

‘Fla. 8970’ Hybrid Tomato and Fla. 7781B and Fla. 8872B Breeding Lines

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‘Fla. 8970’ is a fresh market hybrid tomato (*Solanum lycopersicum*) that has resistance to Tomato yellow leaf curl virus (TYLCV) conferred by the *Ty-1* gene (Verlaan et al., 2013) and to fusarium crown and root rot (FCR) incited by *Fusarium oxysporum* f. sp. *radicus-lycopersici* conferred by the *Frl* gene (Vakalounakis, 1988). There are few acceptable tomato cultivars adapted to Florida conditions which combine FCR and TYLCV resistance. ‘Fla. 8970’ has performed consistently well on the peninsula of Florida, where its strong vine, high yield potential, large fruit size, and good fruit marketability make it an attractive cultivar choice. Fla. 7781B is the FCR- and TYLCV-resistant parent; it is nearly isogenic to the inbred line, Fla. 7781 (Scott and Jones, 2000). Inbred Fla. 8872B, the other parent, has a strong vine and very large fruit size.

Origin

The pedigree of ‘Fla. 8970’ is shown in Fig. 1. TYLCV resistance, conferred by Fla. 7781B, was derived from an F₃ selection from the commercial hybrid, ‘Tygress’. ‘Tygress’ contains a very large wild-species introgression (≈30 Mb) on chromosome 6—which couples the *S. peruvianum* nematode-resistance introgression (*Mi* gene) together with the *S. chilense* begomovirus-resistance introgression (*Ty-1* gene). The F₃ selection, however, was the product of two consecutive crossing-over events selected in the F₂ and F₃ generations. These trimmed the introgression above and below the *Ty-1* gene—eliminating the nematode-resistance locus and resulting in a much smaller wild-species introgression (≈1 Mb). This selection was also advanced as a recombinant inbred line (RIL) and used for building populations to fine-map

Ty-1, and its development is further described by Verlaan et al. (2013). Five rounds of marker-assisted backcrossing were used to advance *Ty-1* from the RIL into Fla. 7781, a crimson line with resistance to fusarium crown rot (Scott and Jones, 2000). The material that was developed is thus, in theory, nearly 97% genetically identical to Fla. 7781. The *Ty-1* gene was fixed in the BC₄F₂ generation, followed by two generations of selfing and selection for horticultural performance. The *Frl* gene was fixed in the BC₄F₄ generation, followed by two seasons of evaluations and selection for trueness-to-type for the Fla. 7781 background. In Fall 2016, seed was increased from a single BC₄F₆ line. Fla. 8872B is a very large-fruited, globe-shaped tomato. The large fruit size originates from Fla. 8626, an inbred that was selected from the UF/IFAS bacterial wilt (*Ralstonia solanacearum*) breeding project, but which does not have resistance to this disease (Hutton et al., 2015). Although Fla. 7781 carries both the *og^c* and *Frl* genes, neither of these was maintained during the inbreeding process of Fla. 8872B. Seed of Fla. 8872B was increased in Fall 2015 at the F₁₃ generation.

‘Fla. 8970’ has a strong, determinate (*sp*) vine that provides excellent fruit cover. The fruit are large (Table 1), flat-round, and have uniform shoulders (*u* or *ug*). Blossom scars are generally stellate and smooth, and do not enlarge and/or catface often. The fruit generally maintain a regular symmetrical shape. ‘Fla. 8970’ has been tested repeatedly in replicated yield trials, where it has consistently demonstrated high yield potential (Table 1; S.F. Hutton, unpublished data). The fruit of ‘Fla. 8970’ have excellent marketability and are highly resistant to cracking and checking. For instance, there was above-average rainfall at Balm in Fall 2014 during the last 2 weeks of November (17 cm during the last 2 weeks of November vs. the 13-year average of 3.4 cm). The timing of these rains was between the first and last harvests and resulted in many hybrids having very high percentages of culls because of cracking and checking. ‘Fla. 8970’, however, was very resistant to these defects, and this is reflected in its low cull rates for this trial (Table 1). Likewise, in Fall 2016, heavy rainfall early in the season resulted in significant bacterial spot infections and, in turn, weaker vines; many hybrids in the trial had very high cull rates because of cracking, but ‘Fla. 8970’ again showed very high fruit marketability (Table 1). The superior marketability is likely due to the combination of a stronger vine that protects the fruit and the glossy fruit epidermis itself that protects even exposed fruit. Fruit flavor of ‘Fla. 8970’ was rated over several seasons by Hutton and Scott as 3 = good flavor on a scale from 1 (poor) to 5 (excellent). On this scale, ‘Fla. 8153’ is 4, widely grown Florida tomatoes such as ‘Soraya’ and ‘Florida 47’ are 3, and ‘HM1823’ is between 2 and 3. Firmness and exterior fruit color of ‘Fla. 8970’ are good (Table 2). Fla. 7781B is homozygous for the recessive *og^c* gene, but Fla. 8872B is not crimson; thus, although ‘Fla. 8970’ also has good internal fruit color, it is not as red as the crimson hybrid ‘Fla. 8153’ (Table 2). Fruit size of ‘Fla. 8970’ is ≈195 g.

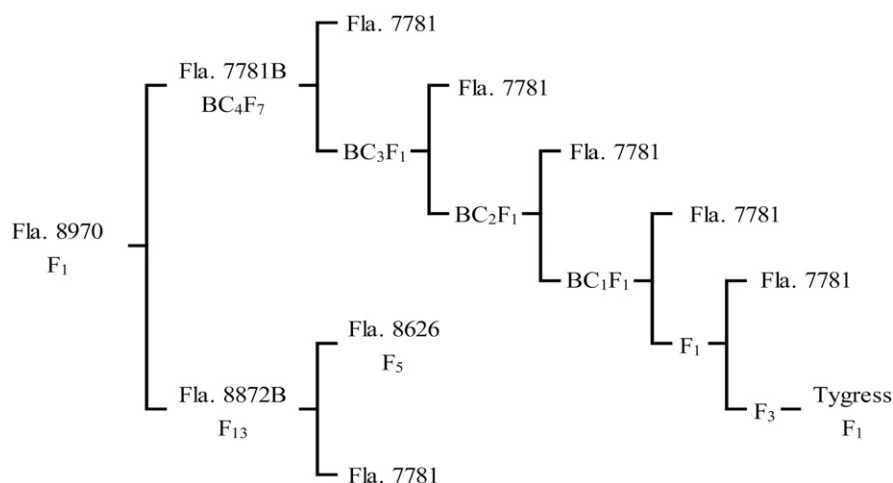


Fig. 1. Pedigree of ‘Fla. 8970’.

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Table 1. Marketable yield, percentage culls, and average fruit size for selected tomato hybrids harvested over multiple seasons.

Season	Hybrid	Marketable yield (11.34 kg cartons/ha)		Culls (% by wt)	Fruit size (g)
		Total	Extra-large		
Balm, Fall 2014	Fla. 8970	4,135 a ^z	3,060 a	20 b	196
	HM1823	3,080 ab	2,697 a	27 ab	218
	Ridge Runner	1,949 bc	1,697 ab	44 a	218
	Florida 91	1,181 c	1,025 b	60 a	238
	Florida 47	1,102 c	783 b	58 a	193
Quincy, Fall 2015	Quincy	5,628 a ^z	2,833	15 ab	241
	Florida 91	5,595 a	3,044	10 c	264
	Fla. 8970	5,373 a	2,330	18 a	222
	Florida 47	5,241 ab	2,583	11 bc	215
	HM1823	5,041 a ^z	3,858 a	19 cd	196 ab
Balm, Spring 2016	Fla. 8970	5,048 a	4,124 a	21 cd	198 ab
	Florida 47	4,085 bc	2,366 b	29 bc	164 c
	Soraya	3,149 cd	2,117 b	23 bd	187 bc
	Ridge Runner	3,014 d	2,423 b	45 a	210 a
	Fla. 8970	3,712 a ^z	1,939 b	14 c	164
Balm, Fall 2016	HM 1823	3,678 a	2,537 a	22 bc	179
	Florida 91	2,643 b	1,788 b	33 ab	184
	Florida 47	2,492 ab	1,354 ab	37 ab	156
	Soraya	2,324 b	1,334 c	38 a	173
	Everglade	2,169 b	1,697 ab	38 a	191

^zMean separation in columns within seasons by Duncan's multiple range test at $P \leq 0.05$. The experiments were completely randomized block designs with two blocks and eight-plant plots in 2014, four blocks and 10-plant plots in 2015, and with three blocks and eight-plant plots in 2016.

Table 2. External color, internal color, and firmness for selected tomato hybrids grown at the Gulf Coast Research and Education Center, Balm, FL, in Fall 2015 and Fall 2016.

Season	Genotype	Fruit color ^z				Firmness ^y (mm deformation)
		External		Internal		
		L	Hue angle	L	Hue angle	
Fall 2015	Fla. 8970	39.5 d*	46.8 c	33.9 b	41.6 c	4.1 a
	Fla. 8153	40.8 c	46.2 c	32.1 c	37.7 d	4.3 a
	Florida 47	41.4 bc	47.8 bc	36.3 a	44.6 b	4.2 a
	HM1823	42.0 b	48.7 b	34.2 b	45.8 a	4.0 a
	Ridge Runner	43.5 a	53.6 a	34.7 b	50.3 a	2.8 b
Fall 2016	Fla. 8970	40.0 bc ^x	43.6 a	34.1 b	42.1 b	4.0 ab
	Fla. 8153	39.5 c	42.0 b	32.8 c	39.8 c	4.3 a
	Florida 47	40.4 ab	43.5 a	35.1 ab	44.1 ab	3.7 bc
	HM1823	41.0 a	44.1 a	35.7 a	45.1 a	3.4 c

^zData taken with a Minolta CR-300 Chroma Meter; higher "L" numbers indicate lighter color (value), and lower hue angles indicate more red color (hue).

^yDetermined with an Institute of Food and Agricultural Sciences pressure tester using a 1-kg weight for 5 s with a fruit-contact plate 1.5 cm in diameter. Pressure applied over a locule in equatorial plane. Lower values indicate greater firmness.

^xMean separation in columns within seasons by Duncan's multiple range test at $P \leq 0.05$. The experiments were completely randomized block designs with two blocks and eight-plant plots in 2015, and with three blocks and eight-plant plots in 2016. Ten fruit per plot were harvested at the breaker stage and ripened in a laboratory at 24 °C until table ripe for color and firmness measurements.

Table 3. Marketable yield, culls, and *Tomato yellow leaf curl virus* (TYLCV) disease severity of inoculated hybrids grown at the Gulf Coast Research and Education Center, Balm, FL, Fall 2016.

Hybrid	Marketable yield (11.4 kg box/ha)		Culls (% by wt)	TYLCV DSI ^z
	Total	Extra-large		
HM 1823 (heterozygous <i>Ty3</i>)	7,918 a ^y	4,418 a	14 ab	2.1 b
Fla. 8970 (heterozygous <i>Ty1</i>)	7,382 a	4,077 ab	12 ab	0.8 c
Fla. 8977 (heterozygous <i>Ty3</i> , <i>Ty6</i>)	4,522 a	2,539 ab	16 ab	0.9 c
Fla. 8153 (susceptible)	155 b	54 b	50 b	4.0 a

^zDisease severity index. Virus symptoms rated at 66 d after inoculation on a 0–4 scale, where lower value indicated less disease; for scale and inoculation information, see Hutton et al. (2012).

^yMean separation in columns by Duncan's multiple range test at $P < 0.05$. The experiment was a completely randomized block design with two blocks and five-plant plots.

Disease Resistance

'Fla. 8970' has resistance to TYLCV and other begomoviruses against which *Ty-1* is

effective (Table 3). It carries the *Frl* gene for resistance to fusarium crown rot (Table 4), as well as the *I* and *I-2* genes for resistance to fusarium wilt (*Fusarium oxysporum* f. Sp.

Table 4. Response of tomato genotypes to inoculation with *Fusarium oxysporum* f. sp. *radicum-lycopersici* (10^7 spores/mL) at the cotyledon stage (22 °C)

Genotype ^z	Total plants (no.)	Healthy plants (%)	Diseased plants (%)
Fla. 7781B	32	100	0
OH 89-1	32	100	0
Fla. 8111B	8	0	100

^zOH 89-1 (*Frl*⁺) was the resistant control, and Fla. 8111B (*Frl*⁻) was the susceptible control.

lycopersici) races 1 and 2, respectively. The *Sm* gene provides resistance to gray leafspot (*Stemphyllium* sp.), and the *Ve* gene provides resistance to verticillium wilt race 1 (*Verticillium dahliae*). Whereas Fla. 7781B is resistant to the fruit disorder, graywall, Fla. 8872B is susceptible; the hybrid, 'Fla. 8970', is quite tolerant of this disorder, and symptomatic fruit are typically only found under conditions of very heavy graywall pressure.

Availability

Seeds of 'Fla. 8970', Fla. 7781B, and Fla. 8872B are being released through the Florida Foundation Seed Producers (FFSP), P.O. Box 309, Greenwood, FL 32443 (<http://ffsp.net>). A seed company will be solicited for exclusive rights to produce commercial seed of 'Fla. 8970'. Small quantities of seed for research purposes are available from S.F. Hutton under a material transfer agreement. If Fla. 7781B or Fla. 8872B is used in developing other commercial hybrids, users should contact FFSP to discuss a royalty contract.

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