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The Effects of Genotype and Ethephon on Rhizoctonia Soil Rot of Processing Tomatoes

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Abstract. **Two Arkansas breeding lines, 2 USDA breeding lines, and 2 commercial cultivars were evaluated for resistance to fruit rot caused by *Rhizoctonia solani* Kuehn. Each line or cultivar was field evaluated for the percentage of rot of fruit touching the ground and for yield. Arkansas breeding lines and USDA breeding line 79B 888-3 had the lowest percentage of rot and the highest yield, whereas the commercial cultivars and USDA 79B 823-3 had the highest percentages of rot and the lowest yields. The use of Ethephon at 500 ppm significantly decreased the percentage of rot in the field and increased yield.**

Soil rot of processing tomatoes (*Lycopersicon esculentum* Mill.) caused by *Rhizoctonia solani* is a major problem in southern United States. The pathogen is most infective in warm, humid environments which are typical growing season conditions in the South (1, 6, 12). The sprawling habit of the tomato vine permits a majority of ripening fruit to come in contact with soil often infested with *R. solani*. Because of the ubiquitous nature and excellent saprophytic survival capacity of *R. solani*, control is difficult. Fungicides must be applied frequently and yet do not give satisfactory control (3, 4, 7, 10, 11). Mulching is time consuming and expensive (5). A stable tomato processing industry has not been established in the South, in part, because available cultivars are susceptible to soil rot diseases, the most important being Rhizoctonia soil rot (8).

Progress has been made in developing material with acceptable polygenic resistance, but most breeding lines are indeterminate and horticulturally unacceptable. Processing-type breeding lines possessing good horticultural characteristics and useful levels of resistance have been developed by the Univ. of Arkansas at Fayetteville and the USDA at Beltsville, Md. Investigations at Mississippi State Univ. have identified sources of resistance among plant introductions (2, 8, 9).

One purpose of this study was to evaluate resistance of genotypes under field conditions. Arkansas breeding lines 79-85 and 79-86 and USDA breeding lines 79B 888-3 and 79B 823-3 were tested. The commercial cultivars Cal J and Chico 111 were included for comparison.

The other purpose was to study the effects of Ethephon (2-chloroethyl) phosphonic acid on incidence of fruit rot. The rational was that fruit ripening and removal from the field would be hastened, thereby lowering disease incidence because of reduced exposure time to fruit rot organisms.

Twenty plant plots of each genotype were established, and Ethephon was applied to one-half of the plants in all plots. Spacings within and between plots were 46 cm and 1.22 m, respectively. A strip split plot design replicated 3 times was used. Main plots were genotypes and Ethephon treatments were subplots.

The experimental plots were infested with 6 pathogenic isolates of *R. solani* in order to simulate the variability of natural population of the fungus more closely than could be provided by a single isolate. The isolates were grown 14 days on whole kernel oats soaked 12 hr in water before autoclaving for 2 hr (one hour each on consecutive days) in heat stable, 4 liter plastic bags were sealed with twine around 6–7 cm diameter cotton plugs. Inoculum was shredded by passage through 1.27 cm hardward cloth followed by thorough blending of isolates. Inoculum was applied at the rate of about 2 liters per 30.48 m of row by sprinkling as uniformly as possible over the entire foliage area when the first fruit were beginning to show red color. Sprinkle irrigation was applied immediately after field infestation to wash the inoculum to the soil surface. One-half inch of water was applied by overhead sprinklers every other day to maintain a moist, humid environment for the development of soil rot.

When fruit of each genotype showed about 40% red color, Ethephon was applied. Seven days after Ethephon application, fruit were harvested, and the yield and the percentage of rot were determined. Fruit of unsprayed plants were harvested about 5 days after fruit from Ethephon sprayed plants. Only fruit touching the ground were considered in the rot analysis. Once-over hand harvest was accomplished, and yields were expressed in kilograms per 10 plants. Arcsin transformations were performed on rot data expressed as percentages.

Genotype and Ethephon effects on soil rot. The 2 Arkansas breeding lines and the USDA breeding line 79B 888-3 had the lowest rot percentages (Table 1). The commercial cultivars were intermediate in rot percentages, whereas USDA breeding line 79B 823-3 had the highest rot percentage. Rot in USDA 79B 888-3 and Arkansas 79-85 were not significantly different from one another whether sprayed with Ethephon or not.

When genotypes were pooled within the respective spray treatments, Ethephon reduced the percentage of rot significantly. Several factors may have been involved in the effect of Ethephon on the percentage of rot. Ethephon sprays resulted in accelerated maturation and allowed earlier removal of fruit from the field, thus shortening the exposure time to the pathogen. The partial removal of foliage by Ethephon treatment also allowed the topsoil to dry rapidly, and the relative humidity in the area of the ground fruit was probably reduced. Thus, the effects of Ethephon were probably indirect by encouraging an environment less than optimum for the pathogen, and reducing the time fruit were vulnerable to infection.

Yield comparisons. When genotypes in sprayed treatments were pooled and genotypes in unsprayed treatments were pooled and compared, Ethephon significantly influenced yield. The interaction between genotype and Ethephon was not significant. The Arkansas breeding lines and USDA breeding

Table 1. The effect of genotype and Ethephon on yield and soil rot of selected cultivars and breeding lines of processing tomatoes.

	Yield (kg/10 plants)		Rot of fruit touching ground (%)	
Genotype	Ethephon	Control	Ethephon	Control
79-85	22.20 a[z]	19.69 a	46.66 c	52.33 cd
79-86	22.16 a	18.59 a	53.66 b	64.33 c
79B 888-3	18.54 ab	19.16 a	37.33 c	39.33 d
Chico 111	14.64 bc	7.90 b	69.33 ab	85.33 ab
Cal J	13.84 c	8.66 b	71.33 ab	78.00 abc
79B 823-3	7.04 d	5.03 b	83.33 a	93.66 a
$\bar{x}$	16.40 a	13.17 b	60.27 b	68.83 a

[z]Mean separation within columns and between columns means at K = 100 (Waller Test).

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line 79B 888-3 yielded more than the other genotypes tested (Table 1). The commercial cultivars were intermediate in yield, whereas USDA breeding line 79B 823-3 yielded poorly. Although small differences in the percentage of rot were obtained between treatments and in yield between treatments, the gain in yield was significant and resulted from concentrated ripening. The primary use of Ethephon is to concentrate ripening as an aid to mechanical harvest, but the indirect control of fruit rot would be sufficient reason for the practice.

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Developmental Stages of 'Flora-Dade' Tomatoes

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Abstract. **Phenological stages of 'Flora-Dade' tomatoes are described using a nomenclature system to be used for tomato pest management. Two vegetative stages (TV_1, TV_2) are listed as well as 3 reproductive plant stages (TR_1, TR_2, and TR_3). Vegetative stage TV_1 describes plants 1–15-days old with 2–3 primary leaves. TV_2 describes plants 6–39 days-old with 5–7 leaves. Reproductive stages (TR_1, TR_2, and TR_3) cover plants 40–135 days-old, characterized by presence of flowers clusters, and fruit formation and ripening. Characteristics of each stage are discussed. A senescent stage (TS_1) is present from 136–200 days after plant emergence.**

There is a continuing trend in modern horticulture to use a nomenclature system that describes plant phenology from a pest management point of view. Several important economic plants (e.g., soybean and cotton) (2, 8) have systems of names that facilitate an understanding of the plant substrate under field conditions. This information is useful in a sampling program or to describe the plant stage for pest management decisions against weeds, arthropods, and pathogens. This information is lacking for tomatoes, however, despite extensive studies on taxonomy, growth, and development (1, 3, 6, 7, 9).

The objectives of this research were to divide tomato plant development into recognizable growth periods and to develop a simple, standarized nomenclatural system for use by scouts and other field personnel.

Tomatoes 'Flora-Dade' were planted on 30 Oct., 25 Nov., and 30 Dec. 1980, and on 30 Jan. and 28 Feb. 1981, at the Univ. of Florida, Tropical Research and Education Center, Homestead. After metribuzin was incorporated into the soil at a rate of 0.84 kg a.i./ha, beds 45 m long were prepared and fertilized with 160N–320P–320K kg/ha. At the time of fumigation, drip tubing for irrigation was placed at a depth of 1.5 cm beneath the soil and 15 cm away from the bed center. Distance between beds was 70 cm. The beds were covered immediately with plastic mulch. Tomato seeds were planted 30 cm apart in the rows using the plug-mix seeding method (10). Two weeks after emergence, the seedings were thinned to one per hill. Plants were protected from pests by applications of fenvalerate 2.4 EC (0.045 kg a.i./ha) and of maneb and tribasic copper sulfate (0.97 + 5.71 a.i. kg/ha) at weekly intervals.

Table 1. Stage of development description for tomato 'Flora-Dade[z]' at Homestead, Fla.

Plant stage	Tomato plant description
Vegetative	
TV_1	Complete formation of 2–3 primary leaves; loss of cotyledons; plant height ca 5–7 cm. Plants 1–15 days old.
TV_2	Plant erect (12–16 cm); 5–7 leaves, development of laterals; plant with only 1 main stem. Plants 16–39 days old.
Reproductive	
TR_1	Development of laterals from nodes 1–5; at leaf 4–5 the stem bifurcates producing another stem as vigorous as the 1st main stem; production of floral clusters at node 5 and 2nd main stem; height 50 cm. Plants 40–50 days old.
TR_2	Fruit set; plant prostrated; yellowing of primary leaves. Plants 50–109 days old.
TR_3	90% fruit ripe; post-harvest maturity; at least 60% of the primary leaves necrosed, development of secondary laterals at nodes 3–5; plant totally postrate; height ca 32–57 cm. Plants 109–135 days old.
Senescence	
TS_1	Dead leaves on main stem and 2nd main stem; regrowth of plant from auxillary buds at nodes 1 and 2 and production of up to 3 floral clusters may occur; possible fruit development. Plants 135–200 days old.

[z]Description is based on observations from tomato plants grown during fall 1980 through winter 1981.

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