Fusarium Head Blight Management Coordinated Project: Uniform Fungicide Trials 2022

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Introduction: Miravis Ace®, a new Succinate Dehydrogenase Inhibitor (SDHI; Adepidyn/Pydiflumetofen) + Demethylation Inhibitor (DMI; Propiconazole) fungicide, was recently labeled for the management of diseases of wheat, barley, and other small grain crops. Uniform fungicide trials (UFT) were conducted over the last four years (2018, 2019, 2020, and 2021) to compare the efficacy of this new fungicide against Fusarium head blight (FHB) and deoxynivalenol (DON) when applied at, before, or after anthesis, or sequentially with a DMI fungicide to that of a standard anthesis-only application of Prosaro® (tebuconazole + prothioconazole) or Caramba® (metconazole). Preliminary results from these trials showed that when applied at early anthesis (Feekes 10.5.1) or within the first 6 days after anthesis (DAA), Miravis Ace was just as effective as Prosaro and Caramba (2,3). However, the most effective control was achieved when Miravis Ace was applied at early anthesis followed by a DMI fungicide (Prosaro, Caramba, or Folicur) after anthesis.

Two new fungicide mixtures, Sphaerex® (metconazole + prothioconazole) and Prosaro Pro® (tebuconazole + prothioconazole + Fluopyram), are currently being marketed for use in wheat for FHB and DON management. However, it is unclear whether these new fungicides are just as consistently effective as or more effective than the current industry standards Prosaro, Caramba, and Miravis Ace against FHB and DON across a range of wheat market classes, cropping systems, and growing conditions. In addition, having a new, effective fungicide, particularly one of different chemistry creates opportunities for evaluating two-treatment fungicide programs for FHB and DON management. Thus, efforts to evaluate strategies for FHB and DON management in wheat and barley using new fungicide mixtures continued in 2022. The overall objective in this study was to provide stakeholders with useful information regarding the efficacy of the new fungicides Sphaerex and Prosaro Pro relative to the current industry standards Prosaro, Caramba, and Miravis Ace for control of FHB and DON, when applied to a susceptible cultivar at anthesis or when applied after anthesis as part of two-treatment programs consisting of an anthesis application of Miravis Ace. Results from the first year of this new UFT cycle are summarized herein.

Materials and Methods: To accomplish the aforementioned objective, field experiments were conducted in 16 US wheat-growing states in 2022. The standard protocol consisted of the application of the fungicide treatments in **Table 1** to plots of a susceptible cultivar. The experimental design was a randomized complete block, with at least 4 replicate blocks. In all experiments, plots were artificially inoculated with either *F. graminearum*-colonized grain spawn or a spore suspension of the fungus applied approximately 24-36 hours after anthesis. Plots were mist-irrigated during and shortly after anthesis in some experiments to enhance inoculum production and infection. FHB index (IND) was rated or calculated as previously described (1) on 60-100 spikes per plot at approximately Feekes growth stage 11.2. Grain was harvested and samples were sent to a USWBSI-supported laboratory for mycotoxin analysis. Separate linear mixed models (multi-location) were fitted to arcsine square root-transformed IND and log-transformed DON data pooled across environments (trial x state combinations) to evaluate treatment effects. Efficacy of fungicide treatment was estimated based on percent reduction in IND and DON relative to the nontreated check.

Table 1. The following treatments were randomly assigned to experimental units. All fungicide treatment mixtures included a nonionic surfactant at a rate of 0.125% (vol/vol)

Treatment	Product	Rate/Acre (fl oz)	Timing*
CK	Untreated check	…	…
I	Prosaro	6.5	Feekes 10.5.1 (early anthesis)
II	Caramba	13.5	Feekes 10.5.1 (early anthesis)
III	Miravis Ace	13.7	Feekes 10.5.1 (early anthesis)
IV	Prosaro Pro	10.3	Feekes 10.5.1 (early anthesis)
V	Sphaerex	7.3	Feekes 10.5.1 (early anthesis)
VI	Miravis Ace fb Prosaro Pro	13.7/10.3	Early anthesis/4-6 DAA
VII	Miravis Ace fb Sphaerex	13.7/7.3	Early anthesis/4-6 DAA
VIII	Miravis Ace fb Tebuconazole	13.7/4	Early anthesis/4-6 DAA

*Early anthesis was defined as when approximately 50% of the tillers have fresh anthesis extruded in the center of the spikes. DAA = days after anthesis.

Results and Discussion: Mean Fusarium head blight index (IND) data from 21 environments and deoxynivalenol (DON) contamination data from 20 environments are summarized for different fungicide treatments in Figures 1A and 1B, respectively. IND ranged from 0 to 50% and DON from 0 to 52 ppm across environments. For both responses, the nontreated check has the highest means, whereas treatments consisted of early anthesis (Feekes 10.5.1) application of Miravis Ace followed by an application of Prosaro Pro, Sphaerex, or tebuconazole at 4-6 DAA had the lowest means (**Fig. 1** and **2**).

FHB index: Means varied across 21 environments and among fungicide treatments, as shown by the distribution of data points around the median in Figure 1. All treatments resulted in significantly lower mean IND (on the arcsine square root-transformed scale) than the nontreated check (**Fig. 1A** and **Fig. 2A**). A single application of Miravis Ace at anthesis (III) resulted in significantly lower mean IND compared to a single application of Prosaro (I), Caramba (II), Prosaro Pro (IV), or

Sphaerex (V) at anthesis (**Fig. 2A**), where pairwise differences between I, II, IV, and V treatments were not statistically significant (P = 0.49 to 0.97). The greatest reductions in mean IND were observed with the sequential applications of Miravis Ace at anthesis followed by a late application (4-6 DAA) of Prosaro Pro (VI) or Sphaerex (VII) (**Fig. 2A**); contrast between these two fungicide programs was not statistically significant (P = 0.85). However, the program consisting of an application of Miravis Ace at anthesis followed by a late application of tebuconazole (VIII) was not as effective as VI and VII at reducing mean IND. VIII was not significantly different (on the arcsine square root-transformed scale) from a single application of Miravis Ace at anthesis (P = 0.25).

Deoxynivalenol: All treatments resulted in significantly lower mean DON contamination of grain (on the log-transformed scale) than the nontreated check (**Fig. 1B** and **2B**). Among the treatments with a single application at anthesis, Miravis Ace resulted in the lowest mean DON ($P < 0.05$, on the log-transformed scale). The only exception was for the contrast between Miravis Ace and Prosaro Pro applied at anthesis (P = 0.08, on the log-transformed scale). Pairwise differences between anthesis-only applications of Prosaro, Caramba, Prosaro Pro, and Sphaerex were not statistically significant on the log-transformed scale (P = 0.07 to 0.80). Treatment programs with sequential applications of Miravis Ace followed by Prosaro Pro or Sphaerex 4-6 DAA had lower mean DON (1.6 and 1.8 ppm, respectively) than a single application of Miravis Ace at anthesis (3.1 ppm) ($P <$ 0.05, on the log-transformed scale). Like IND, Miravis Ace applied at Feekes 10.5.1 followed by an application of tebuconazole 4-6 DAA did not result in significantly lower mean DON contamination of grain (on the log-transformed scale) than a single application of Miravis Ace at anthesis.

Efficacy of FHB management treatments against IND and DON contamination of grain: Relative to the nontreated check, percent control (C) across fungicide treatments ranged from 55 to 86% for IND and 36 to 75% for DON. Among the treatments with a single application at anthesis, Miravis Ace resulted in the highest percent reduction in mean IND (C = 75%) and DON (C = 52%). An anthesis application of Prosaro Pro (IV) or Sphaerex (V) was of comparable efficacy to the standard anthesis-only application of Prosaro (I) against IND and DON. Miravis Ace at anthesis (III) was more effective than Prosaro at anthesis against both IND and DON. Percent change in IND and DON for III relative to I was 41 and 25%, respectively. Sequential applications of Miravis Ace at anthesis followed by a late application (4-6 DAA) of Prosaro Pro (VI) or Sphaerex (VII) were considerably more effective against IND and DON than Prosaro at anthesis, with percent reduction in IND and DON ranging from 56 to 66%. Similarly, the highest percent reduction in IND and DON relative to Miravis Ace alone applied at anthesis was observed for these two double-application treatments (VI and VII), with values ranging from 41 to 47%.

As additional data become available, a more complete set of analyses will be performed. However, the results summarized herein suggest that an application of Prosaro Pro or Sphaerex at Feekes 10.5.1 are generally of comparable efficacy to Prosaro, and treatments consisting of an anthesis application of Miravis Ace followed by a “later” application of Prosaro Pro or Sphaerex are more effective against IND and DON than an anthesis-only application of any of the tested fungicides. The experiments will be repeated, and all data will be analyzed to formally quantify efficacy and determine the additivity of active ingredient mixtures and sequentially applied fungicide treatments.

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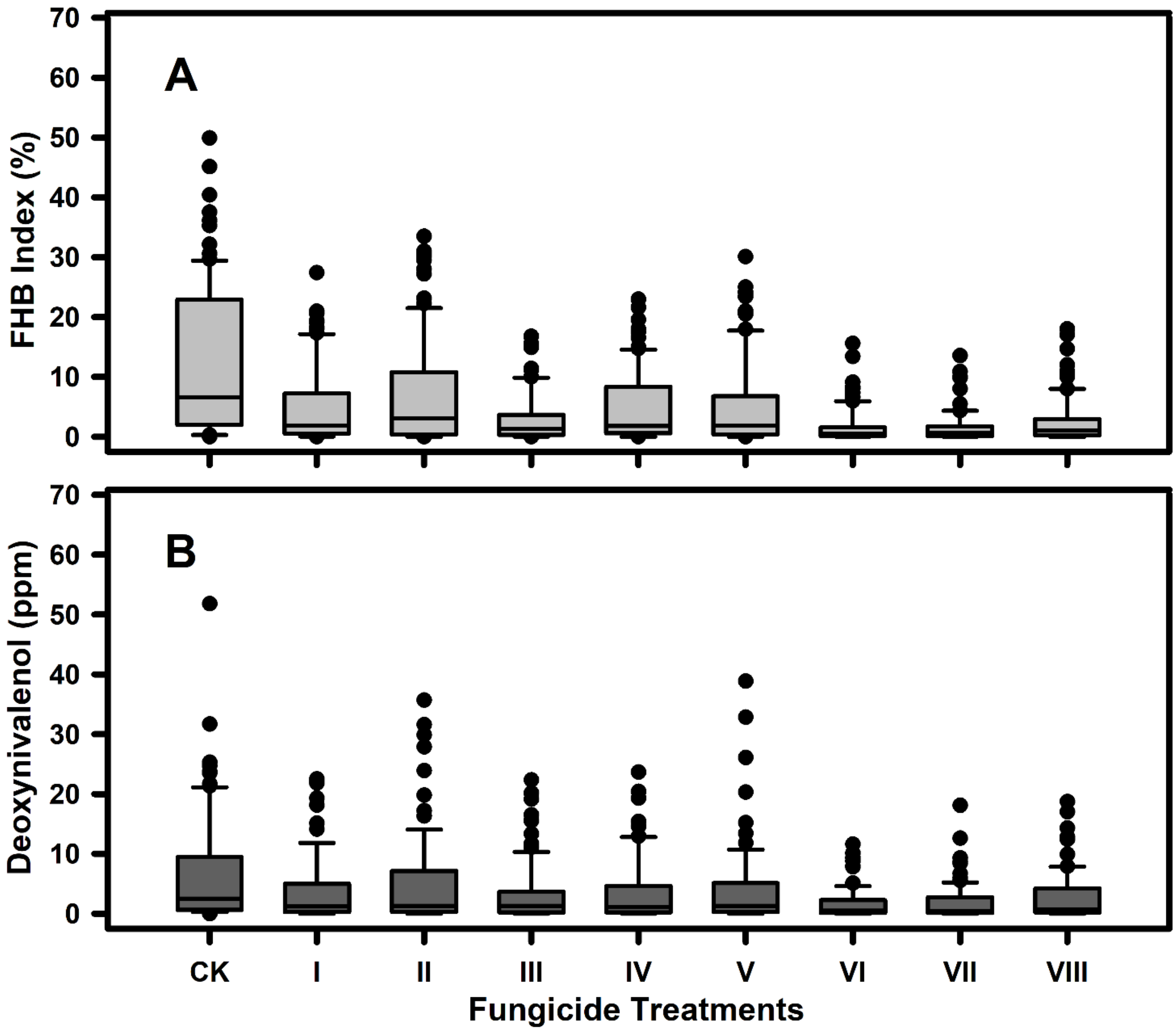

Fig. 1. Boxplots showing the distribution of **A**, mean Fusarium head blight index and **B**, deoxynivalenol grain contamination for different fungicide treatments. **CK** = nontreated check, **I** = Prosaro (6.5 fl. oz.) applied at anthesis, **II** = Caramba (13.5 fl. oz.) applied at anthesis, **III** = Miravis Ace (13.7 fl. oz.) applied at anthesis, **IV** = Prosaro Pro (10.3 fl. oz.) applied at anthesis, **V** = Sphaerex (7.3 fl. oz.) applied at anthesis, **VI** = Miravis Ace applied at anthesis followed by Prosaro Pro 4-6 days later, **VII** = Miravis Ace applied at anthesis followed by Sphaerex 4-6 days later, and **VIII** = Miravis Ace applied at anthesis followed by Tebuconazole (4 fl. oz) 4-6 days later. For FHB index, each box in **A** represents data points across 21 trials, whereas for DON, each box in **B** represents data points across 20 trials.

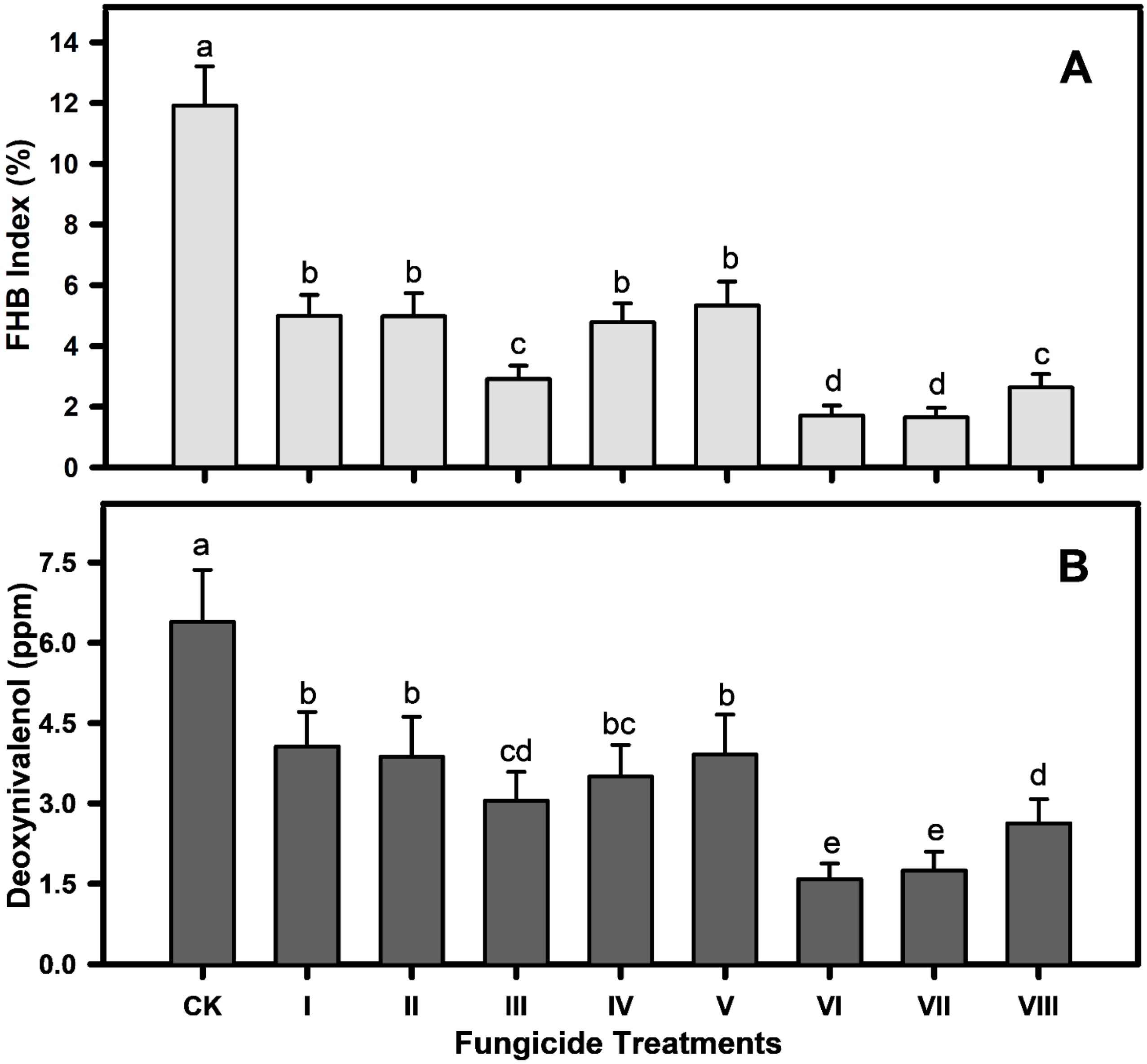

Fig 2. Mean **A**, Fusarium head blight index and **B**, deoxynivalenol grain contamination for different fungicide treatments. **CK** = nontreated check, **I** = Prosaro (6.5 fl. oz.) applied at anthesis, **II** = Caramba (13.5 fl. oz.) applied at anthesis, **III** = Miravis Ace (13.7 fl. oz.) applied at anthesis, **IV** = Prosaro Pro (10.3 fl. oz.) applied at anthesis, **V** = Sphaerex (7.3 fl. oz.) applied at anthesis, **VI** = Miravis Ace applied at anthesis followed by Prosaro Pro 4-6 days later, **VII** = Miravis Ace applied at anthesis followed by Sphaerex 4-6 days later, and **VIII** = Miravis Ace applied at anthesis followed by Tebuconazole (4 fl. oz) 4-6 days later. For FHB index, each bar in **A** represents the mean across 21 trials, whereas for DON, each bar in **B** represents the mean across 20 trials. Errors bars are standard errors of the mean. Models were fitted and means were compared on the arcsine square root-transformed scale for IND and log-transformed sale for DON, with fungicide treatments as a fixed effect. Graphs are shown on the raw data scale for convenience.