

Report for FY22-IM-021: Fungicide and Genetic Resistance for FHB and DON Management on Winter Wheat in Ohio

Note: Report must cover the *entire* duration of the project period of performance, May 1, 2022-July 30, 2026.

1. What are the major goals and objectives of the research project?

The overall goal of this project as part of the FHB Integrated Management Coordinated Project (IM_CP) is to develop best practices for managing Fusarium head blight (FHB) and deoxynivalenol (DON) in wheat and barley that are robust to conditions experienced in production fields. The specific objectives were to:

- 1) Evaluate the integrated effects of fungicide application and host genetic resistance on FHB and DON, with emphasis on the new combination fungicides Prosaro® PRO and Sphaerex®.
- 2) Compare the efficacy of Prosaro PRO, Sphaerex, and A23751C (Pydiflumetofen + Prothioconazole) to that of existing products: Prosaro, and Miravis® Ace.
- 3) Determine the additive effects of fungicide mixtures and sequential applications for managing FHB and DON; and
- 4) Assess the rainfastness of Prosaro PRO, Sphaerex, and Miravis Ace under varying rainfall scenarios in the presence or absence of an adjuvant.

2. What was accomplished under these goals or objectives? (For each major goal/objective, address these three items below.)

What were the major activities?

Obj. 1 (Integrated management: IM_CP - Ohio): In each of the four years of the project under the current agreement, replicate plots of four soft red winter wheat cultivars with different levels of resistance to FHB were either left **1)** untreated and inoculated, **2)** untreated and not inoculated, or treated with the fungicides **3)** Prosaro; **4)** Miravis Ace; **5)** Prosaro Pro; or **6)** Sphaerex, and spray-inoculated at Feekes 10.5.1. All products were applied at label-recommended rates.

Obj. 2 and 3 (Wheat Uniform Fungicide Trial: UFT - Ohio): In each of the four years of the project under the current agreement, replicate plots of a susceptible cultivar were either left untreated or subjected to one of eight core fungicide programs consisting of Feekes 10.5.1-only or sequential applications of the fungicides tested under Obj. 1, as well as A23751C, Proline, and Tebuconazole. Sequential treatments consisted of Miravis Ace applied at anthesis, followed by Prosaro, Prosaro Pro, Sphaerex, or Tebuconazole 4-6 days after anthesis. All products were applied at label-recommended rates.

Obj 4 (Rainfastness [RFT]): In all but one (2024) year of the project under the current agreement, field plots were established in the fall of the previous year and managed according to standard agronomic practices in the spring. Rainfall and fungicide treatments were applied as planned following a split-split plot design, with surfactant (with or without a non-ionic surfactant) as the whole-plot factor, rainfall treatment (simulated rainfall start

times of 0, 15, 45, and 60 min, all with a 60 min duration), as the subplot factor, and fungicide treatment (Prosaro® PRO, Sphaerex®, and Miravis® Ace) as the sub-subplot factor.

What were the significant results?

Obj 1: FHB index (IND) and DON contamination of grain varied among years. In all cases, all fungicide treatments had significantly lower mean DON contamination of grain than the nontreated check across all resistance classes, except when FHB levels were too low to discern differences among treatments. Relative to the nontreated susceptible check, management programs consisting of a fungicide application to an MR or MS variety reduced mean IND by 36 to 89%, compared to 36 to 61% when a fungicide was applied to an S variety. Correspondingly, mean DON was reduced by 53-97% and 59 to 73%, respectively.

Obj 2: Mean FHB index (IND) and DON levels varied among years. In all cases, all tested fungicide programs resulted in significantly lower mean IND and DON than the nontreated check. For comparisons among treatments applied only at anthesis, the significance and magnitude of differences between the newer fungicides (Miravis Ace, Prosaro Pro, A23751C, and Sphaerex) and Prosaro, the industry standard, varied by year based on baseline IND and DON levels. In many cases, sequential applications of Miravis Ace followed by either Prosaro Pro or Sphaerex yielded mean IND and DON levels comparable to a single application of Miravis Ace and, on occasion, to Prosaro Pro, Sphaerex, or A23751C. Relative to the untreated check, a single application of Prosaro, Miravis Ace, Prosaro Pro, and Sphaerex led to mean reductions in IND of 66, 78, 87, and 79%, respectively, and mean reductions in DON of 60, 73, 78, and 71%, respectively, on average. Sequential application programs involving Miravis Ace followed by Prosaro, Miravis Ace, Prosaro Pro, Caramba, and Sphaerex reduced mean IND by 90 to 96% and DON by 73 and 84%. Results from 2026 are not included.

Obj 3: In most cases, sequential applications of Miravis Ace at early anthesis followed by an application of Prosaro, Prosaro Pro or Sphaerex 4-6 days after early anthesis had additive effects on IND and DON in terms of mean percent control. However, we are conducting further analyses on the pooled data, including data from the 2026 trial, to better quantify additivity.

Obj 4: All tested fungicides were rainfast almost immediately after application when applied with a surfactant. Rainfall start time had no effect on fungicide efficacy when Induce was used ($P = 0.090$ to 0.999), with percent control ranging from 68 to 75% for IND and from 68 to 75% for DON across fungicides. Similarly, rainfall duration had very little effect on fungicide efficacy when the surfactant was used, with comparable percent control of IND and DON across durations for a given fungicide treatment. However, when applied without Induce and subjected to two hours of simulated rain immediately after application, the efficacy of the three fungicides in terms of percent control was less than 47% for both IND and DON.

List key outcomes or other achievements.

For **Obj 1** and **2**, the data were pooled with data from other states collected by PI participating in the coordinated project. Overall efficacy results are summarized below as a measure of the overall accomplishment of the CP.

Obj 1: Relative to the untreated check, integrated management programs combining one of the tested fungicides with a moderately resistant cultivar provided the greatest efficacy against IND and DON contamination, with 82–88% control of IND and 71–78% control of DON. Programs involving a moderately susceptible cultivar treated with a fungicide showed intermediate efficacy, with 72–76% reduction in mean IND and 52–61% reduction in mean DON. The least effective programs consisted of susceptible cultivars treated with fungicides, which provided 55–72% control of IND and 50–59% control of DON.

Based on the pooled data from 2022–2025 growing seasons, the newly released fungicides Prosaro Pro and Sphaerex were as effective as the industry-standard Prosaro in reducing IND and DON when applied to moderately resistant or moderately susceptible cultivars within integrated management programs. In contrast, when applied to susceptible cultivars, Prosaro Pro and Sphaerex provided greater control of IND (based on percent reduction) than Prosaro, while exhibiting comparable efficacy for DON. The experiments were repeated during the 2026 growing season; additional data will be pooled and analyzed to more fully quantify the effects of different management combinations.

Obj 2. The efficacy of the tested fungicide programs against IND and DON contamination of grain relative to the nontreated check varied considerably, with percentage control (C) ranging from 49 to 75% for IND and 31 to 60% for DON. Among the single-application programs, Miravis Ace provided the highest percentage reduction of IND (C = 66%) IND. Relative to the industry standard Prosaro applied at anthesis, Miravis Ace reduced mean IND by 31%. Except for Caramba, the least effective single-application treatment relative to Prosaro, other single-application treatments (Prosaro Pro, Sphaerex) showed comparable efficacy. In contrast, the new fungicide A23751C showed the lowest efficacy for IND among all the treatments relative to Prosaro. Sequential applications of Miravis Ace at anthesis followed by a late application (4 to 6 days after anthesis) of either Prosaro Pro or Sphaerex were the most effective of all tested fungicide programs.

The efficacy of the tested fungicide programs for DON suppression also varied among treatments, with percent control relative to the nontreated check ranging from 31 to 60% for DON. Among the single-application programs, Miravis Ace provided the highest percentage reduction of DON (C = 44%). Compared with the industry standard Prosaro applied at anthesis, Miravis Ace reduced mean DON by 17%. For DON, the new fungicide A23751C showed the lowest efficacy (C = 30% relative to the nontreated check) and was 2% less effective than Prosaro. Sequential applications of Miravis Ace at anthesis followed by a late application (4 to 6 days after anthesis) of either Prosaro Pro or Sphaerex were the most effective of all tested fungicide programs. These two-application programs resulted in approximately 24 to 29% reductions in IND and DON relative to Miravis Ace applied alone at anthesis.

The findings from this four-year study indicate that Miravis Ace at anthesis was the most effective of the tested anthesis-only treatments and that the newly registered fungicides Prosaro Pro and Sphaerex were generally as effective as Prosaro. Sequential fungicide application programs were generally more effective at reducing IND and DON levels than single applications at anthesis. For example, programs applying Miravis Ace at anthesis

followed by a later application of Prosaro Pro or Sphaerex provided greater control of FHB and DON than any single anthesis application of the tested fungicides.

Return on investment (ROI) varied across single and sequential fungicide programs, but mean values exceeded the break-even threshold for all programs. Miravis Ace was the most economically feasible fungicide program, with ROI of \$33 ha⁻¹ (spring) and \$96 ha⁻¹ (winter), compared with Prosaro (\$9 ha⁻¹ spring; \$43 ha⁻¹ winter). In winter wheat, Miravis Ace showed the highest probability of break-even (ROI ≥ 0; 0.75), among all fungicide programs, including single and sequential applications.

Obj3. Overall, results from the four years of this project, pooled with data from prior years and other sources, provided sufficient evidence supporting additive effects of sequential fungicide application programs. There were consistent, clear benefits to applying Miravis Ace at early anthesis, followed by an application of Prosaro, Caramba, Tebuconazole, Prosaro Pro, or Sphaerex 4-6 days after early anthesis in terms of overall percent FHB and DON control. However, we are conducting further analyses on the pooled data, including data from the 2026 trial, to better quantify additivity.

Obj 4: When applied with the surfactant Induce, the tested simulated rainfall treatments had no effect on the efficacy of Prosaro, Caramba, Miravis Ace, Sphaerex, or Prosaro Pro against FHB or DON, suggesting that once applied with Induce, all tested fungicides are rainfast immediately after application.

3. What opportunities for training and professional development has the project provided?

Over the four years of the project, postdoctoral researchers, research technicians, visiting scholars, and a graduate student contributed and gained hands-on experience in multiple aspects of applied research. Learning opportunities included wheat husbandry, designing and establishing field experiments, scouting for diseases, assessing and collecting FHB and DON data, and conducting statistical analyses. Participants also actively prepared abstracts, posters, and presentations for scientific meetings; developed graphs and tables for extension outreach; and contributed to writing a manuscript for publication.

4. How have the results been disseminated to communities of interest?

Results were disseminated through posters, abstracts, and talks at scientific meetings, electronic newsletter articles, extension talks, and field demonstrations.

5. What do you plan to do during the next reporting period to accomplish the goals and objectives?

Not applicable; this is the final report for the agreement.