Development of Gibberella Ear Rot on Processing Sweet Corn Hybrids Over an Extended Period of Harvest

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ABSTRACT

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Gibberella ear rot, caused by *Gibberella zeae*, has increased in prevalence recently on late-season processing sweet corn grown in North America. Little information is available about the development of Gibberella ear rot on processing sweet corn hybrids over extended periods of harvest. In five trials from 2003 to 2005, 12 processing sweet corn hybrids were inoculated with *G. zeae* and evaluated for severity of Gibberella ear rot on sequential harvest dates from 19 to 27 days after mid silk. Ear rot severity was assessed using a rating scale based on the percentage of kernels with visible symptoms of *G. zeae* colonization including kernel rot and mycelial growth. Severity ranged from 1.6 to 47.8% over the five trials. None of the hybrids was highly resistant to Gibberella ear rot, although some appeared to be less susceptible. Gibberella ear rot was less severe on three hybrids (GH 2690, GG 147, and Sprint) and more severe on three hybrids (GG 42, GG 145, and Jubilee). Other hybrids had moderate levels of ear rot or responses that varied among years. The relative response of hybrids did not change substantially during the extended period of harvest; however, the rate at which Gibberella ear rot developed on hybrids differed in 2003 and 2005 as reflected by a significant hybrid by harvest interaction. The interaction was primarily the result of Gibberella ear rot developing more severely on susceptible hybrids than on the less susceptible hybrids. The difference in Gibberella development could be exploited to limit losses due to this disease under certain circumstances. If a sweet corn processor had several fields ready to harvest at the same time, and some fields were planted with hybrids that are more susceptible while other fields were planted with hybrids that are less susceptible, losses due to Gibberella ear rot might be minimized by harvesting the most susceptible hybrids first. Other hybrids that might be best suited for early or late harvest can be identified from Gibberella ear rot ratings 28 days after silk channel inoculation at the mid silk growth stage.

Gibberella ear rot, caused by *Gibberella zeae* (Schwein.:Fr.) Petch (anamorph: *Fusarium graminearum* Schwabe), is a significant problem on corn (*Zea mays* L.) in many areas of the world. Although Gibberella ear rot usually occurs sporadically, it has increased in prevalence recently on late-season processing sweet corn grown in North America (4). This increase is a concern to commercial sweet corn processors because Gibberella ear rot greatly reduces the quality of the crop. In some cases, sweet corn infected by *G. zeae* has failed to pass quality standards due to discolored kernels (4). Mycotoxins also are a concern. Grain infected by *G. zeae* may contain deoxynivalenol (DON) and zearalenone. DON is responsible for emesis and feed refusal in swine. Zearalenone F-2 is responsible for estrogenic mycotoxicoses with symptoms such as enlargement of the uteri and mammary glands, vulvar swelling, vaginal prolapse, and atrophy of testes (1,16,22,23).

Symptoms of Gibberella ear rot usually start at the tip of the ear and spread toward the base, although in some cases, the disease starts in the basal end of the ear (22). As the fungus spreads, a red or pink mold may develop over a large portion of the ear. Unlike *Fusarium* ear rot, which infects scattered kernels on the ear, Gibberella ear rot can infect large, contiguous groups of kernels (22). Infection occurs when spores land on emerged silks. Mycelia colonize the silk channel and grow to developing kernels (14). Gibberella ear rot is prevalent in areas with cool, wet weather at flowering (22). The disease is exceptionally damaging from the time of silking through the period of grain fill (5,24,25).

In the Corn Belt of the United States, corn is typically grown in a short rotation with one or two other crops. As a consequence of reduced tillage, corn debris remains on or near the soil (12). Debris can be the source of primary inocula for Gibberella ear rot (22). The effects of tillage, crop rotation, and nutrients on the amount of primary inoculum have been studied (6,20). Flett et al. (6) noted that plowing under corn stubble did not reduce the amount of *Fusarium* spp. inoculum. Reid et al. (20) noted that severity of Gibberella ear rot increased with higher rates of nitrogen (200 kg N ha⁻¹).

Developing resistant hybrids is the best approach for controlling Gibberella ear rot (18). Corn germ plasm varies for reaction to *G. zeae* (7,9–11,13,14,17,18,25). Reid et al. (13,15,17,18) have conducted many studies on resistance to *G. zeae* in corn while evaluating methods of inoculation and components of resistance, such as silk age. Reid et al. (17) observed that severity of ear rot symptoms following silk channel inoculation differed significantly among inbreds and that some lines of corn expressed resistance mechanisms in the silk. Decreases in silk channel length and water content of exposed silk partially accounted for changes in resistance over time within individual inbreds (13). Reid et al. (13) also noted that all plants should be inoculated at the same stage of development to prevent misclassification of the level of resistance when silk inoculation methods are used to screen for *G. zeae*. Reid et al. (18) also concluded that the performance of some hybrids infected by *F. graminearum* could not be predicted simply on the basis of the performance of inbreds or the genetic combining ability of the parents.

The sporadic occurrence of epidemics of Gibberella ear rot requires the use of inoculation to efficiently screen germ plasm for resistance (4,7,10,13,14,17–19,21,27). Numerous studies have evaluated the most suitable method of inoculation (2–5,8,15,21,25). Some inoculation methods involve physical injury of the kernels or cobs to mimic entry of *G. zeae* through wounds (2,3,8). Other methods, such as injecting the silk channel with a spore suspension or inserting an infected toothpick into the silk channel, mimic infection through silks without direct damage to kernels (2,4,5,7,9,10,15,17–19,23,25,27). Inoculation by inserting a colonized wooden toothpick down the silk channel produced high levels of ear mold and provided adequate differentiation of germ plasm (5). Schaafsma et al. (21) noted that wound inoculation resulted in similar levels of disease when plants were inoculated 1, 3, and 6 weeks after silk emergence. Conversely, when 2 ml of spore suspension was injected into the silk channel, severity of ear rot declined as time of inoculation was delayed after silking, and detection of resistance between hybrids was more difficult (21). In a comparison of toothpick and silk channel injection methods of inoculation, du Toit and Pataky (4) found that the toothpick method of inoculation required less effort and ranked sweet corn hybrids

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as consistently as or more consistently than the injection method. Comparing inoculation with one or several isolates of *G. zeae*, Reid et al. (19) concluded that one sufficiently aggressive isolate or a mixture of isolates could be used to screen for resistance.

Many sweet corn hybrids have been reported to be susceptible to *G. zeae* (4,9). None of 33 commercial sweet corn hybrids inoculated with *G. zeae* by Hart et al. (9) was completely resistant, and only five had less than 25% of the ear colonized by *G. zeae*. Mold development ranged from about 25 to 75% on ears of 28 of the 33 hybrids. Similarly, none of 52 processing sweet corn hybrids screened for reactions to *G. zeae* by du Toit and Pataky (4) was extremely resistant to Gibberella ear rot. Since these hybrids represented the main germ plasm used by commercial food processors in the United States, commercially available processing hybrids appeared to lack high levels of resistance to Gibberella ear rot.

Under various environmental conditions, processing sweet corn can be harvested over an extended period of time from about 21 to 30 days after the mid silk growth stage. Timing of harvest is critical because quality (e.g., tenderness, sugar content, kernel moisture) declines with advancing maturity. Under certain circumstances, several fields planted with different hybrids may be ready to harvest at the same time, especially when temperatures are higher than normal. If the rate of Gibberella ear rot symptom development differs among commercial sweet corn hybrids grown for processing, processors may use this knowledge to adjust harvest schedules to their advantage. For example, processors may begin harvest with hybrids that quickly develop Gibberella ear rot in order to avoid severe levels of disease on those hybrids, while harvest may be delayed for hybrids with symptoms that develop slowly. The objective of this study was to determine if the development of *G. zeae* differed among 12 processing sweet corn hybrids when the harvest period was extended by about 1 week.

MATERIALS AND METHODS

Processing sweet corn hybrids were evaluated for the development of Gibberella ear rot in trials planted in 2003, 2004, and 2005 at the University of Illinois South Farm, Urbana. A trial planted 20 May 2003 included 12 processing sweet corn hybrids and three harvest times at which ear rot was assessed. Four hybrids were included as controls based on results in previous research (4). GG 42 and Jubilee were susceptible controls. GH 2690 and Sprint were the less susceptible controls (4). The experimental design was a split-plot of a randomized complete block with four replicates of a 12 by 3 factorial treatment design. Hybrids were planted in main

plots. In subplots, ears were harvested and rated for severity of infection at three times: 19 to 21 days, 23 to 26 days, and 27 to 30 days after the mid silk growth stage, which was recorded for each hybrid as the date at which 50% of the plants had approximately 1 to 2 cm of silk extending from the husk leaves. An experimental unit was a single row 3 m long with approximately 15 plants per row. Rows were spaced 0.76 m apart.

Subsequent trials were planted 22 May and 1 June 2004 and 10 and 23 May 2005. These trials included 12 hybrids and five harvest times at which severity of Gibberella ear rot was assessed. The experimental design was a split-plot of a randomized complete block with four replicates of the 12 by 5 factorial treatment design. Hybrids were planted in main plots. In subplots, ears were harvested and rated for severity of infection at five times: 19, 21, 23, 25, and 27 days after mid silk. An experimental unit was a single row 3 m long with approximately 15 plants per row. Rows were spaced 0.76 m apart.

Plants were inoculated with *G. zeae*, using the toothpick method. Square wooden toothpicks with round tips were autoclaved five times in distilled water (4,5,9,27). Toothpicks were placed in 800-ml glass beakers to which 300 ml of distilled water was added. A large glass petri dish lid was placed on top of the beaker to keep toothpicks in place during sterilization. Toothpicks were autoclaved at 116°C for 15 min at 103 kPa. After cooling, toothpicks were rinsed in distilled water and autoclaved again. This process was repeated five times. After being autoclaved in water five times, the toothpicks were rinsed in distilled water and placed on end into a 400 ml glass beaker to which 100 ml of potato dextrose broth was added. A glass petri dish lid was again placed over the toothpicks and the toothpicks were autoclaved at 116°C for 15 min at 103 kPa. The toothpicks were then stored in the sterile potato dextrose broth for 3 days. Twenty or thirty toothpicks were then placed in a lattice fashion two or three layers deep on potato dextrose agar in a petri plate (100 × 15 mm). In 2003 and 2005, each plate was inoculated with a 4-mm plug from a 3- to 4-day old culture of *G. zeae*. In 2004, the plates were inoculated by flooding with 3 to 4 ml of a ground suspension of *G. zeae* cultures. Cultures were grown for approximately 2 to 3 weeks under a 12-h cycle of light and dark at room temperature (23 ± 2°C) until mycelial growth was abundant on the toothpicks. A single isolate of *G. zeae* was used each year. Isolates used in 2004 and 2005 produced perithecia on the toothpicks.

Primary ears of each hybrid were inoculated approximately 7 days after the mid silk growth stage by inserting a single toothpick colonized by *G. zeae* into the silk channel. Primary ears infected natu-

rally by *Ustilago maydis* (common smut) were removed and secondary ears were inoculated if present. Plants that did not have ears with silk present at the time of inoculation were removed.

In 2003, each hybrid was harvested 19 to 21 days, 23 to 26 days, and 27 to 30 days after the mid silk growth stage. In 2004 and 2005, each hybrid was harvested 19, 21, 23, 25, and 27 days after mid silk (12, 14, 16, 18, and 20 days after inoculation). Harvested ears were husked by hand. Severity of ear rot symptoms was assessed using a rating scale based on the percentage of kernels with visible symptoms of *G. zeae* colonization including kernel rot and mycelial growth. Individual ears were rated from 0% (no visible symptoms present) to 100% severity. Means were calculated from all ears in an experimental unit.

Data were analyzed by analysis of variance using PROC GLM of SAS (SAS Institute, Cary, NC). Individual trials were analyzed separately and a combined analysis was done for the four trials in 2004 and 2005 for which the treatment design was the same. Treatment means for hybrids, harvest times, and the hybrid by harvest time interaction were compared using Fisher's protected least significant difference (LSD) at $\alpha = 0.05$ based on the ANOVA. FLSD-values at $\alpha = 0.20$ also were reported in order to protect against Type II errors, although data were interpreted based on $\alpha = 0.05$. Hybrid reactions were ranked within harvest times based on mean severity of ear rot weighted by number of ears per replicate. Correlation coefficients were calculated among trials using hybrid by harvest time treatment means.

RESULTS

Gibberella ear rot was more severe in the 2003 and 2005 trials than in the 2004 trials. Mean ear rot severity at the first harvest was similar among years, ranging from 8.9 to 11.3%. By the last harvest, mean severity was 31.4% in 2003, 21.7% in 2005, but only 13% in 2004. In the combined ANOVA for the four trials in 2004 and 2005, severity differed significantly among trials, hybrids, and harvest times. All interaction terms involving trials were significant and accounted for a substantial amount of variation. Also, correlation coefficients for hybrid by harvest date means were low ($r < 0.4$) between trials done in 2004 and 2005 even though correlation coefficients were higher ($r > 0.6$) between the two trials within each year (Table 1). Because of differences in severity between years, data were analyzed within years.

Trial in 2003. In 2003, severity of Gibberella ear rot differed significantly ($\alpha = 0.05$) among hybrids and harvest times. The hybrid by harvest time interaction also was significant ($\alpha = 0.05$). Mean ear rot severity averaged across all hybrids increased from 10.3 to 31.4% between the

first and third harvests (Table 2). Among hybrids, ear rot severity ranged from 2.1 to 17.8% at the first harvest (19 to 21 days after mid silk), from 8.1 to 40.8% at the second harvest (23 to 26 days after mid silk), and from 13.3 to 47.8% at the third harvest (27 to 30 days after mid silk) (Table 2).

Mean ear rot severity was lowest on GH 2690 at each harvest (Table 2). Ear rot severity on GG 147 and Sprint was not significantly different ($\alpha = 0.05$) than GH 2690 at two of the three harvests. Mean ear rot severity was highest on GG 42 at the first and third harvests, and second highest on GG 42 at the second harvest. Severity of ear rot on GG 145 and Jubilee was not significantly different ($\alpha = 0.05$) from GG 42 at two of three harvests. Two hybrids (GG 148 and GG 67) had consistently moderate ear rot ratings that were significantly different ($\alpha = 0.05$) from the lowest (GH 2690) and the highest (GG 42) at each harvest. GG 64, GG 143, GG 144, and GG 146 also had moderate ear rot ratings that were significantly different ($\alpha = 0.05$) from the highest and lowest at two of the three harvests.

Trials in 2004. In 2004, interaction terms involving trials were not significant except for the hybrid by trial interaction which accounted for less than 5% of the total variation. The correlation coefficient for hybrid by harvest time mean severity was 0.79 between the two trials (Table 1). Therefore, data from the two trials in 2004 were combined for analysis. Severity of *Gibberella* ear rot differed among hybrids and harvest times, but the hybrid by harvest time interaction was not significant. Therefore, main effect means were compared. Mean ear rot severity increased only slightly between the first and last harvests, 19 and 27 days after mid silk, respectively (Table 3). Among hybrids, mean ear rot severity over all harvest times ranged from 3 to 12.8%. Mean ear rot severity was lowest on GH 2690 and was not above 5% at any harvest. Mean ear rot severity was highest on Jubilee and was above 10% at all harvests except 19 days after mid silk. Ear rot severity was not significantly different among Jubilee and GG 42, GG 64, GG 145, GG 146, and GG 147. Mean ear rot severity was moderate for Sprint, GG 67, GG 143, GG 144, and GG 148. Severity on these hybrids was significantly ($\alpha = 0.05$) greater than that on GH 2690 and significantly ($\alpha = 0.05$) less than that on Jubilee.

Trials in 2005. In 2005, interaction terms involving trials accounted for a small amount of the total variation, and the correlation of hybrid by harvest time means was 0.61 (Table 1). Therefore, data from the two trials in 2005 were combined for analysis. In 2005, severity of *Gibberella* ear rot differed among hybrids and harvest times, and the hybrid by harvest time interaction also was significant ($\alpha = 0.05$).

Mean ear rot severity averaged across hybrids increased from 11.3 to 21.7% between harvests at 19 and 27 days after mid silk, respectively. Among hybrids, severity ranged from 7.4 to 17.7% 19 days after mid silk, from 9.8 to 26.3% 21 days after mid silk, from 10.2 to 31.3% 23 days after mid silk, from 11.2 to 35.2% 25 days after mid silk, and from 13.8 to 40.4% 27 days after mid silk (Table 4). Mean ear rot severity was lowest on GG 147 at four of five harvests. Ear rot severity also was low on GG 67, GG 143, and GG 144 and was not significantly different ($\alpha = 0.05$) from GG 147 at four of five harvests. Ear rot severity was highest on GG 42 at each harvest. Four hybrids (GG 64, GG 148, GH 2690, and Jubilee) had consistently moderate ear rot that was significantly different ($\alpha = 0.05$) from GG 147 and GG 42 at each harvest. Two hybrids (GG 145 and GG 146) had moderate ear rot that was significantly different

($\alpha = 0.05$) from GG 147 and GG 42 at four of five harvests. Sprint had moderate ear rot that was significantly different ($\alpha = 0.05$) from GG 147 and GG 42 at three of five harvests.

Weather. Weather differed somewhat among the five trials. From the time that the first hybrid was inoculated until the first harvest, average temperature ranged from 20 to 25°C and total rainfall ranged from 16.5 to 101.3 mm among the five trials (Table 5). From the first harvest until the last harvest, average temperature ranged from 17 to 25°C, and total rainfall ranged from 4.8 to 21.8 mm among the five trials. When severity of ear rot did not increase substantially between the first and last harvest in 2004, the average temperatures during the period from the first to last harvest were 4 to 7°C lower than the average temperatures for these periods in 2003 and 2005. Also during the harvest period in 2004, minimum temperatures were unsea-

Table 1. Correlation coefficients for severity (%) of *Gibberella* ear rot on 12 processing sweet corn hybrids inoculated with *Gibberella zeae* and harvested on sequential harvest times for all trials in 2003, 2004, and 2005

Year	Trial	Years and trials			
		2004		2005	
		1	2	1	2
2003		0.65 ^a	0.67	0.36	0.74
2004	1	...	0.79 ^b	-0.12	0.31
	2		...	-0.03	0.37
2005	1			...	0.61
	2				...

^a Correlation coefficients for trials in 2003 based on means of 36 combinations of 12 hybrids by three harvest dates.

^b Correlation coefficient for trials in 2004 and 2005 based on means of 60 combinations of 12 hybrids and five harvest dates.

Table 2. Severity (%) of *Gibberella* ear rot on 12 processing sweet corn hybrids inoculated with *Gibberella zeae* and rated at three sequential harvests in 2003

Hybrid	2003			
	First harvest ^a	Second harvest ^b	Third harvest ^c	Mean ^d
GH 2690	2.1 ^e	8.1	13.3	7.8
GG 147	6.2	14.5	24.0	14.9
Sprint	15.1	16.5	23.1	18.2
GG 64	9.3	24.5	21.1	18.3
GG 143	13.7	12.3	29.9	18.6
GG 144	10.8	13.8	36.8	20.5
GG 148	9.1	27.6	27.6	21.4
GG 67	8.5	28.0	29.2	21.9
GG 146	10.5	33.3	36.3	26.7
GG 145	10.7	37.2	41.1	29.7
Jubilee	10.0	40.8	46.2	32.3
GG 42	17.8	37.3	47.8	34.3
Mean	10.3	24.5	31.4	...
FLSD ^f at $\alpha = 0.05$	4.0	8.6	10.1	...
FLSD ^g at $\alpha = 0.20$	2.6	5.6	6.6	...

^a First harvest, 19 to 21 days after mid silk.

^b Second harvest, 23 to 26 days after mid silk.

^c Third harvest, 27 to 30 days after mid silk.

^d Mean = weighted mean severity for all harvests in 2003.

^e Weighted mean ear rot severity (0 to 100%) based on visual ratings of percentage of an ear colonized by *G. zeae*.

^f FLSD = Fisher's protected least significant difference at $\alpha = 0.05$.

^g FLSD = Fisher's protected least significant difference at $\alpha = 0.20$.

sonably low (9 to 11°C) and maximum temperatures (29 to 30°C) were cooler than normal. Although Gibberella ear rot is reported to be favored by cool, wet weather (26), we observed greater ear rot development under slightly warmer conditions of 2003 and 2005.

DISCUSSION

Despite some hybrids with lower and higher levels of Gibberella ear rot in these trials, the variation in reaction to *G. zeae* among hybrids was small. None of the hybrids was highly resistant to Gibberella ear rot, although some (e.g., GG42, GG

145, and Jubilee) appeared to be more susceptible. When hybrids were broadly categorized for levels of Gibberella ear rot as low (not significantly different from the lowest severity), moderate (significantly different from the lowest and highest severity), and high (not significantly different from the highest severity), three hybrids appeared to be more resistant and three appeared to be more susceptible (Table 6). Gibberella ear rot was less severe on GH 2690, GG 147, and Sprint in two of the three years, and more severe on GG 42, GG 145, and Jubilee. In a previous trial, GG 42 and Jubilee were among a group of hybrids with more severe ear rot 28 days after mid silk, and GH 2690 and Sprint were among a group of hybrids with less severe ear rot 28 days after mid silk (4). Other hybrids had moderate levels of ear rot or they varied among years from low to high levels of ear rot. The rate at which Gibberella ear rot developed on hybrids differed in 2003 and 2005 as evident from a significant hybrid by harvest interaction. Nevertheless, the relative response of the hybrids remained the same during the harvest period (i.e., hybrids that were more susceptible at early harvest dates had severe ear rot at later harvests, and hybrids that were less susceptible at early harvest had less severe ear rot at later harvests). Hence, the interaction was not due to substantial rank changes among hybrids across harvest times but was primarily the result of a faster rate of progress of Gibberella ear rot on susceptible hybrids than on the less susceptible hybrids. This difference in Gibberella development could be exploited to limit losses due to this disease under certain circumstances.

Based on the results of these and previous trials, there appear to be a few processing sweet corn hybrids that are more susceptible to Gibberella ear rot than others. If a sweet corn processor had several fields ready to harvest at the same time, and some fields were planted with hybrids that were more susceptible while other fields were planted with hybrids that were less susceptible, losses due to Gibberella ear rot might be minimized by harvesting the most susceptible hybrids first because, based on our results, Gibberella ear rot will progress more rapidly on the highly susceptible hybrids during an extended or delayed harvest period. Of the hybrids

Table 3. Severity (%) of Gibberella ear rot on 12 processing sweet corn hybrids inoculated with *Gibberella zeae* and rated at five sequential harvests in 2004

Hybrid	Days after mid silk					Mean ^a
	19	21	23	25	27	
GH 2690	1.6 ^b	2.5	3.2	3.0	4.9	3.0
Sprint	7.2	10.6	9.8	10.5	11.1	9.8
GG 67	9.2	11.4	10.2	12.0	12.1	11.0
GG 148	9.5	9.5	11.4	13.0	13.6	11.4
GG 144	11.1	10.4	12.2	11.7	12.7	11.6
GG 143	10.2	10.1	12.2	12.5	13.7	11.7
GG 147	9.4	12.5	11.3	12.1	13.5	11.8
GG 145	9.7	11.3	9.6	12.9	15.5	11.8
GG 146	9.6	10.5	12.5	13.5	14.3	12.1
GG 42	9.3	11.5	12.1	13.6	15.1	12.3
GG 64	9.8	11.5	12.1	13.9	14.4	12.3
Jubilee	9.6	12.9	12.1	14.6	14.5	12.8
Mean	8.9	10.4	10.7	11.9	13.0	...
FLSD ^c at $\alpha = 0.05$	1.8	2.0	2.3	2.2	3.3	1.0
FLSD ^d at $\alpha = 0.20$	1.1	1.3	1.5	1.4	2.1	0.7

^a Mean = weighted mean severity for all harvests in 2004.

^b Weighted mean ear rot severity (0 to 100%) based on visual ratings of percentage of an ear colonized by *G. zeae*.

^c FLSD = Fisher's protected least significant difference at $\alpha = 0.05$.

^d FLSD = Fisher's protected least significant difference at $\alpha = 0.20$.

Table 4. Severity (%) of Gibberella ear rot on 12 processing sweet corn hybrids inoculated with *Gibberella zeae* and rated at five sequential harvests in 2005

Hybrid	Days after mid silk					Mean ^a
	19	21	23	25	27	
GG 147	7.4 ^b	9.8	10.2	11.2	15.3	10.8
GG 143	11.0	11.4	11.6	13.4	14.0	12.3
GG 144	12.3	12.4	12.6	13.6	13.8	12.9
GG 67	8.2	12.5	12.9	16.6	18.7	13.8
Sprint	12.8	13.8	12.7	16.0	16.3	14.3
GG 145	8.7	13.5	16.1	20.6	22.3	16.2
GG 64	13.2	16.1	16.5	17.1	19.2	16.4
GG 146	9.4	15.0	16.5	19.2	23.1	16.6
GG 148	11.6	15.4	16.7	20.8	22.5	17.4
Jubilee	12.5	16.4	19.7	22.2	26.8	19.5
GH 2690	10.3	14.3	24.8	25.2	27.8	20.5
GG 42	17.7	26.3	31.3	35.2	40.4	30.2
Mean	11.3	14.7	16.8	19.3	21.7	...
FLSD ^c at $\alpha = 0.05$	2.1	2.9	3.2	3.5	4.9	...
FLSD ^d at $\alpha = 0.20$	1.4	1.9	2.1	2.3	3.2	...

^a Mean = weighted mean severity for all harvests in 2005.

^b Weighted mean ear rot severity (0 to 100%) based on visual ratings of percentage of an ear colonized by *G. zeae*.

^c FLSD = Fisher's protected least significant difference at $\alpha = 0.05$.

^d FLSD = Fisher's protected least significant difference at $\alpha = 0.20$.

Table 5. Average daily temperature and total rainfall following inoculation and during harvest of trials in 2003, 2004, and 2005

Year	Trial	Inoculation to 19 DAI ^a				19 DAI to 27 DAI			
		Rainfall (mm)	Average daily temperature (°C)			Rainfall (mm)	Average daily temperature (°C)		
			Mean	Minimum	Maximum		Mean	Minimum	Maximum
2003		22.9	22	13	32	4.8	24	14	33
2004	1	16.5	22	22	32	21.8	17	9	29
	2	37.8	20	9	31	12.4	20	11	30
2005	1	101.3	25	13	35	1.8	24	13	34
	2	49.5	25	13	35	14.7	25	18	36

^a Days after inoculation.

Table 6. Categories^a of hybrid reaction to *Gibberella* ear rot following inoculation in 2003, 2004, and 2005

Hybrid	Level of severity		
	2003	2004	2005
GH 2690	Low	Low	Moderate
GG 147	Low	High	Low
Sprint	Low	Moderate	Moderate to low
GG 67	Moderate	Moderate	Low
GG 143	Moderate	Moderate	Low
GG 144	Moderate	Moderate	Low
GG 148	Moderate	Moderate	Moderate
GG 64	Moderate	High	Moderate
GG 146	Moderate	High	Moderate
GG 145	High	High	Moderate
Jubilee	High	High	Moderate
GG 42	High	High	High

^a Categories: low = not significantly different ($\alpha = 0.05$) from the lowest severity for at least two of three harvests in 2003 and for at least four of five harvests in 2004 and 2005; moderate to low = significantly different ($\alpha = 0.05$) from the lowest and highest severity for at least three of five harvests, and not significantly ($\alpha = 0.05$) different from the lowest severity for at least two of five harvests in 2005; moderate = significantly different ($\alpha = 0.05$) from the lowest and highest severity for at least two of three harvests in 2003 and for at least four of five harvests in 2004 and 2005; and high = not significantly different ($\alpha = 0.05$) from the highest severity for at least two of three harvests in 2003 and for at least four of five harvests in 2004 and 2005.

evaluated in our trials, Jubilee, GG 42, and GG 145 were more susceptible and might need to be harvested sooner than the less-susceptible hybrids GH 2690, Sprint, and GG 147 in order to minimize losses due to *Gibberella* ear rot. To identify other hybrids that might be best suited for early or late harvest, *Gibberella* ear rot ratings at 28 days after mid silk appear to be adequate based on the relative consistency of hybrid responses during the extended harvest period evaluated in these trials and the greater differences in severity of *Gibberella* ear rot among hybrids at the later harvest time.

Differences in hybrid reactions among the trials in our study may have been affected by the environment. In previous studies, phenotypic response of corn lines to *G. zeae* varied among environments and years (4,11,13). Hooker (11) noted that ear rot ratings of 25 field corn inbreds did not correlate between 2 years. Reid et al. (13) also noted that the resistance to silk infection by *F. graminearum* following injection of a spore suspension into the silk channel was not expressed under all environments. For 52 sweet corn hybrids evaluated for *Gibberella* ear rot 28 days after the mid silk growth stage, du Toit and Pataky (4) observed rank changes among years. Additional information on the effects of environment on *Gibberella* ear rot development between silking and 28 days after silking also could be useful in evaluating reaction of sweet corn hybrids and making harvest decisions.

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