# Maternal Influence on Response of Corn to Fusarium moniliforme

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ABSTRACT

Four inbred lines of corn were seeded in sand infested with *Fusarium moniliforme* and placed under fluorescent light banks. Stand counts showed that SC270P was the most resistant line, GEC119A was intermediate, and that SC155 and GA172 were most susceptible. Crosses were made among these four inbred lines to comprise a diallel series. The six diallel crosses, plus their reciprocals, were planted in flats of sand infested with *F. moniliforme*. Diallel analysis of emergence and stand counts from these tests showed that the general combining ability and maternal variances were highly significant. Specific combining ability and reciprocal variances were not significant. Therefore, additive gene action and maternal effects are more important than dominant gene action in the inheritance of resistance to seedling blight caused by *F. moniliforme*. This female control could be caused by maternal tissue of the seed or cytoplasmic factors in the embryo.

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*Additional key words:* infested sand, single-cross hybrid.

*Fusarium moniliforme* causes a seedling blight (1), which reduces stands of corn in the southern United States (6). Investigations showed that a toxin (3) produced by the fungus causes symptoms on corn seedlings like those caused by the fungus (8). Inoculated seedlings of some resistant × susceptible crosses were resistant to the fungus, but those of others were susceptible (4). These data suggested a maternal influence on the reaction of the hybrid to *F. moniliforme*.

The objectives of this study were (i) to gain information on the type of gene action conditioning resistant to *F. moniliforme,* and (ii) to determine if maternal effects influenced the reaction of single-cross hybrids.

MATERIALS AND METHODS.—Four inbred lines, and a diallel series of six single crosses plus reciprocals, were evaluated for their reaction to *F. moniliforme,* Sheld. emend. Snyd. & Hans. Inbred corn lines used were SC270P, GEC119A, GA172, and SC155. Seeds were produced by hand-pollinations of all combinations of these inbred lines and the reciprocals.

*F. moniliforme* was isolated from maize dwarf mosaic virus-infected johnsongrass growing on the Plant Science Farm of the Mississippi Agricultural and Forestry Experiment Station. The isolate was highly virulent in laboratory tests. The medium for growing the fungus was a mixture of 500 ml perlite, 50 ml cornmeal, and 100 ml of distilled water. This mixture was placed in 8 × 10-cm storage dishes and autoclaved for 15 minutes at 250 C. The medium was cooled overnight before inoculation. Five petri plates of *F. moniliforme* grown in Czapek's agar for 10 days at 24 C were comminuted in a sterile blender with 200 ml of sterile distilled water. Petri dishes with the sterile perlite-cornmeal medium were inoculated with 10 ml of a spore and mycelial fragment suspension, and were placed in an incubator at 20 C for 60 days.

Inoculations of inbreds and single-cross hybrids were carried out in 23 × 30-cm metal flats half-filled with sand. Four evenly-spaced furrows 1.5 cm deep were made in the sand with a small round piece of wood, 2 cm in diameter. The *F. moniliforme* grown on perlite-cornmeal was dislodged from the petri dishes and crumbled into small particles. For all inbred tests, perlite-cornmeal medium with the inoculum was applied at quantities of 25 $cm^3$, 50 $cm^3$, and 100 $cm^3$ per row. The 50-$cm^3$ level of inoculum was used to inoculate the single-cross hybrids. The inoculum was evenly distributed in the furrows, and gently packed with the bottom of a small glass beaker. Ten corn seeds per row were then placed on top of the inoculum, 3-5 cm of sand were added, and the flats were placed in larger metal trays to allow watering from the bottom. Plants were grown under fluorescent lights, with 12 hours of light per day at an intensity of 43,040 lux.

A split-plot design with six replications was used in the inbred test, with whole plots as inoculum levels, and split plots as inbred lines. A randomized complete-block design was used in the single-cross test, with four replications. Measurements taken in the inbred test were the number of plants emerged 6 days after planting, and stand counts of plants 2.5 cm in height, 15 days after planting. The diallel series was analyzed by the design developed by Cockerham (2). Measurements taken in the diallel series of 12 single crosses were the number of plants emerged 6 days after planting, and final stand counts of plants 2.5 cm in height 12 days after planting. Duncan's (9) multiple range test was used to test significant differences among treatment means.

RESULTS.—Evaluation of inbred responses to various inoculum levels showed significant differences among the four inbred lines at each inoculum level (Table 1). Emergence counts after 6 days showed that inbreds SC270P and GEC119A were more resistant than SC155 and GA172. Stand counts after 15 days showed similar results, except that SC270P appeared to be more resistant than GEC119A.

Diallel analysis of single-cross emergence counts 6 days after planting showed that general combining ability (GCA) and maternal variances were highly significant. Specific combining ability and nonmaternal reciprocal variances were not significant. Three of the four most resistant single crosses had SC270P as the maternal parent (Table 2). In the inbred test, SC270P was found to be the most resistant. The four most susceptible hybrids

TABLE 1. Comparison between percentage of plants of four inbred corn lines emerged after 6 days and those at least 2.5 cm tall 15 days after planting, at three inoculum levels of *Fusarium moniliforme*

| | Inoculum Levels[y] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Check | | 25 $cm^3$ | | 50 $cm^3$ | | 100 $cm^3$ | |
| Inbred | 6 days | 15 days | 6 days | 15 days | 6 days | 15 days | 6 days | 15 days |
| SC270P | 92 a[z] | 93 a | 65 a | 83 a | 32 a | 57 a | 37 a | 60 a |
| GEC119A | 82 a | 92 a | 47 b | 48 b | 32 a | 40 a | 27 a | 35 b |
| SC155 | 93 a | 93 a | 12 c | 18 c | 8 b | 10 b | 7 b | 5 c |
| GA172 | 92 a | 97 a | 28 c | 35 bc | 22 a | 18 b | 6 b | 12 c |

[y]The inoculum [grown 60 days in petri plates on autoclaved perlite-cornmeal-water (10:1:2, v/v) mixture] was crumbled into small particles and distributed (preplant, in flats of sand) into 30-cm rows from 25-, 50-, and 100-ml (≅ $cm^3$) beakers.
[z]Means not followed by the same letter within a column differ significantly, $P = 0.05$, as determined by Duncan's multiple range test.

TABLE 2. Comparison between percentages of plants emerged at 6 days, and those at least 2.5 cm tall 12 days, after planting of single-cross corn hybrids inoculated with *Fusarium moniliforme* at a level of 50 ml of inoculum[y]

| | Six days after planting | Twelve days after planting |
|---|---|---|
| Hybrid | Percentage emergence | Percentage of plants at least 2.5 cm in height |
| SC270P × SC155 | 57 a[z] | 60 a |
| SC270P × GA172 | 52 ab | 45 ab |
| GEC119A × SC270P | 45 abc | 40 abc |
| SC270P × GEC119A | 40 abc | 37 abc |
| GEC119A × SC155 | 30 bcd | 30 cde |
| GA172 × SC270P | 27 bcd | 37 cde |
| GEC119A × GA172 | 22 cd | 12 de |
| SC155 × SC270P | 20 cd | 17 cde |
| GA172 × SC155 | 10 d | 17 cde |
| SC155 × GA172 | 7 d | 10 e |
| SC155 × GEC119A | 7 d | 5 e |
| GA172 × GEC119A | 5 d | 5 e |

[y]The inoculum [grown 60 days in petri plates on autoclaved perlite-cornmeal-water (10:1:2, v/v) mixture] was crumbled into small particles and distributed (preplant, in flats of sand) into 30-cm rows from 25-, 50-, and 100-ml (≅ $cm^3$) beakers.
[z]Means not followed by the same letter within a column differ significantly, $P = 0.05$, as determined by Duncan's multiple range test.

had SC155 or GA172 as the maternal parent. These hybrids were shown to be the most susceptible in the inbred test. Diallel analysis of stand counts 12 days after planting were similar to those of the 6-day emergence test.

The two-way table shows that inbred SC270P contributed the most to general combining ability; thus, genetic differences existed among these hybrids, and the hybrid reactions were not caused entirely be maternal effects (Table 3). By +16 and +11 percentages of maternal differences, SC270P and GEC119A show an advantage when these inbreds are used as the female parent. Inbred GA172 does not contribute much (-2 percentage points). However, crosses with SC155 as the female parent, would be at a great advantage (-25 percentage points).

DISCUSSION.—In 1922, Eriksson (5) postulated that susceptibility to plant diseases could be maternally inherited. Most plant pathologists of that era were too busy criticizing Eriksson to peruse his theories. In 1969 and 1970, susceptibility to plant diseases was demonstrated to be maternally inherited. Male-sterile cytoplasm was shown to condition susceptibility of maize to yellow leaf blight, caused by *Phyllosticta maydis,* and southern corn blight, caused by *Bipolaris maydis* race T. Proof of this cytoplasmic control of susceptibility or maternal inheritance was easily shown because of the large differences between the resistance found in normal cytoplasm and the susceptibility in Texas male-sterile cytoplasm. This proved that the cytoplasmic factor has

TABLE 3. Percentage of corn, inoculated with 50 ml of *Fusarium moniliforme,* at least 2.5 cm in height 12 days after planting for diallel crosses

| | Male parent | | | | Mean for | Differences |
|---|---|---|---|---|---|---|
| Female parent | SC270P | GEC119A | GA172 | SC155 | female parents | contributing to GCA[x] |
| SC270P | . . . | 37 | 45 | 60 | 47 | 39 |
| GEC119A | 40 | . . . | 12 | 30 | 27 | 21 |
| GA172 | 37 | 5 | . . . | 17 | 20 | 21 |
| SC155 | 17 | 5 | 10 | . . . | 11 | 23 |
| Means for male parent | 31 | 16 | 22 | 36 | | |
| Maternal differences[w] | +16 | +11 | -2 | -25 | | |

[x]GCA = General Combining Ability, the average performance of all crosses involving one inbred line.
[w]Maternal differences over all crosses when a line was used as the female parent, as compared to when it was used as the male parent.

more control over susceptibility to these diseases than do nuclear genes (7).

In our study, we were not concerned with male sterility nor with differences between T and N cytoplasm. We were concerned with the inconsistent results when single-cross hybrids made between resistant and susceptible inbreds were inoculated with *F. moniliforme*. Evaluation of the diallel series among the four inbreds showed that general combining ability and maternal variances were highly significant. Therefore, additive gene action and maternal effects were more important than dominant action in the inheritance of resistance to seedling blight caused by *F. moniliforme*. These data show that resistance and susceptibility are strongly influenced by the maternal parent in hybrid combinations of maize. This female control could be caused by either maternal tissue of the seed, or cytoplasmic factors in the embryo.

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