Fungi Causing Stalk Rot of Conventional-Tillage and No-Tillage Corn in Delaware

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ABSTRACT

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During 1982 and 1983, 420 rotted cornstalks were collected on the basis of rind discoloration and weakness from commercial farm fields in Delaware. Stalks were collected from both conventionally tilled and nontilled fields. On the basis of stalk symptoms and laboratory isolations, a single major stalk-rot pathogen was identified for each stalk. Representative samples of the most frequently occurring fungi in 1982 were cultured, and spore suspensions were prepared for inoculation tests in 1983. *Fusarium* spp., *Stenocarpella maydis* (syn. *Diplodia maydis*) and *Colletotrichum graminicola* accounted for 91% of the fungi identified. *Fusarium* spp. were isolated more frequently from corn in conventionally tilled fields in the sandy soils of southern Delaware, whereas *S. maydis* was more prevalent in samples collected from no-tillage corn growing in the heavier soils of northern Delaware.

In the eastern United States, many fungi have been identified as stalk-rot pathogens of field corn (*Zea mays* L.). In 1921, Manns and Adams (5) isolated *Cephalosporium sacchari* Butler, *Gibberella saubineti* (Mont.) Sacc., *Fusarium moniliforme* Sheld, and *Diplodia zeae* (Schw.) Lév. from seeds and implicated them in root and stalk rot of corn in Delaware. In New Jersey, Peterson (6) determined that *G. zeae* (Schw.) Petch, *F. moniliforme, Helminthosporium sativum* Pamm., *Trichoderma* sp., and *Curvularia* sp. were pathogenic on cornstalks. *F. moniliforme*, *F. moniliforme* var. *subglutinans*, and *G. zeae* were determined to be the major stalk-rot pathogens in Pennsylvania (1). In Virginia, *D. zeae* and *G. fujikuroi* (Saw.) Wr. were the predominant stalk-rot fungi (7).

This study was conducted to determine the fungi causing stalk rot of modern corn hybrids in Delaware. Because of the recent large increase in no-tillage corn farming, samples from conventionally tilled and nontilled fields were compared to investigate the effects of tillage on the occurrence of stalk-rot fungi.

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MATERIALS AND METHODS

During 1982 and 1983, 420 stalks were collected on the basis of rind discoloration and weakness from commercial farm fields in Delaware. Sites sampled were distributed as evenly as possible throughout the state. Delaware consists of only three counties; the southern counties, Kent and Sussex, have a flat topography and soils that are predominantly sandy loams and loamy sands, whereas New Castle County has a rolling terrain and soils that are primarily silt loams. An attempt was made to find an equal number of conventionally tilled and nontilled fields at each location, but this was not always possible. In 1982, 23 nontilled and 47 conventionally tilled fields were included in the sample. In 1983, 31 nontilled and 39 conventionally tilled fields were sampled. Three stalks were taken from each field during early October 1982 and late September 1983.

In 1982, 1-cm^2 sections were removed from three positions on the rind and surface-disinfested by a 1-hr tap water flush and a 2-min soak in 0.525% sodium hypochlorite. In 1983, two locations on the rind and one on the crown were sampled and surface-disinfested for 1 min in 70% ethanol and for 2 min in 0.525% sodium hypochlorite followed by a quick rinse in sterile distilled water. In 1982, the samples were placed on acidified potato-dextrose agar (APDA), oatmeal agar, and Martin's peptone agar. In 1983, only APDA was used because it was the best medium in the 1982 test. Before the sections were cut, visual external and internal symptoms were recorded for each stalk.

Cultures were incubated at 28 C until colonies matured, then the fungi were identified. A single major pathogen was assigned to each stalk on the basis of fungi isolated and stalk symptoms, although more than one fungus was frequently obtained from each stalk.

Pure cultures of four *Fusarium* spp., *F. subglutinans* Wr. & Rienk, *F. graminearum* Schwabe, *F. equiseti* (Corda) Sacc. (teleomorphic states *G. subglutinans* Gdw., *G. zeae*, and *G. intricans* Wollenw., respectively) and *F. semitectum* Berk. & Rav. as well as *Colletotrichum graminicola* Wils. and *Stenocarpella maydis* (Earle) Sutton (syn. *D. maydis*) were saved from the 1982 locations. Sporulation was induced on APDA (*Fusarium* spp. and *S. maydis*) or oatmeal agar (*C. graminicola*), and colonies were washed with sterile distilled water to collect a spore suspension. The *Fusarium* spore suspensions contained 70,000 macroconidia per milliliter with varying numbers of microconidia. *C. graminicola* suspensions contained 100,000 spores per milliliter and *S. maydis* suspensions contained 30,000 spores per milliliter. On 5 August 1983, a modified hog inoculator (9) was used to inject 2 ml of each spore suspension into the first elongated internode of six corn hybrids, on both tilled and nontilled soils. Three of the hybrids, B73× Mo17, Wyffel 21, and Wyffel 48, were considered poor standing varieties, and three others, Pioneer Brand hybrids 3358, 3535, and 3572, were known to stand well. The corn was grown with standard cultural practices used in Delaware for herbicide and fertilizer applications.

On 20–22 September 1983, plants were evaluated by splitting stalks lengthwise and rating for spread of discoloration from the point of inoculation. Longitudinal internal discoloration was measured in centimeters, and the average width of discoloration was estimated as one-fourth, one-half, three-fourths, or the full width of the stalk. Ten plants for each hybrid were evaluated for each of 11 fungal isolates on both tilled and nontilled soils.

RESULTS AND DISCUSSION

The fungi most frequently identified as stalk-rot pathogens in Delaware were *Fusarium* spp., *S. maydis*, and *C. graminicola* (Table 1). Less frequently identified were *Macrophomina phaseolina* (Tassi) Goid., *Helminthosporium* spp., *Trichoderma* spp., and *Nigrospora* spp. (listed as "others" in Table 1).

Twenty-four isolates of *Fusarium* spp. were verified at the Fusarium Research Center, Pennsylvania State University. Nine were identified as *F. subglutinans*, 12 as *F. graminearum* (*G. zeae*), two as *F. equiseti*, and one as *F. semitectum*.

Table 1. Stalk-rot fungi identified from conventional-tillage and no-tillage corn in Delaware

Pathogen	1982		1983		1982–1983 Combined	
	Tillage	No-tillage	Tillage	No-tillage	Tillage	No-tillage
Fusarium spp.	60 [a]	53	46	21* [b]	53	33*
Stenocarpella maydis	17	12	24	61*	20	42*
Colletotrichum graminicola	15	26	19	11	17	17
Others	8	9	11	7	10	8

[a] Values expressed as percentages of total identifications.
[b] An asterisk indicates that tillage and no-tillage treatment values differ significantly at $P = 0.05$ (chi-square).

Overall, *Fusarium* spp. were the most frequently identified pathogens causing stalk rot in Delaware. These species were identified more frequently from corn grown in tilled versus nontilled soils and from southern Delaware, where the soils are sandy and prone to drought (Tables 1 and 2). This is consistent with literature indicating that *Fusarium* is a stress pathogen that attacks mostly weakened or senescing plants (4).

S. maydis was the predominant stalk-rot organism identified in 1983 (Table 1). This is consistent with literature stating that a wet spring followed by hot, dry summer periods and a wet fall favor this pathogen (2,4). These conditions occurred in Delaware during 1983 but not during 1982. It is interesting that neither Ayers et al (1) in Pennsylvania nor Peterson (6) in New Jersey found *S. maydis* in their samples, especially since the soils, climate, and crops grown in southern New Jersey are very similar to those in Delaware. Peterson, however, did not indicate where in New Jersey the samples were taken, and Ayers et al took few samples in southeastern Pennsylvania, which is closest to Delaware. *S. maydis* was identified more frequently from corn in nontilled fields than from corn in tilled fields (Table 1). Some research indicates that *S. maydis* enters the stalk through the leaf sheath (2,4). The increased exposure to splashing rain of pycnidia on debris in a nontilled field could account for this effect. *S. maydis* was also found more frequently in northern Delaware, where the soils have a higher clay content (Table 2).

C. graminicola has only recently become a serious leaf-blight pathogen (3,10) and was not reported in the East in earlier evaluations of stalk-rot fungi. It was identified frequently in Delaware but did not appear to be affected by tillage system (Table 1). This is unusual because increases in occurrence of the leaf blight phase have been attributed at least in part to increases in no-tillage corn production (8,10). *C. graminicola* was identified less frequently than *Fusarium* spp. or *S. maydis* (Table 1) and appeared unrelated to location (Table 2).

Table 2. Stalk-rot fungi isolated from corn in three Delaware counties for the combined 1982–1983 seasons

Pathogen	New Castle	Kent	Sussex
Fusarium spp.	24 [a]	40	63
Stenocarpella maydis	52	28	13
Colletotrichum graminicola	19	20	15
Others	5	12	9

[a] Values expressed as percentages of total identifications.

In this study, some differences occurred between tillage and no-tillage corn with regard to isolation of stalk-rot fungi. However, when selected isolates of these fungi were inoculated into six corn hybrids grown under tillage and no-tillage, they did not show a pattern of difference in infection severity attributable to tillage system nor did the pooled data differ significantly (Table 3). This indicates that the effects of tillage system on stalk rot are subtle, and artificial inoculations may not provide answers. The highest ratings were obtained for the *C. graminicola* isolates, which is consistent with reports that this pathogen is capable of attacking green tissue and prematurely killing plants (10).

Table 3. Combined responses of six corn hybrids to inoculation with 11 fungal isolates[a]

Isolate	Tillage	No-tillage
Fusarium subglutinans		
No. 2	1.9	4.5
No. 47	3.9	2.9
F. graminearum		
No. 20	2.9	3.1
No. 48	2.0	1.9
F. semisectum	2.4	3.4
F. equiseti	2.2	1.7
Stenocarpella maydis		
No. 54	6.5	7.3
No. 59	5.4	8.7
Colletotrichum graminicola		
No. 1	14.5	21.4
No. 2	13.6	18.4
No. 3	17.8	15.3
Mean	6.7 NS[b]	8.1 NS

[a] Values expressed as length of longitudinal times average width of internal discoloration.
[b] NS indicates that tillage and no-tillage treatment values do not differ significantly at $P = 0.05$ (chi-square with homogeneity test).

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