Breeding Approach to Diminish Barley Yellow Dwarf Epidemics in Kansas Wheat

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Introduction

Barley yellow dwarf virus (BYDV) is a prevenient viral disease affecting winter wheat yields in Kansas and throughout the central great plains. Bockus et al. (2001) reported the Kansas state average yield loss from 1976 to 2000 was1.25%. However, fields with extreme infection can have yield losses that exceed 35%.

The virus is spread by several aphid species such as the cherry-oat aphid, green bug and English grain aphids. Current attempts to control the virus are typically through management strategies and limited genetic resistance. Late planting and using chemical control such as seed treatment and insecticides are effective at suppressing the disease but do not eliminate the potential for the virus. Currently no commercial wheat varieties display resistance to BYDV. However, some varieties are more tolerant than others.

Objectives

The objective of this project was to evaluate, identify and characterize new sources of resistance or tolerance to BYDV by screening current varieties and Kansas State advanced experimental breeding lines.

Materials and Methods

Experiments were conducted at the Kansas State University research farms at Rocky Ford (2016 and 2017) and Ashland Bottoms (2015). Replicated yield-plot trials containing six blocks of the annual yield nursery (AYN) material, one susceptible check (Art) and one tolerant check (Everest) were planted two to three weeks earlier than the recommended wheat planting dates. The six blocks were treated in to two groups. The treated group consisted of three blocks that were treated with seed treatment prior to planting and treated with foliar insecticide every 14-21 days post emergence if the mean air temperatures were greater than 10^{0}C. Growing season phenotyping data was done weekly using an unmanned aerial vehicle (UAV) and a RedEdge (MicaSense Inc.) multispectral camera. A visual BYDV severity rating was done using an infection scale of 0 to 100 percent using the Field Book phenotyping application (Rife and Poland, 2014). Yield data was obtained using a small plot combine.

Figure 1. (a) Rating BYDV severity using Field Book phenotyping application (b) BYDV severity comparison between two plots.

Results and Discussion

Treatment Effects

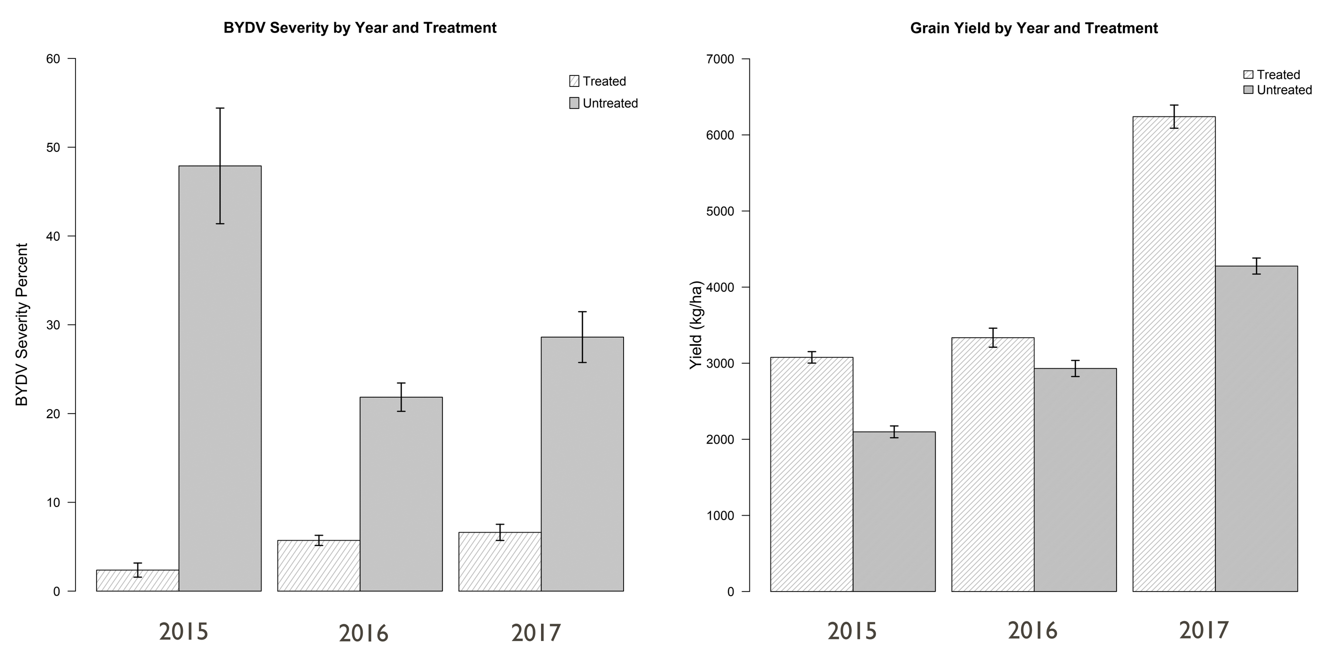

Figure 2. Treatment effects on BYDV severity and grain yield loss by year.

There was a significant treatment effect for BYDV severity and grain yield loss all years (Figure 2). However, in 2016 the difference was not as great due to reduced infection variances. Over three years of data, on average the susceptible check "Art", had a 63% BYDV severity rating and a 41% grain yield loss. Whereas, the "tolerant" check Everest, exhibited a 19% BYDV severity rating and a 16% grain loss over the same period. From this study several Kansas State advanced experimental breeding lines were identified with tolerance similar to Everest (Table 1). These identified lines include two sister lines (KS080099-M-3 and KS080099-M-4) from the 2016 study and two sister lines (KS12DH0296-43 and KS12DH0296-156) from the 2017 study.

Variety	Treated Grain Yield (kg/ha)	BYDV Severity	Grain Yield Loss
2015			
ART	3081ᵃ	77.2%ᵇ	47.0%ᵇ
EVEREST	3315ᵃ	38.3%ᵃ	18.3%ᵃ
KS060430-M-1	3711ᵃ	33.3%ᵃ	5.7%ᵃ
2016			
ART	3396ᵃ	48.1%ᵇ	26.9%ᵇ
EVEREST	3226ᵃ	10.8%ᵃ	7.5%ᵃ
KS080099-M-3	3496ᵃ	5.0%ᵃ	6.2%ᵃ
KS080099-M-4	3786ᵃ	10.0%ᵃ	6.9%ᵃ
2017			
ART	6420ᵃ	66.3%ᵇ	47.5%ᵇ
EVEREST	6144ᵃ	8.3%ᵃ	23.3%ᵃ
KS12DH0296-43	5401ᵃ	5.0%ᵃ	23.4%ᵃ
KS12DH0296-156	6430ᵃ	16.7%ᵃ	8.3%ᵃ
KS12DH0230-30	6013ᵃ	28%ᵃ	22.0%ᵃ

Table 1. Comparison by year of breeding line performance to the susceptible check Art and tolerance check Everest.

Results and Discussion

UAV Data

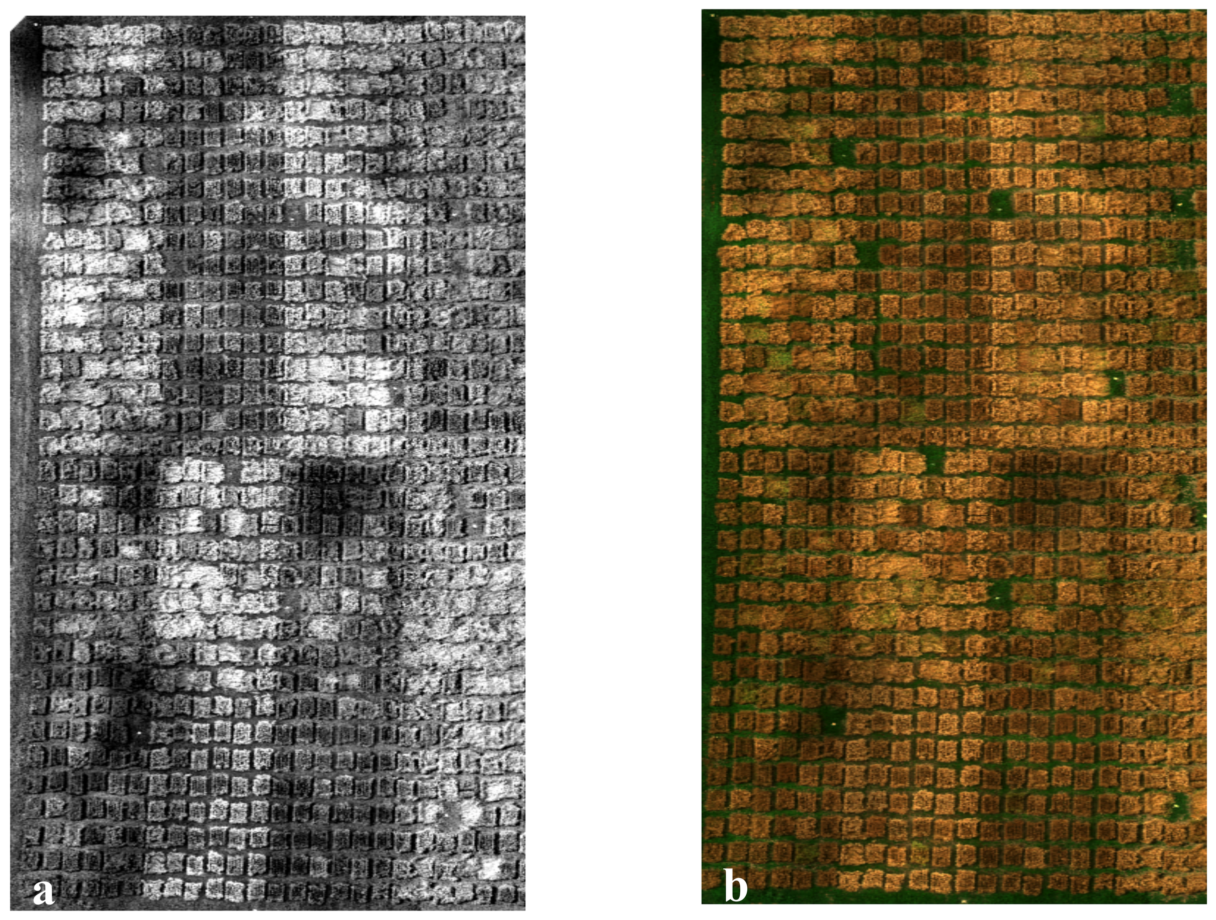

Figure 3. (a) RedEdge imagery of BYDV plots on June 13th 2017. (b) Red, Green, Blue imagery of BYDV plots on June 13th 2017.

In 2017, treatment block patterns became noticeable in images taken after May 21st. This pattern continued for the rest of the growing season and became very pronounced at maturity (Figure 3). All five individual bands (Red, Blue, Green, Near-infrared and RedEdge) and four vegetative indicies (NDVI, GNDVI, GRVI and NDRE) were calculated and correlated to the visual BYDV severity ratings. Correlation of BYDV severity and UAV data strengthened over the growing season (Figure 4).

Figure 4. RedEdge correlation to BYDV severity over time.

Conclusions

This study showed that large populations of advanced breeding material can be effectively screened for BYDV through treatments. The high throughput method of screening in addition to genotype data can lead to improved tolerance and resistance in released lines. Furthermore, this study indicates that late season phenotypic data collected from UAVs maybe a useful tool to assessing disease severity.

References

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