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Fungicides for Winter Wheat

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Foliar Fungicides for Winter Wheat

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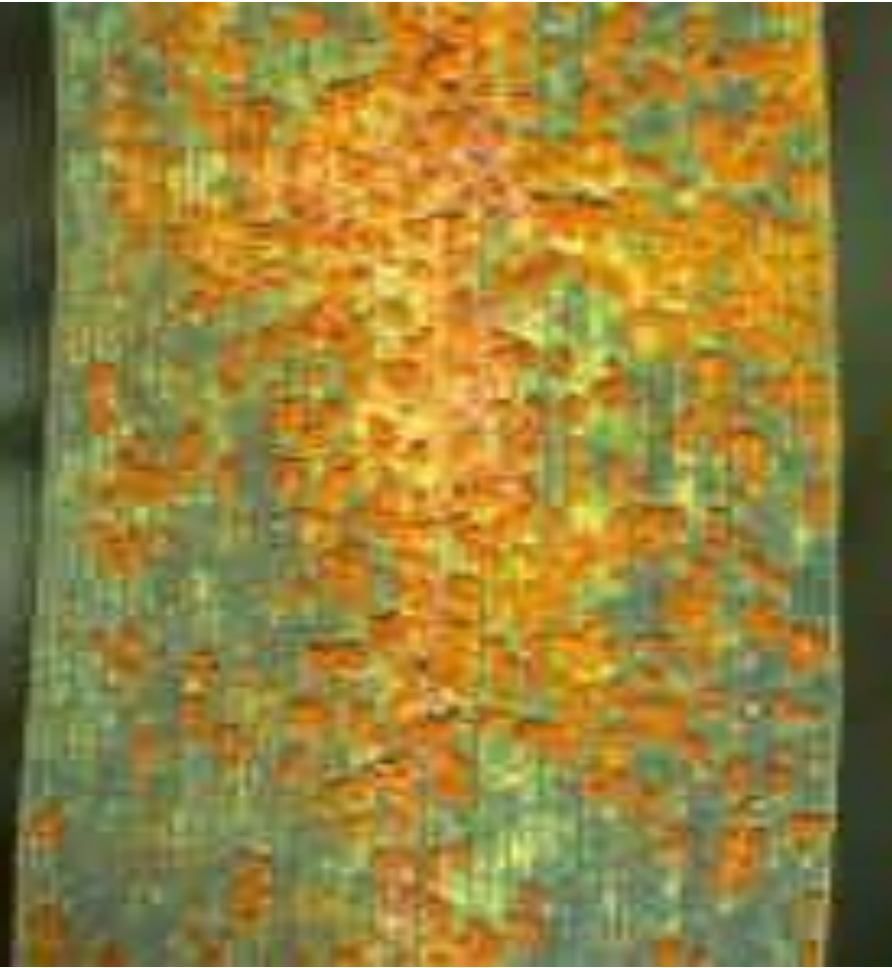
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Introduction

Grain yields of winter wheat in the southern Great Plains are often limited by the presence of foliar diseases.



Leaf Rust



Stripe Rust



Powdery Mildew

Traditionally, control of these diseases through foliar fungicides has not been economical for U.S. producers. However, recent wheat prices and decreasing fungicide costs have generated interest into fungicide applications on winter wheat. Wheat grain yield response to fungicide has been found to be highly variable, and dependent on several factors including incidence and severity of specific foliar diseases, yield potential, and environmental conditions. Additional considerations include application method:

- Ground application – wheel tracks or tram lines
- Aerial application – sufficient water volume to achieve adequate plant leaf coverage

Previous literature has evaluated only the expected returns to fungicide treatment, and ignored the risk or variability associated with disease management alternatives.

Objectives

- To determine expected net returns to fungicide treatment on hard red winter wheat cultivars with differing levels of genetic resistance to foliar diseases in the southern Great Plains.
- Determine if fungicide treatment is an economically optimal management strategy for several levels of risk aversion.

Framework

Expected utility maximization:

$$\max_{R,F} EU(\pi|R,F) = \sum_{i=1}^T p_i[U(\pi_{R,F,i})]$$
$$s.t. \pi_{R,F,i} = PE[y_i(R,F)](1 - \gamma F) - rF$$
$$R \in \{1, 2, 3\}, F \in \{0, 1\}$$

where $\pi_{R,F,i}$ is the net returns to fungicide treatment (\$/acre), R is the choice variable for varietal resistance, F is choice variable for fungicide treatment, P is price of wheat grain (\$/bu), y_i is wheat grain yield (bu/acre), γ is the percentage yield loss associated with ground application of fungicide, and r is fungicide treatment cost (\$/acre) for both chemical and application.

Method

- Hard red winter wheat grain yield data were produced in field experiments at two locations, Apache, and Lahoma, OK, for harvest years 2005 to 2012.
- Two fungicides were rotated between the two locations and applied at recommended rates at Feekes growth stage 9.5 to 10 (approximately early to mid-May).

Economic Analysis

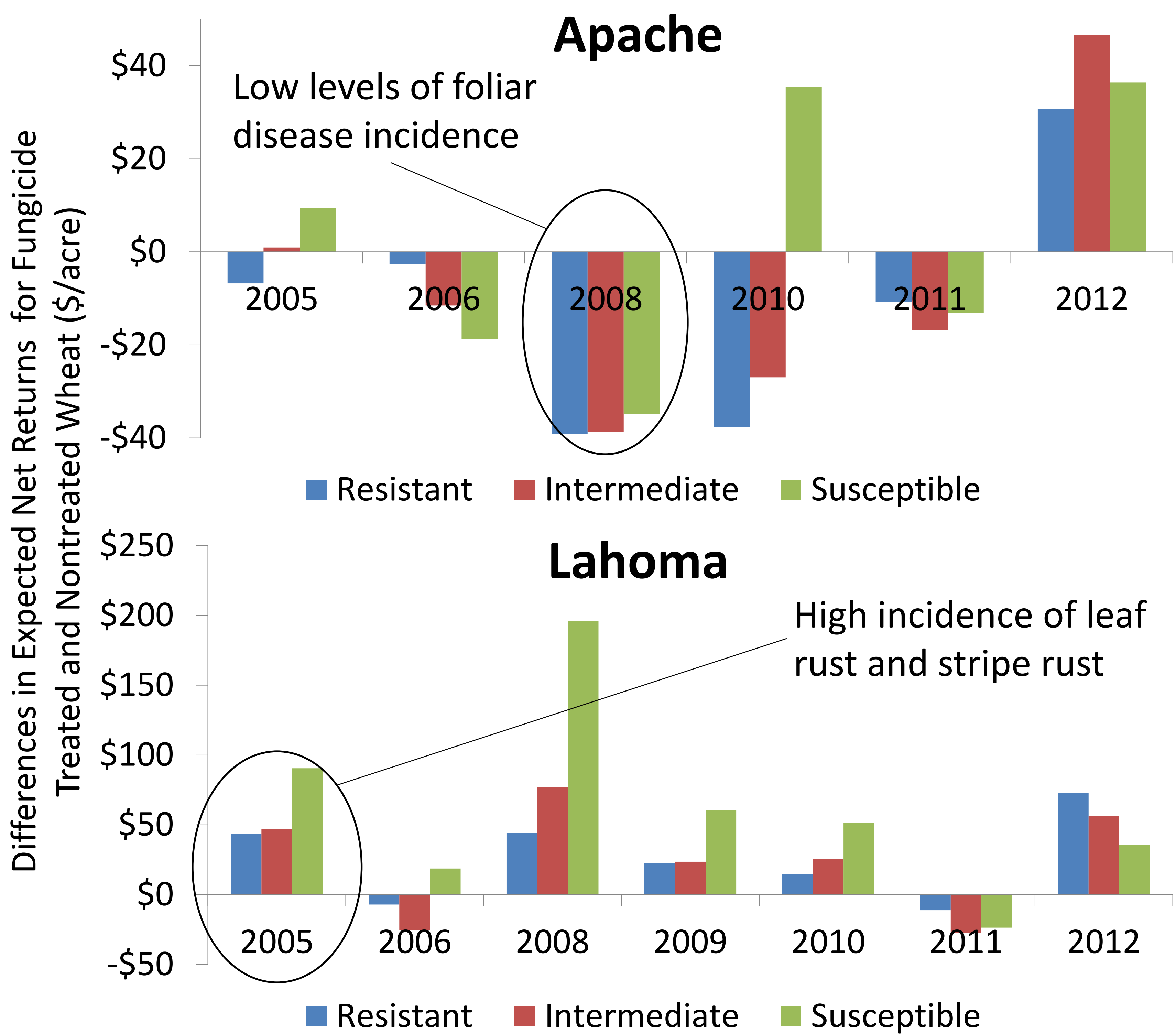
- Partial budgeting analysis using:
 - Wheat grain price (\$7.50/bu).
 - Fungicide treatment cost (\$15.45/acre) includes per acre cost of chemical and per acre rental rate for ground application.
 - Expected yield loss from wheel tracking ($\approx 2.8\%$).

Risk Analysis

- Risk analysis was conducted using SIMETAR (Richardson, Schumann, and Feldman 2005).
- Assuming each season was equally likely, and the years of the study are representative of the entire distribution, CDFs of net returns to alternative strategies were evaluated using stochastic dominance criteria.

Results

- Yield response to fungicide was variable, but was greater and more consistent at Lahoma than at Apache.
- Significant yield responses to fungicide treatment can be linked to high levels of observed disease incidence and severity.



Differences in Expected Net Returns to Fungicide Treated and Nontreated Winter Wheat for Resistant, Intermediate, and Susceptible Varieties by Year.

Risk Efficient Sets by Location for Second Degree Stochastic Dominance and Stochastic Efficiency with Respect to a Function

	Efficient Set			
	Lower Bound	Upper Bound	Apache	Lahoma
SSD	0.000	∞	Intermediate/No Fungicide	Resistant/Fungicide
SERF				
Risk averse	0.00125	0.01	Intermediate/No Fungicide	Resistant/Fungicide

Note: Negative exponential utility function was used for SERF analysis (Hardaker et al. 2004), and risk coefficient bounds were approximated using Anderson and Dillon (1992).

- Although fungicide treatment increased expected net returns in some cases, it also increased variability of net returns, or risk.
- Foliar disease management strategies identified by SSD as appropriate for risk averse producers were intermediate varieties not treated with fungicide at Apache and resistant varieties treated with fungicide at Lahoma.
- These results are largely due to the higher incidence and severity of foliar diseases at Lahoma, which are partially influenced by weather.
- Lahoma is approximately 105 miles north of Apache, and has slightly cooler temperatures and higher humidity during critical disease development period of March through May, making it more conducive to foliar disease development.

Conclusions

- Fungicide treatment yielded positive expected net returns in some cases, but did not generate positive returns in each individual year at either location.
- Although the response of winter wheat was quite variable, it did tend to protect producers from the downside risk of large yield losses in years of high disease incidence and severity, especially when growing susceptible varieties.
- When making foliar disease management decisions farmers should monitor the input-output price ratio, current yield potential, and current foliar disease situation through local extension and/or USDA, ARS' Cereal Rust Bulletin.

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