Fusarium Head Blight Management Coordinated Project: Integrated Management Trials 2022

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Introduction: Given that Prosaro, a premix of two demethylation inhibitors (DMI) (tebuconazole + prothioconazole), is one of the most consistently effective fungicides against Fusarium head blight (FHB) and deoxynivalenol (DON), a logical question is whether other mixtures of active ingredients (AI) will be just as or more effective than Prosaro. The focus of the integrated management coordinated project (IM_CP) over the past four years (2018-2021) was Miravis Ace, a new Succinate Dehydrogenase Inhibitor (SDHI; Adepidyn – Pydiflumetofen) + Demethylation Inhibitor (DMI; Propiconazole) premix fungicide that was recently labeled for managing diseases of wheat, barley, and other small grain crops. Preliminary results from these trials showed that when applied at early anthesis (Feekes 10.5.1) or within the first 6 days after early anthesis, Miravis Ace was just as effective as Prosaro and Caramba (2,3,4). Like the latter two fungicides, Miravis Ace was most effective against FHB and DON when combined with genetic resistance, suggesting that this new fungicide alone also will not be sufficient to manage FHB and DON under highly favorable conditions.

Other new mixtures of DMI AIs or DMI + SDHI AIs are now being marketed for FHB and DON management. These include Sphaerex, a premix of the DMIs metconazole and prothioconazole; and Prosaro Pro, a premix of tebuconazole, prothioconazole, and the SDHI Fluopyram. More information is needed on the overall efficacy of these new products when used alone or in combination with genetic resistance. Thus, efforts to evaluate integrated management strategies for FHB and deoxynivalenol DON management in wheat and barley using new fungicide mixtures continued in 2022. The overall objective was to provide stakeholders with useful information regarding the efficacy of these new fungicide mixtures relative to the industry standards when used in combination with genetic resistance as part of integrated management (IM) programs to control FHB and DON. Results from the first year (2022) of the new IM_CP cycle are summarized herein.

Materials and Methods: To accomplish the aforementioned objective, field experiments were conducted in 18 US wheat-growing states in 2022. The standard protocol consisted of the application of fungicide treatments in Table 1 (sub-plot) to plots of FHB-susceptible (S), -moderately susceptible (MS), and -moderately resistant (MR) cultivars (whole-plot). Hereafter, the combinations of fungicide programs by cultivar resistance classes will be referred to as: MR_CK (MR untreated), MR_I (MR treated with Prosaro at early anthesis [Feekes 10.5.1]), MR_II (MR treated with Miravis Ace at early anthesis), MR_III (MR treated with Prosaro Pro at early anthesis), and MR_IV (MR treated with Sphaerex at early anthesis). When referring to the same fungicide programs applied to the MS and S cultivars, the combinations were labelled MS_CK, MS_I, MS_II, MS_III, MS_IV, S_CK, S_I, S_II, S_III and S_IV. The experimental design was a randomized complete block, with at least 4 replicate blocks. In most experiments, plots were spray inoculated with a spore suspension of the fungus *Fusarium graminearum* approximately 24-36 hours after the anthesis treatments were applied, with or without mist-irrigation. Trials were naturally infected at some locations. FHB index (IND) was rated or calculated as previously described (1,5) on 60-100 spikes per plot at approximately Feekes 11.2. Plots were harvested, and a grain sample from each experimental unit was sent to a USWBSI-supported laboratory for mycotoxin analysis. Separate linear mixed models (multi-location analysis) were fitted to arcsine square root-transformed IND and log-transformed DON data pooled across environments (trial x state x year combinations), with management combination (15 levels) as fixed effect and environment, block nested within environment, cultivar nested within block and environment as random effects. Contrasts were used to compare pairs of fungicide programs within each resistance class.

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

Treatment	Product	Rate (fl oz/A)	Timing*
1 (CK)	Untreated check	…	…
2 (I)	Prosaro	6.5	Feekes 10.5.1 (early anthesis)
3 (II)	Miravis Ace	13.7	Feekes 10.5.1 (early anthesis)
4 (III)	Prosaro Pro	10.3	Feekes 10.5.1 (early anthesis)
5 (IV)	Sphaerex	7.3	Feekes 10.5.1 (early anthesis)

*Early anthesis was defined as when approximately 50% of the tillers have fresh anthesis extruded in the center of the spikes

Results and Discussion: Mean Fusarium head blight index (IND) data from 22 environments and deoxynivalenol (DON) grain contamination data from 20 environments are shown in Figures 1A and B, respectively. The environments represent spring and winter wheat from five market classes (durum, hard red spring, hard red winter, soft red winter, and soft white winter). At the time of this report data were received from 14 of the 18 participating states.

FHB index: Means varied across the 22 environments and among management combinations within environments, as shown by the spread of the data points around the median in **Fig 1A**. Means ranged from 0 to 71% across management combinations and were more variable across environments for S (interquartile range [IQR] 0.4 to 6.5%) and MS (IQR 0.5 to 3.2%) cultivars than for MR (IQR 0.1 to 1.8%) cultivars. The susceptible, nontreated check (S_CK) had the highest mean IND (13.7%), whereas the application of Prosaro (I), Miravis Ace (II), Prosaro Pro (III), or Sphaerex (IV) at anthesis to MR cultivars resulted in the lowest means (1.2, 0.8, 1.0, and 1.0%, respectively) (**Fig. 2A**). For all tested resistance classes, all fungicide programs resulted in significantly lower mean IND (on the arcsine square root-transformed scale) than the nontreated check, and pairwise differences between fungicide programs were not statistically significant ($P < 0.05$), except for comparisons between S_I and S_II, S_I and S_III, S_I and S_IV, and S_II and S_IV (**Fig. 2A**).

Deoxynivalenol: Mean DON contamination of grain ranged from 0 to 35 ppm across the 20 environments and among management combinations **(Fig. 1B**). Similar to what was observed for IND, DON was more variable across environments for S (interquartile range [IQR] 0.2 to 5.3%) and MS (IQR 0.2 to 2.6%) cultivars than for MR (IQR 0 to 1.3%) cultivars. The lowest mean DON contamination was observed when any of the tested fungicides (I, II, III, or IV) was applied to MR cultivars (1.1, 1.0, 0.8, and 1.1 ppm, respectively), whereas the highest mean level was observed for S_CK (6.1 ppm) **(Fig. 2B**). Within each resistance class, all treatments resulted in significantly lower mean DON (on the log-transformed scale) than the nontreated check, and pairwise differences between fungicide programs were not statistically significant, except for comparisons between II and III for the MS cultivar (**Fig. 2B**).

Efficacy of FHB management programs against IND and DON contamination of grain: Relative to the nontreated susceptible check (S_CK), mean percent control (C) across fungicide programs ranged from 91 to 95% for IND on MR and 87 to 89% on MS cultivars, compared to 55 to 81% on S cultivars. Similarly, C values for DON ranged from 82 to 86% on MR and 62 to 67% on MS cultivars, compared to 56 to 66% on S cultivars. New fungicide-only management programs (S_II, S_III, and S_IV) were more effective than the standard Prosaro treatment (S_I), but with higher efficacy against IND than DON. Percent change in IND for S_II, S_III, and S_IV relative to S_I was 58, 39, and 31%, respectively. However, the new fungicide-only management programs were only 23% (S_II), 16% (S_III), and 9% (S_IV) more effective than S_I in reducing DON contamination of grain. IM programs that combined an MR or MS cultivar with a fungicide application (I, II, III, and IV) were more effective than S_I against IND and DON. Percent change in IND for a tested fungicide relative to S_I ranged from 80 to 88% for applications made to MR cultivars and from 71 to 75% for applications in MS cultivars. For DON, these values varied from 60 to 69% for applications made to MR cultivars and from 14 to 24% for applications in MS cultivars.

As additional data become available, a more complete set of analyses will be performed. However, the results summarized herein suggest that the new fungicide mixtures were quite effective against FHB and DON, with the highest percent control when used in combination with genetic resistance.

The experiments will be repeated in 2023, and all data will be pooled and analyzed to formally quantify management combination effects.

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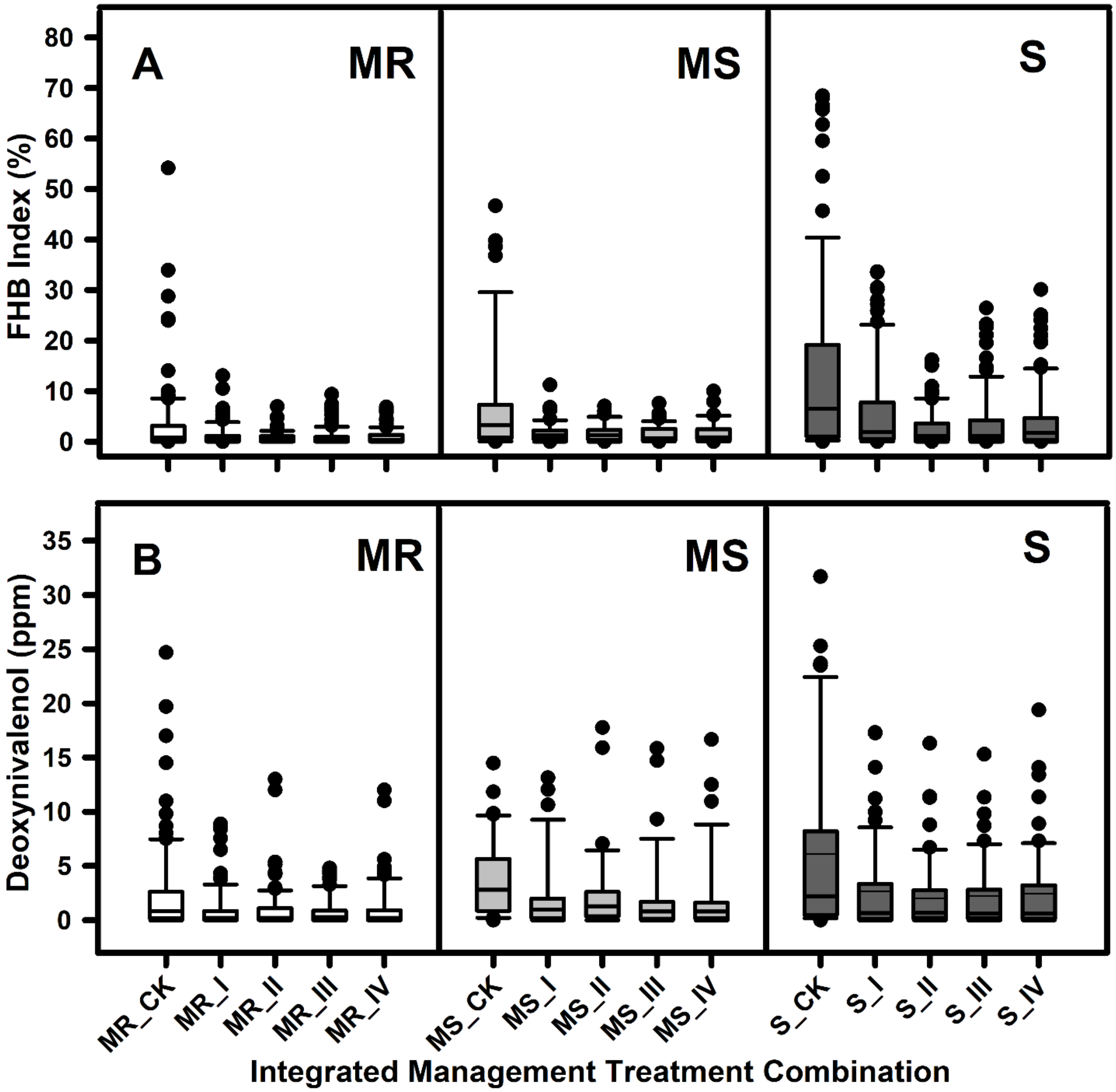

Fig. 1. Boxplots showing the distribution of **A**, mean Fusarium head blight index and **B**, deoxynivalenol grain contamination for different fungicide program x cultivar resistance management combinations. **S**, **MS**, and **MR** represent susceptible, moderately susceptible, and moderately resistant, respectively, whereas **CK** = nontreated check, **I** = treated with Prosaro (6.5 fl. oz.) at anthesis, **II** = treated with Miravis Ace (13.7 fl. oz.) at anthesis, **III** = treated with Prosaro Pro (10.3 fl. oz.) at anthesis, and **IV** = treated with Sphaerex (7.3 fl. oz.) at anthesis. For FHB index, each box in **A** represents data points across 22 trials, whereas for DON, each box in **B** represents data points across 20 trials.

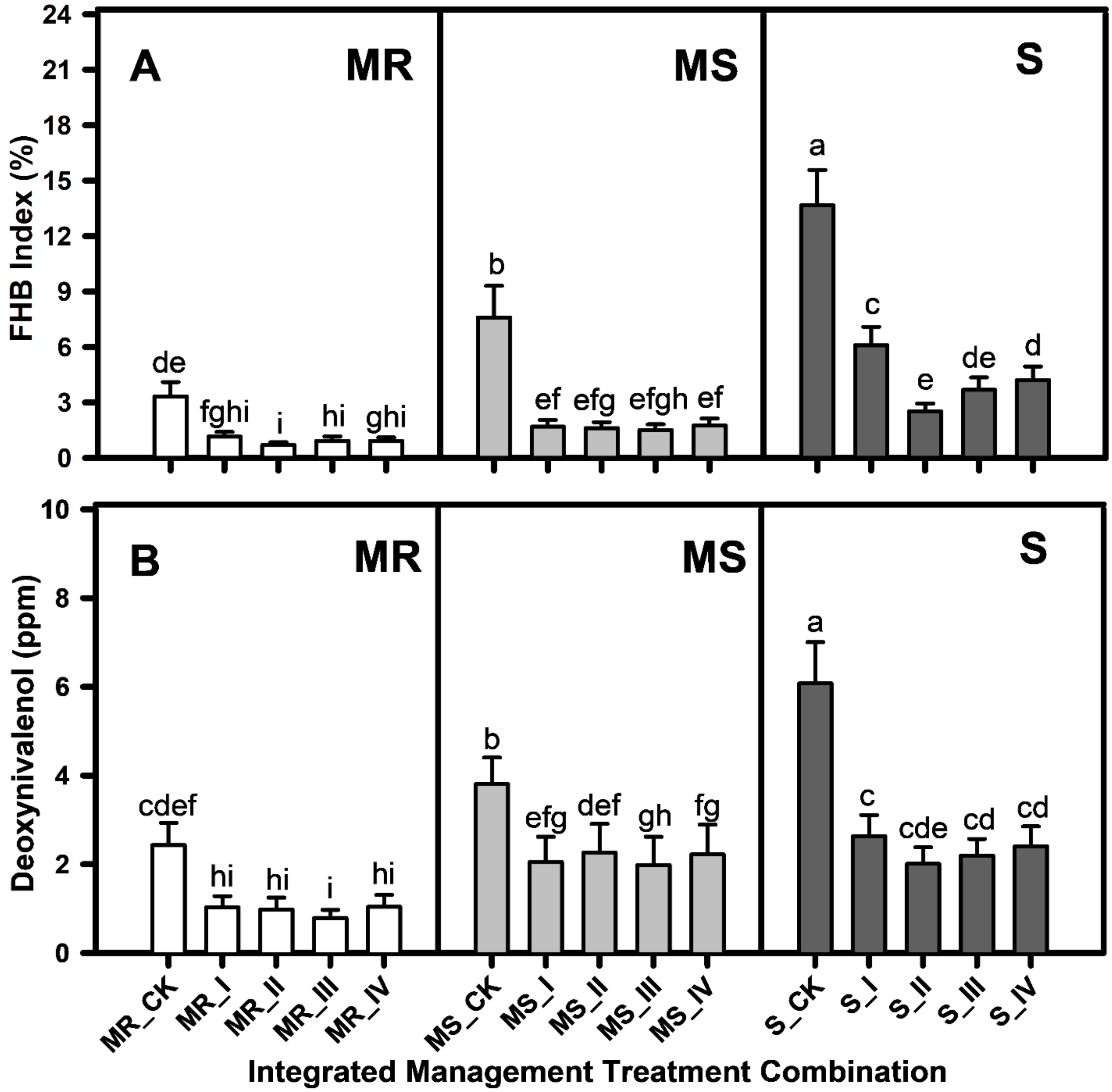

Fig. 2. Arithmetic mean **A**, Fusarium head blight index (IND) and **B**, deoxynivalenol (DON) grain contamination for different fungicide program x cultivar resistance management combinations. **S**, **MS**, and **MR** represent susceptible, moderately susceptible, and moderately resistant, respectively, whereas **CK** = nontreated check, **I** = treated with Prosaro (6.5 fl. oz.) at anthesis, **II** = treated with Miravis Ace (13.7 fl. oz.) at anthesis, **III** = treated with Prosaro Pro (10.3 fl. oz.) at anthesis, and **IV** = treated with Sphaerex (7.3 fl. oz.) at anthesis. For FHB index, each bar in **A** represents the mean across 20 trials, whereas for DON, each bar in **B** represents the mean across 22 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 management combinations as a fixed effect. Graphs are shown on the raw data scale for convenience.