

Southern Blight-resistant Tomato Breeding Lines: 5635M, 5707M, 5719M, 5737M, 5876M, and 5913M

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Southern blight, incited by the fungus *Sclerotium rolfsii* Sacc., is a soil-borne pathogen that is ubiquitous in the tropics, subtropics, and subtemperate regions of the world. It infects >200 plant species and is an important disease of tomato (*Lycopersicon esculentum* Mill.) on warm ($\geq 30^\circ\text{C}$), noncalcareous acid soils (Sherf and MacNab, 1986). Presently, the only sources of resistance to *S. rolfsii* are selections from wild Peruvian accessions of *L. pimpinellifolium* Mill. (PI 126932 and PI 126432); high levels of resistance are not currently deployed in tomato (Mohr, 1955; Mohr and Watkins, 1959; Phatak and Bell, 1983). As a result, management practices for this disease have relied heavily on crop rotation and application of chemicals. Because *S. rolfsii* has long-term soil persistence and an extremely wide host range and geographic distribution, genetic resistance is economically important and

a useful tactic for the control of southern blight.

Symptoms on tomato typically include dark brown or black lesions that usually appear near the soil surface on herbaceous stems or soft vegetative tissue. With soil moistures at or above field capacity, lesions expand rapidly on the roots and shoots. A white mycelium extends radially up the stem and later

produces 1- to 2-mm-diameter sclerotia. Infected plants are partially or fully girdled, which causes seedlings to damp-off, while mature plants progress through a leaf yellowing and wilting phase that begins on the lower leaves. Fruits near or in contact with the soil can also become infected. The fungus penetrates the epidermis of the fruit and develops surface lesions that are yellowish and sunken. As lesions enlarge from 10 to 20 mm, the fruit surface cracks and becomes water-soaked. Fruits can rot in 3 or 4 days under ideal temperature and moisture (Jones et al., 1991; McColloch et al., 1968).

Resistance is attributed to the precocious development of secondary tissue (periderm) on the basal mainstem. Resistant individuals develop an overlapping phellem barrier five to six cell layers deep as 6- to 9-week-old seedlings. Destruction of the phellem barrier allows entry of the pathogen and results in a loss of resistance. Conversely, increases in plant tissue Ca levels confer more resistance to susceptible genotypes (Mohr, 1955; Watkins et al., 1958).

Origin

General. This breeding program was originally intended to develop heat-tolerant processor-type tomato cultivars suitable for machine harvest. Routine evaluation for southern blight resistance revealed that certain lines or plants within lines carried superior resistance under field conditions. These southern blight-resistant (SBR) breeding lines were

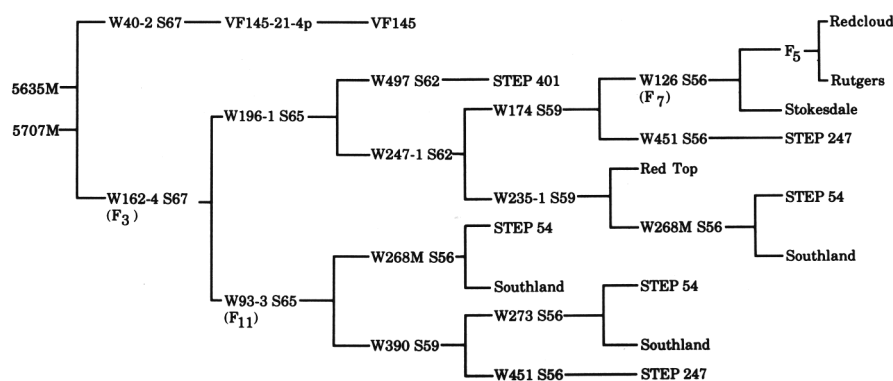


Fig. 1. Pedigree of 5635M and 5707M, southern blight-resistant tomato breeding lines.

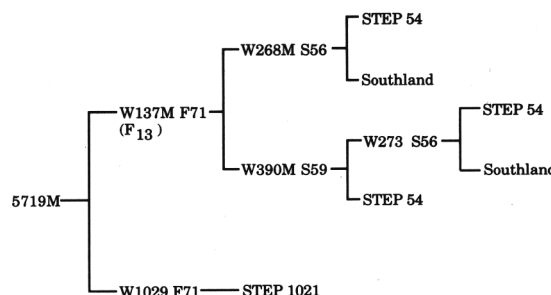


Fig. 2. Pedigree of 5719M, a southern blight-resistant tomato breeding line.

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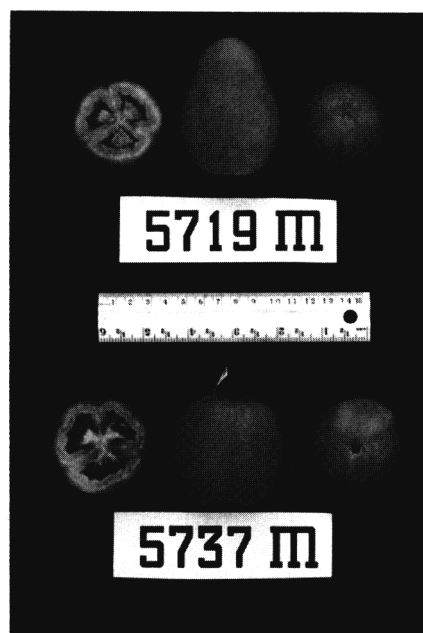


Fig. 6. Fruits of 5719M and 5737M, southern blight-resistant tomato breeding lines.

Table 1. Sources of cultivars and breeding lines used to develop southern blight (*Sclerotium rolfsii*) resistant breeding lines.

| Cultivar or breeding line | Originator |
|---------------------------|---|
| Redcloud | Univ. of Nebraska, Lincoln |
| Red Top | Cornell Univ., Ithaca, N.Y. |
| Rutgers | Rutgers Univ., New Brunswick, N.J. |
| STEP 54 | Univ. of Hawaii, Manoa |
| STEP 247 | USDA-ARS, Charleston, S.C. |
| STEP 401 | USDA-ARS, Beltsville, Md. |
| STEP 438 | Tropical Res. and Educ. Ctr., IFAS, Univ. of Florida, Homestead |
| STEP 1021 ^a | Tropical Res. and Educ. Ctr., IFAS, Univ. of Florida, Homestead |
| Stokesdale | Stokesdale Seed Co. |
| Southland | USDA-ARS, Charleston |
| VF 145 | Univ. of California, Davis |

^aSTEP numbers > 1000 indicate a series of processor type tomatoes that were distributed for evaluation in the late 1960s and early 1970s (J.W. Scott, personal communication).

(B.A. Perry, personal communication).

5719M. This line was inbred to F₁₃, derived from a simple pedigree that included four crosses, each made in 1971, 1959, 1956, and 1950 (Fig. 2). The original parents used in the development of 5719M included 'Southland', STEP 54, STEP 247, and STEP 1021. W273 S56 and W268M S56 were used as parents in 1956 and 1959, respectively. The last cross was between a selection from STEP 1021 (W1029 F71) and an F₁₃ breeding line (W137M P71) and STEP 54, STEP 247, and 'Southland' in its background (Fig. 2).

5737M and 5913M. These sib lines were inbred to F₁₃ from a final cross made in 1971 between a selection (W1023 F71) derived from STEP 1021 and an F₁₃ breeding line

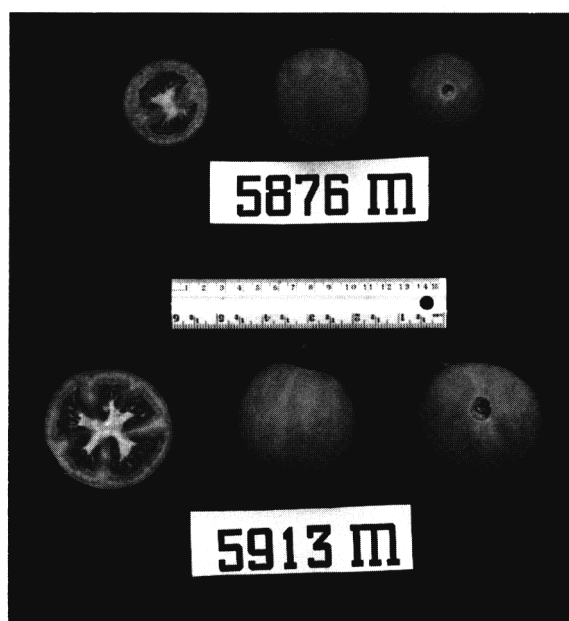


Fig. 7. Fruits of 5876M and 5913M, southern blight-resistant tomato breeding lines.

numbered W546 F71 (Fig. 3). This line derived from a background of 11 crosses among Weslaco breeding lines that were made in 1967 (1), 1965 (1), 1963 (1), 1962 (1), 1959 (3), and 1956 (4). The original parents included 'Redcloud', 'Red Top', 'Rutgers', STEP 54, STEP 247, STEP 401, STEP 438, STEP 1021, 'Stokesdale', and 'Southland' (Fig. 3). W273 S56 was used as a parent twice in 1956, while W268M S56 was used once in 1956 and 1959. W371 S56 was another progeny line derived from the STEP 54 by 'Southland' cross and was used as a parent in 1959.

5876M. This F₁₃ line arose from a cross made in 1971 between a selection (Fig. 4). M168 derived from four crosses among Weslaco breeding lines made in 1965 (1), 1959 (1) and 1956 (2). W273 S56 was crossed with a selection from STEP 247 (W451 S56) in 1956, while W268M S56 was used as a parent in 1959. Included in the pedigree of 5876M was 'Redcloud', 'Rutgers', STEP 54, STEP 247, STEP 1021, 'Stokesdale' and 'Southland'.

Description

General. Plants were inoculated with Tomato Isolates *Scr* 20, 24, 30, and 32 of *S. rolfsii* isolated from fruits and plants using the procedure developed by Phatak and Bell (1983). Resistance was assessed on the basis of vegetative and root response to the pathogen. Fruits were not specifically challenged with the pathogen, but showed superior tolerance when grown in fields infested with 100 kg *S. rolfsii* /ha. Plant survival of these SBR lines was compared to the wild PI 126432 (*L. pimpinellifolium*) selection and 'Arc', the resistant and susceptible controls, respectively (Table 2). Over 2 years, survival of the SBR lines was equivalent to the resistant PI 126432. Preliminary yield data indicated that 5719M and 5876M had su-

Table 2. Comparison of plant survival and yield of southern blight-resistant tomato breeding lines (M) and two controls in an infested field over 2 years at Tifton, Ga.

| Cultivar or breeding line | USDA plant introduction (PI) no. | Plants surviving (%) | Mean fruit biomass* (kg/plant) |
|---------------------------|----------------------------------|----------------------|--------------------------------|
| 5635M | 560 323 | 100 a | 1.50 b |
| 5707M | 560 324 | 100 a | 1.33 b |
| 5719M | 560 325 | 100 a | 2.40 a |
| 5737M | 560 326 | 100 a | 1.18 b |
| 5876M | 560 327 | 100 a | 2.38 a |
| 5913M | 560 328 | 100 a | 1.45 a |
| PI 126432 | --- | 100 a | 0.60 c |
| Arc | --- | 70b | 1.60 b |

*Mean separation with Duncan's multiple range test at $P \leq 0.05$.

perior average plant yields in Tifton (Table 2).

Plants of all six lines are small, determinate vines about one-third the size of 'Chico III' (Leeper, 1969) and have a high harvest index. Leaf margins tend to curl toward the midrib, and sometimes have a purple tint in the veins on the underside of the leaf. Fruit set is compact and dense, commonly with four to six fruits per inflorescence. Fruit color is medium to dark red, with fruit shape, size, and quality appropriate for processing. Crack resistance is equivalent to 'Chico III', and plants are adapted for fruit set at high relative humidities (65% to 95% RH), and high temperatures (34 to 36C). Lines 5707M, 5737M, and 5876M have similar maturity and are commonly a few days to 1 week earlier than 5635M, 5719M, and 5913M. In addition to southern blight resistance, each line exhibited field resistance to race 1 of fusarium wilt [*Fusarium oxysporum* f. *lycopersici* (Sacc.) Snyder and Hansen] and gray leaf spot (*Stemphylium solani* Weber). These lines are genetically stable, near commercial quality, and suitable for evaluation in hybrid combinations. However, sufficient genetic di-

versity was maintained within these releases to permit the selection of unique genotypes.

5635M. Fruits of this line are globe- to plum-shaped with two to three locules (mostly two) and carried on jointed pedicels. Fruits range in size from 55 to 70 mm long and 45 to 60 mm wide; wall thickness averages 7 mm. The stem scar is 6 to 12 mm wide, and the blossom end is slightly apiculate (≥ 1 mm). Fruits average 73 g and ripen uniformly.

5707M. Fruits are plum-shaped with two to four locules (mostly three) and range in size from 60 to 70 mm long, 45 to 55 mm wide, with an average wall thickness of 7.0 to 8.0 mm (Fig. 5). Fruits are carried on jointed pedicels with a stem scar 4.0 to 8.0 mm wide. The blossom end is strongly apiculate, ranging from 3 to 8 mm. Average fruit weight is 68 g; they ripen uniformly.

5719M. This line produces nearly pear-shaped fruits 6.4 to 8.5 cm long with a widest diameter of 45 to 50 mm and 20 to 30 mm width at the neck (Fig. 6). Fruits mostly have three locules, with a fruit wall thickness that ranges from 6 to 7 mm. The blossom end of the fruit has a 1- to 3-mm apicule, while the stem end has a 4.0- to 5.0-mm scar when detached from a jointed pedicel. Fruits average 50 g and ripen uniformly.

5737M. Rounded to blocky pear-shaped fruits are carried on jointless pedicels and commonly range from 55 to 75 mm long with a maximum diameter of 45 to 60 mm (Fig. 6). Fruits are mostly three-loculed, occasionally puffy, with 6.0- to 7.0-mm-thick walls. The stem end of the fruit has a 6.0- to 7.0-mm scar, while the blossom end is smooth to slightly recessed. Fruits are green-shouldered and average 55 g.

5876M. Fruits are mostly blocky with a tendency toward rounded to pear shapes that average 50 to 70 mm long, 40 to 55 mm wide, with three to four locules (mostly three) and are occasionally puffy (Fig. 7). Fruit walls average 6.0 to 8.0 mm. Pedicels are jointed and leave a 6.0- to 9.0-mm stem scar when detached from the fruit. The blossom end of the fruit is smooth to slightly recessed (≥ 1 mm). Fruits ripen uniformly and average ≈ 45 g.

5913M. Fruit of this line vary from blocky pear to blocky round, and range in size from 50 to 65 mm long and 40 to 60 mm in diameter. This line also is heterogenous for jointed and jointless pedicels, with fruits that have three or four locules and walls 4.0 to 7.0 mm thick. The stem scar is 7 to 13 mm wide, while the blossom end is smooth to recessed (≥ 1 mm). Fruits ripen uniformly and average 86 g.

Availability

These six southern blight-resistant breeding lines are a public release from Texas A&M Univ. Foundation seed was deposited with the Foundation Seed Service of Texas A&M Univ., College Station TX, 77843. Breeders seed has also been deposited in the U.S. Dept. of Agriculture tomato collection held in Geneva, N.Y., and plant introduction numbers

have been assigned (Table 2). For research purposes, small samples of seed are available from G.E.O.

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