungicide application. Based on reduction of fruit rot, the levels of resistance in the lines were equal to the control provided by three to seven fungicide applications.

Anthracnose, caused by *Colletotrichum coccodes* (Wallr.) Hughes, is the most serious ripe fruit rot disease of processing tomatoes in the eastern and midwestern United States. The current technology for controlling anthracnose requires routine application of a fungicide, although some modifications of timing and amounts have been studied (6,10,11).

Resistance to anthracnose has been reported in several PI lines with small fruit, and this resistance is heritable (1–3,5,9). In our breeding program for multiple disease-resistant processing tomatoes, we have used several PI lines, chiefly PI 272636, as sources of anthracnose resistance (4). In 1979, we compared five anthracnose-resistant advanced breeding lines with two standard cultivars for yielding ability and assessed the levels of anthracnose resistance in terms of their ability to permit a reduction in the number of fungicide applications.

MATERIALS AND METHODS

We chose five breeding lines on the basis of a puncture-inoculation test (8) made the previous year. The lines and the cultivar checks were determinate and resistant to Fusarium wilt, race 1 (*Fusarium oxysporum* Schlecht. f. sp. *lycopersici* (Sacc.) Snyder & Hansen), to Verticillium wilt (*Verticillium albo-atrum* Reinke & Berthold), or to gray leaf spot (*Stemphylium solani* Weber) as indicated in Table 1.

Seed was planted on 19 April in a peat-vermiculite mix in the greenhouse, and plants in the four or five leaf stage were transplanted to the field on 24 May. The field had been planted with tomatoes each year for the previous 4 yr, during which no fungicides were applied, in an effort to obtain high disease pressure. Eighteen-plant plots of each line were

This article reports results only. Mention of a pesticide does not constitute a recommendation for use by the USDA nor does it imply registration under FIFRA as amended.

Table 1. Disease resistance of tomato plants

Line or cultivar	Disease reaction[a] Fusarium wilt	Verticillium wilt	Gray leaf spot
79B702	R	R	R
79B703	R	S	S
79B704	R	R	R
79B705	R	R	R
79B707	R	R	S
Red Rock	R	R	R
US28	R	R	S

[a] R = resistant, S = susceptible.

Table 2. Affect of resistance to anthracnose on yield and fruit rot of tomatoes sprayed with chlorothalonil on a weekly schedule[z]

Tomato line	Marketable yield of ripe fruit per 10 plants (kg) No. of spray applications		Ripe fruit with rots (%) No. of spray applications		Weight per healthy ripe fruit (g) (avg. of all spray treatments)
	8	0	8	0	
79B702	30.6 a	11.7 ghi	14.1 cdefgh	32.0 cdef	72.8 d
79B703	26.0 abcd	17.0 cdefgh	4.7 gh	9.0 efgh	50.4 e
79B704	22.1 abcdefg	13.8 fghi	6.1 fgh	19.0 cdefgh	78.4 cd
79B705	22.7 abcdef	17.5 cdefgh	17.9 cdefgh	36.6 bcd	95.2 a
79B707	19.8 bcdefgh	15.5 defghi	6.0 fgh	16.8 cdefgh	56.0 e
Red Rock	25.7 abcde	15.8 cdefghi	4.0 h	31.1 cdef	86.8 b
US28	26.6 abc	5.8 i	4.7 gh	58.0 ab	81.2 bc

[z] Values in columns for marketable yield, fruit rot, and fruit weight followed by the same letter do not differ significantly at the 0.05 level according to Duncan's multiple range test.

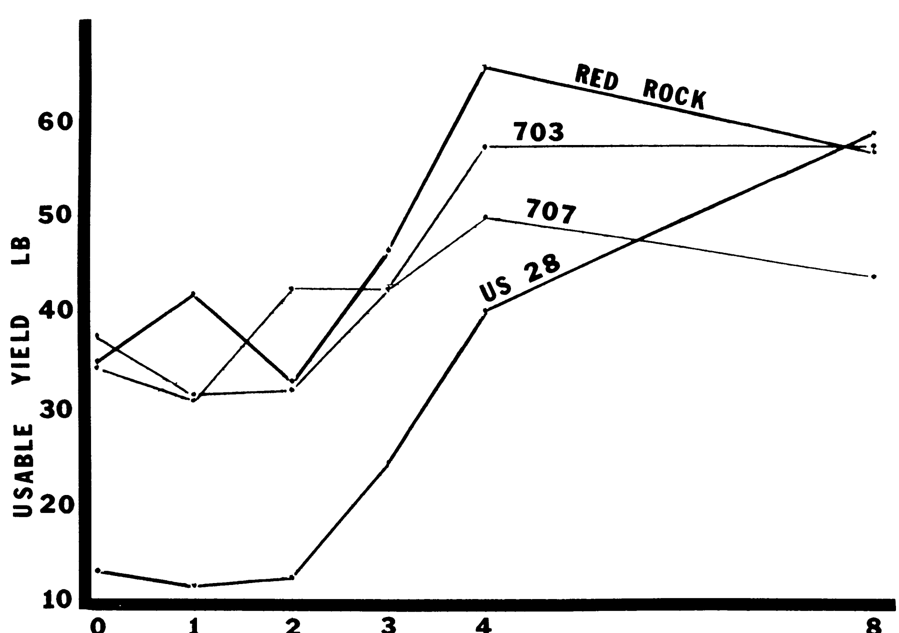

Fig. 1. Usable yield of 10-plant tomato plots sprayed with chlorothalonil. US28 and Red Rock are cultivars; 79B703 and 79B707 are anthracnose-resistant breeding lines.

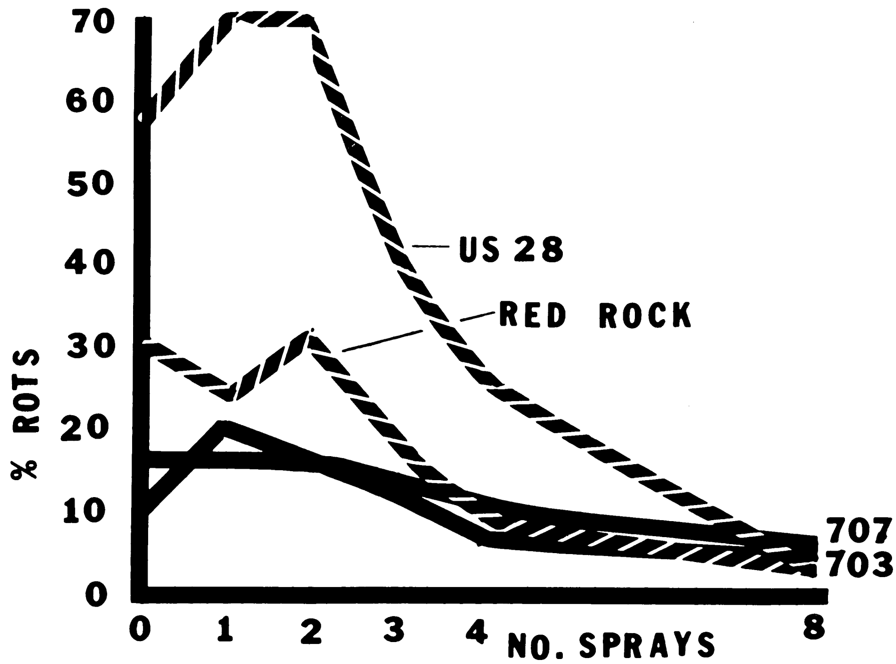

Fig. 2. Fruit rot of tomatoes sprayed with chlorothalonil.

randomly planted in each spray treatment block, and there were two replications; treatment blocks were randomized within each replicate.

A handsprayer was used to apply chlorothalonil at 1.75 kg a.i./ha. Plants in each block were sprayed eight, four, three, two, one, or zero times. The eight-spray weekly schedule began 25 June and ended on 13 August; the four-spray biweekly schedule began 2 July and ended 13 August; the three-spray biweekly schedule began 16 July and ended on 13 August; the two-spray biweekly schedule began 30 July and ended 13 August; and the one-spray treatment was applied on 13 August. A check treatment with no fungicide application was included.

One replication was harvested on 22 August and the other on 29 August. All fruits were harvested in a single destructive harvest from 10 consecutive plants in each plot. Fruits were graded as ripe, ripe with rots, or green, and each group was counted and weighed. Anthracnose was the most common rot, but in counting and weighing, different kinds of rots were not kept separate. An analysis of variance and Duncan's multiple range test were performed.

RESULTS

Yields of the breeding lines did not differ significantly from those of the checks when a routine spray schedule was followed (Table 2). Yields of healthy ripe fruit were substantially lower for all lines not sprayed than of those sprayed on a routine schedule. The two check cultivars performed differently from each other. Red Rock has a general ability to hold well without rotting in the field (good so-called vine storage), although this is obviously improved with fungicide applications. US28 is more typical of most eastern cultivars in that it does not have good vine storage unless it is sprayed. Neither check has any specific anthracnose resistance.

When usable yield of the two most resistant breeding lines is compared with that of the checks for each spray schedule, yield improved markedly between two and four applications but not between four and eight (Fig. 1).

The amount of fruit rot was markedly reduced between two and four applications for the two check cultivars, but reduction was less between four and eight sprays (Fig. 2). For the anthracnose-resistant breeding lines, reduction in the amount of fruit rot was gradual as the number of sprays increased.

Fruit size of the breeding lines approaches that of Red Rock and US28. However, the two most resistant lines in this test, 79B703 and 79B707, produce fruit that may be too small for commercial consideration (Table 2).

DISCUSSION

All of the PI lines used as sources of anthracnose resistance had small fruit and were indeterminate and susceptible to Fusarium and Verticillium wilts and to gray leaf spot. We have been able to incorporate substantial anthracnose resistance into determinate lines that have yields comparable to those of commercial cultivars, fruit that approaches desirable commercial size, and resistance to some other diseases.

Little yield increase or rot reduction occurred by increasing the number of sprays from four to eight. We think this is due to the schedule—the four biweekly sprays were timed over almost as much of the growing season as were the eight weekly sprays (Table 1). Furthermore, no affect on yield or rot reduction occurred when only one or two sprays were timed near crop maturity. These observations are consistent with those of Wilson (12) and others who have shown that anthracnose control is best when sprays are begun early in the season and with those of Ludwig (7) who showed that green fruit can be infected.

How valuable is the anthracnose resistance in these breeding lines? From the data (Fig. 2), we estimate that the resistance is worth three to four fungicide applications when compared with Red Rock and about seven when compared with US28.

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