INTEGRATED MANAGEMENT OF STRIPE RUST OF WHEAT IN WISCONSIN

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Introduction

Wheat stripe rust, caused by the fungal plant pathogen *Puccinia striiformis* f. sp. *tritici,* has been an increasing problem in the central Great Plains and areas of the upper Midwest due to milder winters (Chen, 2005). Since 2000, stripe rust has become an increasing concern on winter wheat in the Midwest. In Wisconsin over the last four seasons, we have observed consistent stripe rust pressure on some varieties throughout the wheat production area of the state. In 2016, some cultivars were hit very hard by this disease. Because of the consistent occurrence of stripe rust over the last few seasons, it is reasonable to expect continued pressure from this disease in 2017.

Stripe rust can be observed on leaves and leaf sheaths and may also infect glumes or kernels if infection is severe. Stripe rust can be identified by orange/yellow pustules that typically occur in a striped pattern on the surface of the wheat leaf. Inoculum (spores) sources are most likely windblown from the southern states and infection occurs when spores land on wheat leaves. Disease is favored by prolonged periods of rain (or dew), high relative humidity, and cool temperatures ranging from 50 to 60 ºF. The major concern of stripe rust is yield loss. Management for stripe rust includes resistant varieties and fungicide applications, along with using cultural practices such as avoiding excessive fertilizer applications and removing volunteer wheat. When choosing resistant varieties, refer to Wisconsin varietal trial results. Timing of fungicide application is critical for chemical control of stripe rust. Flag leaf application (Feekes 8) is often recommended for control of stripe rust. Scouting early is an important factor when making decisions on fungicide application. Fungicide application is based on risk of disease on the emerging flag leaf. Some of these management practices are being investigated for their utility in wheat production in Wisconsin.

Objectives

1. Evaluate stripe rust-resistant cultivars and fungicide timings in the wheat-growing region of Wisconsin for control of stripe rust.
2. Evaluate yield loss from stripe rust in soft red winter wheat.

Method

Data used in the yield loss analysis were collected from the Wisconsin winter wheat variety trials located in Chilton, Fond du Lac, Arlington, and Sharon Wisconsin in 2016. Sites consisted of individual plots planted with different cultivars with a range of resistance to stripe rust. Stripe rust

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was evaluated by visually estimating average incidence (% plants with symptoms) and disease severity (% flag leaf with symptoms) by use of a standard area diagram. Yield (corrected to 13.5% moisture) was determined by harvesting the center 5 feet of each plot using an Almaco SPC40 small-plot combine equipped with a HarvestMaster HM800 Classic Grain gauge. Yield loss due to disease severity was analyzed by regression analysis.

The integrated management trial was established at the Arlington Agricultural Research Station located in Arlington, WI. Fungicides were applied at three growth stage timings; jointing, flag leaf emergence, and boot stage. These applications were compared to a non-treated control or a full-season fungicide application which acted as the positive control. Growth-stage applications were applied to winter wheat cultivars varying in resistance to stripe rust: resistant ('Pro 380'), moderately susceptible ('Kaskaskia') and susceptible ('Pro 420'). The experimental design was a randomized complete block with four replicates. Plots were 21 ft long and 7.5 ft wide with four-ft alleys between plots. Standard wheat production practices as described by the University of Wisconsin Cooperative Extension Service were followed. Fungicides were applied using a CO_2 pressurized backpack sprayer equipped with TTJ60-11002 Turbo TwinJet flat fan nozzles calibrated to deliver 20 GPA at 30psi. Stripe rust was evaluated by visually estimating average incidence (% plants with symptoms) and average severity (% flag leaf with symptoms) per plot. Yield was determined by harvesting the center five feet of each plot using an Almaco SPC40 small-plot combine equipped with a HarvestMaster HM800 Classic Grain gauge. All disease and yield data were analyzed using a mixed model analysis of variance and means were separated using Fisher's least significant difference (P=0.05) yield. Contrast statements were used to analyze treatment structure.

Results and Discussion

Trial locations had an average yield potential of 130.4 bu/a. For every one percent increase in stripe rust severity a loss of 0.5 bu/a (R^2=0.4059) is projected, based on our model (Fig. 1). Stripe rust can result in significant yield losses in Wisconsin. Thus, integrated management strategies for stripe rust will be important for future wheat crops in Wisconsin.

In the integrated management trial, flag leaf and boot fungicide applications led to a significant reduction in stripe rust incidence for cultivars Kaskaskia and Pro 420 when compared to the non-treated control at the (P<0.01; Fig. 2). Jointing application resulted in no significant difference in disease compared to not treating for the cultivars Pro Seed 420 and Kaskaskia. Disease incidence scores were not significantly different among all treatments applied to the resistant cultivar Pro Seed 380. Pro Seed 380 is a highly resistant cultivar. Therefore, lack of response in disease levels by applying fungicide was expected. The presence of disease prior to flag leaf emergence and the susceptibility of Kaskaskia and Pro Seed 420 to stripe rust, resulted in elevated disease levels on those cultivars compared to Pro Seed 420. This enabled the detection of significant differences between single flag leaf and boot applications for these cultivars.

Cultivars and fungicide treatment main effects on yield were significant *(P*<0.001). There was no interaction of cultivar or fungicide treatment *(P*>0.05). Pro Seed 420 and Pro Seed 380 had significantly (P<0.01) higher yields than Kaskaskia (data not shown). Full season fungicide coverage led to the highest yields across all cultivars (Fig. 3). Headline applied at boot and flag leaf led to comparable yields to full season fungicide coverage.

Due to the nested treatment structure of application timing within the fungicide programs, contrast statements were utilized to investigate application timing of fungicides. Jointing applications compared to no treatment were not significant (Table 1). Jointing application showing no benefit to yield or disease control may be because fungicide protection is lost after approximately 14 days after application. Boot stage application led to significantly higher yields than jointing applications or not treating. Furthermore, Boot applications were not significantly different in yield for flag leaf applications (P>0.40). Complete fungicide coverage led to a 6.4 bu/a increase over the boot application. Full coverage application resulted in the highest yields and lowest disease levels but this program is not recommended because of the cost to apply that many treatments in a season. These results suggested that applying a fungicide at or near the boot stage in 2016 led to nearly optimal control of stripe rust in Wisconsin.

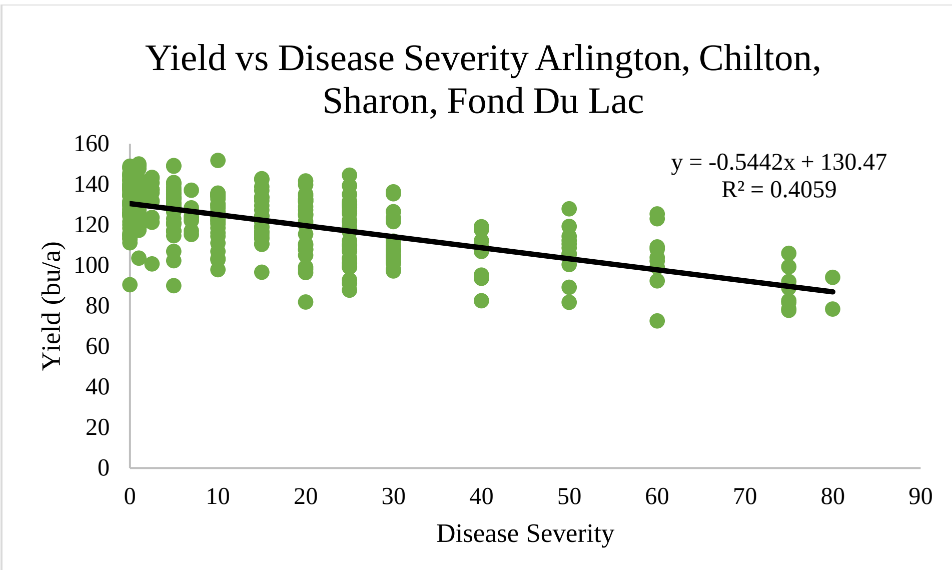

Figure 1. The relationship between wheat stripe rust severity and yield loss across four Wisconsin locations in 2016

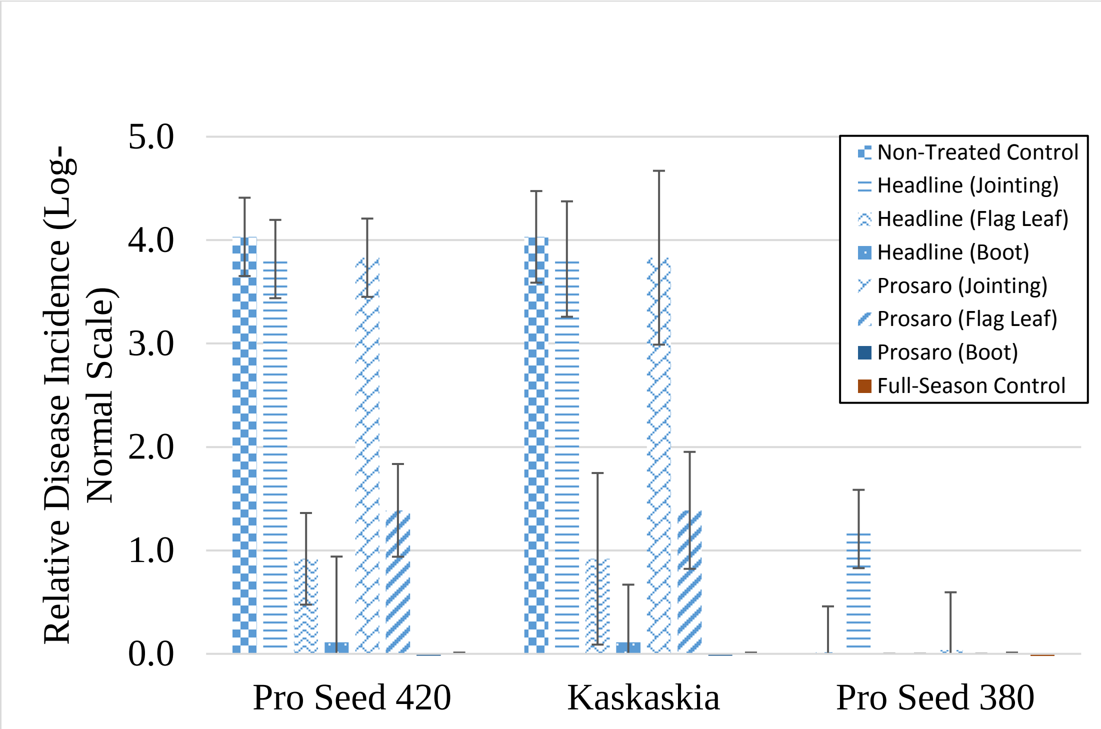

Figure 2. Relative disease incidence (%) by treatment for three cultivars in Wisconsin in 2016. Brackets on bars indicate the standard errors of the mean.

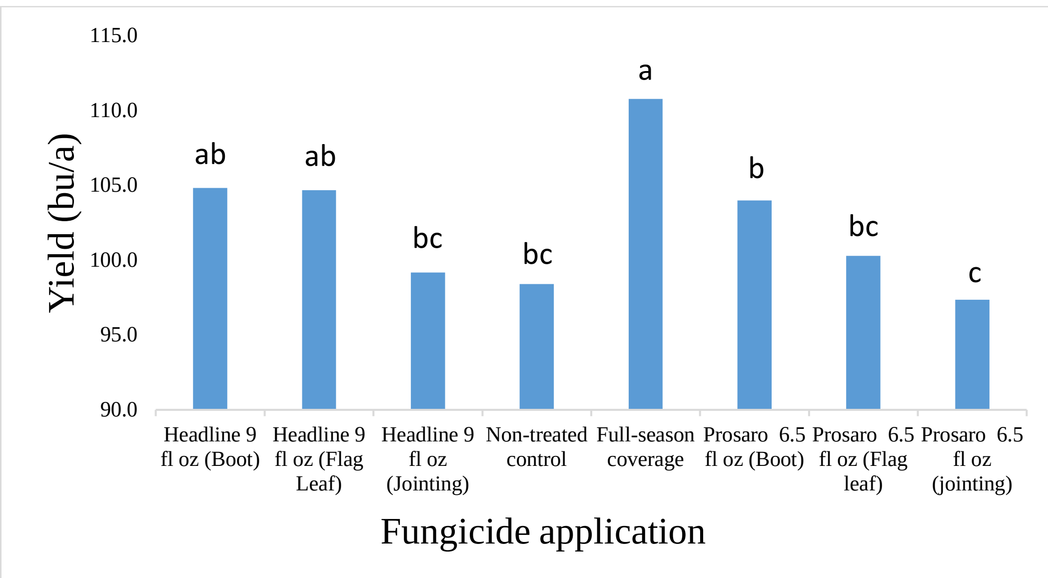

Figure 3. Mean yield (bu/a) for eight fungicide treatment programs on winter wheat in Wisconsin in 2016. Bars with the same letter are not significantly different based on the test of Least Significant Difference (LSD) at (P = 0.05).

Table 1. Contrast statements comparing yield (bu/a) by application timing for all fungicides used in the integrated management trial in Wisconsin in 2016.

Treatment Timing Tests	Yield Difference (bu/a)	SE*	DF**	t Value	Pr > |t|
Flag leaf vs. Jointing	8.4	4.6	67	1.83	0.0709
Flag leaf vs. Boot	-3.8	4.5	66.9	-0.85	0.4001
Jointing vs. Boot	-12.3	4.6	67	-2.67	0.0095
Complete Coverage vs. All timings	9.1	2.5	66.9	3.69	0.0005
Jointing vs. No treatment	-0.2	2.9	67.0	-0.05	0.9584
Flag leaf vs. No Treatment	4.1	2.9	67.0	1.41	0.1627
Boot vs. No Treatment	6.0	2.9	67.0	2.08	0.0416
Complete coverage vs. No Treatment	12.4	3.3	67.0	3.75	0.0004
Complete Coverage vs. Boot	6.4	2.8	66.9	2.29	0.0251

*SE=standard error
**DF=degrees of freedom

Summary

Stripe rust management begins with selecting a high yielding, resistant variety appropriate for your location, based on the Wisconsin Winter Wheat Performance Trial Report. Planting a resistant variety is a key component to managing stripe rust but does not guarantee complete control. Resistance can eventually be overcome by the pathogen, which makes referring to yearly performance trial reports necessary in a successful management system. Frequent scouting is recommended in the spring, and if disease is active in the lower leaf canopy prior to flag leaf emergence, then a single fungicide application at the boot growth stage or during flag leaf emergence may provide adequate protection and prevent significant yield loss. Strobilurins, demethylation inhibitors (DMI), or a combination of these modes of action are suitable for control of stripe rust prior to wheat heading.

References

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