Using Remote Sensing to Determine the Response of Resistant and Susceptible Wheat Varieties to Fungicide Application

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INTRODUCTION

- Stripe rust infestation of wheat affects the active photosynthetic area of the leaf that is actively involved in the physical control of the reflectance, absorption and transmittance of solar radiation.
- In the visible part of the spectrum (400- 700nm), plant pigmentation controls the energy – matter interaction. This results in high absorption, low reflection, and nearly zero transmittance of the energy-matter.
- While in the near-infrared (NIR) part of the spectrum (700 – 1350 nm) the plant internal leaf structure controls the energy-matter interaction. This results in high reflectance and transmittance, but very low absorption.
- The normalized difference vegetation index (NDVI) vegetative index takes advantage of the reflectance in the red region that is due to chlorophyll absorption and the NIR due to the high transmittance that capture NIR reflectance from deep within a vegetation canopy.
- Therefore, NDVI measurements can be used to provide an objective measurement of stripe rust infestation and level of control, because the reflectance of a healthy leaf is greater compared to an infected leaf.

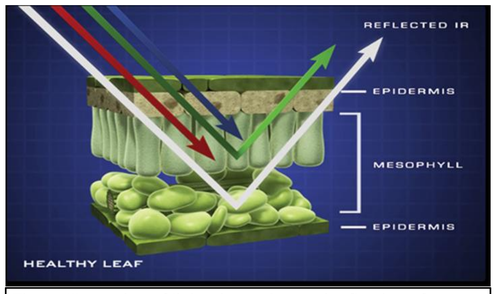

Fig 1. Illustration of light absorption and reflection of a healthy leaf. (Source: missionscience.nasa.gov (Credit Jeff Carns)

OBJECTIVE

- In this study, we examine the use of NDVI measurements to determine the level of stripe rust control following fungicide application for a resistant and a susceptible wheat variety.

MATERIALS AND METHODS

- An experiment was established at the Southwest-Research – Extension Center in Garden City, KS, in fall 2015.
- The design of the experiment was a randomized complete block design with three replications consisting of eleven fungicide application treatments and two wheat varieties (Oakley CL with very high resistance to stripe rust, and TAM 111 more susceptibility to stripe rust).
- The experiment treatment descriptions are summarized in Table 1.
- The plots were 7.5 ft x 30 ft.
- The plots were fertilized with 45 kg. of N at Feekes GS 4 in March of 2016 and sprayed with a mixture of 190 ml of Starane, 355 ml of MCPA, 3 ml of Ally and 355 ml non-ion surfactant the first week of April for weed control.
- Fungicides were applied with 190 L/ha of water using a CO_2 backpack sprayer.
- A plot combine 1.5 feet wide was used to harvest 7.62 m from each plot for yield. Subsample was collected from each plot to determine the test weight and moisture content.
- Normalized difference vegetative index (NDVI) was collected throughout the season, as well as prior to fungicide application on April 25, 2016 and 30 days after on May 25, 2016.
- A handheld Greenseeker sensor was used to measure the NDVI. The difference between the before and after NDVI values were used to access the efficacy of the fungicide.

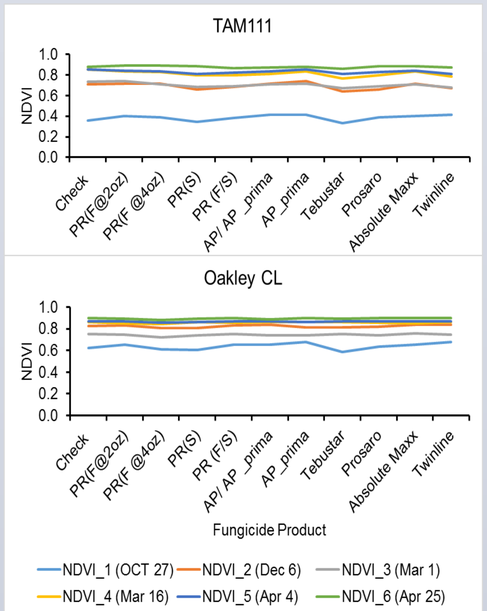

Fig 2. Seasonal NDVI captured at different times during the growing season.

Fig 3. TAM 111 untreated plot 30 days after fungicide application.

Fig 4. Oakley CL untreated plot 30 days after fungicide application.

Table 1. Fungicide rate, time and growth stage of application for each treatment.

TREATMENT	PRODUCT	TIME OF APPLICATION	PRODUCT RATE	DATE APPLIED	GROWTH STAGE
1	CONTROL	NA	NA	NA	NA
2	PRIAXOR ® (PR)	FALL	60 ml	27-Oct	Feekes, GS2
3	PRIAXOR ® (PR)	FALL	120 ml	27-Oct	Feekes, GS2
4	PRIAXOR ® (PR)	SPRING	60 ml	21-Mar	Feekes, GS4
5	PRIAXOR ® (PR)	FALL	60 ml	27-Oct	Feekes, GS2
5	PRIAXOR ® (PR)	SPRING	60 ml	7-Apr	Feekes, GS 7
6	APROACH ® (AP)	SPRING	90 ml	7-Apr	Feekes, GS 7
6	APROACH PRIMA ®	SPRING	200 ml	25-Apr	Feekes, GS 9
7	APROACH PRIMA ®	SPRING	200 ml	25-Apr	Feekes, GS 9
8	TEBUSTAR ®	SPRING	120 ml	25-Apr	Feekes, GS 9
9	PROSARO ®	SPRING	190 ml	25-Apr	Feekes, GS 9
10	ABSOLUTE MAXX ®	SPRING	150 ml	25-Apr	Feekes, GS 9
11	TWINLINE ®	SPRING	270 ml	25-Apr	Feekes, GS 9

RESULTS

- Fungicide application increased yield over the control for TAM 111, but did not affect the yield of Oakley CL.(Oakley CL lodged 100%).
- The degree of Δ in NDVI 30 days after application indicates effectiveness of the fungicide on stripe rust control in TAM 111, but not in Oakley CL due to its genetic resistance that precluded the need for a foliar fungicide.
- The generic fungicide Tebustar and BASF Twinline ® offered the best level of stripe rust control, but were not significantly different from Aproach ® & Aproach prima ®, and Prosaro ®.

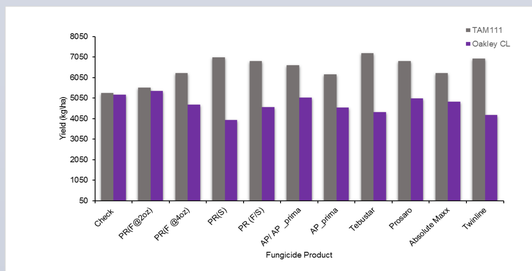

Fig 5. Effect of different fungicide product on wheat yield of a susceptible (TAM 111, LSD =1356) and resistant (Oakley CL, LSD= 1292) wheat varieties. *(Oakley CL lodged 100%)*

RESULTS

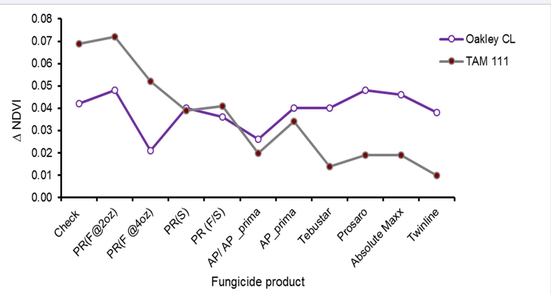

Fig 6. Effect of different fungicide products on ΔNDVI (before and 30 days after application) on a susceptible (TAM 111) and resistant (Oakley CL) wheat varieties.

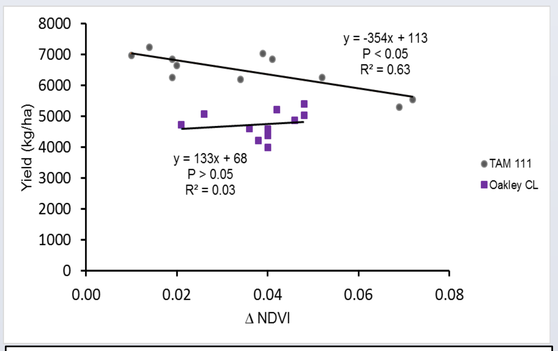

Fig 7. Relationship between grain yield and ΔNDVI (before and 30 days after application) following the application of different fungicide product on a susceptible (TAM 111) and resistant (Oakley CL) wheat varieties.

CONCLUSIONS

- The susceptible variety (TAM 111) benefited from a flag leaf fungicide application.
- Δ in NDVI measured before and 30 days after fungicide application showed strong relationship with yield and the level of stripe rust control from the different fungicide products.

ACKNOWLEDGEMENT

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