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Managing Field Corn Infected with Common Rust

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Introduction

Common corn rust (*Puccinia sorghi* Schw.) can be found in most temperate areas of the world where corn (*Zea mays* L.) is grown. Disease development depends upon the presence of the pathogen, favorable temperature, and humidity. In temperate regions, the uredospore stage of the fungus is considered too fragile to overwinter.

Thus, the uredospores needed to initiate rust epidemics are believed to be windblown into the continental U.S. from tropical and subtropical areas. Germination of spores of the common rust fungus may occur over a wide range of relatively cool temperatures (approximately 54�F to 82�F) and requires nearly 100% humidity for several hours (Headrick and Pataky 1987). These conditions frequently occur during the early part of the growing season in the Midsouth. Thus, monitoring uredospore populations of common rust on corn is considered more useful than using weather-based forecasts to determine the need for fungicidal control.

Common rust rarely causes significant yield reduction of dent corn grown in temperate regions. Yield reductions are more likely in tropical areas and where corn planting is staggered throughout the growing season. In Hawaii, common rust reduced grain yield of 10 double-cross hybrids an average of 35%, compared with the paired resistant hybrids (Kim and Brewbaker 1976). Fungicide applications have been used to reduce disease severity and increase sweet corn yields when common rust was severe (Dillard and Seem 1990).

Corn grain development is very sensitive to stress timing. Corn is extremely susceptible to different kinds of environmental stress, including water deficit (Grant et. al 1989), light deficit (Kiniry and Ritchie 1985) and defoliation (Shapiro et al. 1986) from silking to approximately 2 weeks after silking. These stresses reduce grain yield by limiting photosynthesis. During pollination, corn grain development is extremely dependent upon current photosynthate production, even when accumulated carbohydrates are plentiful (Schussler and Westgate 1991). The sink capacity of the ear is limited, compared with stalks, during this transition from vegetative to reproductive growth (Edmeades and Daynard 1979; Setter and Meller 1984).

Although common rust epidemics are rare, the amount and timing of common rust development on Mississippi field corn during the 1997 growing season warranted evaluation of fungicidal control. The primary objective of this study was to determine whether fungicide application would control common rust development in field corn and improve grain yields.

Materials and Methods

Four grower field sites were selected to evaluate common rust control using fungicides. Pioneer 3223 (Pioneer Hi-Bred International, Inc., 1997), a corn hybrid susceptible to common rust, was grown at sites 1, 2, and 3. Pioneer 3394, a moderately resistant hybrid, was grown at site 4. A fungicide treatment of either propiconazole (4 ounces of Tilt per acre) or mancozeb (1.5 pounds of Dithane DF per acre) was applied aerially from either an

Air Tractor 402 Turbine or 502 Turbine airplane traveling at 130-140 mph. The spray adjuvant Latron CS-7 was added to the Dithane DF treatment at 0.25% by volume to improve initial spray deposit, fungicide redistribution, and weatherability. The fungicide treatments were applied at 25-32 pounds per square inch in a spray volume of 5 gallons per acre at an altitude of 4-8 feet above the crop canopy. The airplane was equipped with CP nozzles, manufactured by CP Products, Co., Inc., angled straight back with the deflector set at 45 degrees. The treatments were applied in adjoining blocks. A sequential treatment of Dithane DF was applied as an additional treatment 1 week after the initial application.

Visual estimates of rust severity were performed on corn ear leaves at weekly intervals after fungicide application. These ratings were based upon percentage of the total leaf area infected with uredinia (pustules) using the Peterson scale (1948). Rust severity at different time intervals represented a cumulative estimate of uredinia. Twenty ear leaves randomly selected from plants were evaluated for each treatment. Data were analyzed as a series of completely randomized designs combined over sampling dates and sites.

Grain yield was estimated by hand harvesting ears from 0.001-acre plots within each block and shelling them in a manual single-ear sheller. Grain yields were calculated from grain weights, and moisture was adjusted to 15.5% moisture. Three replications were evaluated for each treatment. Data were analyzed as a series of completely randomized designs combined over sites.

Results

Common rust was first detected in the 1997 growing season during the first week of June. The state average daily temperature during this week was 71�F, which is 5�F below normal. Symptomatic corn was at the V9-V12 growth stages as defined by Ritchie et al. (1996). Cool, humid environmental conditions promoted rapid disease spread and development over the next several weeks. The average daily temperature did not reach the 82�F upper developmental threshold for common rust until the first week of July. Common rust development was minimal after this time.

Fungicide application controlled rust development, compared with untreated checks. Rust severity on ear leaves 1 week after fungicide treatment was significantly reduced at each site, except site 2, where no data were collected at this interval (Figures 1-4). The reduction in disease severity by fungicide treatment averaged 41%, compared with the untreated plots. This level of control is slightly less than the 50% to 60% levels reported by Pataky and Eastburn (1993) and Raid (1994). Control differences were no longer evident between treated and untreated plots 2 weeks after treatment at site 1 and 4 weeks after treatment at sites 2 and 4. Rust severity was only measured 4 weeks after treatment at site 2 (Figure 2). Although the use of two applications of Dithane was more effective than one application at lowering rust severity, the treatments were not significantly different.

Fungicide efficacy appears to be associated with fungicide application timing relative to crop development stage. Fungicide efficacy lasted longer when the corn was treated at an earlier vegetative growth stage. Differences in rust severity between treated and control plots were no longer evident after pollination, except at site 3. This finding could have two possible causes: hybrids becoming more resistant to common rust infection after pollination as reported by Headrick and Pataky (1987); and/or average daily temperatures exceeding the upper developmental threshold for common rust. The hybrid grown at site 4 is also moderately resistant to common rust.

Yield response resulting from fungicide treatment was dependent upon factors at each site. Fungicide application significantly improved grain yield at site 3 (Table 1). There was no significant difference between treatments at the other locations, although the yield was slightly higher with fungicide application. The cultural factors for sites 2 and 3 were similar, except for timing of the fungicide application. The fungicide application at site 2 did not occur until the corn reached V18 stage. At site 3, the fungicide was applied at the V12 growth stage. Therefore, early fungicide treatment timing increased the likelihood of yield improvement associated with control of common rust. Sites 3 and 4 were grown under similar culture, except that the hybrid grown at site 3 was susceptible to common rust. Thus, the lack of yield response at site 4 may be due to the moderate disease resistance of this hybrid. The lack of yield response at site 1 may be related to the yield level. Location 1 was not irrigated and produced lower grain yields compared with the other locations. Sites 2, 3, and 4 were all irrigated and produced grain yield levels exceeding 150 bushels per acre. This is considered a high yield level for any region of the world. Thus, the magnitude of yield response to fungicide treatment of common rust was reduced in a lower-yielding environment, probably due to other limiting factors.

Table 1. Corn grain yield response to fungicide treatments. [1]			
Location	**Untreated**	**Treated**	**Treated twice**
	bu/A	bu/A	bu/A
Site 1	130a	134a	--
Site 2	199a	208a	--
Site 3	156b	189a	183a
Site 4	220a	218a	232a
[1]Values assigned the same letter are not significantly different at the 0.05 level of probability.			

Conclusions

The timing of common rust infection in relation to corn growth stage can critically influence the amount of potential grain yield reduction and fungicidal effectiveness. Common rust development on corn was reduced by fungicide application before tasseling. Fungicidal control of common rust increased yield of a susceptible hybrid grown in a high-yielding environment, compared with an untreated control. This improved grain yield is especially significant since the high-yielding environment is also conducive to common rust development. Corn grown in a lower-yield potential (dry land) environment may be less likely to produce a yield response.

Yield response was attributed to depletion of photosynthate during pollination. Corn grain development is extremely dependent upon current photosythate production during and shortly after pollination. This dependence decreases as grain approaches maturity.

This research supports the use of a fungicide when an action threshold of 1% to 2% disease severity (about six uredinia per leaf) is reached on susceptible field corn hybrids before tasseling, as proposed on sweet corn by Pataky and Headrick (1988) and Dillard and Seem (1990). This action threshold should be relevant for the ear leaf and higher leaves (upper six to eight leaves), since they produce the majority of photosynthetic energy required for grain development.

Yield reduction resulting from common rust infection after pollination is less likely for several reasons. Corn grain yield is less sensitive to stress as kernel development approaches maturity. Pre-tassel treatment differences in disease severity were no longer evident after tassel emergence at two of three sites. This finding could have resulted from hybrids becoming more resistant after tassel emergence, as reported by Headrick and Pataky (1987), or from hot weather arresting the disease development. Temperatures normally exceed the upper developmental threshold for common rust during late June to early July. Thus, fungicide applications after anthesis will likely not be warranted except for susceptible hybrids heavily exposed to common rust in a environment highly conducive to disease development.

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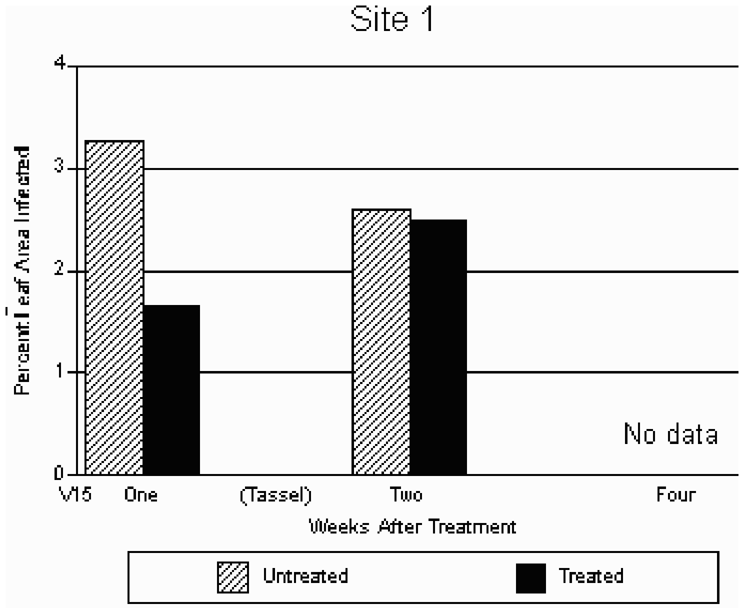

Figure 1. This figure shows common rust control after Tilt fungicide application at site 1 (Lowndes County, MS). Rust severity is rated as the percent of ear leaf area covered by disease uredinia. The treatment was applied to corn at the V15 growth stage. Values assigned the same letter are not significantly different at the 0.05 level of probability.

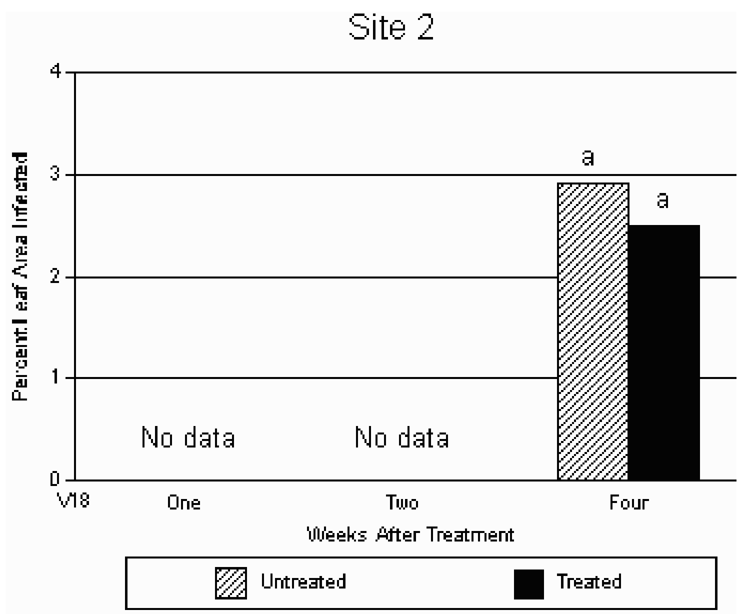

Figure 2. This figure shows common rust control after Tilt fungicide application at site 2 (Sunflower County, MS). Rust severity is rated as the percent of ear leaf area covered by disease uredinia. The treatment was applied to corn at the V18 growth stage. Values assigned the same letter are not significantly different at the 0.05 level of probability.

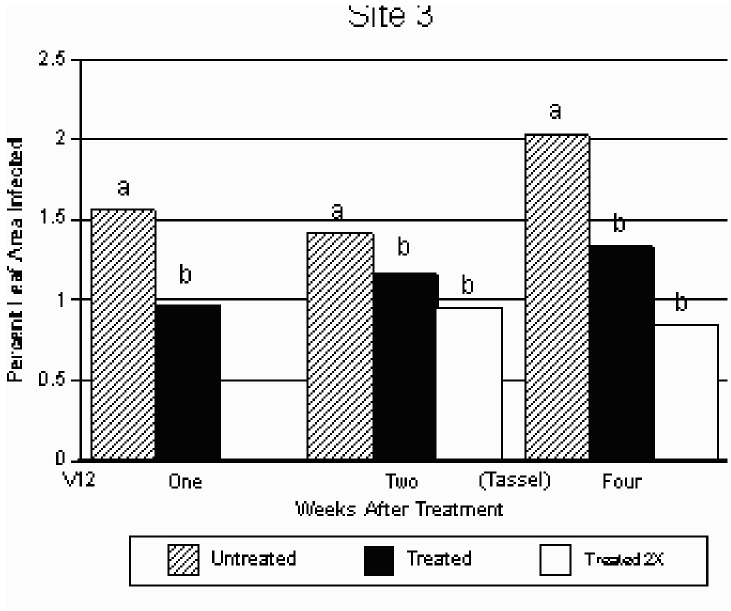

Figure 3. This figure shows common rust control after Dithane application at site 3 (Sunflower County, MS). Rust severity is rated as the percent of ear leaf area covered by disease uredinia. Initial treatment was applied to V12 growth stage corn, and a sequential treatment was applied after 1 week (Treated 2X). Values assigned the same letter are not significantly different at the 0.05 level of probability.

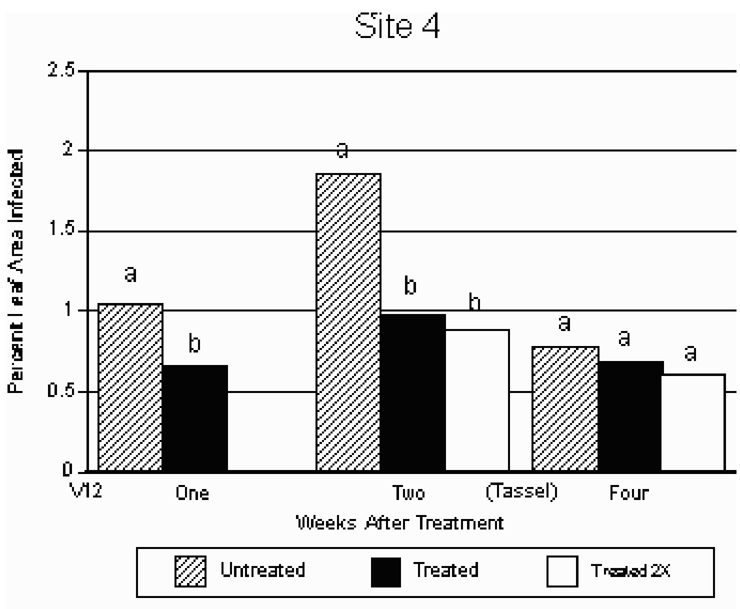

Figure 4. This figure. shows common rust control after Dithane application at site 4 (Holmes County, MS). Rust severity is rated as the percent of ear leaf area covered by disease uredinia. Initial treatment was applied to V12 growth stage corn, and a sequential treatment was applied after 1 week (Treated 2X). Values assigned the same letter are not significantly different at the 0.05 level of probability.

Acknowledgments

Thanks to Novartis Crop Protection, Inc. (Dale Brown, Nancy Crane, and Scott Hendrix) and Rohm and Haas

Company (Larry Walton, Jonny Spivey, and Nathan Buehring) for product and technical assistance with this project. Thanks to Charlie Pilkington, Burke Fisher, Lee Simmons, and Bill Thomas for allowing this project to be conducted in their fields.

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