Resistance of Watermelon Cultivars to Fusarium Wilt

G. W. ELMSTROM, Professor of Horticulture, and D. L. HOPKINS, Professor of Plant Pathology, University of Florida, Agricultural Research Center, Leesburg 32748

ABSTRACT

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Watermelon (*Citrullus lanatus*) cultivars were grown in field soil naturally infested with *Fusarium oxysporum* f. sp. *niveum*. Calhoun Gray, Smokylee, and Summit were highly resistant to Fusarium wilt and produced high yields when planted on land where watermelon had last been planted 6 yr before. Sweet Princess, Jubilee, Charleston 76, Klondike R7, and Summerfield were slightly resistant to wilt, and 11 cultivars were susceptible.

Fusarium wilt of watermelon (*Citrullus lanatus* (Thunb.) Matsum. and Nakai) caused by *Fusarium oxysporum* f. sp. *niveum* E.F. Sm.) Snyd. & Haus., which occurs throughout the world, is one of the most serious production problems confronting growers in Florida. Because of this disease, watermelons are best grown on new land or in a rotation between watermelon crops of at least 6 yr. Resistant varieties and a long rotation are the only controls now used by Florida watermelon growers.

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Most watermelon cultivars are described as "resistant" or "susceptible" to Fusarium wilt. The "resistant" cultivars are not equally resistant and the "susceptible" cultivars are not equally susceptible (2,6). Reports comparing the resistance of several cultivars (1,4–7) are either out-of-date (because most of the tested cultivars are no longer grown) or do not apply to Florida.

We tested various watermelon cultivars at Leesburg in field soil naturally infested with the watermelon Fusarium wilt fungus. This paper reports on a 3-yr study comparing the relative field resistance of the cultivars. A preliminary report was made on part of this work (3).

MATERIALS AND METHODS

1974 test. Cultivars were planted in a test replicated four times in a field naturally infested with *F. oxysporum* f. sp. *niveum*. Watermelons had not been grown in this field for 6 yr. The seeds were planted in two-row plots with five hills per row. Hills were spaced 1.5 m apart in rows 3 m apart. Watermelon seeds were planted on 25 February, and plants were thinned to two per hill on 17 April.

From seedling emergence until 1 wk before first harvest, we counted the plants that died from wilt and removed them twice weekly. The wilt was counted either as seedling wilt (plants that died before thinning) or as wilt after thinning (plants that died between thinning and harvest). Mature fruit was harvested on 4, 11, and 20 June and on 2 July, and the total yield of marketable fruit was determined.

1975 and 1976 tests. The cultivars were evaluated in an area where watermelon had been planted five times in the 5 yr before 1975; therefore, the soil was heavily infested with the Fusarium wilt

fungus. We planted the cultivars in single-row plots with 10 hills per row and four replications. Hills were spaced 0.8 m apart in rows 3 m apart. Watermelon seeds, six per hill, were planted 21 February 1975 and 1 March 1976. Plant were thinned to 10 per row 5 wk after emergence in 1975 and 4 wk after emergence in 1976.

Wilted plants were counted and removed thrice weekly before thinning and once weekly between thinning and harvest. Mature fruits were harvested 3–18 June 1975 and 3, 16, and 24 June 1976.

RESULTS

1974 test. Even though watermelons had not been grown in the test area for 6 yr, many plants of some cultivars were lost to Fusarium wilt (Table 1). Seedling wilt exceeded 20% in Black Seeded Chilean, Petite Sweet, and Peacock. After thinning, at least 50% of the remaining plants of these three cultivars and of Sugar Baby, Klondike R7, Klondike Blue Ribbon, and Top Yield died from wilt. Total yield was related to wilt incidence. Allsweet, Smokylee, Louisiana Queen, and Jubilee produced more than 55 metric tons of marketable fruit per hectare.

1975 and 1976 tests. Wilt was severe in these tests, and only the most resistant cultivars performed well. In 1975, 47% of Charleston Gray, the most extensively grown cultivar, was lost to wilt (Table 2). Only Calhoun Gray, Smokylee, and Summit had less than 30% seedling wilt that year. However, more than half of the cultivars had less than 20% wilt after thinning. All of the plants of five cultivars were dead by the end of the season.

Total yield of most of the cultivars was severely reduced by Fusarium wilt, and seven cultivars had no marketable yield (Table 2). Only Calhoun Gray, Smokylee, Summit, and Crimson Sweet produced yields of more than 30 metric tons per hectare. Charleston Gray yielded only 16.1 metric tons per hectare.

In 1976, Calhoun Gray, Smokylee, Summit, Allsweet, and Dixielee had less than 30% seedling wilt (Table 3). These five cultivars, plus Charleston Gray and Crimson Sweet, had less than 20% wilt after thinning. All of the Peacock #67 plants died by harvest time. Yields were lower than in 1975, with Peacock #67, Kleckley Sweet, and Watson producing no marketable melons. Only Calhoun Gray and Smokylee produced yields of more than 30 metric tons per hectare, with Summit and Dixielee yielding more than 20 metric tons. Charleston Gray yielded only 11.6 metric tons per hectare.

Table 1. Resistance of watermelon cultivars to Fusarium wilt in a naturally infested field last planted to watermelons 6 yr before

Cultivar	Plants with Fusarium wilt (%)		Fruit yield (metric tons per hectare)[c]
	As seedlings[a]	After thinning[b]	
Crimson Sweet	0	1	44.4 wx
Allsweet	3	1	59.6 v
Charleston Gray	3	3	44.6 wx
Smokylee	3	1	55.3 vw
Louisiana Queen	4	3	62.9 v
Sweet Princess	4	11	39.9 x
Tri X-313	5	38	15.7 z
Top Yield	5	79	3.8 z
Jubilee	8	11	57.3 vw
Charleston 76	8	12	49.1 vwx
Klondike Blue Ribbon	11	52	7.2 z
Klondike R7	12	50	22.4 y
Sugar Baby	17	89	1.8 z
Peacock #67	25	84	4.3 z
Petite Sweet	27	86	1.1 z
Black Seeded Chilean	29	100	0.0 z

[a] Average percentage of plants that died between planting and thinning 7 wk later.
[b] Average percentage of plants that died between thinning and harvest.
[c] Means followed by the same letter are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

Table 2. Resistance of watermelon cultivars to Fusarium wilt in a naturally infested field after a 5-yr watermelon monoculture[a]

Cultivar	Plants with Fusarium wilt (%)		Fruit yield (metric tons per hectare)
	As seedlings[b]	After thinning[c]	
Calhoun Gray	4 t	0 w	56.7 u
Smokylee	14 tu	5 w	48.4 uv
Summit	18 tu	5 w	33.6 vw
Allsweet	33 uv	3 w	18.1 wxyz
Crimson Sweet	36 uv	0 w	30.2 w
Charleston Gray	47 vw	0 w	16.1 wxyz
Louisiana Queen	61 wx	0 w	25.8 wx
Klondike R7	69 wxy	12 wx	10.3 xyz
Petite Sweet	71 wxyz	100 z	0.0 z
Jubilee	75 xyz	11 x	22.0 wxy
Garrisonian	76 xyz	48 y	3.6 yz
Sweet Princess	76 xyz	0 w	5.4 yz
Sugar Baby	78 xyz	97 z	0.0 z
Summerfield	78 xyz	24 x	9.6 xyz
Top Yield	80 xyz	94 w	0.0 z
Klondike Blue Ribbon	88 xyz	100 w	0.0 z
Peacock #67	97 yz	100 w	0.0 z
New Hampshire Midget	97 yz	100 w	0.0 z
Black Seeded Chilean	99 z	100 w	0.0 z

[a] Means followed by the same letter are not significantly different ($P = 0.05$) according to Duncan's multiple range test.
[b] Average percentage of plants that died between planting and thinning 7 wk later.
[c] Average percentage of plants that died between thinning and harvest.

DISCUSSION

We ranked the cultivars in order of decreasing Fusarium wilt resistance (Table 4). Resistance levels followed a continuous gradient, but we divided the cultivars into the categories used previously: highly resistant, moderately resistant, slightly resistant, and susceptible (1,6). The highly resistant cultivars had less than 20% seedling wilt and produced adequate yields even on land in continuous watermelon culture for 5–6 yr. The moderately resistant cultivars had 20–60% seedling wilt and little wilt after thinning on the highly infested land, and they produced high yields on the less infested land. The slightly resistant cultivars usually had 50–80% wilt on the highly infested land, where they yielded very few melons, and less than 50% wilt on the less infested land, where they produced moderate yields. The susceptible cultivars usually died on the highly infested land, and they had 50–100% wilt and very low yields when grown on land last planted to watermelons 6 yr earlier.

Most of the Florida watermelon acreage is planted with Charleston Gray, Crimson Sweet, and Jubilee, which were moderately to slightly resistant to Fusarium wilt in these tests. These cultivars are grown on new land and on land in rotations of 10 yr or more. Wilt is more likely to cause crop losses as rotation between watermelon crops is shortened, especially with Jubilee but also with Charleston Gray and Crimson Sweet. Other characteristics have prevented the ready acceptance by commercial growers of the highly resistant Calhoun Gray, Smokylee, and Summit. Dixielee is a new release that

Table 3. Resistance of watermelon cultivars to Fusarium wilt in a naturally infested field after a 6-yr watermelon monoculture[a]

Cultivar	Plants with Fusarium wilt (%)		Fruit yield (metric tons per hectare)
	As seedlings[b]	After thinning[c]	
Calhoun Gray	9 u	0 x	41.7 u
Smokylee	14 uv	0 x	33.6 uv
Summit	14 uv	11 xy	20.4 vwx
Allsweet	20 uvw	18 xy	18.8 vwxy
Dixielee	22 uvwx	6 x	22.4 vw
Charleston Gray	44 vwxy	6 x	11.6 wxyz
Sweet Princess	47 vwxyz	28 xy	4.5 xyz
Louisiana Queen	52 wxyz	25 xy	11.0 wxyz
Crimson Sweet	55 xyz	7 xy	10.1 wxyz
Charleston 76	71 yz	33 xy	8.1 wxyz
Jubilee	74 yz	48 y	2.2 yz
Peacock #67	79 yz	100 z	0.0 z
Garrisonian	84 z	96 z	2.5 yz
Kleckley Sweet	84 z	88 z	0.0 z
Watson	86 z	92 z	0.0 z

[a] Means followed by the same letter are not significantly different ($P = 0.05$) according to Duncan's multiple range test.
[b] Average percentage of plants that died between planting and thinning 6 wk later.
[c] Average percentage of plants that died between thinning and harvest.

performed better in these tests than any other cultivars in the moderately resistant category, and its use in Florida is increasing. The chance of a total loss with any of the susceptible cultivars is very high, even on new land.

When cultivars with high resistance to Fusarium wilt and other acceptable quality and production characteristics are developed, growers may be able to plant watermelons on a shorter rotation. Until that time, we have little alternative but to use a lengthy rotation. Our results also support the recommended cultural practice of delaying final thinning as long as possible to eliminate the greatest number of susceptible plants. The highly resistant and moderately resistant cultivars developed very little wilt after thinning; therefore, the plants with wilt could be weeded out at thinning. This was not true of the susceptible cultivars.

Table 4. Classification of watermelon cultivars for Fusarium wilt resistance

Classification	Cultivar
Highly resistant	Calhoun Gray
	Smokylee
	Summit
Moderately resistant	Dixielee
	Allsweet
	Crimson Sweet
	Charleston Gray
	Louisiana Queen
Slightly resistant	Sweet Princess
	Jubilee
	Charleston 76
	Klondike R7
	Summerfield
Susceptible	Garrisonian
	Petite Sweet
	Tri X-313
	Top Yield
	Klondike Blue Ribbon
	Sugar Baby
	Peacock #67
	Kleckley Sweet
	Watson
	New Hampshire Midget
	Black Seeded Chilean

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