Effect of Nonhost Crop Plants on Watermelon Fusarium Wilt

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ABSTRACT

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Nine crop plant species that are nonhosts of *Fusarium oxysporum* f. sp. *niveum* were grown for 3 yr in a field naturally infested with high levels of the watermelon Fusarium wilt fungus. Decline of the wilt fungus, as determined by greenhouse bioassay, was similar with all nine nonhost crops. Watermelon yields were highest after 3 yr of bahiagrass than after any of the other nonhosts. Apparently, a reduction in Fusarium wilt was not the sole benefit of the bahiagrass sod.

Fusarium wilt of watermelon (*Citrullus lanatus* (Thunb.) Matsum. & Nakai), caused by *Fusarium oxysporum* f. sp. *niveum* (E.F. Sm.) Snyd. & Hans. is among the most serious problems for watermelon growers in Florida. The best control is obtained by planting on land not previously used for watermelons and by using resistant cultivars. When this is not possible, a crop rotation with at least 6 yr (preferably 8–10 yr) between watermelon crops is necessary.

In Florida, watermelons are frequently grown in a long rotation on land previously used as pasture for cattle. The most commonly used pasture grass is Pensacola bahiagrass, *Paspalum notatum* Flugg. The effect of bahiagrass on propagules of *F. oxysporum* f. sp. *niveum* in soil has not been determined. The role of nonhost plants on Fusarium wilt pathogens has been investigated in some cases (1,2,11).

With Fusarium wilt of muskmelon caused by *F. oxysporum* f. sp. *melonis*, only host plants contributed greatly to the increase of inoculum in the soil (2). Of the nonhost plants, some were better symptomless carriers of the pathogen than others; for example, soybean was better than corn. It was suggested that failure of the pathogen population to increase in the rhizosphere of certain nonhosts and failure of the fungus to become established on the root surface of certain plants might be useful in biological control of the pathogen.

In our study, the effects of various nonhosts of *F. oxysporum* f. sp. *niveum* on propagule populations of *F. oxysporum* in the soil and on Fusarium wilt of watermelon were determined. The effect of a 3-yr nonhost cropping period was evaluated on watermelon in the fourth year.

MATERIALS AND METHODS

The test area (Apopka fine sand soil type) had been planted to watermelon for 8 of 9 yr before 1979 and was severely infested with *F. oxysporum* f. sp. *niveum*. Test plots (9 × 18 m) were arranged in randomized complete blocks with four replicates. Treatments consisted of nine monocrops, which are considered nonhosts of *F. oxysporum* f. sp. *niveum*, and watermelon in monoculture.

Before the watermelon evaluation year

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(1982), the following crops were grown in 1979, 1980, and 1981: Pensacola bahiagrass, digitgrass (*Digitaria* sp.), soybeans (*Glycine max* (L.) Merr.), hairy indigo (*Indigofera hirsuta* L.), bermudagrass (*Cynodon dactylon* (L.) Pers.), corn (*Zea mays* L.), pearl millet (*Pennisetum americanum* (L.) Leeke), cucumbers (*Cucumis sativus* L.), and pepper (*Capsicum annuum* L.) followed in the same year by eggplant (*Solanum melongena* L.).

Bahiagrass was planted in March 1979, and bermudagrass and digitgrass were planted in July 1979. Soybeans and hairy indigo were planted in March or April each year. Corn, pearl millet, cucumbers, and watermelons were planted in March or April and August each year. In one treatment, pepper was planted in March or April and eggplant in August each year. In 1982, one row of the watermelon cultivar Smokylee (highly resistant to Fusarium wilt) and one row each of the cultivars Charleston Gray and Crimson Sweet (moderately resistant to wilt) (3) were planted in the previously established nonhost plots. Charleston Gray and Crimson Sweet are the two most popular commercial cultivars in Florida. Rows were 18 m long and consisted of 12 hills with 1.5 m between hills and 3 m between rows. Six watermelon seeds were planted in each hill, and 5 wk after emergence, plants were thinned to one per hill.

In 1982, counts of watermelon seedlings killed by Fusarium wilt were made three times a week the first 5 wk after emergence. The percentage of emerged seedlings that died from Fusarium wilt was calculated. At maturity, fruit were harvested and the total yields of marketable fruit determined. At regular intervals, soil samples were taken from the field plots and brought into the laboratory. Soil samples from the plots weighed about 100 g and resulted from mixing six subsamples taken from the top 20 cm of soil in each plot. Propagules of *F. oxysporum* per gram of air-dry soil were determined using soil dilutions on Komada's selective medium (8). Five-gram subsamples of soil were diluted and plated on five petri plates. The average of the five plates was used as the propagule population.

Greenhouse bioassays for *F. oxysporum* f. sp. *niveum* were done by planting Garrisonian (a very susceptible check cultivar) in soil from the various field plots and determining the percentage of plants killed by wilt after 5 wk. Two 4-in. pots were used for each field plot and 10 seeds were planted in each pot.

RESULTS

Concentrations of propagules of *F. oxysporum* in the soil were variable during the 3 yr that the nonhosts were grown (Table 1). With most nonhost plants, *F. oxysporum* propagules appeared to decline. Hairy indigo was the exception in that *F. oxysporum* populations increased in those plots during the second and third years of the test. The watermelon monoculture plots also had high propagule counts.

In May 1979, about 2 mo after most of the nonhost crops were planted, more than 50% of Garrisonian watermelon wilted in soil from all nonhost plots in the greenhouse bioassay (Table 1). In November 1979, significantly fewer watermelons wilted in soil from eight nonhost plots than from the watermelon plots. The largest decline in the proportion of watermelon seedlings wilting in the greenhouse bioassay occurred during the first year. Hairy indigo plot soil was unique in that wilt declined as numbers of *F. oxysporum* propagules increased.

In the field, losses from seedling wilt in all three watermelon cultivars were lowest following cucumber or pepper-eggplant (Table 2). Differences in seedling wilt among nonhost crops were not usually significant, but all nonhost crops except bermudagrass reduced wilt in two or more watermelon cultivars compared with watermelon monoculture. With all three cultivars, yields were highest following bahiagrass; however, the differences from other nonhosts were not significant. Yields were relatively good for all three cultivars following cucumber, pepper-eggplant, and pearl millet. Crimson Sweet did very well following bermudagrass, corn, and soybeans, but Charleston Gray and Smokylee did not yield as well after these crops. With Charleston Gray, yields were higher following all nonhost crops than following the watermelon monoculture.

Table 1. Populations of propagules of *Fusarium oxysporum* and percentage of wilt of watermelon in greenhouse bioassays during 3 yr of nonhost cropping

	Propagules of *F. oxysporum* per gram of soil[y]				Percentage of wilt in Garrisonian[y,z]			
Nonhost crop	May 1979	Nov. 1979	Nov. 1980	Nov. 1981	May 1979	Nov. 1979	Nov. 1980	Nov. 1981
Bahiagrass	708	676 ab	575 abc	257 a	64	14 a	14 ab	5 a
Digitgrass	447	513 a	550 abc	389 ab	67	17 a	13 ab	25 ab
Cucumber	1,000	977 ab	1,413 bc	427 ab	67	32 a	1 a	15 a
Corn	631	575 ab	295 a	398 ab	52	17 a	5 a	11 a
Pearl millet	1,096	759 ab	417 ab	479 abc	66	27 a	2 a	22 a
Pepper-eggplant	1,072	724 ab	832 abc	457 abc	57	45 ab	14 ab	28 ab
Soybeans	933	603 ab	447 ab	832 bc	63	13 a	8 ab	22 a
Bermudagrass	1,072	912 ab	692 abc	741 bc	60	35 a	5 a	14 a
Watermelon	1,047	1,259 b	1,230 abc	1,122 cd	78	69 b	34 b	56 b
Hairy indigo	955	933 ab	1,995 c	2,512 d	63	19 a	5 a	11 a

[y] Means in columns followed by the same letter are not significantly different ($P=0.05$) according to Duncan's multiple range test. There were no significant differences in propagules or percentage of wilt in May 1979. The propagule data were analyzed after logarithmic transformation, and data for percentage of wilt were analyzed after transformation to arc sine $\sqrt{x}$.

[z] Average percentage of Garrisonian plants that died within 5 wk of planting in the greenhouse bioassay.

Table 2. Incidence of Fusarium wilt and yield of three watermelon cultivars following nonhost crops and monocrop watermelon

	Percentage of wilt[x,y]			Yield (t/ha)[x]		
Nonhost crop[w]	CG[z]	CS	S	CG	CS	S
Bahiagrass	22 a	16 bc	8 ab	24.2 a	24.2 a	24.0 a
Pepper-eggplant	13 a	2 a	7 ab	19.5 a	17.0 ab	20.6 ab
Cucumbers	14 a	7 ab	2 a	17 5 a	17.7 ab	17.5 ab
Bermudagrass	25 a	15 bc	26 bc	17.7 a	23.5 a	8.5 bc
Pearl millet	27 a	18 bc	12 ab	17.0 a	17.3 ab	16.6 ab
Hairy indigo	26 a	17 bc	9 ab	15.9 a	15.0 ab	13.5 abc
Corn	21 a	8 ab	16 ab	13.2 a	20.0 a	10.8 abc
Soybeans	29 a	25 bc	13 ab	13.0 a	19.5 a	11.4 abc
Digitgrass	28 a	18 bc	11 ab	12.8 a	15.7 ab	12.6 abc
Watermelon	71 b	33 c	45 c	0.9 b	6.5 b	1.3 c

[w] The nonhost crops were grown for 3 yr following watermelon for eight of the nine previous years.

[x] Means in columns followed by the same letter are not significantly different ($P=0.05$) according to Duncan's multiple range test; data for percentage of wilt were analyzed after transformation to arc sine $\sqrt{x}$.

[y] Average percentage of plants that died between emergence and thinning 5 wk later.

[z] CG = Charleston Gray, CS = Crimson Sweet, and S = Smokylee.

DISCUSSION

Growers in Florida frequently plant watermelon after bahiagrass. This reflects the popularity of Pensacola bahiagrass as a pasture grass on Florida's sandy soils, the results of research on vegetable-pasture rotations (4,5), and the past experience of watermelon growers with bahiagrass-watermelon rotations. In our test, the relatively good yields following bahiagrass were not entirely explained by a reduction in Fusarium wilt because there was less wilt in plots where cucumbers or pepper-eggplant were used as the nonhost crop in the 4-yr rotation. Plowing under bahiagrass sod may also improve yields by increasing the organic matter content of the sandy soils and the water-holding and cation-exchange capacities of the soil. Other grasses were less effective.

Concentrations of *F. oxysporum* propagules were not very useful in monitoring Fusarium wilt pressure in soil. Saprophytic isolates of *F. oxysporum* are ubiquitous in soil. We did not determine populations of *F. oxysporum* f. sp. *niveum* in the soil; this would have required pathogenicity tests of many *F. oxysporum* isolates from each plot (2). If this were done, it might give a useful measure of the wilt pressure of the soil. *F. oxysporum* accumulated in the hairy indigo plots, but it apparently was not *F. oxysporum* f. sp. *niveum.*

The greenhouse bioassay with Garrisonian gave a better measure of the wilt pressure of the soil than that given by *F. oxysporum* propagule populations. By this measure, *F. oxysporum* f. sp. *niveum* declined most rapidly during the first year nonhost crops were grown. A similar decline of watermelon Fusarium wilt occurred after all nine nonhost crops.

Although bahiagrass was the best nonhost crop for watermelon, yields obtained with the 4-yr rotation used in this study were only slightly more than half the yields normally obtained in a 6- to 8-yr rotation at the ARC Leesburg, where Pensacola bahiagrass is used as the nonhost crop. There was still a 25% loss of Charleston Gray seedlings to wilt in this rotation; therefore, 3 yr of bahiagrass was not sufficient. *Fusarium* spp. can persist in soils for several years in a dormant state as chlamydospores (9). Many plant species other than those that show external symptoms may be parasitized by *F. oxysporum* (1,7,10,11). These symptomless carriers enable the fungus to reproduce and form more chlamydospores. The need for the 8- to 10-yr watermelon rotation may be a result of the wide parasitic host range of *F. oxysporum.*

Because of the increasing difficulty of finding bahiagrass pastureland that has not been used to grow watermelons for 8–10 yr and because of the increasing cost of renting pastureland, there is a need to shorten the rotation. This is possible only with costly fumigation (6). Use of high-value cash crops in the rotation with watermelon might also be important as land becomes more scarce. Fusarium wilt pressure appeared to decline as much, or more, following cucumbers, pepper-eggplant, corn, and soybeans as after bahiagrass. It would appear that any of these would be satisfactory in the watermelon rotation as far as Fusarium wilt is concerned. The benefits of bahiagrass to the physical and nutritional condition of the soil would have to be considered. Perhaps, bahiagrass or an equally effective cover crop need be included only the year before watermelon is planted.

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