# *Fusarium moniliforme* Colonization of Corn Ears in Missouri

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**ABSTRACT**

Calvert, O. H., Foudin, A. S., Minor, H. C., and Krause, G. F. 1985. *Fusarium moniliforme* colonization of corn ears in Missouri. Plant Disease 69: 988-990.

Data from hybrid kernel samples taken throughout the corn belt area of Missouri show that *Fusarium moniliforme* and *F. moniliforme* var. *subglutinans* are the internal fungi that predominate in *Zea mays* in the state. Results of the study also indicate that differences in hybrids and environmental conditions significantly affect the number of kernels that become colonized.

The purpose of this study was to survey the internal fungi in *Zea mays* L. kernels to define which species are most often present in commercial corn hybrids grown in the corn belt area of Missouri under normal growing conditions. Hybrid yield trials conducted by the University of Missouri Agricultural Experiment Station at several sites from 1979 to 1982 (2–4) were the source of the material screened.

## MATERIALS AND METHODS

Duplicate (triplicate in 1980 and 1982) 100-kernel samples of sound, intact seed were surface-sterilized in a phosphate-free NaClO solution (Clorox; 1:5, v/v) for 10 min, placed on potato-sucrose agar (1), five kernels per petri dish (100 × 15 mm), and incubated in the dark at 28 C for 5 days. After incubation, each colony was examined macroscopically and microscopically for species identification. Each species of the total colony count was analyzed as the square root of $x + 1$ to normalize and stabilize variance. Duncan's multiple range test was used to identify significant differences among hybrids.

The effect of environment at different locations on the presence of internal fungi in the kernels was tested at eight sites in Missouri (10–13) (Fig. 1). The northern sites were near Fairfax, Spickard, and Novelty, and all hybrids were grown under dryland conditions. The plots near


**Fig. 1.** Locations in Missouri where the effect of environment on the presence of internal fungi was tested. • = Sites where corn was grown under dryland conditions and o = sites where corn was grown under dryland and irrigated conditions.

**Table 1.** Incidence of internal fungi isolated from seed of hybrid corn grown in Missouri from 1979 to 1982

| Genera of species isolated from kernels | Mean number of colonies per 100 kernels | | | | |
|---|---|---|---|---|---|
| | 1979[a] | 1980[b] | 1981[c] | 1982[d] | Mean |
| *Fusarium* spp. | 21.0 | 43.0 | 47.1 | 43.5 | 38.6 |
| *Penicillium* spp. | 4.6 | 16.1 | 1.3 | 2.7 | 6.2 |
| *Aspergillus* spp. | 1.8 | 16.1 | 1.8 | 1.1 | 5.2 |
| *Rhizoctonia* spp. | 3.0 | 0.5 | 2.0 | 8.2 | 3.4 |
| *Drechslera* spp. | 0.0[e] | 0.0 | 3.4 | 1.0 | 1.1 |
| *Alternaria* spp. | 0.8 | 0.1 | 0.5 | 2.5 | 1.0 |
| *Nigrospora* spp. | 1.8 | 0.0 | 0.2 | 0.4 | 0.6 |
| *Trichoderma* spp. | 0.4 | 0.2 | 0.1 | 0.3 | 0.2 |
| Others[f] | 3.4 | 0.0 | 3.5 | 1.0 | 2.0 |
| Total | 34.7 | 75.9 | 59.9 | 60.7 | 57.8 |

[a] Kernels (200 plated) from each of 53 hybrids grown at Spickard, Novelty, and Columbia.
[b] Kernels (300 plated) from each of 39 hybrids grown at one location (Novelty).
[c] Kernels (200 plated) from each of five hybrids grown at eight locations: Fairfax, Spickard, Novelty, Marshall, Columbia, Weldon Spring, Cape Girardeau, and Portageville, all under dryland conditions.
[d] Kernels (300 plated) from each of four hybrids grown at nine locations: Fairfax, Spickard, Novelty, Marshall, Columbia, Cape Girardeau, and Portageville under dryland conditions, and in irrigated plots at Columbia and Portageville.
[e] Number of colonies averaged less than 0.01/100 kernels.
[f] Bacteria, *Cladosporium, Chaetomium, Mucor*, and *Rhizopus* spp.

Accepted for publication 3 May 1985.

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**Table 2.** Effect of location environment on number of *Fusarium* spp.[w] isolated per 100 kernels of corn hybrids grown in Missouri in 1981[x]

| Hybrid[y] | Northern locations | | | Central locations | | | Southeastern locations | | Mean |
|---|---|---|---|---|---|---|---|---|---|
| | L1 | L2 | L3 | L4 | L5 | L6 | L7 | L8 | |
| H1 | 80 | 50 | 74 | 56 | 42 | 72 | 36 | 83 | 61.8 a[z] |
| H2 | 70 | 58 | 32 | 58 | 20 | 6 | 12 | 56 | 38.8 c |
| H3 | 92 | 47 | 52 | 37 | 38 | 54 | 19 | 84 | 52.8 b |
| H4 | 85 | 52 | 36 | 53 | 30 | 30 | 26 | 65 | 47.1 b |
| H5 | 72 | 22 | 52 | 36 | 14 | 38 | 14 | 49 | 37.2 c |
| Mean | 79.9 a | 45.7 bc | 49.3 b | 48.1 b | 28.6 de | 39.8 cd | 21.4 e | 68.4 a[z] | 47.5 |

[w] Primarily *F. moniliforme* was isolated.
[x] Northern locations: L1 = Fairfax, L2 = Spickard, and L3 = Novelty. Central locations: L4 = Marshall, L5 = Columbia, and L6 = Weldon Spring. Southeastern locations: L7 = Cape Girardeau and L8 = Portageville, all under dryland conditions.
[y] Hybrids: H1 = U.S. 13 (DX), H2 = Zimmerman Z254W (3X), H3 = DeKalb XL72AA (SX), H4 = PAG SX98 (SX), and H5 = Pioneer Brand 3183 (SX). Duplicate 100-kernel samples were from each hybrid at each location plated on potato-sucrose agar.
[z] Means for either locations or hybrids followed by the same letter are not significantly different ($P \leq 0.01$) according to Duncan's multiple range test.

**Table 3.** Effect of location environment on number of *Fusarium* spp.[w] isolated per 100 kernels of corn hybrids grown in Missouri in 1982[x]

| Hybrid[y] | Northern locations | | | Central locations | | | Southeastern locations | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | L1 | L2 | L3 | L4 | L5 | L6 | L7 | L8 | L9 | |
| H1 | 66 | 43 | 30 | 15 | 71 | 27 | 42 | 64 | 77 | 48.2 a[z] |
| H2 | 65 | 27 | 20 | 15 | 48 | 26 | 25 | 67 | 80 | 42.3 ab |
| H3 | 63 | 45 | 17 | 21 | 53 | 32 | 33 | 54 | 78 | 44.2 ab |
| H4 | 59 | 27 | 14 | 22 | 49 | 19 | 30 | 68 | 75 | 39.1 b |
| Mean | 63.4 b | 35.7 c | 20.2 d | 17.2 d | 55.2 b | 26.0 cd | 32.5 c | 63.6 b | 77.5 a[z] | 43.5 |

[w] Primarily *F. moniliforme* was isolated.
[x] Northern locations: L1 = Fairfax, L2 = Spickard, and L3 = Novelty. Central locations: L4 = Marshall, L5 = Columbia, and L6 = Columbia overhead-irrigated. Southeastern locations: L7 = Cape Girardeau, L8 = Portageville, and L9 = Portageville furrow-irrigated.
[y] Hybrids: H1 = U.S. 13 (DX), H2 = Golden Harvest H2680 (SX), H3 = DeKalb XL72AA (SX), and H4 = PAG SX98 (SX). Triplicate 100-kernel samples were from each hybrid at each location plated on potato-sucrose agar.
[z] Means for either locations or hybrids followed by the same letter are not significantly different ($P \leq 0.01$) according to Duncan's multiple range test.

Marshall, Columbia, and St. Charles (Weldon Spring) were located near the Missouri River across the central portion of the state. Overhead irrigation was used on some plots at Columbia. Plots in southeastern Missouri were along the Mississippi River near Cape Girardeau and Portageville. Furrow, surface-irrigation was used on some plots at the latter site.

## RESULTS AND DISCUSSION

The average number of colonies produced from 100 kernels was 58, with some kernels yielding more than one colony; most (38.6 colonies) were *Fusarium* spp. (Table 1). All of the other fungi combined produced only half this number of colonies per 100 kernels plated. Many fungal species produced less than one colony per 100 kernels. The mean number of *Aspergillus* and *Penicillium* spp. colonies per 100 kernels was high (5.2–6.2 colonies) because of their unusually high prevalence in 1980, when high temperatures and drought caused plant stress (6,7) (Table 1). Gulya et al (5) obtained similar results, but their higher percentages of infections may be due to the vulnerable nature of high-lysine corn. King and Scott (8), however, obtained higher percentages of *F. moniliforme* from natural infections of plants grown in Mississippi.

The number of *Fusarium* spp. colonies from kernels harvested in 1981 and 1982 varied significantly ($P \leq 0.01$) by hybrid and by location (Tables 2 and 3). The double cross U.S. 13 (H1) had significantly more *Fusarium* spp. colonies per 100 kernels than other hybrids in 1981 (Table 2). Kernels from the Fairfax (L1) and Portageville (L8) locations produced significantly ($P \leq 0.01$) more *Fusarium* spp. colonies than kernels grown at the other locations. The number of colonies ranged from six to 92 per 100 kernels (Table 2).

In 1982, the double cross U.S. 13 (H1) had fewer kernels that produced *Fusarium* spp. colonies than in the previous season (48 vs. 62), and the number of colonies differed significantly ($P \leq 0.01$) only from the single cross PAG SX 98 (H4) (Table 3). Kernels from the Fairfax (L1), Columbia (L5), and Portageville (L8) locations produced significantly ($P \leq 0.01$) fewer *Fusarium* spp. colonies than kernels from Portageville (L9) grown under furrow irrigation (61 vs. 78 colonies). Furrow irrigation apparently enhanced *Fusarium* spp. colonization (Table 3). Overhead irrigation at the Columbia (L6) site had the opposite effect, lowering plant stress and significantly ($P \leq 0.01$) decreasing the number of *Fusarium* spp. colonies from kernels compared with dryland conditions (55 vs. 26 colonies). The average number of *Fusarium* spp. colonies ranged from 14 to 78 colonies in 1982 (Table 3).

The predominant *Fusarium* spp. cultured from kernels were *F. moniliforme* Sheldon and *F. moniliforme* var. *subglutinans* Wollenw. & Reink. A question in Missouri and perhaps in other corn belt states is, do these fungi produce significant mycotoxins? These species may or may not produce one or more mycotoxins in the trichothecene family (9). *F. moniliforme* is reported to be the most widespread pathogen of maize in the United States (14). We found *F. moniliforme* in all hybrids at every location, although not all kernels of even a single hybrid were infected. We observed *F. graminearum* Schwabe colonies less frequently.

Our data show that *F. moniliforme* and *F. moniliforme* var. *subglutinans* are almost always found in kernels wherever corn is grown in Missouri and that different hybrids and different environments have significant effects in determining the number of kernels that are colonized.

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