

Occurrence of a Third Race of *Fusarium* Wilt of Tomatoes in Queensland

R. GRATTIDGE, District Experimentalist, Plant Pathology Branch, Department of Primary Industries, Bowen, Queensland, Australia, and R. G. O'BRIEN, Senior Pathologist, Plant Pathology Branch, Department of Primary Industries, Indooroopilly, Brisbane, Queensland

ABSTRACT

Grattidge, R., and O'Brien, R. G. 1982. Occurrence of a third race of *Fusarium* wilt of tomatoes in Queensland. *Plant Disease* 66:165-166.

A third race of *Fusarium* wilt (*Fusarium oxysporum* f. sp. *lycopersici*) causing typical vascular wilt symptoms on field-grown tomato cultivars resistant to race 2 is reported from Queensland. First sighted in 1978, the disease is now widespread and causing reduced yields on 25% of farms in the Bowen district.

The Bowen district of Queensland (lat 20° S long 148° E) is a major center for the production of fresh tomatoes. Three million 10-kg containers are produced annually, mainly during the winter and spring, for export to southern markets.

Fusarium wilt of tomatoes caused by *Fusarium oxysporum* Schlecht. f. sp. *lycopersici* (Sacc.) Snyder & Hansen was recorded in this area more than 60 yr ago (6). Because the disease is favored by the tropical climate, high production has

only been possible when cultivars with resistance to the predominant races of the organism are grown. Cultivars resistant to race 1, such as Campbell 1402, were grown successfully between 1963 and 1968, after which they succumbed to race 2 of the pathogen (5). The Florida cultivar Walter, which is resistant to race 2 (9), was released in 1970 and quickly became the standard for the district. A second cultivar resistant to race 2, Flora-Dade (10), was introduced in 1977.

Late in the 1978 season, we noticed three small areas of wilt-affected plants. Two of the outbreaks were in the Walter cultivar and the other was in Flora-Dade. The outbreaks were on three farms more than 5 km apart. Symptoms were typical of *Fusarium* wilt, with bright yellowing of the lower foliage progressing up the plant

and red brown vascular discoloration extending to the apex. *Fusarium oxysporum* was readily isolated from affected stem tissue.

Resistance to races 1 and 2 in cultivar Walter originated from PI 126915-1-8-1, a selection of PI 126915. This resistance was later incorporated in Flora-Dade. The mode of inheritance to each race is similar to that of a single dominant gene (8). Several reports (3,4,7,11) have been made of isolates of *F. oxysporum* pathogenic to such cultivars, but disease symptoms are those of a root and basal stalk rot rather than a vascular wilt. In most cases, vascular discoloration does not extend more than 25 cm above the soil line, and wilting occurs mainly as a result of stem girdling. Young seedlings inoculated with this organism show damping off symptoms after 4 days, whereas similar seedlings inoculated with *F. oxysporum* f. sp. *lycopersici* races 1 or 2 do not show symptoms until after 8 days (7). The disease is also favored by cool (< 20 C) soil temperatures, in contrast to races 1 and 2, which have an optimum of about 28 C. In view of these differences, Jarvis and Shoemaker (2) have proposed that this organism be called *F. oxysporum*

Accepted for publication 8 May 1981.

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked "advertisement" in accordance with 18 U.S.C. § 1734 solely to indicate this fact.

0191-2917/82/02016502/\$03.00/0

©1982 American Phytopathological Society

Table 1. Disease severity in four tomato cultivars following inoculation with isolates of *Fusarium oxysporum* f. sp. *lycopersici*

Isolate	Disease severity ^a			
	Q2	Strobe-lee	Walter	Flora-Dade
Race 1	3.5	0	0	0
Race 2	3.0	2.0	0	0
Bowen isolate (21991)	3.8	2.5	2.8	3.3

^a0 = no symptoms, 1 = slight yellowing or wilting of foliage, 2 = moderate yellowing or wilting of foliage, 3 = complete yellowing or wilting of foliage, and 4 = plant dead.

f. sp. *radicus-lycopersici* to distinguish it from the organism that causes typical Fusarium wilt.

MATERIALS AND METHODS

During 1978 through 1980, records were kept of outbreaks of Fusarium wilt in the cultivars Walter and Flora-Dade. An isolate (Acc. 21991) from a wilt-affected Walter plant was selected, and a single-spore culture used in inoculation tests. The isolates of races 1 and 2 were those used previously by Peterson (5), which had been maintained in a freeze-dried state. All cultures are deposited in the culture collection of the Plant Pathology Branch, Department of Primary Industries, Indooroopilly.

Race was determined in two tests. In the first, the set of differential cultivars used were Q2 (no known resistance), Stroblee (resistant to race 1), Walter (resistant to races 1 and 2), and Flora-Dade (resistant to races 1 and 2).

Seedlings were inoculated 30 days after sowing by dipping washed roots in a conidial suspension (5×10^6 conidia per milliliter) and repotting in a steamed peat/sand (1:1) mix. Six plants of each cultivar were inoculated with each isolate. The severity of Fusarium wilt was assessed 28 days later using the following scale: 0 = no symptoms, 1 = slight yellowing or wilting of foliage, 2 = moderate yellowing or wilting of foliage, 3 = complete yellowing or wilting of foliage, and 4 = plant dead.

In the second test, isolate 21991 was used to inoculate lines PI 126915 and PI 126915-1-8-1, the race 2 resistance donors. Also included for comparison were Walter and Q3, the latter having no known resistance to Fusarium wilt.

Seedlings were inoculated 3 wk after sowing as described above and assessed for disease severity 21 days later. The assessment was based on the amount and extent of vascular discoloration: 0 = no discoloration; 1 = slight vascular discoloration confined to the taproot; 2 = moderate vascular discoloration extending into the stem; and 3 = extensive discoloration, plant severely stunted or dead.

Table 2. Disease severity in four tomato cultivars and lines following inoculation with isolate 21991 of *Fusarium oxysporum* f. sp. *lycopersici*

Line	Severity ^a	Plants inoculated	Plants with vascular discoloration
		(no.)	(%)
Q3	2.5	30	87
Walter	2.9	30	97
PI 126915	2.7	40	100
PI 126915-1-8-1	1.6	50	82

^a0 = no discoloration; 1 = slight vascular discoloration confined to the taproot; 2 = moderate vascular discoloration extending into the stem; and 3 = extensive vascular discoloration, plant severely stunted or dead.

RESULTS

The area affected by the disease has increased each season since 1978. In 1979, there were 12 known outbreaks, and in 1980 there were an additional 15. Although the three initial sightings were small in area (20–100 plants), continued tomato production on infested areas has resulted in up to 40 ha at one site being affected during the 1980 season. At older infection foci, disease symptoms have become obvious at an earlier stage of plant growth, and yields have been greatly reduced because of premature plant death.

The new isolate (21991) was clearly differentiated in the first test from race 1 and race 2 isolates on the basis of its pathogenicity to cultivars Flora-Dade and Walter (Table 1).

The cultivars Walter, Q3, and line PI 126915 were severely affected in the second test (Table 2). Although the selection PI 126915-1-8-1 was more resistant overall, 41 plants out of the 50 inoculated were rated as showing vascular symptoms, with 11 of these in the severe category.

DISCUSSION

The recent outbreak of Fusarium wilt in the Bowen district can be attributed to the occurrence of a new race of *F. oxysporum*. Symptoms are typical of the disease caused by *F. oxysporum* f. sp. *lycopersici*. Pathogenicity to tomato cultivars resistant to race 1 and race 2 suggests that it should be considered as a third race of *F. oxysporum* f. sp. *lycopersici*.

A third race of *F. oxysporum* f. sp. *lycopersici* has previously been reported from Tunisia (1). In inoculation tests, several isolates collected from different areas of Tunisia between 1967 and 1974 were typed as race 3. They caused symptoms that were equally severe on Walter, Marmande (susceptible), and Roma (race 1 resistant). In contrast to the development of the third race in the Bowen district, race 3 was present in Tunisia and widely distributed before the field use of lines resistant to race 2 became generally accepted. Because the designation "race 3" is determined on the basis of virulence of an isolate to a set of

differential hosts, isolates from Tunisia and Queensland may differ in some other respects.

Although the new race has not yet been reported from other tomato-growing areas of Queensland, the rapid increase in affected areas in the Bowen district shows that the disease is a serious threat to tomato production. We are currently engaged in screening a large collection of cultivars and lines for resistance to the new race. Some of these have shown good tolerance in field tests. As short-term alternatives, we are also investigating various chemical and cultural control measures.

ACKNOWLEDGMENT

J. J. Augustine, formerly of the University of Florida, Institute of Food and Agricultural Science, Bradenton, supplied seed of PI 126915 and PI 126915-1-8-1.

LITERATURE CITED

1. el-Mahjoub, M. 1974. Mise en évidence d'une nouvelle race de *Fusarium oxysporum lycopersici* Sn. et H. Ann. Inst. Nat. Rech. Agron. Tunis. 47:1-17.
2. Jarvis, W. R., and Shoemaker, R. A. 1978. Taxonomic status of *Fusarium oxysporum* causing foot and root rot of tomato. Phytopathology 68:1679-1680.
3. Jarvis, W. R., Thorpe, H. J., and MacNeill, B. H. 1975. A foot and root rot disease of tomato caused by *Fusarium oxysporum*. Can. Plant Dis. Surv. 55:25-26.
4. Leary, J. V., and Endo, R. M. 1971. A *Fusarium* induced root rot of staked tomatoes. Phytopathology 61:900.
5. Peterson, R. A. 1973. Occurrence of race 2 of *Fusarium* wilt of tomatoes in Queensland. Queensl. J. Agric. Anim. Sci. 30:323-326.
6. Pollock, N. A. R. 1922. Some notes on *Fusarium* in the tomato plant in north Queensland. Queensl. Agric. J. 18:10-12.
7. Sonoda, R. M. 1976. The occurrence of a *Fusarium* root rot of tomatoes in south Florida. Plant Dis. Rep. 60:271-274.
8. Stall, R. W., and Walter, J. M. 1965. Selection and inheritance of resistance in tomato to isolates of races 1 and 2 of the *Fusarium* wilt organism. Phytopathology 55:1213-1215.
9. Strobel, J. W., Hayslip, N. C., Burgis, D. S., and Everett, P. H. 1969. Walter—A determinate tomato resistant to races 1 and 2 of the *Fusarium* wilt pathogen. Fla. Agric. Exp. Stn. Circ. S-202.
10. Volin, R. B., and Bryan, H. H. 1975. Flora-Dade, a fresh market tomato for south Florida with resistance to Verticillium wilt. Proc. Fla. State Hort. Soc. 88:218-221.
11. Yamamoto, I., Komada, H., Kuniyasu, K., Saito, M., and Ezuka, A. 1974. A new race of *Fusarium oxysporum* f. sp. *lycopersici* inducing root rot of tomato. Proc. Kansai Plant Prot. Soc. 16:17-29.