Fusarium head blight — also called head scab or FHB — is a disease of small grain crops that can significantly affect grain yield and quality. The fungus that causes FHB can also produce mycotoxins, which are chemicals that are toxic to humans and livestock. In particular, FHB is often associated with the mycotoxin deoxynivalenol — also called vomitoxin or DON.

The best way to manage FHB and the associated mycotoxins is to integrate varietal, cultural, and chemical controls. Fungicides are critical tools in this management strategy. A number of factors influence the effectiveness of a fungicide application, including the fungicide’s efficacy, when you apply the fungicide, the orientation of the sprayer nozzles, and water volume.

This publication reviews some of the most important factors to consider when applying a fungicide to manage FHB and mycotoxins.

**Application Recommendations**

**Ground Applications**

For ground applications of fungicides, we recommend:

- A spray volume of 10-20 gallons per acre (93.5-187 L/ha)
- Fine to medium-size droplets (approximately 300-350 microns)
- Nozzles positioned 8-10 inches (0.2-0.25 meters) above the grain spikes
- Forward and backward nozzles angled 30 to 45 degrees down from horizontal

The nozzle types commonly used for herbicide applications are less effective on small grain crops. That’s because small grain spikes are a vertical target rather than a horizontal target (leaf). Therefore, it is important to select the right nozzle to adequately cover a spike.
If your spray rig will travel at less than 6 mph (9.7 kph), the most coverage will come from using forward- and backward-facing 80-degree flat-fan nozzles. Angle the nozzles 30-45 degrees down from horizontal.

If your spray rig will travel at 6 mph or faster (9.7 kph), adequate coverage will come from using a single, forward-facing nozzle. Angle the nozzle 30 degrees down from horizontal.

**Aerial Applications**

For aerial fungicide applications, we recommend:

- A spray volume of 4-5 gallons per acre (15-18.9 liters)
- Fine to medium-size droplets
- Positioning small aircraft 8-10 feet (2.4-3.0 meters) above the spray target
- Positioning larger aircraft 10-12 feet (3.0-3.7 meters) above the spray target
- Mount nozzles to cover 65 percent of the wingspan and mount them as low as possible

For nozzle spacing and placement, we recommend applicators conduct a pattern test to examine the uniformity of the spray pattern.

**Select the Right Fungicide**

The only group of fungicides labeled for adequate FHB and DON suppression is demethylation inhibitors — DMI/triazoles/Fungicide Resistance Action Committee (FRAC) Group 3. Within this fungicide class, there are differences in efficacy among products.

The United States Wheat and Barley Scab Initiative (USWBSI) funded multi-state field trials to evaluate the efficacy of labeled and soon-to-be-labeled fungicides. Trial data indicate that metconazole (Caramba®), prothioconazole (Proline®) and prothioconazole + tebuconazole (Prosaro®) suppressed DON production 45-60 percent. Tebuconazole (Folicur® and generic formulations of this active ingredient) suppressed DON production 20-30 percent. And propiconazole (Tilt® and generic formulations of this active ingredient) suppressed DON production 12-20 percent.

Do not use fungicides that contain a quinone-outside inhibitor (QoI/strobilurin/FRAC 11) to manage FHB and DON. QoI fungicides (such as Headline®, Quadris®, and Aproach®) have been shown to increase DON levels in finished grain compared to an untreated check.

For fungicide selection, see *Small Grain Disease Management: Fungicide Efficacy for Control of Wheat Diseases* (Purdue Extension publication BP-162-W), available from the Education Store, edustore.purdue.edu.

**Apply the Proper Rate**

The table below provides the recommended and maximum use rates for fungicides that are labeled for FHB and DON suppression. Before applying a fungicide, always read and follow the label. Research shows that tank-mixing an appropriate nonionic surfactant improves coverage.

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Active Ingredient(s)</th>
<th>Recommended Rate (fl. oz./A)</th>
<th>Maximum Use Rate (fl. oz./A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caramba®</td>
<td>metconazole</td>
<td>13.5</td>
<td>34</td>
</tr>
<tr>
<td>Folicur®</td>
<td>tebuconazole</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Proline®</td>
<td>prothioconazole</td>
<td>5.7</td>
<td>9.37</td>
</tr>
<tr>
<td>Prosaro®</td>
<td>prothioconazole + tebuconazole</td>
<td>6.5</td>
<td>8.2*</td>
</tr>
</tbody>
</table>

*Prosaro® at 8.2 fl. oz./A contains the maximum use rate of tebuconazole (4 fl. oz. per acre). You may also use a tank-mix of a tebuconazole (such as Folicur® at 3 fl. oz. per acre) and a prothioconazole (such as Proline® at 3 fl. oz. per acre).

**Know When to Apply**

**Wheat**

It is important to monitor the growth stage of your small grain crops, because the timing window is narrow for applying fungicides that suppress FHB. The best time to apply a fungicide for all classes of wheat is at early flowering stage (Feekes 10.5.1 or Zadoks 60). Early flowering is when yellow anthers (flowers) appear or extrude from the center of the wheat spike (Figure 1).

Applying fungicides earlier (at heading, Feekes 10-1-10.5) will not sufficiently suppress FHB and DON. However, recent studies have shown that delaying application 5-7 days after the start of flowering can still suppress FHB and DON — in other words, later fungicide applications can still be effective in case of delays (such as weather).
Spring Barley
Most spring barley varieties are closed-flowering types, so the best time to apply a fungicide is at full-head stage (Feekes 10.5 or Zadoks 59). Full-head is when the spike has completely emerged and is above the flag leaf collar (Figure 2).
Like in wheat, applying a fungicide late (3 to 7 days after heading) will suppress FHB and DON better than applying to growth stages prior to full-head.

Winter Barley
When anthers emerge in winter barley depends on variety and environment. USWBSI research shows that applying a fungicide at full-head stage (Feekes 10.5 or Zadoks 59) or up to 7 days after full-head will suppress FHB and DON the most. However, more research is needed on winter barley to strengthen timing recommendations.
Find Out More

Other publications in the Small Grain Disease Management series are available on the Crop Protection Network website (CropProtectionNetwork.org).

Authors

Andrew Friskop, North Dakota State University
Kiersten Wise, University of Kentucky
Carl Bradley, University of Kentucky
Damon Smith, University of Wisconsin-Madison
Nathan Kleczewski, University of Illinois
Heather Darby, University of Vermont
Hillary Mehl, Virginia Tech University
Alyssa Collins, Pennsylvania State University

Reviewers

Kira Bowen, Auburn University
Gary Bergstrom, Cornell University
Mary Burrows, Montana State University
Emmanuel Byamukama, South Dakota State University
Marty Chilvers, Michigan State University
Christina Cowger, North Carolina State University
Erick DeWolf, Kansas State University
Paul Esker, Pennsylvania State University
Heather Kelly, University of Tennessee
Juliet Marshall, University of Idaho
Martin Nagelkirk, Michigan State University
Pierce Paul, Ohio State University
Madeleine Smith, University of Minnesota-Crookston
Albert Tenuta, OMAFRA
Stephen Wegulo, University of Nebraska-Lincoln

Photo Credits

All photos were provided by and are the property of the authors.

Acknowledgments

This publication was developed by the Crop Protection Network, a multi-state and international collaboration of university/provincial extension specialists and public/private professionals that provides unbiased, research-based information to farmers and agricultural personnel.

This material is based upon work supported by the U.S. Department of Agriculture, under Author Agreement Nos. 59-0206-4-012, 59-0206-5-007, 59-0206-6-012, 59-0206-4-036, 59-0206-4-035, 59-0206-6-010 and 5-0206-5-005. This is a cooperative project with the U.S. Wheat & Barley Scab Initiative. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

This project was funded in part through Growing Forward 2 (GF2), a federal-provincial territorial initiative. The Agricultural Adaptation Council assists in the delivery of GF2 in Ontario.

The authors thank the U.S. Wheat & Barley Scab Initiative and the Grain Farmers of Ontario for their support. Design and production by Purdue Agricultural Communication.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual’s income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA’s TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

©2018 by the Crop Protection Network. All rights reserved.

Small Grain Disease Management