# Ohio Private Pesticide Applicator 2020 Recertification Proceedings

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Core Information

How to Safely Remove Disposable Gloves

1. Pinch outside of glove near wrist. It is advisable to wash disposable gloves prior to removing remaining PPE.

2. Peel glove downward away from wrist, turning glove inside out.

3. Pull glove away until it is completely removed, holding it in your gloved hand.

4. Carefully slip two fingers under the wrist of the remaining glove, only touching the inside of the contaminated glove.

5. Pull second glove downward over the first glove. Dispose of gloves according to the pesticide label.

6. Thoroughly wash hands after removing gloves.
OSU Extension Resources

Agricultural Teams and Resources

Agricultural Health and Safety Program: agsafety.osu.edu/
- Safe Tactics for Ag Today (STAT) Newsletter: agsafety.osu.edu/newsletter/ag-safety-stat

Agronomic Crops Network: agcrops.osu.edu/
- CORN Newsletter: agcrops.osu.edu/newsletter/corn-newsletter
- Field Crop Diseases: u.osu.edu/osufieldcropdisease/
- Agronomic Crop Insects: aginsects.osu.edu/home
- Agronomy and Farm Management Podcast: go.osu.edu/FAM

Soybean & Small Grain Agronomy: stepupsoy.osu.edu

Beef Team: u.osu.edu/beefteam/
- Ohio Beef Cattle Letter: u.osu.edu/beef/

Dairy Team: dairy.osu.edu/
- Dairy Issue Briefs: dairy.osu.edu/dibs

Farm Office: farmoffice.osu.edu/
- Ag Law Blog: farmoffice.osu.edu/blog

Forages: forages.osu.edu/home

Livestock Handling Safety: agsafety.osu.edu/programs/cfaes-osha/livestock-handling-safety

Meat Goat Team: ohioline.osu.edu/factsheet/14

New and Small Farm Team: agrn.osu.edu/small-farm-programs

Ohio Ag Manager Team: u.osu.edu/ohioagmanager/

Ohio Farm Business Analysis and Benchmarking Program: u.osu.edu/farmprofitability/

Ohio Women in Agriculture: u.osu.edu/ohwomeninag/

On-Field Ohio: nutrientmanagement.osu.edu (Coming Soon!)

OSU Farm Management: aede.osu.edu/research/osu-farm-management

Weed Management: u.osu.edu/osuweeds
- YouTube: youtube.com/user/osuweeds

Poultry Team: u.osu.edu/poultry/

Precision agriculture: digitalag.osu.edu

Sheep Team: u.osu.edu/sheep/
- Program Coordinator: Brady Campbell, Campbell.1279@osu.edu, 740-434-3252
- Sheep Team Blog: http://u.osu.edu/sheep/

Soil Fertility: soilfertility.osu.edu/

Sustainable Streams and Watershed Stewardship: fabe.osu.edu/node/532

Swine Team: porkinfo.osu.edu/who-we-are/swine-team
Horticultural Teams and Resources

Aquaculture Team: southcenters.osu.edu/aquaculture
- Program Coordinator: Jordan Maxwell, Maxwell.411@osu.edu, 740-289-2071
- Aquaculture Extension Specialist: Matthew Smith

Buckeye Turf: buckeyeturf.osu.edu/

Buckeye Yard and Garden Online: bygl.osu.edu/

Extension Nursery Landscape and Turf Team: bygl.osu.edu/team
- Amy Stone, stone.91@osu.edu, 419-578-6783

Floriculture Extension Team: hcs.osu.edu/extensionoutreach/floriculture

Fruit and Vegetable Safety Team: producesafety.osu.edu/

Fruit Pathology Lab: u.osu.edu/fruitpathology/
- Ohio Fruit News: u.osu.edu/fruitpathology/fruit-news-2/

Fruits: southcenters.osu.edu/horticulture/fruits
- Gary Gao: gao.2@osu.edu, 740-289-2071 Ext. 123

Grape Wine Team: ohiograpeweb.cfaes.ohio-state.edu/

Integrated Pest Management: ipm.osu.edu/

Maple Syrup Program: agnr.osu.edu/specialty-crop-business/maple-syrup

Ohio Woodland Stewards Team: woodlandstewards.osu.edu/

Organic Food and Farming Education and Research Program: offer.osu.edu

Vegetable and Fruit Insect Pest Management: u.osu.edu/pestmanagement/
- Vegnet Newsletter: u.osu.edu/vegnetnews/

Vegetable Disease Facts: u.osu.edu/vegetablediseasefacts/

Miscellaneous Resources

Biting Insect Team Education: u.osu.edu/bite

C. Wayne Ellett Plant and Pest Diagnostic Clinic: ppdc.osu.edu/

Master Gardeners: mastergardener.osu.edu/
- Program Director: Pam Bennett, bennett.27@osu.edu, 937-521-3860

Pollinators: cfaes.osu.edu/impacts/pollinators

OSU Extension Publications: extensionpubs.osu.edu/

Urban Agriculture Outreach: dirt.osu.edu/urban-agriculture-outreach

Online Pesticide Recordkeeping: pested.osu.edu/onlinerecords

Apps
- Bed Bug Field Guide: Available for free for IOS or Android devices
Pesticide Safety Education Program, Ohio State University Extension

Agencies

- Ohio Department of Agriculture: agri.ohio.gov, 614-728-6987
- Ohio EPA: https://www.epa.state.oh.us/, 614-644-3020
- Environmental Protection Agency: www.epa.gov

Weather

- State Climate Office: climate.osu.edu
- FARM (Field Application Resource Monitor): farm.bpcrc.osu.edu

Departments:

- Entomology: entomology.osu.edu/home, 614-292-8209
- Plant Pathology: plantpath.osu.edu/, 614-292-1375
- Animal Sciences: ansci.osu.edu/, 614-292-6401
- Food, Agriculture and Biological Engineering, fabe.osu.edu, 614-292-6131
- Pesticide Safety Education Program: pested.osu.edu, 614-292-4070

Spotlight on Key Extension Resources

Pesticide Safety Education Program: The Pesticide Safety Education Program helps private and commercial pesticide applicators apply pesticides safely and legally in Ohio. Applicators and trained servicepeople can review the requirements for licensing and locate new applicator training and recertification meetings throughout Ohio on the program website. Dicamba-specific training sessions will be listed for 2020 as they become available. Information on Worker Protection Standards, Pesticide Safety, Storage, and Disposal, and free online self-study modules for the pesticide core exam are also available. For resources, see: pested.osu.edu or call 614 292-4070 to talk to PSEP staff.

Nutrient Education & Management: This web resource helps farmers and commercial agricultural applicators apply fertilizers legally in Ohio. Applicators can review the requirements for fertilizer certification and locate fertilizer recertification meetings throughout Ohio on the program website. This site is also managed by the Pesticide Safety Education Program. For resources, see: nutrienteducation.osu.edu or call 614 292-4070 to talk to PSEP staff.

Online Pesticide Recordkeeping: This website is available free of charge for private, commercial and fertilizer applicators in Ohio to assist in compliance with Ohio Pesticide and Fertilizer recordkeeping requirements. Keep records on any electronic device where Wi-Fi is available. Data is user name and password protected for security, allowing for multiple users for each account. Easily export, copy or delete files according to your needs, pested.osu.edu/onlinerecords

FARM: The Field Application Resource Monitor uses advanced weather forecasting to advise farmers when to apply fertilizers and pesticides to keep them on the field and out of Ohio waters. This app is easily accessible by most computers and electronic devices, providing highly specific forecasts for areas as small as 1.5 miles wide. FARM provides guidance on the best time to apply fertilizer and manure based on precipitation forecast, saving farmers time and money. For details, go to: farm.bpcrc.osu.edu/

Coming Soon!

On-Field Ohio: On-Field Ohio! Is an online P index tool that farmers can use to estimate field-scale erosion and phosphorus runoff risk based on field properties and different management practices. By using field-specific inputs such as crop rotation, field drainage, and soil test data, risks associated with fertilizer or manure applications can be estimated for each crop year in a rotation, or averaged across the rotation. Comparing alternative management practices demonstrates how voluntary changes can contribute to meeting water quality targets. For more information, go to: nutrientmanagement.osu.edu
Farm Stress and Safety Resources

Sarah Noggle, Extension Educator, Extension, Paulding County, The Ohio State University.

Thanks for checking out the farm stress and safety resources. This list includes websites, articles and handouts from across the US.

Ohio resources and handouts
• Ohio State Rural and Farm Stress Task Force
  • https://extension.osu.edu/about/resources/extensions-task-forces/rural-and-farm-stress
  • Resources relating to Rural and Farm economics, Workforce Development and Personal Stress Management
• Addressing Ohio's Agricultural Challenges
  • https://go.osu.edu/agcrisis
  • Resources related specifically to livestock, crops, vegetables, farm management, forages and fruit crops with an option for submitting specific questions.
  • #LeanOnYourLandGrant
• Ohio Department of Agriculture Farm Stress
  • www.gotyourbackohio.org
  • Options for males, females and youth
  • #GotYourBack
• Ohio State Extension Agricultural Safety and Health Program
  • https://agsafety.osu.edu/

Other University Extension resources
• Michigan State University – Managing Farm Stress
  https://www.canr.msu.edu/managing_farm_stress/
• Farm Crisis Center https://farmcrisis.niu.org/
• North Dakota State University Farm and Ranch Stress
  https://www.ag.ndsu.edu/farmranchstress

Ohio State is working with farmers, landowners, livestock managers to help address the 2019 Agricultural Challenges. The website http://u.osu.edu/agcrisis has many help links to economic, agronomic and livestock topics. Please feel free to submit a direct question via our online portal. Portal questions and topics are being answered as they come in.

Other University Extension resources
• Northeast Extension Risk Management Education
  http://www.nerme.org/farm-stress-management/
• Upper Midwest Agricultural Safety and Health Center (UMASH) Farm & Safety Stress Check
  http://umash.umn.edu/farm-safety-check-stress/
• Resilient Farms, Families, Businesses & Communities: Responding to Stress
  https://fyi.extension.wisc.edu/farmstress/
• University of Wisconsin Education Disaster Education Network
  http://www.uwyo.edu/uwe/programs/wyo-disaster/stress.html
• South Dakota State
  https://extension.sdstate.edu/tags/farm-stress
• University of Wyoming
  http://www.uwyo.edu/uwe/programs/wyo-disaster/stress.html
• University of Maine Extension
  https://extension.umaine.edu/agriculture/farmers-under-stress/
• University of Maryland Extension
  https://extension.umd.edu/FarmStressManagement
• Minnesota Department of Agriculture
  https://www.mda.state.mn.us/about/mnfarmerstress
Other Stress handouts related to farms
- My Coping Strategies Plan, Kansas State
  https://www.bookstore.ksr.e.ksu.edu/pubs/MF3418.pdf
- Responding to Distressed People, NDSU

Video Links:

Potential Training:
- Mental Health First Aid Training
  https://www.mentalhealthfirstaid.org/
- QPR Training https://qprinstitute.com/

Other helpful places to go:
- Mental Health Awareness Project
  https://u.osu.edu/cphp/ohio-mental-health-resource-guides/
- Center for Rural Affairs: http://www.cfra.org/news/180130/10-helpful-resources-farmers
- Crisis Text Line: https://www.crisistextline.org/textline/
- Iowa State University. Iowa Concern 24-hour hotline: 1-800-447-1985
- National Suicide Prevention Lifeline: 1-800-273-TALK (8255)
- National Suicide Prevention Lifeline Crisis Chat:
  https://suicidepreventionlifeline.org/talk-to-someone-now/
- Veterans Crisis Line: 1-800-273-8255, Press 1 (website also has a chat option) https://www.veteranscrisisline.net/
- Disaster Distress Helpline 1-800-985-5990 (or text TalkWithUs to 66746)
- Youth Mental Health Line 1-888-568-1112
- CDC Division of Violence Prevention
  https://www.cdc.gov/violenceprevention/index.html

Ohio’s Crisis Text Line
- Text 4HOPE to 741741 to connect with a trained volunteer crisis counselor within five minutes.
- Free, confidential, anonymous and secure 24/7.
- Features active rescue where trained counselors connect with emergency services to save texters from immediate self-harm.

Reaching out further:
- Local Mental Health Boards
  https://www.oacbha.org/mappage.php
- Local Health Departments
  https://odh.ohio.gov/wps/portal/gov/odh/find-local-health-districts
- Ohio Job and Family Services
  https://jfs.ohio.gov/ocf/index.stm

**Take the OSU Extension health survey:**

Tells us your health behaviors for sun safety and seven (7) other areas for: sleep, nutrition and healthy eating, physical activity, smoking, alcohol, non-prescription drug use, and stress. The information will help us develop future Extension programs and resources for healthy living.

We value your time – you may earn a $10 gift card for completing the 15-minute survey. Read more about the health assessment and take the survey at:

www.go.osu.edu/HealthSurvey2020

Or use your smart phone and scan the QR code:

Request a paper survey by contacting:

Pat Brinkman                                          Dee Jepsen
740-335-1150 ext 17                                   614-292-6008
Brinkman.93@osu.edu                                   Jepsen.4@osu.edu
Current Status of Dicamba for Over-the-top Use in Dicamba-Tolerant Soybeans

In November 2018, EPA announced new labels and restrictions for dicamba products designed for over-the-top use on dicamba-tolerant crops. Currently there are four products in this group: Xtendimax, Engenia, FeXapan, and Tavium Herbicides. All product labels will expire in December 2020, so the EPA will have to take action on new labels for the 2021 growing season. Direct supervision is prohibited, so only certified applicators may apply these products. Unlicensed applicators cannot purchase or apply these restricted-use products. Applicators must take annual dicamba training. Dicamba-specific training opportunities for 2020 will be posted online at pested.osu.edu/privateapplicator as soon as they become available. The pesticide labels have numerous restrictions designed to manage spray drift. Users are required to keep dicamba-specific records for two years and must document that they have 1) consulted a sensitive crop registry and 2) surveyed adjacent fields before making an application.

www.epa.gov/newsreleases/epa-announces-changes-dicamba-registration

Concerns about Glyphosate in Our Food and Cancer

In recent years there have been disturbing reports about glyphosate, the most widely used herbicide in the world. In 2018, Environmental Working Group (EWG), a non-profit organization concerned with health and environment, reported finding glyphosate in breakfast cereals. Also in 2018, a California pesticide applicator with terminal cancer sued Monsanto and was awarded $289 million in a jury trial (later reduced $78M). It is likely that the jury was influenced by World Health Organization's International Agency for Research on Cancer (IARC) announcement in 2015 that glyphosate was a probable human carcinogen. Encouraged by the trial outcome, thousands of similar lawsuits have been filed across the country.

Pesticide applicators should be concerned about potential harmful effects from pesticides. However, it is helpful to put some of the information about glyphosate in perspective. IARC’s task was to determine “whether glyphosate could cause cancer under some circumstances,” and the circumstances it reviewed were laboratory tests. In the glyphosate draft risk assessment published in 2017, the U.S. EPA delivered a very different conclusion - that glyphosate is unlikely to be carcinogenic. In reality, the implications of the two pronouncements were very different. In the pesticide registration process, EPA assesses risk – which considers exposure and the likelihood of harmful effects under real-world conditions. IARC does not consider exposure, thus cannot assess risk, real-world or otherwise. Based on human health risk assessment, EPA continues to affirm at this time that glyphosate, when used as labeled, is not a carcinogen. Furthermore, EPA findings on human health risk are consistent with science reviews from other federal and world pesticide regulatory agencies.

The U.S. Agricultural Health Study also sheds light on the potential real-world effects of glyphosate. This very large, on-going study has examined how agricultural practices affect cancer and health outcomes among licensed pesticide applicators in Iowa and North Carolina since 1993. A 2001 analysis of the data found no significant associations between glyphosate and cancer. In 2018, an updated analysis of the Agricultural Health Study included 54,252 pesticide applicators and 5779 cancer cases. Glyphosate was not associated with any solid tumors or lymphoid malignancies, including non-Hodgkin’s lymphoma. While there was some indication of increased risk of acute myeloid leukemia in the highest exposure quartile, this association was not statistically significant.

What about those breakfast cereals? The reported levels were all within EPA tolerances (legal maximum contaminant level) for glyphosate in those foods.

In April 2019, EPA released its proposed interim decision on glyphosate, restating once more that it found no risks to public health from current registered uses of glyphosate. This is not the same as saying glyphosate is risk-free. If you use glyphosate or any other pesticide, you must read and follow the
pesticide label. To keep pesticide residues in crops within legal tolerances, strictly adhere to limits on application frequency, pre-harvest intervals, and maximum use rates per treatment or crop cycle. To protect yourself, always wear and maintain your personal protective equipment (PPE) properly.

- [www.epa.gov/home/links-epa-web-content-about-glyphosate](http://www.epa.gov/home/links-epa-web-content-about-glyphosate)

**Paraquat Update**

The EPA will be phasing in key safety requirements and label changes for paraquat herbicide to stop improper use that has led to poisonings and deaths. Only certified applicators who complete an EPA-approved paraquat training will be allowed to make applications. Direct supervision of uncertified applicators will be prohibited. Applicators will have to take an online safety training every three years and keep documentation of the training. New pesticide labels will highlight paraquat toxicity, new application restrictions, and training requirements. Registrants submitted their label changes in March 2018 and have 12 months from EPA’s label approval date to adopt labels with new restrictions. Registrants were also required to submit registrations for new closed system packaging by March 2019, and have 12 months from EPA’s approval date to adopt the closed system packaging for all non-bulk containers (less than 120 gallon).

The U.S. EPA opened its draft risk assessment for paraquat for public comment in October 2019. [https://www.epa.gov/ingredients-used-pesticide-products/paraquat-dichloride#action](https://www.epa.gov/ingredients-used-pesticide-products/paraquat-dichloride#action)

**New Respirator Requirements under the Revised Worker Protection Standard.**

New requirements for respirators were adopted in the 2015 Revised Worker Protection Standard. Although family members are exempt from many requirements under WPS, in this case the new respiratory protections are required for family members, yourself, and any workers you employ whenever agricultural pesticides that require a respirator are used. These requirements are already standard for other industries; now these protections have been extended to agricultural uses.

The purpose of the medical evaluation requirement is to prevent possible health complications from wearing a respirator. The person intending to use a respirator fills out a standard medical questionnaire and submits it for evaluation by a professional. How someone responds to the questionnaire determines whether he is cleared for respirator use, requires further medical evaluation, or denied clearance. The medical evaluation is required only once unless someone develops new health issues, or later has difficulty wearing a respirator.

The fit test requirement ensures that the respirator forms a good seal, because without a good seal, the respirator offers little protection. Fit testing is required once a year, or whenever the respirator model is changed. If the handler has facial hair between the sealing surface and the face, they cannot wear a tight-fitting respirator. Fit testing is required once a year, or whenever the respirator model is changed.

WPS also requires keeping a record of compliance and training employees in the care and use of their respirators. In the absence of other indicators or manufacturer instructions, replace respirator cartridges after every 8 hours of cumulative use.

See the article “Worker Protection Standard and the 2015 Revision” in this proceedings for additional information and locations for medical evaluation and fit testing.
Ohio Department of Agriculture

The Ohio Department of Agriculture has the authority to enforce Ohio and federal pesticide laws. ODA inspectors have the authority to investigate pesticide complaints and inspect pesticide records, pesticide storage, and application sites. ODA also registers all pesticides used in Ohio. Contact ODA at 614-728-6987.

Private Pesticide Applicator

Private pesticide applicators may apply restricted use pesticides in the production of agricultural commodities on property owned or rented by them or their employer. Licensed private applicators may supervise the use of restricted use pesticides by their employees or unlicensed family members; the license holder must provide the necessary safety equipment to the applicator and instruct them in the appropriate precautions. If applying in the license holder’s absence, the pesticide label must be available at the worksite to unlicensed applicators.

Adverse Effects

Pesticide applications can potentially cause problems. These are sometimes due to illegal or faulty applications, but may occur even when proper precautions are taken.

Ohio Pesticide Law contains two regulations concerning problem reporting. Private and commercial applicators are required to report adverse effects to the Ohio Department of Agriculture (ODA):

By telephone, within 48 hours of his/her knowledge of any human illness requiring medical attention, resulting from, or allegedly resulting from a pesticide used by the applicator, followed by a written report within seven (7) days.

By written report within ten (10) days of his/her knowledge of any property damage, in excess of $500 resulting from or allegedly resulting from a pesticide used by the applicator.

Reporting the incident does not mean the applicator will be assumed guilty of wrongdoing. ODA will conduct an investigation into the incident. Records of the application and other evidence will be reviewed during the investigation.

Protecting Bees in Ohio

Applicators are required to read the label and follow directions to avoid harm to the environment, non-target organisms and endangered species. The label will indicate if the pesticide is toxic to non-target organisms such as fish, aquatic invertebrates, bees, or other organisms.

According to Ohio law, if a pesticide label indicates it is toxic to bees, it is the applicator’s responsibility to contact any beekeepers with registered apiaries (beehives) within ½ mile of the area to be treated when the treatment area is more than ½ acre in size and the crop plant is in flower. Apiaries must be notified at least 24 hours before application. A complete list of registered apiaries is available through the ODA Apiary Section at (614) 728-6406, or by submitting a records request through the ODA Legal Office website. Applicators also may register to use Fieldwatch (fieldwatch.com) to find the locations of beehives and sensitive crops. Please note that the Fieldwatch program is voluntary, so not all beehives in your area may appear there.

The law also states that pesticides with bee hazard statements on the label may not be applied at times when pollinating insects are actively foraging in the target area. Bees tend to be least active early in the morning or late in the evening.

Follow label precautions that relate to drift and be aware of the potential risk of drift to neighboring areas. Filter strips or other conservation areas that border fields may also have flowering plants and weeds with foraging bees that must be avoided.

Pesticide formulation has an impact on bee toxicity. Dusts and wettable powders are more toxic than emulsifiable concentrates. Ultra-low volume applications are generally more toxic than a high volume applications. Repellents are not effective in keeping bees away from treated areas.

Pesticide Storage Requirements

Storing pesticides correctly is important to prevent contaminating water and cross contamination with other stored items. Applicators need to be aware of Ohio regulations for storing pesticides and also follow any label instructions for storage. Applicators must not store pesticides in a manner that could contaminate animal feeds or commercial fertilizers. It is advisable that pesticide storage areas not have a drain, or the drain should be plugged.

Use Inconsistent with the Label

Using a pesticide in a manner inconsistent with its labeling is illegal and considered a misuse. The label is the law. Examples of misuse may include:
Applying a pesticide to a site, crop, or for a use that is not listed on the label.

Applying a pesticide at a rate higher than the labeled rate or at more frequent intervals.

Handling a pesticide in a way that is against label instructions, such as:

- Not wearing appropriate personal protective equipment (PPE).
- Not observing well-setbacks.
- Not following preharvest- and restricted-entry intervals

**Worker Protection Standard**

Private applicators may be required to follow the guidelines for the Agricultural Worker Protection Standard (WPS). This regulation is issued by the Environmental Protection Agency (EPA) and enforced by the ODA.

The purpose of WPS is to reduce occupational pesticide-related illness. The regulations apply to growers who use pesticides for production of agricultural plants and employ workers or pesticide handlers who are exposed to such pesticides. You are under the regulation if you employ anyone (even one employee) outside of immediate family who is working in areas that have had a pesticide application or a restricted entry interval (REI) in effect within the last 30 days. A limited number of WPS protections are also required for family members.

You must follow the label directions for “Agricultural Use Requirements.” These include restricted entry intervals (REI) and personal protective equipment (PPE). The Agricultural Use Requirements box cites the Worker Protection Standard, 40 CFR part 170. Most WPS requirements will not be on the label; you will need to consult the regulation requirements at www2.epa.gov/agriculture or by calling the National Agriculture Compliance Assistance Center at (888) 663-2155. The WPS employer compliance manual also can be downloaded from pesticideresources.org.

In 2015, the Worker Protection Standard was substantially revised, including changes to safety training, decontamination sites, hazard communication, and entry restrictions. For more information, see the article on “The Worker Protection Standard and the 2015 Revision” in this publication.

**Drift is the Most Frequent Complaint to the Ohio Department of Agriculture**

Historically, drift has been the most common pesticide-related complaint to ODA. The past year was no exception. Agricultural drift made up 88% of the total number of agricultural complaints, about the same percentage as the previous year. However, the total number of agricultural complaints (92) was down from the previous year (129). The dicamba-related complaints also decreased by half, from 52 (2018) to 25 (2019).

Ohio law states that you must not apply pesticides in a manner that adjacent crops, pasture land, water, or other areas will be damaged or contaminated. To help reduce pesticide drift on sensitive areas, ODA offers a free tool, FieldWatch, for applicators to locate sensitive areas. Growers and beekeepers can securely share their locations with pesticide applicators using DriftWatch and BeeCheck (see FieldWatch article in this book).

**New Laws Regulate Fertilizer Use in Ohio**

Ohio passed a law in 2014 requiring certification if you apply fertilizer to more than 50 acres of agricultural production grown primarily for sale. Under this law, fertilizers are defined as materials that contain one or more recognized nutrients and have a guaranteed analysis; manure is not included.

Applicators can become certified by taking an exam offered by ODA, or by attending a 3-hour educational program offered by OSU Extension. Every three years, one hour of recertification training, or passing the exam will be required to maintain certification. Pesticide applicators may obtain a fertilizer certificate at no additional cost, but those without a pesticide license must pay a $30 fee for the certificate.

Certified fertilizer applicators are required to keep records of all fertilizer applications.

In 2015, additional regulations were passed that impose certain restrictions on fertilizer and manure applications. Statewide, no person may apply manure from a concentrated animal feeding facility (CAFF) unless: 1) The person is an Ohio Certified Livestock Manager (CLM) or 2) The person has been certified through the Fertilizer Applicator Certification (FACT) training. In the Western Lake Erie Basin watershed, applications are restricted under certain weather and soil conditions. For more information about fertilizer certification, record keeping, and information on fertilizer certification or recertification meetings, see nutrienteducation.osu.edu.
Ohio Private Applicator Pesticide Recordkeeping Requirements
Pesticide Safety Education Program
Ohio State University Extension

Private pesticide applicators are required to keep application records for all restricted use pesticides. Although there is no standard format required, Ohio pesticide application records need to follow these guidelines:

- **Who**
  - Record the responsible applicator’s name and license number.

- **What**
  - Record the trade or brand name of the pesticide used.
  - List the EPA registration number which is the unique identifying number located on the front panel of the pesticide label. This will help indicate exactly what product was used.
  - Record the total amount applied.

- **Where**
  - Indicate location and/or field number of area treated. Farm map keys may be used.
  - Record the size of the area or acreage treated.
  - Remember to record spot treatments.
  - Specify the crop in the treated area.

- **When**
  - Record the month, date, and year of application.

- **Why**
  - Records are required by law for all restricted-use (RUP) applications, but are recommended for all pesticide applications.
  - Records must be:
    - Recorded on the day of application.
    - Kept for three years.
    - Provided to rental or lease landowners within 30 days of request.
    - Provided to the state pesticide regulatory agency (OH Dept. of Agric.) upon request
  - Benefits of recordkeeping:
    - Easier handling of complaints and legal action.
    - Many lenders require pesticide records when property sells.
    - Keeping good records is a Best Management Practice.
    - Food processors may require history of fields for food security.
    - Evaluate Integrated Pest Management (IPM) effectiveness.

A sample excel file of the Private Applicator Restricted Use Pesticide Recordkeeping Form is available at pested.osu.edu/PrivateApplicator/recordkeeping

Your county extension office may have copies of the Ohio State University Extension, “Private Applicator Pesticide Records” books available for distribution.

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**ONLINE PESTICIDE RECORDKEEPING IS NOW AVAILABLE:**
[pested.osu.edu/onlinerecords](pested.osu.edu/onlinerecords)
<table>
<thead>
<tr>
<th>What</th>
<th>Where</th>
<th>When</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop</td>
<td>Location</td>
<td>Application Date (mm/dd/yyyy)</td>
</tr>
<tr>
<td>Size of Area Treated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Amount Applied</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPA Registration Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brand or Product Name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notes</td>
<td></td>
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</tbody>
</table>
PESTICIDE COMPLAINTS

What to Expect After Filing a Pesticide Complaint

The Ohio Department of Agriculture (ODA) regulates the use and distribution of pesticides in Ohio. ODA also investigates consumer complaints when there are potential violations of Ohio Pesticide Law. The investigation of complaints is at no cost to the complainant.

Here’s what will happen after you file a formal complaint with ODA:

1. ODA will immediately investigate cases that involve human health. Most other complaints can take up to 10 days or longer before action, depending on the inspector’s case load.

2. An ODA inspector will make an appointment with you to see the location where the alleged violation occurred.

3. The inspector will examine and photograph the site and may take physical samples.

4. The inspector will contact the applicator to inquire about what pesticides were applied and other pertinent information.

5. After the inspector has gathered all of the necessary information, ODA administrative and technical staff will review the case for possible violations of Ohio Pesticide Laws. This process can take a few months to a year.

6. If ODA concludes that there was a violation, ODA will address the violation with the applicator.

7. ODA will provide a case summary to the complainant at the conclusion of the investigation and enforcement action (if applicable). Completed ODA cases are considered public information and can be requested by anyone.

Remember: Ultimately, pesticide complaints are a civil matter between the parties involved. ODA’s primary focus in any complaint investigation is to determine whether Ohio’s pesticide laws have been violated. ODA is authorized to take enforcement action if a violation is found. However, ODA is not authorized to pursue damages or restitution on behalf of any individual or person whose property has been damaged due to a pesticide application. You may wish to contact an attorney to discuss any options that you may have to pursue restitution associated with any damaged property.

Complaint Timeline

- **STEP 1**: Site Inspection: - Documents Collected - Samples Collected - Photographs Taken
- **STEP 2**: Samples submitted to Consumer Analytical Lab.
- **STEP 3**: Investigation reviewed and samples requested to be analyzed, if applicable.
- **STEP 4**: Meet with Applicator - Interviews - Investigation Report
- **STEP 5**: Enforcement action against responsible parties.

**CONCLUSION**

| Case # | Pesticide Safety Education Program, Ohio State University Extension | 15 |
FREQUENTLY ASKED QUESTIONS

What is the role of the pesticide inspector?

After receiving a complaint, an inspector will contact pertinent individuals to conduct inspections and/or interviews. The investigator will document the incident through evidence collection that may include: maps, photographs, affidavits, pesticide label reviews, on-site assessments and sample collection. The inspector’s observations will be compiled into a case report of the incident.

How soon after I make a complaint will an investigation be conducted?

An ODA inspector will generally make telephone contact with the complainant within 2-3 days of the initial complaint. This telephone contact will allow the inspector to schedule a site inspection at a mutually convenient time for the complainant and the inspector. The site visit will generally be conducted within 10 days of the initial complaint. Complainants are encouraged to complete a written statement prior to the inspector’s arrival. Complainants should also collect and photocopy for the inspector all bills, invoices, contracts, correspondence or other documents that relate to the complaint.

What happens after the Inspector’s visit to my property?

After the site inspection, the inspector will meet the applicator to inquire about what pesticides were applied and obtain all other pertinent information. When the inspector has gathered all of the necessary information related to an investigation, a case report will be generated. Then the ODA staff will review the case for possible violations of Ohio Pesticide Law. If a violation has been detected, one of the following enforcement actions may be applied: Field Notice of Warning, Notice of Warning, Civil Penalty, License Action, or Criminal Prosecution.

How long does an investigation usually take from start to finish?

Although the goal of ODA is to complete every case as quickly as possible, many factors delay the conclusion of a case. (i.e. complicated laboratory analyses; lack of cooperation of applicator and complainant; the need to conduct follow-up investigations; and the need to respond to other complaint incidents). Because each case varies, it is impossible to provide an estimate on how long it may take to conclude a particular case. If you are interested in a status update of your case, you can contact ODA at (614) 728-6987 for an update.

Who has access to complaint investigation information and case summaries?

A final written report will be provided to the complainant and anyone else who makes a public records request for it. Case files are public documents once the investigation has been concluded.

How will I be compensated for my pesticide damages?

The focus of ODA complaint investigations is to determine if pesticides were used according to label directions and applicable laws. Damage compensation is a civil matter between the parties that are involved in the complaint. ODA is not authorized to pursue damages or restitution on behalf of any individual or person whose property has been damaged due to a pesticide application. You may wish to contact an attorney to discuss any options that you may have to pursue restitution associated with any damaged property.

Who can I call if I have a question regarding a complaint?

Call ODA at 614-728-6987 Monday through Friday, 8:00am-5:00pm. Be sure to reference your case number.
Ohio Sensitive Crop Registry, Provided by FieldWatch, Inc.
Pesticide and Fertilizer Regulation Section
Ohio Department of Agriculture

The Ohio Sensitive Crop Registry (OSCR), which is now provided by FieldWatch, Inc., is a free and voluntary online tool for beekeepers and growers of specialty crops to securely share their locations with pesticide applicators. Applicators can search the map to see where these high-value, sensitive areas are that registered growers and beekeepers have mapped.

This registry displays the locations of registered apiaries, organic crops and pesticide-sensitive locations including but not limited to: fish farms, nurseries, orchards, greenhouses and high tunnels, vegetables and fruit such as brambles, grapes and tomatoes. Conventional, organic, and certified organic crops are eligible for inclusion on the registries. A new program, called CropCheck for Row Crop Producers, is available in certain states for commodity field crops such as field corn, soybeans, cotton, rice, hay (alfalfa), wheat or pasture. This new registry is not currently available in Ohio, however it may be added in the future.

OSCR is intended to be used by pesticide applicators and agricultural producers only. Both hobbyist and commercial honey bee hives are included, but only commercial specialty crop fields are mapped. Private gardens, yards, playgrounds, wildlife habitat and other sensitive areas are not included on the registry.

Benefits
Many pesticides now carry instructions concerning honey bees and susceptible crops; buffer zones and downwind restrictions are common when these sensitive areas are adjacent to the application area. Specialty crops are typically high-value (some may be 5-10 times more valuable than row crops) and sensitive to volatile pesticides like 2,4-D and dicamba. The registry provided by FieldWatch is a simple tool for growers of specialty crops to show applicators where these locations are, so label directions can be easily followed and risk of off-target damage minimized. It also allows beekeepers to inform applicators of their contact info and clearly identify their hive locations so that they may be contacted prior to spraying.

Since honey bees are sensitive to many pesticides, Ohio law has given them special protections. Pesticide applicators are required to contact beekeepers 24 hours before using a product that is labeled as being toxic to honey bees, if the crop to be treated is in bloom, greater than half an acre, and within a half-mile of a certified and identified apiary. This registry can help applicators easily locate these apiaries and find beekeeper contact information.

How it works
Users will need to create a free account with FieldWatch before searching or adding registered locations in Ohio. One of the benefits of the FieldWatch program is that users from one member state can view the sites in any other member state – without needing to create multiple accounts or use different registry programs.

1. Go to fieldwatch.com
   a. Applicators should click on “FieldWatch for Applicators” and create an account to search the maps.
   b. Beekeepers should click on “BeeCheck for Beekeepers” and create an account to add apiary locations to the registry.
   c. Specialty crop producers should click on “DriftWatch for Crop Producers” and create an account to add commercial specialty crop locations to the registry.

People who register as Applicators will have access to search tools to view and print the location maps and access producer or beekeeper contact information. Applicators can also opt-in to receive automated emails that tell them when a commercial specialty crop field or apiary site has been newly approved. Notifications can be set up based on the entire state, one or more counties, or a customized area.

Users who register as producers or apiarists will have access to tools allowing them to add, edit, or remove their locations from the map at any time during the year. There is no limit to the number or type of locations a user can add to the map. Mobile apps are also available for Apple and Android products – FieldCheck for Applicators, and BeeCheck for Beekeepers.

Advanced Features
While using the FieldWatch registries are free,
applicators and businesses who choose to become paid members will have access to some special features. Paid members will be able to download the registry data, or work with one of our Software Partners to view the sites directly from their navigation equipment. For more information about membership and these features, please contact FieldWatch, Inc. (contact information is provided below).

**Status**
Ohio first started its honey bee and crop registry in the spring of 2014, and eventually grew to include over 17,000 registered acres. In the spring of 2018, Ohio joined the multi-state registry program provided by FieldWatch, Inc. At this time, 21 states are participating in the FieldWatch program, including Ohio, Indiana, Michigan, and Pennsylvania. Currently, Ohio has over 500 pesticide applicators & businesses using the system, and 830 crop producers and beekeepers. A new crop that will be added for the 2020 growing season is Industrial Hemp; growers will have to first become licensed by the Ohio Department of Agriculture before locations can be added to the DriftWatch registry.

<table>
<thead>
<tr>
<th>Location Type</th>
<th>Registered Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apiaries</td>
<td>460</td>
</tr>
</tbody>
</table>

**Registered Acreage**

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Registered Acreage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquaculture</td>
<td>6</td>
</tr>
<tr>
<td>Brambles/Berries</td>
<td>145</td>
</tr>
<tr>
<td>Fruit (Other)</td>
<td>124</td>
</tr>
<tr>
<td>Grapes</td>
<td>543</td>
</tr>
<tr>
<td>Greenhouse - High Tunnel</td>
<td>184</td>
</tr>
<tr>
<td>Hops</td>
<td>26</td>
</tr>
<tr>
<td>Non-specialty Certified Organic</td>
<td>11,800</td>
</tr>
<tr>
<td>Nursery Crops</td>
<td>989</td>
</tr>
<tr>
<td>Orchard</td>
<td>342</td>
</tr>
<tr>
<td>Other</td>
<td>1,599</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>3,197</td>
</tr>
<tr>
<td>Vegetables (other)</td>
<td>5,929</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24,884</strong></td>
</tr>
</tbody>
</table>

**Requesting Bee Locations**
As the locations in OSCR are voluntarily provided, it is not a complete listing of beehives in Ohio. Beekeepers in Ohio are required by law to register with the Department’s Apiary Program (ORC 909); currently there are over 8,000 apiaries across the state. To find if there is a registered apiary in your spray area, you may request a copy of apiary locations by contacting the Apiary Program at apiary@agri.ohio.gov and specifying the county or counties you are interested in. Note that it may take several days to complete a records request.

**Contact Us**
Questions about membership or for tech support, please contact FieldWatch, Inc.:
- Phone: 877-443-4353
- Email: info@FieldWatch.com

General questions and concerns can be addressed to:
- Attention: Sensitive Crop Registry
- Ohio Department of Agriculture
- Pesticide & Fertilizer Regulation
- 8995 E. Main St, Bldg 23
- Reynoldsburg OH 43068-3399
- Phone: 614-728-6386
- Fax: 614-466-9754
- SensitiveCropRegistry@agri.ohio.gov
The Worker Protection Standard and the 2015 Revision

Mary Ann Rose

Pesticide Safety Education Program, Ohio State University Extension

What is the Worker Protection Standard (WPS)?

WPS is a federal regulation first established in 1992 to protect agricultural workers on farms, forests, nurseries and greenhouses from exposure to pesticides. These regulations provide protections to two types of employees: 1) workers involved in crop production who perform tasks such as weeding, watering, and harvesting; and 2) pesticide handlers who mix, load, and apply pesticides and those who assist them. For family operations, owners are exempt from providing some, but not all WPS protections to immediate family members who perform these kinds of tasks.

Who is responsible for WPS protections, and how do I know if they apply to my establishment?

If you grow an agricultural commodity (crops, not livestock) and employ workers or handlers as described above, you must provide WPS protections when using a pesticide with WPS labeling. Most pesticides used in crop production will carry the WPS reference; the WPS reference occurs in the “Agricultural Use Requirements” section of the pesticide label. Employers of commercial applicators who treat crops and agricultural labor contractors also must provide certain protections. In Ohio, the Ohio Department of Agriculture is responsible for enforcing WPS.

What kind of protections are required? - A brief review of the major components of WPS Information & Training.

WPS requires annual pesticide safety training with specific content for workers and handlers, and a central display area that has pesticide application records, Safety Data Sheets, and the EPA-approved safety poster.

The Pesticide Educational Resources Collaborative (PERC) has developed free, EPA-approved materials that are available to download from the PERC Site, pesticideresources.org/index.html. PowerPoint presentations and training videos for both workers and handlers are available in both English and Spanish versions, as well as handler training materials and a trainer reference manual. There are many other useful materials on the site including a “How to Comply” manual for employers. A new EPA-approved safety poster for use in the central display may be downloaded or copies may be ordered from PERC. pesticideresources.org/index.html

Protection.

WPS requires specific procedures for excluding workers from pesticide-treated areas. Workers must be notified, or in some cases, treatment areas must be posted to inform workers of pesticide applications on the premises so they may take all necessary precautions. Pesticide handlers must be provided with personal protective equipment (PPE) required by labels as well as other specific protections.

Exposure Reduction/Mitigation.

Decontamination supplies must be supplied to workers and handlers for both routine wash-up and emergency decontamination. Emergency transportation to a medical facility is required for an employee who becomes sick due to pesticide exposure.

What has been changed?

The 2015 revision to WPS is a comprehensive overhaul of the existing rule; these changes were made to reduce pesticide exposure incidents. One of the biggest changes is the requirement to train all workers and handlers annually. Formerly there was a grace period for training new employees. This has been eliminated, and workers must now receive training before they enter an area that was under a restricted entry interval within the past 30 days. WPS trainers for workers either must be licensed pesticide applicators or have taken an EPA-approved train-the-trainer course. Trainers must use EPA-approved training materials with newly expanded content.

Pesticide handlers must be at least 18 years of age. When pesticides requiring respirators are used, the applicator must have a medical evaluation, annual fit test and training in the care and use of the respirator.

Posting of treated areas was previously required only in greenhouses; now posting of outdoor production will be required if the pesticide has a restricted entry interval (REI) of greater than 48 hours. During certain kinds of applications, application exclusion zones (AEZ) of up to 100 feet away from the application area may be required depending on the type of application. Pesticide handlers must suspend application if anyone enters the AEZ during the application. Amounts of decontamination supplies for handlers and workers are specified in the
Record-keeping requirements are a significant new addition to WPS. In addition to posting pesticide application information at a central location, Growers must retain records of pesticide applications and relevant safety data sheets for two years. Workers, their designated representative, and medical personnel must have access to these records upon request. Records of training and respirator compliance also must be kept for two years.

When providing emergency assistance, the employer must provide to medical personnel specific information on the pesticide product, safety data sheet(s), as well as the circumstances of the application and exposure incident.

If I only employ family members on my farm, what parts of WPS apply to me?

Family are exempt from many of the WPS requirements, such as annual training. However, you must provide the following protections to family as well as yourself. You are required to supply personal protective equipment listed on the label, and to comply with restricted entry intervals and other restrictions during applications, including the application exclusion zone. When the label requires a respirator, the applicator must have a medical evaluation, fit test, and training prior to use.

The WPS family member definition has been expanded to include spouse, children, siblings, grandparents, grandchildren, aunts, uncles, nieces, nephews, first cousins, in-laws, foster or step-parent, child or sibling.

What are the details of the new respiratory protection requirement?

When the pesticide label requires a respirator, the user must have a medical evaluation, annual fit test, and training in the care and use of the respirator.

The purpose of the medical evaluation requirement is to prevent any health complications from wearing a respirator. The person intending to use a respirator fills out a confidential medical questionnaire and submits it for evaluation by a professional. There are online services in addition to occupational safety clinics that can provide the evaluation. If using an online service, be sure to choose one that is qualified to operate in your state. How someone responds to the medical questionnaire determines whether he is cleared for respirator use, requires further medical evaluation, or denied clearance. The medical evaluation is required only once unless someone develops new health issues or difficulties wearing the respirator. Reasonable fees for evaluating the questionnaire range from $20 to $50.

The fit test requirement ensures that a respirator forms a good seal, because without a good seal, the respirator offers little protection. If the handler has facial hair between the sealing surface and the face, they cannot wear a tight-fitting respirator. Fit testing is required once a year, or whenever the respirator model is changed. You may purchase a test kit to do fit testing in-house, but for one or two fit tests per year it is probably easier and cheaper to go to an occupational safety clinic. Cost for fit testing ranges between $35 and $95. Some clinics offer package deals for both medical evaluation and fit test. The employer is responsible for costs associated with medical evaluation and fit testing.

WPS also requires keeping a record of compliance and training employees in the care and use of their respirators. In the absence of other indicators or manufacturer instructions, replace respirator cartridges after every 8 hours of cumulative use.

See pested.osu.edu/resources/wps/respiratorrequirements or call the Pesticide Safety Education Office at 614 292-4070 for more information about these requirements and for a list of fit testing and medical evaluations locations. Your local hospital also may have an occupational health clinic that provides the services.

How can I get more information on the new WPS rules?

The Pesticide Educational Resources Collaborative (PERC) (pesticideresources.org) has many resources for compliance and training. You also may contact the Ohio Pesticide Safety Education Program at 614-292-4070 or page pested.osu.edu/resources/wps for additional information.

When will the new rule take effect?

The new requirements are now in effect.
Changes to Ohio’s Noxious Weed List and Noxious Weeds Q & A

Mary Ann Rose

Pesticide Safety Education Program, Ohio State University Extension

Changes to Ohio’s Noxious Weed List and Noxious Weed Q & A

The director of the Ohio Department of Agriculture (ODA) has the authority to declare noxious weeds. In ODA’s most recent five-year review of rules there were both additions and deletions that took effect in September 2018. These three weeds were removed from the list:

- Oxeye daisy (Chrysanthemum leucanthemum var. pinnatifidum)
- Wild carrot (Daucus carota L.)
- Wild mustard (Brassica kaber var. pinnatifida).

These weeds were added, or remain on the Noxious Weed list:

<table>
<thead>
<tr>
<th>New to Noxious Weed list in 2018</th>
<th>Remain on Noxious Weed list</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columbus grass (<em>Sorghum x almum</em>)</td>
<td>Apple of Peru (<em>Nicandra physalodes</em>)</td>
</tr>
<tr>
<td>Field bindweed (<em>Convolvulus arvensis</em>)</td>
<td>Canada thistle (<em>Cirsium arvense</em>)</td>
</tr>
<tr>
<td>Forage Kochia (<em>Bassia prostrata</em>)</td>
<td>Cressleaf groundsel (<em>Senecio glabellus</em>)</td>
</tr>
<tr>
<td>Hairy whitetop or ballcress (<em>Lepidium appelianum</em>)</td>
<td>Giant Hogweed (<em>Heracleum mantegazzianum</em>)</td>
</tr>
<tr>
<td>Heart-podded hoary cress (<em>Lepidium draba sub. draba</em>)</td>
<td>Grapevines (uncultivated, in groups ≥100)</td>
</tr>
<tr>
<td>Hedge bindweed (<em>Calystegia sepium</em>)</td>
<td>Japanese knotweed (<em>Polygonum cuspidatum</em>)</td>
</tr>
<tr>
<td>Leafy spurge (<em>Euphorbia esula</em>)</td>
<td>Johnsongrass (<em>Sorghum halepense</em>)</td>
</tr>
<tr>
<td>Perennial sowthistle (<em>Sonchus arvensis</em>)</td>
<td>Kochia (<em>Bassia scoparia</em>)</td>
</tr>
<tr>
<td>Russian knapweed (<em>Acroptilon repens</em>)</td>
<td>Kudzu (<em>Pueraria montana var. lobata</em>)</td>
</tr>
<tr>
<td>Serrated tussock (<em>Nassella trichotoma</em>)</td>
<td>Marestail (<em>Conyza canadensis</em>)</td>
</tr>
<tr>
<td>Water Hemp (<em>Amaranthus tuberculatus</em>)</td>
<td>Mile-A-Minute Weed (<em>Polygonum perfoliatum</em>)</td>
</tr>
<tr>
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<td>Musk thistle (<em>Carduus nutans</em>)</td>
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<tr>
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<tr>
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<td>Wildparsnip (<em>Pastinaca sativa</em>)</td>
</tr>
</tbody>
</table>

Questions and Answers on Ohio Noxious Weed Law

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I’ve been notified by my township trustees that I have noxious weeds on my property. What should I do?

Be aware that you must respond within five days of the date the trustees notified you about the weeds or the trustees will have the authority to destroy. Your options are to destroy or cut the weeds or to provide information to the township trustees showing that there is no need to take action. For example, such information might include showing that noxious weeds don’t exist on the property or showing that plants were incorrectly identified as noxious weeds.
**Do I have to destroy my crop if noxious weeds are on my land?**

No, Ohio law states that you must only “cut or destroy the weeds” if you have been notified by the township trustees that noxious weeds are on your property.

**My neighbor doesn’t keep his fence row clear of noxious weeds. What can I do about it?**

First, talk to the neighbor. If your neighbor doesn’t respond favorably, the second step is to provide a written notice to the neighbor stating that he has ten days to clear the fence row of the noxious weeds. Third, if the neighbor still doesn’t take action, provide a written notice of the situation to the township trustees, which will initiate a process that could result in the trustees determining that there is a valid need to clear the fence row and hiring someone to do the work. Your neighbor will be legally obligated to pay for the costs on his property tax bill.

**Noxious weeds are growing in the road right-of-way. Can I remove them myself and charge the township for my costs?**

You may remove the noxious weeds, but you will probably not receive reimbursement for your costs unless the township trustees violated their duty to cut the weeds even after you followed the proper legal process for demanding their action. Ohio law requires the township trustees to cut road right-of-way weeds in early June and August, in early September if necessary, and at other times if public safety is at issue. If they fail to do so, you should formally complain to the township trustees in writing or by speaking at a township meeting. If the trustees still fail to take action, the next step is to file a “writ of mandamus” action that asks the court to order the clearing. Seeking reimbursement for your work prior to following this legal process is not the proper method for enforcing the township’s duty, according to the Second District Court of Appeals in Mezger v. Horton, 2013 Ohio 2964.

**How do I know which weeds are “noxious”?**

The director of the Ohio Department of Agriculture conducts rulemaking to designate a plant as a prohibited noxious weed. The list of plants that the director has formally designated as noxious weeds is in the Ohio Administrative Code and is available at http://codes.ohio.gov/oac/901:5-37-01.
What are Temperature Inversions?

Aaron B. Wilson, Climate Specialist, Agriculture and Natural Resources, The Ohio State University

There are many challenges when it comes to pesticide application. Weather conditions can pose one of the greatest obstacles. Even when conditions seem perfect (e.g., light winds), the temperature profile near the surface of the Earth can lead to unwanted drift. This is called a temperature inversion, a common occurrence in Ohio during the growing season. Understanding what temperature inversions are, how they form, and signs of their presence should help applicators judge the appropriate time to apply. The following information from a variety of sources provides details on temperature inversions including structure, formation, when they form, and how to recognize them in the field.

### How Temperature Inversions Form

- **On a typical day with clear skies and little to no wind, incoming solar radiation heats the Earth’s surface. This heat is conducted to the cooler soil below and the air molecules just above the surface (net energy gain).**

- **The heated air expands, becomes less dense, and begins to rise. This creates a circulation pattern that grows as the heating continues at the surface.**

- **Figure 1 shows the resultant temperature profile a few hours after sunrise (unstable atmosphere).**

- **The warmest air is located near the surface with cooler air aloft. Often, puffy white cumulus clouds form at the tops of the columns of rising warm air.**

- **By late afternoon-early evening with few clouds or clear skies, the incoming solar radiation decreases and the surface emits more longwave radiation energy than it is gaining (net energy loss).**

- **The air near the surface begins to cool as well. Soon the air next to the Earth’s surface will be colder and denser than the air above it (stable atmosphere; Figure 2). This is the beginning of a temperature inversion.**

- **As long as skies remain clear, more radiation will be emitted from the surface than it receives from the atmosphere and deeper soil. The surface will continue to cool.**

- **As long as winds remain light, the height of the cool air or inversion layer, will increase.**
Impediments to Development

- Temperature inversions can usually persist with wind speeds less than 4 or 5 mph.

- During greater wind speeds, any surface unevenness (e.g., topography) or obstructions causes random, chaotic, swirling motions called turbulence, which greatly hinder the development or strengthening of inversions.

- Clouds are made up of water droplets and/or ice crystals that absorb and emit longwave radiation.

- Clouds also reflect some of the incoming solar radiation back to space, which can limit the amount of surface heating taking place.

- Clouds absorb nearly all of the outgoing terrestrial longwave radiation emitted from Earth’s surface and radiate this energy back toward the surface.

- Therefore, cloud cover during the late afternoon and overnight will restrict or prohibit inversion formation.

- Greater atmospheric moisture will also limit the intensity of an inversion, as drier air allows for rapid surface cooling and inversion formation.

Structure and Timing

- Colder, dense air is found near the surface with warmer, less dense air near the top of the inversion (Figure 3).

- The height is defined as the thickness of the inversion throughout which temperatures are increasing with height.

- Air within the inversion is stable; thus, it resists vertical motion. Air flow (and potential pesticide droplets) can move horizontally within this inversion layer.

- The intensity of the inversion is defined by the difference in temperature at two heights (near the surface minus height aloft e.g., 8-10°).

- Temperature inversions typically form 1 to 3 hours before sunset. May be sooner in low lying areas.

- Inversions typically persist and strengthen overnight. Maximum intensity usually occurs shortly after sunrise, and often lasts 1 to 2 hours after sunrise.
Temperature Inversion Detection: Dew or Frost

- The dew point temperature refers to the temperature to which air must be cooled in order for saturation to occur.

- The lower the dew point temperature, the less water vapor there is in the air to absorb terrestrial radiation emitted from the surface and emit back toward the surface.

- On a calm, clear night, upper canopy leaves cool to the dew point temperature, water vapor condenses on the leaf surface as dew, or as frost if the surface temperature is below freezing. Therefore, dew or frost deposition is a warning that a temperature inversion may exist.

Temperature Inversion Detection: Fog

- As the surface cools, overlying air also cools by conduction. Condensation occurs and fog appears when the air temperature cools to the dew point temperature.

- Dew or frost will appear before fog. Therefore, the presence of fog nearly always indicates that an inversion condition existed PRIOR to fog formation and that it has intensified.

Temperature Inversion Detection: Others

- Inversions form first in low lying areas, as topography allows cold air to flow downslope.

- Dust or smoke that hangs in the air close to the ground indicates the air is stable and is not able to mix.

- Sounds (train) or smells (feedlot) that carry long distances may indicate an inversion (Williams, UNL).

Forecasting Temperature Inversions

- Temperature inversions are dependent on small-scale features. Predicting their occurrence is a challenge. Any forecast calling for clear skies, dry air, and light wind speeds will likely result in a temperature inversion. These conditions typically exits when high pressure is forecast, which leads to large-scale sinking air and the prime conditions for inversion formation.

References

Effective and Efficient Application of Pesticides
Dr. Erdal Ozkan
Professor and Extension Specialist
The Ohio State University

Application of pesticides requires more skill and knowledge than any other field operation you may be involved in when producing field crops such as corn, soybean, wheat and alfalfa. Although each crop may require a slightly different approach to application of pesticides, there are some general principles that apply to almost all spraying situations. Following these principles will get you much closer to success in achieving satisfactory and economic control of the problem, regardless of whatever it is that you are trying to control.

These major principles are:

1. Make positive identification of the pest;
2. Use the right pesticide designed to specifically control that pest;
3. Select the right equipment, and particularly the right type and size of nozzle for the job;
4. Apply the pesticide at the right time; and
5. Check the accuracy of equipment (calibration) periodically to make sure that you are applying the amount recommended on the label and applying pesticides uniformly onto the target.

Certain tasks taking place during application of pesticides must be accomplished to achieve maximum biological efficacy from pesticides applied. These tasks include:

1. Uniform mixing of pesticides (especially dry products) in the sprayer tank which can only be accomplished if the agitation system in the tank has sufficient capacity for a given tank size, and is operating properly;
2. Choosing a pump that has sufficient capacity to deliver the required gallonage (gallons/acre) to the nozzles;
3. Making sure hoses and fittings between the pump and the nozzles are sized properly to reduce pressure losses to a minimum;
4. Transporting the pesticides with minimum loss from the nozzles to the target;
5. Attaining maximum retention of droplets on the target (minimum rebound); and
6. Providing thorough and uniform coverage of target with droplets carrying active ingredients.

In this publication, only the most critical issues related to application of pesticides are discussed. For detailed coverage of these and other topics visit the web sites of other resources given throughout the paper.

Select the best equipment / nozzle type for the job

Although each component of the sprayer plays a role in achieving success in pesticide application, nozzles may play the most significant role.

Nozzles come in a wide variety of types and sizes. Each nozzle type is designed for a specific type of target and application. Most nozzle manufacturers’ catalogs and websites have charts showing which nozzle type will be best for a specific job. To choose the most appropriate nozzle for a given situation, you will need to be aware of all the factors involved in selecting the right nozzle. Any one of the factors listed below may be the deciding factor when selecting the most appropriate nozzle for the job on hand.

- Sprayer operation parameters (application rate, spray pressure, travel speed)
- Type of chemical sprayed (herbicides, insecticides, fungicides, fertilizers or growth regulators)
- Mode of action of chemical (systemic, contact—for spray coverage requirement)
- Application type (broadcast, band, directed, air-assisted)
Choose the most appropriate nozzle size

Once you determine the type of nozzle that will be best for a specific spraying situation, next you need to determine the appropriate size of that nozzle that will provide the application rates (gallons/acre) prescribed by product labels under various operating conditions (spray pressures and travel speeds).

Steps to select the proper nozzle size:

The following steps must be taken to determine the nozzle flow rate in gallons per minute \((\text{gpm})\):

**Step 1.** Select the application rate in gallons per acre (gpa). This is a management decision you will have to make based on pesticide label recommendations, field conditions and water supply.

**Step 2.** Select a practical and safe ground speed in miles per hour (mph).

**Step 3.** Determine the spray width per nozzle \((W)\).

- For broadcast applications, \(W = \text{nozzle spacing} \text{(distance between two nozzles on the boom)}\) in inches.
- For band spraying, \(W = \text{band width}\) in inches. For directed spraying, \(W = \text{row spacing} \text{(or band width)}\) divided by the number of nozzles per row (or band).

**Step 4.** Determine the flow rate \((\text{gpm})\) required from each nozzle by using the following equation:

\[
\text{gpm} = \text{gpa} \times \text{mph} \times \frac{W}{5940}
\]

**Step 5.** Select a nozzle size from the manufacturer’s catalog that will give the flow rate \((\text{gpm})\) determined in Step 4 when the nozzle is operated within the recommended pressure range. If a nozzle of this size is not available, change the travel speed in the equation above and determine the new flow rate required.

More information on selecting the best nozzle type and size are given in Ohio State University Extension fact sheet FABE-528, “Selecting the Best Nozzle for the Job” (ohioline.osu.edu/factsheet/fabe-528).

Keep spray drift in mind when selecting nozzles

Although complete elimination of spray drift is impossible, problems can be reduced significantly if you are aware of the major factors which influence drift, and take precautions to minimize their influence on off-target movement of droplets. Drift is influenced by many factors which are discussed in detail in Ohio State University Extension publication FABE-525 (“Effect of Major Variables on Drift Distances of Spray Droplets”, (ohioline.osu.edu/factsheet/fabe-525). Here are some tips on how to minimize spray drift:

1. Equipment, especially nozzles, used to spray pesticides play a significant role in generating as well as reducing spray drift. Research clearly indicates that nozzles labeled as “low-drift” significantly reduce spray drift as discussed in Ohio State University Extension publication FABE-523 “Effectiveness of Turvodrop® and Turbo TeeJet® nozzles in drift reduction” (ohioline.osu.edu/factsheet/fabe-523). If drift is, or becomes a concern, it may be best to switch from a conventional flat-fan nozzle to a “low-drift” flat-fan nozzle with the same flow rate. Keep your nozzles as close to the target as possible while still producing a uniform distribution of spray on the target.

2. Consider using a sprayer equipped with the air-assist technology on the sprayer boom. When used under fully-, or partially-developed crop conditions, air flow coming out of the boom just behind the nozzles carries the small, drift-prone droplets into the canopy where they can be deposited.

3. There are “drift retardant” chemicals sold in the market that are designed to increase the droplet size and reduce the number of very small droplets when added to the spray mixture. This, however, should be the last defense against drift. First consider the other options such as better targeting of the spray and switching to low-drift nozzles.

4. If weather conditions (wind speed and direction, humidity, temperature, inversions) are not favorable, and there is any doubt about a spray job that might result in drift, wait until there is no longer that element of doubt. One good investment you can make is a wind meter that tells the wind velocity at your location and at the time of application.
Maximize pesticide deposit and coverage on the “target”

It is important to choose the nozzle and set up the application equipment based on what it is that we are trying to control, and what part of the plant canopy should be “targeted” when spraying to achieve effective pest control. For example, when applying a fungicide to manage Fusarium head blight or head scab of small grain, the target is the head and not the leaf. When a fungicide is applied using nozzles that direct the spray downward, most of the product is likely to deposit on the leaves or the ground and not the head. On the other hand, when we are trying to control diseases such as soybean rust, the target should be the leaves, especially the ones in the lower part of the canopy. When spraying for soybean white mold, the most critical area of the plant that needs to be treated with fungicides is where the flowering takes place. Nozzle selection will have a significant influence on whether or not the droplets sprayed will reach the specific target site in the canopy.

The following trends have emerged from our multi-year studies on target deposition for diseases on Soybeans and Wheat:

- Use nozzles and equipment set up that provide medium spray quality (approximately 250-350 micron diameter) for better penetration of droplets into lower parts of both wheat and soybean canopies to control aphids and diseases such as stem rot that normally start from the lower part of the canopy.
  - Single pattern flat-fan nozzles producing medium quality spray tend to provide a better penetration of droplets inside soybean canopy under dense canopy conditions.
  - Under dense canopy conditions, flat fan nozzles provided better coverage and penetration into the canopy than the hollow cone nozzle.
- Spray hitting the target from two different angles using nozzles producing twin spray patterns (such as TwinJet) produce better coverage and deposition on upper parts of the soybean canopy, and they may produce acceptable control of diseases in lower part of the canopy if the canopy is not dense. In dense soybean canopy conditions, twin pattern application set up had the lowest coverage and deposits on lower parts of the canopy. So, using twin pattern nozzles, or a single flat-fan nozzle tilted at a forward angle of 30 or 45 degrees from the horizontal is definitely the best for application of fungicides for wheat head scab, but will be the worst set up for soybean insects and diseases, such as aphids and Sclerotinia stem rot (white mold), respectively.
  - If a twin-pattern nozzle is used, it is best to use some of the new twin-flat pattern nozzles rather than the conventional TwinJet nozzles because the conventional nozzles tend to produce a higher number of extremely small droplets that tend to evaporate or drift before having a chance to deposit on the target surface.
- Canopy conditions (tall, dense vs. short, light) and operating conditions (air flow rate, air discharge angle, and proper droplet size) may affect the performance of an air assist sprayer. However, in general, if operated properly, when there is adequate canopy cover under the boom, air-assisted sprayers will likely to do a better job with penetration of droplets into canopy and spray coverage than a conventional sprayer. In our studies, an air-assisted sprayer did a better job with penetration of droplets into soybean canopy and spray coverage underside the leaves than a conventional sprayer, especially under dense canopy conditions. However, it did not produce any noticeable advantages in wheat (for scab and stem rust). In some cases it actually produced lower deposits than the sprayers with conventional (no air assistance) nozzles.

Calibrate the sprayer

The primary goal with calibration is to determine the actual rate of application in gallons per acre, then to make adjustments if the difference between the actual rate and the intended rate is greater or less than 5% of the intended rate. Although rate controllers can regulate the flow rate of nozzles to keep the application rate constant, a manual calibration at least once a year is needed to make sure the rate controller is functioning properly.

Before starting calibration, make sure you have a good set of nozzles on the sprayer. Nozzles wear through extended use causing over-application, or some nozzles or screens may become clogged causing under-application. Clean all the clogged nozzles. Check the output of all the nozzles for a given length of time at a given spray pressure. Compare output from each nozzle’s output with the expected output shown in the manufacturer’s catalog for that nozzle at the same pressure. Replace the nozzles showing an output error of more than 10% of a new nozzle.
Calibrating a sprayer involves taking only three specific measurements: actual ground speed, the distance between nozzles, and nozzle flow rate for a given length of time.

Just three things are needed to take these measurements: a timer showing seconds, a measuring tape, and a measuring cup graduated in ounces.

A mixture containing pesticides may have a slightly higher density or viscosity and these may slightly change the flow rates of nozzles. But usually the difference in flow rates between water alone and a mixture containing pesticides is not significant unless liquid fertilizer is the carrier.

There are several ways to calibrate a sprayer. One easy method, the 1/128th method, is explained in OSU Extension Publication FABE 520, “Calibrating Boom Sprayers” (ohioline.osu.edu/factsheet/fabe-520). Here is a brief summary of steps you will need to take when using this method.

1. Fill the sprayer tank (at least half full) with clean water.
2. Run the sprayer, inspect it for leaks, and make sure all vital parts function properly.
3. Measure the distance in inches between the nozzles.
4. Determine the appropriate travel distance in the field based on this nozzle spacing. The appropriate distances for different nozzle spacing is as follows:
   - 408 ft for 10-inch spacing,
   - 272 ft for 15-inch spacing,
   - 204 ft for 20-inch spacing,
   - 136 feet for 30-inch spacing, and
   - 102 feet for 40-inch spacing.
   - See extension publication FABE 520 for travel distances for other nozzle spacings.
5. Drive the measured distance in the field at your normal spraying speed; record the travel time in seconds. Repeat this procedure and average the two measurements.
6. With the sprayer parked, run the sprayer at the same pressure level and catch the output from each nozzle in a measuring cup for the travel time required in step 5 above.
7. Calculate the average nozzle output by adding the individual outputs and then dividing by the number of nozzles tested. The final average nozzle output in ounces you get is equal to the application rate in gallons per acre. For example, if you catch an average of 15 ounces from a set of nozzles, the actual application rate of the sprayer is equal to 15 gallons per acre.
8. Compare the actual application rate with the recommended or intended rate. If the actual rate is more than 5 percent higher or lower than the recommended or intended rate, you must make adjustments in either spray pressure or travel speed or both.
   - For example, to increase the flow rate you will need to either slow down, or increase the spray pressure. The opposite is true when you need to reduce application rate. As you make these changes stay within proper and safe operating condition of the sprayer. Remember increased pressure will result in increasing the number of small, drift-prone droplets. Follow the equations given in OSU Extension Publication FABE-520 to find optimum travel speed and pressure quickly.
9. Recalibrate the sprayer (repeat steps 5-8 above) until the recommended application error of +5% or less is achieved.

Calibrating the sprayer only once at the beginning of the spraying season is never enough. It should be done frequently throughout the season, especially when changes occur in ground conditions, or the topography of the field sprayed changes.

When using this method, you may also want to calculate the actual travel speed and compare it with what is displayed on the rate controller or the tractor speedometer. Here is how you calculate the actual travel speed in miles per hour (MPH):

$$MPH = \frac{\text{Feet traveled}}{\text{Seconds to travel}} \times \frac{60}{88}$$
Check uniformity of application

How the chemical is deposited on the target is as important as the amount applied. Know the kind of nozzles on your sprayer and the need for overlap for complete coverage. If spraying products directly on a target then banding nozzles should be used. With this type of nozzles, the product sprayed is evenly distributed across the spray pattern. However, when making broadcast applications, the flat-fan nozzles used for this kind of application produce heavy volume discharged from the center of the spray, and the volume tapers off towards both end of the triangular-shaped spray pattern. Therefore, spray patterns from adjacent nozzles must overlap, as shown in the figure below, to obtain uniform coverage across the spray swath. A low boom or a boom set too high will create a poor pattern and misapplication. Check the nozzle catalog to determine the proper boom height recommended for different nozzle types and spacings.

![Flat-fan nozzles used for broadcast spraying](image)

Make sure the nozzles are not fully or partially clogged. Clogging will not only change the flow rate, it also changes the spray pattern. Do not use a pin, knife or any other metal object to unclog nozzles. In addition to clogging, mismatched nozzle tips on the boom, or uneven boom height are the most common causes of non-uniform spray patterns. They can all cause streaks or untreated areas that result in insufficient pest control and economic loss.

Know how to calculate how much chemical product to mix in the tank

Labels give two types of application rates: volume of spray mixture (pesticide and water) applied per unit area (gallons per acre, ounces per 1,000 square feet, etc.), and the amount of actual chemical applied per unit area (ounces, pints, or quarts per acre or 1,000 square feet). The first requirement can be attained by proper calibration and operation of the sprayer. The second label recommendation not only requires proper calibration and operation of the sprayer, but it also requires that the spray mixture contains the right concentration of the actual product applied.

The amount of chemical needed per tankful depends on the recommended rate and the size of area you intend to treat per tank of spray. Detailed information on how to calculate the proper amount of chemical to add to the spray tank is given in Ohio State University Extension Publication FABE-530 (ohioline.osu.edu/factsheet/fabe-530).

Read the label!

In the past, labels on pesticides gave general statements when referring to application equipment. Today many labels are much more specific on nozzle selection, pressure and volume. In addition to satisfying the gallon per acre requirement given on the label, you also need to satisfy the droplet size requirement given on the label. For example, the nozzles shown on the figure below all produce the same flow rate (0.2 gallons per minute) at same or slightly different pressures, but each one provides a different spray quality (droplet size). Check the information given in nozzle manufacturers’ catalogs to make sure the nozzle will provide the required spray quality under the conditions each nozzle will be operating (travel speed, flow rate, pressure).

Which nozzles must be used when applying products containing 2,4-D and Dicamba?

In the past, the labels on chemicals gave some vague and general statements when referring to nozzles to use. For example, we used to see (it is still the same for many chemicals) on labels statements such as: “use nozzles that provide thorough coverage of the canopy”. There was no help with explaining what “thorough coverage” is, and how to achieve it. Then, we saw labels giving us more specific recommendations on nozzles; such as: “use nozzles that provide medium spray quality”, or “do not use nozzles that produce droplets in coarse or larger spray qualities”. Most recently, the labels of the 2,4-D or Dicamba herbicides include very specific requirements on which nozzle or nozzles must be used when spraying these products. This was done to eliminate off-target movement of spray droplets. Simple interpretation of this requirement is that you would be violating the label if you use any other type or size of nozzle. So, it is your responsibility to comply with the label recommendation.
The table shown on the next page lists the currently approved nozzles and their operating pressures required by manufacturers of the several commonly used 2,4-D and Dicamba products. A caution: This table is provided mostly for information purposes and may not be up-to-date; check the manufacturers’ websites before final selection. You are always advised to look at the product label for the most current information.

By the way, don’t assume that you do not have to worry about checking the label this year again because you had applied the same 2,4-D product last year. A nozzle required for the same product last year may not be on the label this year, or the operating pressures may be changed.

Summary

The information related to pesticide application presented here is rather general. More specific and detailed information on this topic can be found in Ohio State University Extension fact sheet FABE-527, “Best Management Practices for Boom Spraying” (ohioline.osu.edu/factsheet/fabe-527). Here are again the key general and specific recommendations discussed in this publication:

- Carefully read and follow the specific recommendations given on the pesticide label, and in the nozzle catalogs and sprayer operator’s manual.
- Calibrate the sprayer to make sure that the amount recommended on the label is applied.
- Check the sprayer setup to make sure the amount sprayed is distributed evenly across the spray swath.
- Operate the nozzles at a pressure that will allow them to produce the spray quality (droplet size) recommended in the product label.
- For best results, keep the spray volume (application rate) above 15 gpa for ground and 5 gpa for aerial applications.
- Slow down when spraying. Spray coverage is usually improved at slower speeds. Also, it is proven that the faster the travel speed, the greater likelihood of drift.
- To improve coverage, if applicable, use directed spraying.
- Probability of spray drift is much greater when using fine to medium droplets than coarser droplets used for application of some other types of pesticides such as herbicides.
- For herbicide applications, flat-fan nozzles are better than cone nozzles to produce a much smaller proportion of extremely small, drift-prone droplets.
- Coverage to just the top of the canopy may be sufficient for adequate control with some products. However, both horizontal and vertical coverage of the plant may be absolutely necessary for other situations such as disease and insects that may be hidden in dense canopies.
- Air-assisted sprayers usually provide better coverage and droplet penetration into the canopy than conventional sprayers when there is a full, dense canopy such as in soybeans sprayed late season.
- Be careful when using twin nozzle/pattern technology for application of fungicides. Two nozzles (or spray patterns) angled (one forward, one backward) work better when the canopy is not dense and tall, or the target is the upper part of the canopy (such as wheat head scab).
- Be safe. Wear protective clothing, goggles and rubber gloves, and respirators if required on the label when calibrating the sprayer, doing the actual spraying, and cleaning the equipment.
### Approved Nozzles and Operating Pressures: 2, 4-D andDicamba Formulations*

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*Check manufacturer website for updated list of approved nozzles and operating pressures. Approved Drift Reduction Agents (DRA) required. Post direct application only.


Compiled by J. Andon, PSEP, June 2019
Safety Tips
FOR SPRAYERS ON THE ROAD

1. **DON’T ADD ANOTHER BLIND SPOT**
   Keep windows clean to increase visibility—it’s just that easy!

2. **DESIGNATE A SPOT IN THE CAB FOR EVERYTHING**
   Keep key items secure and within easy reach.

3. **WEAR YOUR SEATBELT**
   You already do it in your car, do it in a sprayer too!

4. **WAIT FOR VEHICLES TO PASS**
   Spot oncoming traffic before pulling out in front of it.

5. **BE ALERT AT ALL RAILROAD CROSSINGS**
   Lack of signals, lights and grade differences create hazards.

6. **YIELD TO ONCOMING TRAFFIC**
   Your rig’s wide load is a problem on narrow roads—pull over for oncoming traffic.

7. **YIELD AT ONE-LANE BRIDGES**
   Drivers will speed up to beat you to the bridge—let them get there first.

8. **PUT THE MOBILE DEVICE AWAY**
   Use phones and other mobile devices before leaving and upon arrival only.

9. **TAKE CARE WITH OBSTRUCTED VIEWS**
   Assume traffic is coming and confirm it is clear before pulling out.

10. **BACK UP WITH CARE**
    Back up cameras give you eyes where you don’t have any.

11. **PULL OVER FOR TAILGATERS**
    Tailgaters are dangerous—pull over and let them pass!

12. **KNOW LOCAL TRAFFIC PATTERNS**
    Change routes and travel times to avoid trouble spots and bottlenecks.

13. **GRAB THE CENTER LANE FOR LEFT TURNS**
    Be noticed before you take your turn.

14. **BE CAUTIOUS ON SWINGING RIGHT TURNS**
    Use center lane on the left to turn sharp right—be noticed.

15. **BE AWARE OF POSTED WEIGHT LIMITS**
    Spot weight limits and know yours to cross bridges safely.

16. **Pull over for tailgaters**
    Tailgaters are dangerous—pull over and let them pass!

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Fred Whitford, Director; Purdue Pesticide Programs
Dennis Nowaskie, Farm Superintendent; Southwest Purdue Agricultural Center
Jamie Southard, Environmental Health and Safety Director; Effingham Equity
Peter Illingworth, Farm Mechanic Technician; Purdue University
John Obermeyer, IPM Specialist; Purdue University
Mike Titus, Risk and Safety Coordinator; Co-Alliance
Kevin Leigh Smith, Editor; Purdue Agricultural Communication

OCTOBER 2017

PURDUE UNIVERSITY IS AN EQUAL ACCESS/EQUAL OPPORTUNITY INSTITUTION.
Grain and Cereal Crops
2019 Update on Field Crop Insects: 
Asiatic Garden Beetle and Soybean Gall Midge

Kelley Tilmon
Andy Michel
Associate Professors
OARDC/OSUE
The Ohio State University

General update: In the field season of 2019 there was sporadic, typical pressure from common Ohio field crop pests including Mexican bean beetle, bean leaf beetle, slugs, and various caterpillars in soybean; cereal leaf beetle in wheat, some armyworm, slug, Asiatic garden beetle, and corn earworm damage in corn; and leafhopper damage in alfalfa. Western bean cutworm trapping in the state, and damage in corn was much reduced this year. Information on Ohio’s field crop insect pests is available at our Agronomic Crops Insects web site at https://aginsects.osu.edu The featured pests in this article are Asiatic garden beetle in corn, and some preliminary information about soybean gall midge, an emerging and spreading soybean pest in the western soybean belt.

Asiatic Garden Beetle (AGB)

In the past several years, corn growers in the Northwest part of OH have been dealing with a white grub called the Asiatic garden beetle. It causes the most problems in sandy soils. Its life cycle is similar to other annual white grubs such as Japanese beetle. Adults lay eggs in the soil in July and August. These eggs hatch into grubs which feed on plant roots for the rest of the summer but cause little damage to these relatively mature plants. In the fall the grubs dig deeper into the soil (as far as a foot down) to spend the winter. In April when the soil begins to warm, the grubs come back near the surface and feed on the roots of weeds and seedling corn until around the middle of May. This root feeding on young seedlings can cause the plant to wilt and often die, resulting in stunted plants or stand loss. In some fields up to 40% stand loss from AGB has been observed. Once damage occurs there is no rescue treatment. If there is sufficient time, growers may replant though indirect yield loss can occur from late planting. In mid-May the grubs pupate -- enter a resting stage for the transformation to adult. In June and July adults emerge from the soil, mate, and lay eggs in the soil, completing the life cycle.
The most effective way to scout for AGB grubs is to dig the soil near the root zone of the plant and sift through the contents to look for grubs. AGB grubs are easy to distinguish from other white grub species from a bulbous structure near the mouthparts which give the appearance of “chubby cheeks.” AGB grubs are also much more active than most other white grub species. They will wriggle and squirm in the hand and may even bite. There are no established thresholds for AGB – this is a current topic of research at Ohio State University. There are few effective management approaches. Most insecticidal seed treatments and in-furrow treatments are ineffective, even at high rates. Tillage has only a modest effect at best. In early research there is some promise for liquid or granular products containing chlorethoxyfos (an organophosphate). These are closed delivery system products (liquid injection or closed handling box) for in-furrow use only. The main cultural control for AGB is late planting – as late as possible – to minimize the window of overlap between hungry grubs completing their development and young corn roots.

**Soybean Gall Midge**

Soybean gall midge is an emerging pest of soybean in the western soybean belt, which has been causing substantial damage since 2018. In 2018 it was found in a number of counties in Iowa, Nebraska, South Dakota, and Minnesota. In 2019 it was found in additional counties in those states, and in Missouri for the first time. As the range of this pest seems to be expanding, the purpose of this article is to provide early preliminary information to Ohio growers so that they can be on the lookout for this new pest.

The soybean gall midge is a type of fly, but the damaging state is the immature maggot which
infests soybean stems near the ground. These maggots are translucent yellow to orange and show up in late June. They feed inside the stem slightly above soil level and may be mistaken for soybean disease. They cause the stem to blacken and sometimes swell and to become very weak and easily broken. Initially the maggots can be found closer to the pith but once stems start to break down they can be observed at the surface. Infested plants will wilt and eventually die. Up to 100% stand loss has been observed at field borders and up to 20% loss in interiors.

If you think you’ve seen this pest in Ohio soybeans please contact the agronomy Extension Educator in your local county office or state field crop entomologists Kelley Tilmon (tilmon.1@osu.edu) or Andy Michel (michel.70@osu.edu)
The members of the Identification and Biology of Seedling Pathogens of Soybean project funded by the North Central Soybean Research Program and the United Soybean Board, and the North Central Regional Committee on Soybean Diseases (NCERA-137) have developed the following ratings for how well fungicide seed treatments control seedling diseases of soybeans in the United States. Efficacy ratings for each fungicide active ingredient listed in the table were determined by field-testing the materials over multiple years and locations by the members of this group, and include ratings summarized from national fungicide trials published in Plant Disease Management Reports (and formerly Fungicide and Nematicide Tests) by the American Phytopathological Society at http://www.apsnet.org. Each rating is based on the fungicide’s level of disease control, and does not necessarily reflect efficacy of fungicide active ingredient combinations and/or yield increases obtained from applying the active ingredient.

The list includes the most widely marketed products available. It is not intended to be a list of all labeled active ingredients and products. Additional active ingredients may be available, but have not been evaluated in a manner allowing a rating. Products listed are the most common products available as of the release date of the table; all available products may not be listed. Additional active ingredients may be included in some products for insect and nematode control, however; only active ingredients for pathogen control are listed and rated.

Many active ingredients and their products have specific use restrictions. Read and follow all use restrictions before applying any fungicide to seed, or before handling any fungicide-treated seed. This information is provided only as a guide. It is the applicator’s and users legal responsibility to read and follow all current label directions. Reference in this publication to any specific commercial product, process, or service, or the use of any trade, firm, or corporation name is for general informational purposes only and does not constitute an endorsement, recommendation, or certification of any kind by members of the group, or by the North Central Soybean Research Program. Individuals using such products assume responsibility for their use in accordance with current directions of the manufacturer. Efficacy categories: E = Excellent; VG = Very Good; G = Good; F = Fair; P = Poor; NR = Not Recommended; NS = Not Specified on product label; U = Unknown efficacy or insufficient data to rank product. Ratings of NR may mean that the fungal group listed is not a target of the specific fungicide active ingredient.

Please note: Efficacy ratings may be dependent on the rate of the fungicide product on seed. A number of different species of Pythium and Fusarium impact seed and seedling health in soybean. Therefore, wide ranges in efficacy may be observed in fungicide active ingredients listed in the table. This is why several fungicide active ingredients are combined in seed treatments to provide protection to a broader spectrum of pathogens. Contact your local Extension plant pathologist for recommended fungicide product rate information for your area.

**General Comments:**

A major finding in Ohio and several other states is first the number of different species of Pythium and Fusarium that are impacting seed and seedling health in soybean. This is why there is a range of Poor to Good for some of the fungicide active ingredients listed in the Tables below. This is why you see several fungicides combined together for seed treatments to provide protection to a broader spectrum of pathogens.

<table>
<thead>
<tr>
<th>Fungicide Active Ingredient</th>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>E</td>
<td>Excellent</td>
</tr>
<tr>
<td>B</td>
<td>VG</td>
<td>Very Good</td>
</tr>
<tr>
<td>C</td>
<td>G</td>
<td>Good</td>
</tr>
<tr>
<td>D</td>
<td>F</td>
<td>Fair</td>
</tr>
<tr>
<td>E</td>
<td>P</td>
<td>Poor</td>
</tr>
<tr>
<td>F</td>
<td>NR</td>
<td>Not Recommended</td>
</tr>
<tr>
<td>G</td>
<td>NS</td>
<td>Not Specified on product label</td>
</tr>
<tr>
<td>H</td>
<td>U</td>
<td>Unknown efficacy or insufficient data to rank product</td>
</tr>
</tbody>
</table>

---

*Pesticide Safety Education Program, Ohio State University Extension*
<table>
<thead>
<tr>
<th>Fungicide active ingredient</th>
<th><em>Pythium</em> sp.</th>
<th>Phytophthora</th>
<th><em>Rhizoctonia</em> sp.</th>
<th><em>Fusarium</em> sp.</th>
<th>Sudden death syndrome (SDS) (<em>Fusarium virguliforme</em>)</th>
<th><em>Phomopsis</em> sp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azoxystrobin</td>
<td>P-G</td>
<td>NS</td>
<td>VG</td>
<td>F-G</td>
<td>NR</td>
<td>P</td>
</tr>
<tr>
<td>Carboxin</td>
<td>U</td>
<td>U</td>
<td>G</td>
<td>U</td>
<td>NR</td>
<td>U</td>
</tr>
<tr>
<td>Ethaboxam</td>
<td>E</td>
<td>E</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>Fludioxonil</td>
<td>NR</td>
<td>NR</td>
<td>G</td>
<td>F-VG</td>
<td>NR</td>
<td>G</td>
</tr>
<tr>
<td>Fluopyram</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>VG</td>
<td>NR</td>
</tr>
<tr>
<td>Fluxapyroxad</td>
<td>U</td>
<td>U</td>
<td>E</td>
<td>G</td>
<td>NR</td>
<td>G</td>
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<tr>
<td>Ipconazole</td>
<td>P</td>
<td>NR</td>
<td>F-G</td>
<td>F-E</td>
<td>NR</td>
<td>G</td>
</tr>
<tr>
<td>Mefenoxam</td>
<td>E²</td>
<td>E</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Metalaxy</td>
<td>E²</td>
<td>E</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Oxathiapiprolin</td>
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<td>E</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>PCNB</td>
<td>NR</td>
<td>NR</td>
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<td>U</td>
<td>NR</td>
<td>G</td>
</tr>
<tr>
<td>Penflufen</td>
<td>NR</td>
<td>NR</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Prothioconazole</td>
<td>NR</td>
<td>NR</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Pyraclostrobin</td>
<td>P-G</td>
<td>NR</td>
<td>F-G</td>
<td>F</td>
<td>NR</td>
<td>G</td>
</tr>
<tr>
<td>Sedaxane</td>
<td>NR</td>
<td>NR</td>
<td>E</td>
<td>NS</td>
<td>NR</td>
<td>G</td>
</tr>
<tr>
<td>Thiabendazole</td>
<td>NR</td>
<td>NR</td>
<td>NS</td>
<td>NS</td>
<td>P</td>
<td>G</td>
</tr>
<tr>
<td>Fluxapyroxad</td>
<td>U</td>
<td>U</td>
<td>E</td>
<td>G</td>
<td>NR</td>
<td>G</td>
</tr>
</tbody>
</table>

1. Products may vary in efficacy against different *Fusarium* and *Pythium* species.
2. Areas with mefenoxam or metalaxyl insensitive populations may see less efficacy with these products.
3. Listed seed treatments do not have efficacy against *Fusarium virguliforme*, causal agent of sudden death syndrome.

### Fungicide(s)

<table>
<thead>
<tr>
<th>Product/Trade name</th>
<th>Active ingredient</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acceleron</strong></td>
<td>DX-612 Fluxapyroxad; DX-309 Metalaxyl; DX-109 Pyraclostrobin</td>
</tr>
<tr>
<td><strong>Allegiance FL</strong></td>
<td>Metalaxyl</td>
</tr>
<tr>
<td><strong>Allegiance LS</strong></td>
<td>Metalaxyl</td>
</tr>
<tr>
<td><strong>Apron XL LS</strong></td>
<td>Mefenoxam</td>
</tr>
<tr>
<td><strong>ApronMaxx RFC</strong></td>
<td>Fludioxonil; Mefenoxam</td>
</tr>
<tr>
<td><strong>ApronMaxx RTA</strong></td>
<td>Fludioxonil; Mefenoxam</td>
</tr>
<tr>
<td><strong>CruiserMaxx</strong></td>
<td>Fludioxonil; Mefenoxam</td>
</tr>
<tr>
<td><strong>CruiserMaxx Advanced or Cruiser Maxx Plus</strong></td>
<td>Fludioxonil; Mefenoxam</td>
</tr>
<tr>
<td><strong>CruiserMaxx Vibrance or Vibrance Trio</strong></td>
<td>Fludioxonil; Mefenoxam; Sedaxane</td>
</tr>
<tr>
<td><strong>Dynasty</strong></td>
<td>Azoxystrobin</td>
</tr>
<tr>
<td><strong>EverGol Energy SB</strong></td>
<td>Metalaxyl; Penflufen; Prothioconazole</td>
</tr>
<tr>
<td><strong>ILEVO</strong></td>
<td>Fluopyram</td>
</tr>
<tr>
<td><strong>Inovate Pro</strong></td>
<td>Ipconazole; Metalaxyl</td>
</tr>
<tr>
<td><strong>Intego</strong></td>
<td>Ethaboxam</td>
</tr>
<tr>
<td><strong>Lumisena</strong></td>
<td>Oxathiapiprolin; Metalaxyl</td>
</tr>
<tr>
<td><strong>Maxim 4FS</strong></td>
<td>Fludioxonil</td>
</tr>
<tr>
<td><strong>Mertect 340 F</strong></td>
<td>Thiacarboxin</td>
</tr>
<tr>
<td><strong>Preval</strong></td>
<td>Carboxin; Metalaxyl; PCNB</td>
</tr>
<tr>
<td><strong>Trilex 2000</strong></td>
<td>Metalaxyl; Trifloxystrobin</td>
</tr>
<tr>
<td><strong>Vibrance</strong></td>
<td>Sedaxane</td>
</tr>
<tr>
<td><strong>Warden CX</strong></td>
<td>Fludioxonil; Mefenoxam; Sedaxane</td>
</tr>
<tr>
<td><strong>Warden RTA</strong></td>
<td>Fludioxonil; Mefenoxam</td>
</tr>
</tbody>
</table>
The Corn Disease Working Group (CDWG) developed ratings for how well fungicides control major corn diseases in the United States. The CDWG determined efficacy ratings for each fungicide listed in the table by field testing the materials over multiple years and locations. Ratings are based on the product's level of disease control and does not necessarily reflect yield increases obtained from product application. A product's efficacy depends upon proper application timing, rate, and application method as determined by the product label and overall disease level in the field at the time of application. Differences in efficacy among each fungicide product were determined by directly comparing products in field tests using a single application of the labeled rate. For application timing and use considerations, please contact your local cooperative extension service. The table includes marketed products available that have been tested over multiple years and locations. The table is not intended to be a list of all labeled products. Additional fungicides are labeled for disease on corn, including contact fungicides such as chlorothalonil. Other fungicides may be available for diseases not listed in the table, including Diplodia, Gibberella and Fusarium ear rots. Many products have specific use restrictions about the amount of active ingredient that can be applied within a period of time or the amount of sequential applications that can occur. Read and follow all use restrictions prior to applying any fungicide.

Efficacy categories: NR=Not Recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent; NL = Not Labeled for use against this disease; U = Unknown efficacy or insufficient data to rank product

**Table Notes:**

1. Harvest restrictions are listed for field corn harvested for grain. Restrictions may vary for other types of corn (sweet, seed or popcorn, etc.), and corn for other uses such as forage or fodder.
2. A 2ee label is available for several fungicides for control of tar spot, however efficacy data are limited.

This information is provided only as a guide. It is the applicator’s legal responsibility to read and follow all current label directions. Reference in this publication to any specific commercial product is for general information only, and does not constitute an endorsement or recommendation by the CDWG. Individuals using such products assume responsibility for their use in accordance with current directions of the manufacturer. Members or participants in the CDWG assume no liability resulting from the use of these products.
<table>
<thead>
<tr>
<th>Fungicide(s)</th>
<th>Active ingredient (%)</th>
<th>Product/Trade name</th>
<th>Rate/A (fl oz)</th>
<th>Anthracnose leaf blight</th>
<th>Common rust</th>
<th>Eyespot</th>
<th>Gray leaf spot</th>
<th>Northern corn leaf blight</th>
<th>Southern rust</th>
<th>Tar spot</th>
<th>Harvest restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>QoI Strobilurins Group 11</td>
<td>Azoxyrstobin 22.9%</td>
<td>Quadris 2.08 SC Multiple Generics</td>
<td>6.0 - 15.5</td>
<td>VG</td>
<td>E</td>
<td>VG</td>
<td>E</td>
<td>G</td>
<td>VG</td>
<td>NL</td>
<td>7 days</td>
</tr>
<tr>
<td>Pyraclostrobin 23.6%</td>
<td>Headline 2.09 EC/SC</td>
<td>6.0 - 12.0</td>
<td>VG</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>VG</td>
<td>VG</td>
<td>NL</td>
<td>7 days</td>
<td></td>
</tr>
<tr>
<td>Picoxyrstobin 22.5%</td>
<td>Aproach 2.08 SC</td>
<td>3.0 – 12.0</td>
<td>VG</td>
<td>VG-E</td>
<td>VG</td>
<td>F-VG</td>
<td>VG</td>
<td>G</td>
<td>NL</td>
<td>7 days</td>
<td></td>
</tr>
<tr>
<td>DMI Triazoles Group 3</td>
<td>Propiconazole 41.8%</td>
<td>Tilt 3.6 EC Multiple Generics</td>
<td>2.0 - 4.0</td>
<td>NL</td>
<td>VG</td>
<td>E</td>
<td>G</td>
<td>G</td>
<td>F</td>
<td>NL</td>
<td>30 days</td>
</tr>
<tr>
<td>Prothioconazole 41.0%</td>
<td>Proline 480 SC</td>
<td>5.7</td>
<td>U</td>
<td>VG</td>
<td>E</td>
<td>U</td>
<td>VG</td>
<td>G</td>
<td>NL</td>
<td>14 days</td>
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</tr>
<tr>
<td>Tebuconazole 38.7%</td>
<td>Folicur 3.6 F Multiple Generics</td>
<td>4.0 - 6.0</td>
<td>NL</td>
<td>U</td>
<td>NL</td>
<td>U</td>
<td>VG</td>
<td>F</td>
<td>NL</td>
<td>36 days</td>
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</tr>
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<td>Tietraconazole 20.5%</td>
<td>Domark 230 ME</td>
<td>4.0 – 6.0</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td>E</td>
<td>VG</td>
<td>G</td>
<td>NL</td>
<td>R3 (milk)</td>
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</tr>
<tr>
<td>Mixed modes of action</td>
<td>Azoxyrstobin 13.5%</td>
<td>Quilt Xcel 2.2 SE Multiple Generics</td>
<td>10.5 - 14.0</td>
<td>VG</td>
<td>VG-E</td>
<td>VG-E</td>
<td>E</td>
<td>VG</td>
<td>VG</td>
<td>U</td>
<td>30 days</td>
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<tr>
<td>Propiconazole 11.7%</td>
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<tr>
<td>Benzovindiflupyr 2.9%</td>
<td>Trivapro 2.21 SE</td>
<td>13.7</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td>E</td>
<td>VG</td>
<td>E</td>
<td>U</td>
<td>30 days</td>
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<tr>
<td>Azoxyrstobin 10.5%</td>
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<td>Propiconazole 11.9%</td>
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</tr>
<tr>
<td>Ciproxyrstobin 71.7%</td>
<td>Aproach Prima 2.34 SC</td>
<td>3.4 – 6.8</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td>E</td>
<td>VG</td>
<td>G</td>
<td>NL</td>
<td>30 days</td>
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<tr>
<td>Picoxyrstobin 17.94%</td>
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<tr>
<td>Flutriafol 19.3%</td>
<td>Fortix 3.22 SC Preemptor 3.22 SC</td>
<td>4.0 -6.0</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td>E</td>
<td>VG-E</td>
<td>VG</td>
<td>NL</td>
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<tr>
<td>Fluoxastrobin 14.84%</td>
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<tr>
<td>Prothioconazole 16.0%</td>
<td>Delaro 325 SC</td>
<td>8.0-12.0</td>
<td>VG</td>
<td>E</td>
<td>VG</td>
<td>E</td>
<td>VG</td>
<td>VG</td>
<td>U</td>
<td>14 days</td>
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</tr>
<tr>
<td>Trifl oxyrstobin 13.7%</td>
<td></td>
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<td></td>
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<tr>
<td>Pydiflumetofen 7.0%</td>
<td>Miravis Neo 2.5 SE</td>
<td>13.7</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td>E</td>
<td>VG-E</td>
<td>VG</td>
<td>U</td>
<td>30 days</td>
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<td>Azoxyrstobin 9.3%</td>
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<td>Pyraclostrobin 28.58%</td>
<td>Priaxor 4.17 SC</td>
<td>4.0 – 8.0</td>
<td>U</td>
<td>VG</td>
<td>U</td>
<td>VG</td>
<td>VG-E</td>
<td>VG</td>
<td>U</td>
<td>21 days</td>
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<tr>
<td>Fluoxaproxyad 14.33%</td>
<td>Headline AMP 1.68 SC</td>
<td>10.0 - 14.4</td>
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<td>E</td>
<td>E</td>
<td>E</td>
<td>VG</td>
<td>G</td>
<td>U</td>
<td>20 days</td>
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<td>Pyraclostrobin 13.6%</td>
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<tr>
<td>Trifl oxyrstobin 32.3%</td>
<td>Stratego YLD 4.18 SC</td>
<td>4.0 - 5.0</td>
<td>VG</td>
<td>E</td>
<td>VG</td>
<td>E</td>
<td>VG</td>
<td>G</td>
<td>NL</td>
<td>14 days</td>
<td></td>
</tr>
<tr>
<td>Prothioconazole 10.8%</td>
<td></td>
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</tr>
<tr>
<td>Tetraconazole 7.48%</td>
<td>Affiance 1.5 SC</td>
<td>10.0-14.0</td>
<td>U</td>
<td>G-VG</td>
<td>U</td>
<td>G-VG</td>
<td>G-VG</td>
<td>G</td>
<td>NL</td>
<td>7 days</td>
<td></td>
</tr>
<tr>
<td>Azoxyrstobin 9.35%</td>
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Management of Small Grain Diseases: Fungicide Efficacy for Control of Wheat Diseases
(2019 Final Apr 3)
Dr. Anne Dorrance and Dr. Pierce Paul
Department of Plant Pathology, Ohio State University Extension

The North Central Regional Committee on Management of Small Grain Diseases (NCERA-184) has developed the following information on fungicide efficacy for control of certain foliar diseases of wheat for use by the grain production industry in the U.S. Efficacy ratings for each fungicide listed in the table were determined by field testing the materials over multiple years and locations by the members of the committee. Efficacy is based on proper application timing to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in the table. Table includes most widely marketed products, and is not intended to be a list of all labeled products.

Table Notes:
1 Efficacy categories: NL=Not Labeled; NR=Not Recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent; -- = Insufficient data to make statement about efficacy of this product.
2 Product efficacy may be reduced in areas with fungal populations that are resistant to strobilurin fungicides.
3 Efficacy may be significantly reduced if solo strobilurin products are applied after stripe rust infection has occurred.
4 Application of products containing strobilurin fungicides may result in elevated levels of the mycotoxin Deoxynivalenol (DON) in grain damaged by head scab.
5 Multiple generic products containing the same active ingredients also may be labeled in some states.
6 Products with mixed modes of action generally combine triazole and strobilurin active ingredients. Nexicor, Priaxor and Trivapro include carboxamide active ingredients.
7 Based on application timing at the beginning of anthesis (Feekes 10.5.1).
## Efficacy of fungicides for wheat disease control based on appropriate application timing

<table>
<thead>
<tr>
<th>Fungicide(s)</th>
<th>Class</th>
<th>Active ingredient</th>
<th>Product</th>
<th>Rate/A (fl oz)</th>
<th>Powdery mildew</th>
<th>Stagonospora leaf/glume blotch</th>
<th>Septoria leaf blotch</th>
<th>Tan spot</th>
<th>Stripe rust</th>
<th>Leaf rust</th>
<th>Stem rust</th>
<th>Head scab</th>
<th>Harvest restriction</th>
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<tbody>
<tr>
<td>Strobilurin</td>
<td>Picoxystrobin 22.5%</td>
<td>Aproach SC</td>
<td>6.0 – 12.0</td>
<td>G&lt;sup&gt;1&lt;/sup&gt;</td>
<td>VG</td>
<td>VG&lt;sup&gt;2&lt;/sup&gt;</td>
<td>VG&lt;sup&gt;2&lt;/sup&gt;</td>
<td>E&lt;sup&gt;3&lt;/sup&gt;</td>
<td>VG</td>
<td>VG</td>
<td>NL</td>
<td>Feekes 10.5</td>
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<tr>
<td>Pyraclostrobin 23.6%</td>
<td>Headline SC</td>
<td>6.0 - 9.0</td>
<td>G</td>
<td>VG</td>
<td>--</td>
<td>VG</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>G</td>
<td>NL</td>
<td>Feekes 10.5</td>
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<tr>
<td>Trizole</td>
<td>Metconazole 8.6%</td>
<td>Caramba 0.75 SL</td>
<td>10.0 - 17.0</td>
<td>VG</td>
<td>VG</td>
<td>--</td>
<td>VG</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>G</td>
<td>30 days</td>
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<tr>
<td>Tebuconazole 38.7%</td>
<td>Folicur 3.6 F&lt;sup&gt;5&lt;/sup&gt;</td>
<td>4.0</td>
<td>NL</td>
<td>--</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>G</td>
<td>30 days</td>
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<tr>
<td>Prothioconazole 41%</td>
<td>Proline 480 SC</td>
<td>5.0 - 5.7</td>
<td>--</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>E</td>
<td>E</td>
<td>G</td>
<td>30 days</td>
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<td>Prothioconazole 19% Tebuconazole 19%</td>
<td>Prosaro 421 SC</td>
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<td>VG</td>
<td>VG</td>
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<td>E</td>
<td>E</td>
<td>E</td>
<td>G</td>
<td>30 days</td>
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<tr>
<td>Triazole</td>
<td>Propiconazole 41.8%</td>
<td>Tilt 3.6 EC&lt;sup&gt;5&lt;/sup&gt;</td>
<td>4.0</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>P</td>
<td>Feekes 10.5.4</td>
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<td>Mixed modes of action&lt;sup&gt;6&lt;/sup&gt;</td>
<td>Tebuconazole 22.6% Trifloxystrobin 22.6%</td>
<td>Absolute Maxx SC</td>
<td>5.0</td>
<td>G</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>E</td>
<td>VG</td>
<td>NL</td>
<td>35 days</td>
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<td>Cyproconazole 71% Picoxystrobin 17.94%</td>
<td>Aproach Prima SC</td>
<td>3.4 - 6.8</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>E</td>
<td>VG</td>
<td>--</td>
<td>NR</td>
<td>45 days</td>
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<tr>
<td>Prothioconazole 16.0% Trifloxystrobin 13.7%</td>
<td>Delaro 325 SC</td>
<td>8.0</td>
<td>G</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>G&lt;sup&gt;7&lt;/sup&gt;</td>
<td>NL</td>
<td>Feekes 10.5 and 35 days</td>
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<tr>
<td>Pydiflumetofen 13.7% Propiconazole 11.4%</td>
<td>Miravis Ace SE</td>
<td>13.7</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>G&lt;sup&gt;7&lt;/sup&gt;</td>
<td>Feekes 10.5.4</td>
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<tr>
<td>Fluxapyroxad 2.8% Pyraclostrobin 18.7% Propiconazole 11.7%</td>
<td>Nexcior EC</td>
<td>7.0 - 13.0</td>
<td>G</td>
<td>VG</td>
<td>VG</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>VG</td>
<td>NL</td>
<td>Feekes 10.5</td>
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<tr>
<td>Fluoxastrobin 14.8% Flutriafol 19.3%</td>
<td>Preemptor SC</td>
<td>4.0 - 6.0</td>
<td>--</td>
<td>--</td>
<td>VG</td>
<td>VG</td>
<td>E</td>
<td>VG</td>
<td>--</td>
<td>NL</td>
<td>Feekes 10.5 and 40 days</td>
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<tr>
<td>Fluxapyroxad 14.3% Pyraclostrobin 28.6%</td>
<td>Priaxor</td>
<td>4.0 - 8.0</td>
<td>G</td>
<td>VG</td>
<td>VG</td>
<td>E</td>
<td>VG</td>
<td>VG</td>
<td>G</td>
<td>NL</td>
<td>Feekes 10.5</td>
<td></td>
<td></td>
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<tr>
<td>Propiconazole 11.7% Azoxystrobin 13.5%</td>
<td>Quilt Xcel 2.2 SE&lt;sup&gt;5&lt;/sup&gt;</td>
<td>10.5 - 14.0</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>E</td>
<td>E</td>
<td>VG</td>
<td>NL</td>
<td>Feekes 10.5.4</td>
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<td>Prothioconazole 10.8% Trifloxystrobin 32.3%</td>
<td>Stratego YLD</td>
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<td>G</td>
<td>VG</td>
<td>VG</td>
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<td>VG</td>
<td>VG</td>
<td>NL</td>
<td>Feekes 10.5 and 35 days</td>
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<tr>
<td>Benzovindifluipur 2.9% Propiconazole 11.9% Azoxystrobin 10.5%</td>
<td>Trivapro SE</td>
<td>9.4 - 13.7</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>VG</td>
<td>E</td>
<td>E</td>
<td>VG</td>
<td>NL</td>
<td>Feekes 10.5.4 and 14 days</td>
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</table>
The North Central Regional Committee on Soybean Diseases (NCERA-137) has developed the following information on foliar fungicide efficacy for control of major foliar soybean diseases in the United States. Efficacy ratings for each fungicide listed in the table were determined by field-testing the materials over multiple years and locations by the members of the committee. Efficacy ratings are based upon level of disease control achieved by product, and are not necessarily reflective of yield increases obtained from product application. Efficacy depends upon proper application timing, rate, and application method to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in the table, unless otherwise noted. For application timing and use considerations, please contact your local cooperative extension service. Table includes systemic fungicides available that have been tested over multiple years and locations. The table is not intended to be a list of all labeled products. Efficacy categories: NR=Not Recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent; NL = Not Labeled for use against this disease; U = Unknown efficacy or insufficient data to rank product efficacy.

**Table Notes:**
1. Multiple fungicides are labeled for soybean rust only, powdery mildew, and Alternaria leaf spot, including tebuconazole (multiple products) and Laredo (myclobutanil). Contact fungicides such as chlorothalonil may also be labeled for use.
2. In areas where QoI-fungicide resistant isolates of the brown spot pathogen are present, QoI fungicides may result in poor disease control.
3. Cercospora leaf blight efficacy relies on accurate application timing, and standard R3 application timings may not provide adequate disease control. Fungicide efficacy may improve with earlier or later applications; however, efficacy has been inconsistent with some products. Fungicides with a solo or mixed QoI or MBC mode of action may not be effective in areas where QoI or MBC resistance has been detected in the fungal population that causes Cercospora leaf blight.
4. In areas where QoI-fungicide resistant isolates of the frogeye leaf spot pathogen are not present, QoI fungicides may be more effective than indicated in this table.
5. White mold efficacy is based on R1-R2 application timing, and lower efficacy is obtained at R3 or later application timings, or if disease symptoms are already present at the time of application.
6. Harvest restrictions are listed for soybean harvested for grain. Restrictions may vary for other types of soybean (edamame, etc.) and soybean for other uses such as forage or fodder.
7. Multiple generic products containing this mode of action may also be labeled in some states.
8. Proline has a supplemental label (2ee) for white mold in NY.
9. Propulse is not labeled for use on soybean in all states as of January 2019.
10. Stratego YLD has a supplemental label (2ee) for white mold on soybean only in IL, IN, IA, MI, MN, NE, ND, OH, SD, WI.
11. Rating is based on two applications of a 9 fl oz/A rate of Aproach at R1 and R3.

Many products have specific use restrictions about the amount of active ingredient that can be applied within a period of time or the amount of sequential applications that can occur. Please read and follow all specific use restrictions prior to fungicide use. This information is provided only as a guide. It is the responsibility of the pesticide applicator by law to read and follow all current label directions. Reference to products in this publication is not intended to be an endorsement to the exclusion of others that may be similar. Persons using such products assume responsibility for their use in accordance with current directions of the manufacturer. Members or participants in the NCERA-137 group assume no liability resulting from the use of these products.

**Comments for Ohio –**
For these diseases the first line of defense is choosing a resistant variety. But if a field has a history and high level of inoculum and environmental conditions are especially conducive then an application of fungicides may be necessary. Timing of applications is especially critical. For white mold, the timing is when the first flowers have started to bloom in the field prior to cool, rain events. For the remainder of these foliar and pod diseases, timing in Ohio is between R3 and R4 growth stages. Later applications will not result in yield savings.
<table>
<thead>
<tr>
<th>Fungicide(s)</th>
<th>Active ingredient (%)</th>
<th>Product/Trade name</th>
<th>Rate/A (fl oz)</th>
<th>Harvest restriction</th>
<th>White mold</th>
<th>Target spot</th>
<th>Soybean rust</th>
<th>D/gapordie (pod and stem blight)</th>
<th>Frogeye leaf spot</th>
<th>Cercospora leaf blight</th>
<th>Brown spot</th>
<th>Anthracnose</th>
<th>Aerial web blight</th>
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<tbody>
<tr>
<td>QoI Strobilurins Group 11</td>
<td>Azoxystrobin 22.9%</td>
<td>Quadris 2.08 SC</td>
<td>Multiple Generics</td>
<td>6.0 - 15.5</td>
<td>VG</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td>G-VG</td>
<td>U</td>
<td>P</td>
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<td>Fluoxastrobin 40.3%</td>
<td>Aftershock 480 SC</td>
<td>Multicolor 480 SC</td>
<td>6.0 - 5.7</td>
<td>VG</td>
<td>G</td>
<td>G</td>
<td>U</td>
<td>U</td>
<td>P-G</td>
<td>U</td>
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<td>Approach 200 SC</td>
<td>Alpro 200 SC</td>
<td>5.0 - 12.0</td>
<td>VG</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>VG</td>
<td>G-VG</td>
<td>U</td>
<td>P</td>
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<td>Cyproconazole 11.8%</td>
<td>Topguard 1.04 SC</td>
<td>Hero 1.04 SC</td>
<td>7.0 - 14.0</td>
<td>U</td>
<td>U</td>
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<td>Propiconazole 44.8%</td>
<td>Tilt 3.6 EC</td>
<td>Multiple Generics</td>
<td>4.0 - 6.0</td>
<td>U</td>
<td>VG</td>
<td>VG</td>
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<td>F</td>
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<td>Omega 500 DF</td>
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<td>2,6-dinitro-3,3,5-trichlorobenzene</td>
<td>Endura 1.0 DF</td>
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<td>Crop</td>
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<td>Active ingredient (%)</td>
<td>Product/Trade name</td>
<td>Rate/A (fl oz)</td>
<td>harvest restriction</td>
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<td>Brown spot</td>
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<td>2.9%</td>
<td>Topguard EQ</td>
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<td>5.0-7.0</td>
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<td>2.9%</td>
<td>5.0-7.0</td>
<td>21 days</td>
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<td>Topguard EQ</td>
<td>5.0-7.0</td>
<td>21 days</td>
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<td>2.9%</td>
<td>5.0-7.0</td>
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<td>21 days</td>
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<td>21 days</td>
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**Mixed mode of action**
- VG
- G-VG
- U
- G
- F-G
- P-F
- G
- VG-E
- U
- P

**Class**
- Active ingredient (%)
- Product/Trade name
- Rate/A (fl oz)
- Harvest restriction
Status of Palmer amaranth in Ohio
Glyphosate-resistant Palmer amaranth has been expanding its range throughout the Midwest over the past several years, and Ohio is no exception. We have at this point found at least some Palmer in fields in over 28 counties, although many of these “finds” consisted of only a few plants and have since been remediated. Fields where Palmer went out of control to the point of becoming a major infestation remain rare. There is no pattern to the infestations of Palmer in Ohio - it’s all based on local introductions via several mechanisms. It’s evident at this point that we have several primary mechanisms for the introduction of Palmer amaranth seed into an area: 1) the use of animal feed with cotton harvest byproducts as an ingredient, and the manure from these operations that is spread on crop fields (also have instances where the semi-trailers used to haul this feed are cleaned out in fields); 2) the import of infested hay from Kansas and other states where Palmer amaranth is endemic; 3) combines used in a field are infested with Palmer seed, either via purchase of equipment from another area of the country or custom harvesting; and 4) the contamination of seed originating from farther west and south that is used to establish CREP or wildlife areas. ODA will screen any seed used for these purposes for the presence of Palmer amaranth seed. They have to come to wherever the seed is and pick it up, though. Contact them to get this done. Do not mail it to them or drop it off. Seed can also be screened for the presence of Palmer for a fee by the University of Illinois - http://bulletin.ipm.illinois.edu/?p=3231

Status of waterhemp in Ohio
The rate of increase of herbicide-resistant waterhemp populations in the state makes it a more immediate and widespread problem than Palmer amaranth. New infestations of waterhemp can occur via any of the same mechanisms described above for Palmer, but we already have enough waterhemp in the state that is likely to spread with floodwater, animals and birds, and equipment. Waterhemp has many of the same characteristics that make Palmer amaranth so problematic, and also has the capacity to rapidly develop resistance to any new herbicide site of action used to control it. Waterhemp has the same potential as Palmer amaranth to increase herbicide costs and reduce net profit, and prevention of new infestations is well worth the effort, following the steps outlined below. Growers with established infestations need to be aware that the control strategies for this weed are substantially different than for marestail or giant ragweed. It’s essential to know what types of herbicide resistance are already in the population when planning future soybean herbicide programs, especially with regard to glyphosate and site 14 herbicides (PPO inhibitors – Flexstar, Cobra, etc). This information can be obtained by sending leaf samples to the University of Illinois for testing (bulletin.ipm.illinois.edu/?p=3619 - $50 per population).

Herbicide resistance, and especially multiple resistance, may be the most significant long-term issue for management of Palmer amaranth and waterhemp. Waterhemp populations across the Midwest have resistance to up to 6 herbicide sites of action. Resistance to multiple herbicide sites of action is already common in Ohio populations of Palmer amaranth and waterhemp, limiting the number of effective postemergence herbicide options. Resistance to glyphosate and site 2 herbicides (ALS) occurs in almost all populations. In screening of 2016 Ohio populations, about 30% of waterhemp populations had resistance to glyphosate, site 2, and site 14 (PPO), and the PPO resistance also conferred some resistance to atrazine. We had an arrangement with Syngenta in 2018, where they would screen at no charge for the presence of site 14 resistance in suspect plants submitted by OSU Extension educators in west central and northwest Ohio. About half of these populations were resistant to site 14, and we assume the presence of glyphosate and site 2 resistance as well. In our characterization of Palmer amaranth and waterhemp populations collected in September of 2018, populations of both species were mostly resistant to both site 2 and site 9 herbicides, as we have observed in previous years. Several populations of each were resistant to site 14 herbicides also, which we had observed in the past for waterhemp but not for Palmer amaranth. We expect that many more waterhemp populations, especially in west central Ohio, are also multiple resistant, with resistance to site 14 herbicides on the increase.
Overall, these results indicate that Ohio waterhemp populations will continue to develop resistance to additional sites of action used against them, and our education must focus on herbicide and soybean trait management strategies to prevent multiple resistance, along with prevention of seed. We assume that waterhemp and Palmer will develop resistance to any postemergence soybean herbicide after about three uses, even with a year of corn between soybean years. Within the past several years, waterhemp populations in Illinois have developed resistance to site 15 herbicides – metolachlor, acetochlor, pyroxasulfone. Since these residual herbicides provide control of newly germinating plants only, the selection has been through soil activity, not foliar activity. Research at universities with a longer history of waterhemp problems than OSU has shown the importance of two factors: 1) use of diverse herbicide programs, using combinations of at least two effective herbicide sites of action especially in foliar applications; and 2) management of herbicides alone will not prevent resistance unless growers also take steps to prevent any surviving plants from producing seed. Seed from these plants generally increases the seedbank and makes control more challenging in future years, and also likely carries herbicide resistance. Preventing seed keeps populations manageable and prolongs herbicide utility.

Managing Palmer amaranth and waterhemp
Additional information on Palmer amaranth and waterhemp can be found at the resources listed below. The most important advice we can provide on Palmer amaranth and waterhemp is: 1) do not let them become established in the fields that you farm if possible; and 2) even where an effective herbicide program is used, scout fields in late-season and remove any escapes that might be herbicide-resistant and will produce up to one million seeds. Aside from being careful about the possible sources of infestation outlined above, essential steps include the following:

- know if infestations occur near any of the fields that you farm, and be aware of any movement and spread along roadsides;
- use broad-spectrum residual herbicides in both corn and soybeans, which control the early-emerging Palmer amaranth and waterhemp plants and can reduce the chances of a disaster occurring within one growing season;
- if plants are evident before the field is treated with postemergence herbicides, modify the herbicides used in order to address glyphosate-resistance;
- scout fields in late July/August for the presence of Palmer and waterhemp plants visible above the soybeans. Get help with identification if necessary and rogue out Palmer plants before they can produce seed.
- Be on the watch for Palmer amaranth and waterhemp while harvesting. Avoid harvesting through areas of plants with mature seed.
- Both weeds are on the Ohio Noxious Weed Law, which means that landowners/tenants, townships, and state agencies must control it and prevent additional seed.

What is “overlapping residual” and do you need it?
The Palmer amaranth and waterhemp problems have resulted in the development of some new herbicide management strategies, which are not necessarily needed or cost-effective for the control of most other weeds. One of these strategies, known as “overlapping residual”, refers to the use of residual herbicides several times during the growing season to provide more flexibility in postemergence herbicide timing, and minimize the need for multiple postemergence applications. For Palmer amaranth and waterhemp, this is driven by the need to: 1) apply postemergence herbicides when plants are small; 2) control the plants that will emerge after an early postemergence application since these weeds have a wide window of emergence; 3) reduce the number of weeds that have to be controlled by postemergence herbicides, so that selection for resistance is reduced. So residual herbicides are applied twice: 1) preplant or at planting, which is typical for many soybean fields, and 2) in a mixture with the postemergence herbicides (examples – adding metolachlor, Warrant, or Zidua/Anthem to a postemergence application of fomesafen or glufosinate).

We expect that this strategy could become necessary in Ohio as our waterhemp and Palmer amaranth problems become more frequent. For most other weed problems in Ohio, it’s still most important to use residual herbicides prior to or at planting, and not so much in the postemergence treatment. Our research with giant ragweed has shown that making two postemergence applications is the more effective way to reduce populations, partly because any herbicides that can be applied postemergence cannot provide enough residual
ragweed control. However, postemergence application of residual herbicides could be an effective strategy to prevent new infestations of waterhemp or Palmer amaranth in areas where these weeds are becoming more frequent, and some dealers are advocating this. The downside of this use of site 15 herbicides is that it will likely accelerate the rate at which waterhemp develops resistance to them.

**Enlist soybeans/corn and Enlist Duo herbicide**
The approval of Enlist soybeans and corn (Corteva), and the accompanying Enlist Duo herbicide (glyphosate + 2,4-D choline), occurred in late 2014. Approval of Enlist One herbicide (2,4-D choline) occurred in 2017. Approval for the full commercial use and export of Enlist soybeans occurred in early 2019, and seed is being sold. Enlist corn has all export approvals and has been sold for several years. The Enlist soybeans are resistant to glyphosate and 2,4-D, and also glufosinate (Liberty/Cheetah/Interline). Enlist corn is resistant to glyphosate, glufosinate, and 2,4-D, and also the “fop” herbicides (fluazifop, quizalifop). Enlist Duo and Enlist One are the only 2,4-D products approved for: 1) any postemergence applications to Enlist soybeans and corn; 2) any applications of 2,4-D that occur less than 7 days before soybean planting – essentially any preplant or preemergence use that is different than a standard 2,4-D ester label; and 3) any preplant/preemergence use in corn that is different from a typical 2,4-D label. Enlist herbicides can be applied preplant or preemergence to corn without restriction whereas labels for most other 2,4-D products specify application either 7 to 14 days before planting or not until 3 to 5 days after planting. The label for Enlist herbicide labels allows preplant, preemergence, and postemergence applications to Enlist crops, up until the R2 stage of soybean and V8 stage of corn (or 30 inches tall). It is legal to apply glufosinate to Enlist soybeans. Mixing glufosinate and 2,4-D would be an effective way to use two different sites of action on weeds already resistant to glyphosate. The 2,4-D choline formulation in Enlist Duo/One has reduced volatility compared with other available 2,4-D products (according to Corteva). Applicators should be very familiar with stewardship information on the product label and associated materials to reduce the risk of off-target movement. The label contains a detailed section on buffers, approved nozzles and their recommended operating parameters, among other essential information. The website, www.EnlistTankmix.com, contains information on approved nozzles and tank-mix partners, and should be consulted prior to any mixing or application. Do not mix any other product of any type with Enlist One/Duo unless approved and listed on the website.

**Where to find OSU weed management information**
Information on weed and herbicide management can be found in numerous publications available at no charge on the OSU Weed Management website, u.osu.edu/osuweeds/. The Weed Control Guide for Ohio, Indiana, and Illinois can be purchased from OSU county extension offices, online at the OSU Extension eStore (estore.osu-extension.org/index.cfm), or from the OSU publications office - 614-292-1607. We are no longer able to provide a pdf of the guide free. Both hard copy and the pdf can be purchased online, and the pdf is free with purchase of hard copy. We place timely weed management information in the OSU C.O.R.N. newsletter. For example, information comparing the various soybean herbicide resistance traits can be found in the “Sorting out the soybean herbicide resistance traits” article in the 2019-30 issue of the OSU C.O.R.N. newsletter.

**Take Action/USB herbicide resistance information**
There is a wealth of information on herbicide resistance and site of action at the Take Action website, along with recommendations for management of specific weeds that have developed resistance across the region. takeactiononweeds.com. The site contains online versions of the herbicide site of action chart that we have been distributing around the state, along with other posters on identification of Palmer amaranth and fact sheets on control of marestail, giant ragweed, and other weeds. You can also request full-sized copies of the chart and posters to be delivered to you via snail mail, take an online quiz to test your knowledge about resistance, and use the online site of action lookup tool.
Forage Crops and Livestock
Alfalfa Leaf and Stem Diseases and Their Management

R. Mark Sulc
Dept. of Horticulture & Crop Science

Many different pathogens can attack alfalfa leaves and stems, resulting in defoliation that may lead to reduced yield and forage nutritive value. Common foliar diseases of alfalfa include common leaf spot (Pseudopeziza medicaginis), Leptosphaerulina leaf spot (Leptosphaerulina briosiana) often referred to as “lepto”, spring black stem and leaf spot (Phoma medicaginis), summer black stem and leaf spot (Cercospora medicaginis), and Stemphylium leaf spot (Stemphylium spp.); however, other leaf and stem diseases exist in alfalfa stands.

In a study conducted over four years in Iowa, Ohio, Wisconsin, and Vermont, foliar diseases in alfalfa caused yield losses in 22 of 48 growth cycles, with an average yield loss of 19% in the 22 affected harvests (Nutter et al., 2002). In Ohio, yield losses ranged from 3 to 23%, averaging 9.6% with 3 out of 10 harvests having statistically significant yield losses. Although some varieties have been shown to have resistance to specific foliar diseases, that information is not readily available and is not regularly evaluated. Alfalfa growers must rely on other methods for minimizing yield and nutritive value losses to these foliar diseases.

One of the most important management tactics being promoted for reducing the impact of foliar diseases is cutting management. It is believed that a more frequent harvest schedule reduces losses caused by foliar diseases, such as with a 4-cut system in which alfalfa is cut every 30-day, as is common on dairy farms in Ohio. As the harvest interval is lengthened, there is a higher probability of foliar diseases becoming more severe and causing defoliation leading to yield and nutritive value losses.

Controlling potato leafhopper outbreaks is also important to minimizing foliar disease in alfalfa. I have observed severe foliar damage from Lepto and other leaf diseases in alfalfa when the potato leafhopper was not controlled. The combination of potato leafhopper and foliar disease damage can reduce crude protein content of the forage.

Fungicides for Alfalfa

In recent years several fungicides have been registered for use in alfalfa and other forages to control various foliar and stem diseases (Table 1). These fungicides belong to either the respiration inhibitors classified as carboxamides, which are target site of action Group 7 fungicides, or the respiration inhibitors called the quinone outside inhibitors (QoI) or strobilurin fungicides, which are target site of action Group 11 fungicides. Two fungicide products registered for alfalfa, Priaxor and Pristine, are premixes of a Group 7 and a Group 11 fungicide. It is important to rotate the use of fungicide groups in order to prevent resistance from developing in the fungal populations to these fungicides. A gradual or total loss of disease...
control may occur if applications of fungicides from the same group are repeated in the same fields. Kocide (copper hydroxide) is an inorganic fungicide of the Group M1, having multi-site activity with a broad spectrum of disease control. It is a preventative contact fungicide that should be applied before the fungus infects the plant. Studies show that it has not been very effective in controlling foliar diseases in alfalfa. But it might have a role when used in rotation with other fungicides to extend the useful life of the other fungicides before resistance in the fungal populations develops. Read the fungicide labels for specific recommendations for resistance management and application requirements.

Table 1. Fungicides registered for use on alfalfa in Ohio.

<table>
<thead>
<tr>
<th>Product</th>
<th>Group</th>
<th>Anthracnose</th>
<th>Common leaf spot</th>
<th>Downy mildew</th>
<th>Lepto leaf spot</th>
<th>Powdery mildew</th>
<th>Rhizoctonia &amp; stem blight</th>
<th>Rust</th>
<th>Sclerotinia crown and stem rot</th>
<th>Spring black stem &amp; leaf spot</th>
<th>Stagonospora leaf spot</th>
<th>Stemphyllium leaf spot</th>
<th>PHI (days)</th>
<th>Rate (fl ozs/Acre)</th>
<th>Max applications/season</th>
<th>Max rate/season (ozs/Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endura</td>
<td>7</td>
<td>X</td>
<td>X</td>
<td>S</td>
<td>S</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>14</td>
<td>6.5</td>
<td>3</td>
<td>19.5</td>
</tr>
<tr>
<td>Fontelis</td>
<td>7</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>14</td>
<td>12-24</td>
<td>2</td>
<td>48</td>
</tr>
<tr>
<td>Headline EC</td>
<td>11</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>14</td>
<td>6-9</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>Headline SC</td>
<td>11</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>14</td>
<td>3</td>
<td>20.7</td>
<td></td>
</tr>
<tr>
<td>Priaxor</td>
<td>7, 11</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
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<td></td>
<td>14</td>
<td>3</td>
<td>46.5</td>
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</tr>
<tr>
<td>Pristine</td>
<td>7, 11</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>14</td>
<td>12-18</td>
<td>3</td>
<td>54</td>
</tr>
<tr>
<td>Kocide 2000*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.5 lb</td>
<td>0.75 lb</td>
<td>3.2 lb</td>
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<tr>
<td>Kocide 3000*</td>
<td>M1</td>
<td></td>
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</tr>
</tbody>
</table>

S = suppression only.

* Application rate in lbs/acre.

Alfalfa Fungicide Results in Other States

Trials in Wisconsin with several fungicide products and treatments applied to alfalfa on 30-day cutting intervals demonstrated that fungicide application infrequently resulted in significant increases in forage yield or a positive return on investment (Smith et al., 2017). However, with the advent of reduced lignin alfalfa managed on longer cutting intervals (35- to 40-day intervals), the data suggests there is a higher likelihood of a positive return on investment to fungicide treatment.

Studies conducted over six years in Iowa with six fungicide products demonstrated that the first harvest of the year provided a higher probability of a yield response to foliar fungicide application than in later summer harvests (Lang and Pecinovsky, 2018). Although fungicide treatments improved the visual ratings of leaf retention, the fungicide applications showed
little improvement in forage nutritive value. The authors of those studies also concluded that copper hydroxide treatments did not perform as well as the other fungicides they tested. Timing of fungicide application was also evaluated and the authors suggested that fungicides be applied to alfalfa in the spring when it is at a 6 to 8 inch canopy height and in the summer when it is at a 5 to 6 inch canopy height.

Alfalfa Fungicide Results in Ohio

Two experiments were conducted with foliar fungicides on alfalfa at the Western Agricultural Research Center near South Charleston, OH. In the first study, Headline was applied to an established alfalfa stand at 6 oz/acre once during each of the first three growth cycles in 2013 and 2014 (Table 2). The second study was conducted on an established stand of alfalfa maintained on either a 28-day or 35-day cutting schedule in 2018 and 2019; Priaxor was applied at 6.9 oz/acre once during each of the first three growth cycles in 2018 while in 2019 it was applied to the first, second, and last growth cycles of the season (Table 2).

Table 2. Forage yield advantage from fungicide application in established alfalfa stands at South Charleston, OH. In 2018 and 2019, fungicide application was made to alfalfa maintained on a 28-day or 35-day harvest interval. Bolded values indicate statistically significant fungicide effect ($\alpha = 0.05$).

<table>
<thead>
<tr>
<th>Year</th>
<th>Product</th>
<th>Cut 2</th>
<th>Cut 1</th>
<th>Cut 3</th>
<th>Cut 4</th>
<th>Cut 5</th>
<th>Annual Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry matter yield increase (tons/acre)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Headline</td>
<td>0.10</td>
<td>0.32</td>
<td>0.32</td>
<td>0.20</td>
<td>0.94</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>Headline</td>
<td>0.06</td>
<td>0.09</td>
<td>0.20</td>
<td>0.07</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>Priaxor, 28-day</td>
<td>0.25</td>
<td>0.27</td>
<td>0.23</td>
<td>0.03</td>
<td>-0.02</td>
<td>0.76</td>
</tr>
<tr>
<td>2018</td>
<td>Priaxor, 35-day</td>
<td>0.14</td>
<td>0.29</td>
<td>0.10</td>
<td>0.01</td>
<td></td>
<td>0.54</td>
</tr>
<tr>
<td>2019</td>
<td>Priaxor, 28-day</td>
<td>0.20</td>
<td>0.09</td>
<td>0.13</td>
<td>0.05</td>
<td>0.03</td>
<td>0.49</td>
</tr>
<tr>
<td>2019</td>
<td>Priaxor, 35-day</td>
<td>0.08</td>
<td>0.13</td>
<td>0.10</td>
<td>0.06</td>
<td>0.01</td>
<td>0.37</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>0.14</td>
<td>0.20</td>
<td>0.18</td>
<td>0.07</td>
<td>0.01</td>
<td>0.59</td>
</tr>
</tbody>
</table>

There was a statistically significant effect on forage yield in 9 of 31 comparisons across the four years. One of the nine significant comparisons occurred in a growth cycle when the fungicide was not applied, indicating a carryover effect from the previous growth cycle (Cut 4 in 2013). Visual differences were evident in these trials, with the fungicide treatment showing less foliar disease and a deeper green color. Even the stubble after cutting had a greener color.

We hypothesized that fungicide treatment would provide a greater benefit when cutting intervals were delayed. But this does not appear to be the case so far, in that the advantage for fungicide has been similar if not numerically greater in the 28-day cutting schedule versus the 35-day cutting schedule within each year (Table 2).
Only 29% of the comparisons showed a statistically significant effect on yield in the Ohio studies (Table 2), but the trend was consistent for the fungicide treatment to be numerically higher in yield than the plots receiving no fungicide. We considered the annual cost of fungicide application to be $53/acre each year for three applications: $15/acre for the product plus $8/acre application cost in the spring, then $15/acre for the product only in the two summer applications because it was combined with insecticide treatment for potato leafhopper. If alfalfa hay is priced at $200/ton, the breakeven yield improvement for the fungicide application would be 0.27 ton/acre ($53/acre cost divided by $200/ton). If alfalfa is priced lower at $150/ton, the breakeven yield improvement would be 0.35 ton/acre. Therefore, in every year, the three fungicide applications would have provided a positive return on the investment, as the yield improvement ranged from 0.37 to 0.94 tons/acre with an average of 0.59 tons/acre on an annual basis.

Nutritive value of the forage was assessed in 2013 and the Headline treatment resulted in a slight improvement in relative forage quality (+12 RFQ units) and higher crude protein content (+1.6 CP units). This would add to the return on investment for the fungicide treatment. Forage nutritive value results are still being processed for the 2018 and 2019 samples.

Summary

Foliar diseases reduce alfalfa yield in Ohio and can reduce forage nutritive value. Fungicide applications have been shown to provide a consistently positive response in alfalfa yield and return on investment on a total annual yield basis, but the yield improvement is not always statistically significant. Timing of application, weather conditions, and fungal inoculum load can affect the response. There is a low probability of return on investment to fungicide applications made in late summer during the last growth cycle of the season. Further work is needed to determine if two versus three applications per season would provide similar returns on investment, which might help extend the time before fungal population resistance to the fungicides develops in the field.

References


Internal and external parasites can have negative effects on animal health and cause serious production losses. The use of antiparasitic drugs to treat and control infestations of external and internal parasites in cattle, sheep, and goats is an effective way to help manage animal health. As the livestock industry has utilized several different classes of drugs to control parasites, resistance to those drugs by the parasites has emerged, and will continue to be a major impact on the livestock industry. Careful use of these antiparasitic drugs, along with management changes, monitoring of treatment results, and the use of alternative control methods can help extend the efficacy of the available antiparasitic drugs on the market.

In terms of external parasite resistance in cattle, sheep, and goats that may impact producers in Ohio, the parasite most commonly observed with resistance is the cattle Horn fly. Horn flies feed primarily on the backs of cattle, out of the reach of the head and tail of the animal. Horn flies gather by the hundreds or even thousands on each bovine and take 20-40 blood meals per day. Severe infestations can cause major production losses from weight loss and anemia. Horn flies reproduce in fresh manure, and during an Ohio summer 5-10 generations of flies can be produced, dependent on the weather. Horn flies can also travel 5-7 miles to find cattle to feed on.

With the advent of pyrethroid-impregnated fly tags in the 1980s, horn fly control became very convenient and effective. After several decades in use, however, resistance to these tags has emerged within horn fly populations across the United States. The presence of the R (resistant) gene in horn flies was increased during the use of DDT early in the 20th century, wiping out large populations of susceptible flies, and it is thought that the method by which horn flies became resistant to DDT is similar for that of pyrethroids. A case of resistant horn flies is typically defined as a failure to reduce horn fly numbers to less than 150 flies per animal two weeks after treatment. Several strategies can be utilized to maximize horn fly (as well as other major fly pests) control while preserving the effectiveness of the approved fly kill products on the market. Fly tags should be applied to the animals most susceptible to production losses, which includes young and growing calves. Tags should be applied only when fly populations are more than 200 flies per animal, and at or near the peak of fly season. Utilization of back rubbers and dusters with organophosphate or pyrethroid compounds can help complement tag fly control. The use of horn fly traps can also help reduce fly numbers on growing cattle. Keeping a population of cattle untreated for horn flies helps maintain a population of flies that are susceptible to the available treatments (Refugia), diluting the population of resistant flies. Annual rotation in the compounds used in fly control tags will also decrease the amount of resistance from horn flies, as well as the use of single compound tags (i.e. no combination pyrethroid/organophosphate tags). The use of pour-on fly control during periods of heavy infestation can also cut down on fly numbers. If cattle are being fed a ration, the use of feed-through insect growth regulators can help control those flies that
depend on manure for their life cycle. For flies that breed in combinations of manure and spoiled feed, removal of spoiled feed and areas of pastures and lots heavily contaminated with manure can also reduce fly numbers.

The emergence of resistant internal parasites in sheep and goats is a major industry issue, and this problem is also starting to be recognized in the cattle business. *Haemonchus contortus*, or the Barber Pole worm, is the parasite of most concern to sheep and goat producers, due to dramatic increases in multidrug resistant *Haemonchus* across the US. The overuse of anthelmintic drugs, annual rotation to different anthelmintics, use of blanket treatment protocols, and other mismanagement has led to the current state of anthelmintic resistance.

*Haemonchus* is a voracious blood feeder that attaches itself to the wall of the abomasum and takes a blood meal via a small tooth on its head. It has a direct life cycle, with worm larvae deposited on feces onto pasture, maturing and subsequently being eaten by another susceptible host. Barber Pole worms can detect the periparturient hormone rise in pregnant sheep and goats and release large numbers of eggs to be deposited on pastures prior to the birth of lambs or kids. Resistance by Haemonchus to the various approved anthelmintic drugs is widespread and growing due to misuse of these drugs.

Control of *Haemonchus contortus* (and other internal parasites) in sheep and goats can be maintained via several management and treatment methods. The use of blanket deworming protocols, where every animal receives a dose of deworming drug, is a practice that should be eliminated. All blank deworming achieves is ensuring all worms on the farm are exposed to the drug, leaving only resistant worms behind. Instead, the concept of refugia should be employed, where only part of the herd or flock is treated. This leaves a susceptible population of worms behind to dilute the population of any resistant worms created by the treatment. Refugia in sheep and goats can be easily implemented by the use of FAMACHA scoring, which monitors the level of anemia via observation of the conjunctiva of the eye. Only the most anemic animals are treated under this system, sparing healthy animals from a dose of dewormer. This system treats only the most infested animals, which also are typically carrying 80% of the entire farm worm load anyway. This system also allows a producer to cull these animals instead of treatment, to further cut the use of anthelmintics on the farm. The drug used to deworm sheep and goats on any given farm should not be rotated to a different class annually, as this will contribute to resistance to multiple drug classes. Instead, careful use of a single type of drug should be utilized. In case of resistant worms, the use of combination treatments, with two different drugs administered at the same time, should also be considered. The use of combination treatments can dramatically cut worm numbers, if it is used carefully within a FAMACHA system that also monitors efficacy. It is critical to maintain a Refugia when using combination treatments, to dilute any multidrug resistant worm loads left after treatment. Efficacy can best be monitored by the use of Fecal Egg Count Reduction tests. This test consists of taking a fecal sample, examining for number of egg larvae via Stoll’s or McMaster’s methods, and treating the sheep or goats at the same time. The test is repeated around 14 days later to determine the number of eggs present, with around 95% reduction of larvae considered to be ideal.

Administration of deworming agents in sheep and goats should be via the oral route, as this presents the drugs right to the area of the body where the worms are typically located in the gastrointestinal
tract. Topical applications of these drugs in sheep and goats are absorbed poorly, and injectable agents can have very long slaughter withdrawals (especially moxidectin). Removing sheep and goats from feed for 24 hours prior to oral deworming agents helps keep drug levels in the gut at higher levels for longer periods of time. Placing the tip of the drenching gun at the back of the tongue in sheep and goats helps facilitate the deposit of the drugs into the rumen and not directly into the abomasum.

In cattle, the emergence of resistant Cooperia worms is alarming, and is present in approximately 70% of US operations per Dr. Ray Kaplan at the University of Georgia. Ostertagia, the abomasal worm of cattle, is also beginning to become resistant to available anthelmintic drugs. The use of blanket treatment protocols in addition to poor application of drugs and lack of refugia is creating resistance in cattle. There are multiple approved methods to deliver anthelmintic agents to cattle, including oral drench, feed-based, injectable and topical applications. Oral and injectable formulations provide the best efficacy against worms, with topical applications providing more challenges. Topical deworming agents are absorbed at different rates, and can be affected by hair length, skin conditions and weather. It is also critical that topical applications of anthelmintics be completely applied to the top of the animal. Observation of efficacy of anthelmintic drugs in cattle is also critical. Cattle should have fecal exams performed to determine if worm burdens are actually a problem, prior to the use of deworming agents. If an issue is discovered the careful use of drugs in selected susceptible animals should be employed. Monitoring of success of treatment for internal parasites in cattle should also be utilized. While Fecal Egg Count Reduction tests are fairly accurate in sheep and goats, the use in cattle is more difficult to interpret. Eggs are shed in lower numbers in cattle, in larger volumes of manure, so sensitivity of the FECRT is lower in this species. Producers should work with their veterinarian to develop post treatment monitoring programs to determine if their anthelmintic program is working.

Sources:

Management of Horn Fly Resistance – Robert G Arther, Mobay Animal Health

Antiparasitic Resistance in Cattle And Small Ruminants in the United States: How to Detect it and What To Do About It – US Food and Drug Administration Center for Veterinary Medicine

Managing External Parasites of Texas Livestock and Poultry – Texas A&M Agrilife Communications

American Consortium for Small Ruminant Parasite Control
Ohio Cover Crop Recipe
Post Corn, Going to Soybean: Use Cereal Rye
Sarah Noggle, Ohio State University Extension; James Hoorman, USDA-NRCS

This publication is intended to provide a starting point for farmers who are new to growing cover crops. With experience, farmers may fine-tune the use of cover crops for their systems.

Introduction
The following recipe provides an introductory approach to integrating a cover crop into a corn-soybean rotation. Planting a cover crop ahead of a soybean cash crop is often the easiest way to introduce cover crops into your rotation.

Planning and Preparation
- **Planning**—Educate yourself. Start small. Be timely. Prioritize management based on your purpose and objectives.
- **Corn hybrid and planting**—If possible, plant the preceding corn crop early and use an early maturity corn hybrid. One strategy is to use cover crops on the field you usually harvest first, on sloping ground, or on a field where you can watch it regularly, and to plant your earliest maturity hybrid on that field.
- **Residual corn herbicides**—Cereal rye can be seeded and a successful stand will occur in the fall following most of the spring-applied residuals used in corn. However, if cereal rye will be grazed or fed to livestock, there are some restrictions (see Resources section).
- **Seed purchase**—Order cereal rye seed early. Named varieties have more predictable growth but are more expensive. Start with VNS (variety not stated) seed with a good germination rate purchased from a reputable seed dealer. Note that this means the seed has been cleaned and has a certified lab tested germination tag. Additionally, seeding rate calculations are based on one of two factors, pure live seed (PLS) or seed count. Natural Resource Conservation Service (NRCS) calculations are based on PLS for compensation.

Fall Work
- **Corn harvest**—Harvest fields where cereal rye is to be planted as early as possible.
- **Tillage or no-tillage**—To allow for adequate cover crop growth, it is best or easier if full-width tillage is minimized before rye planting or before the intended rye termination date. To achieve maximum benefits, integrate cover crops into no-till or strip-till systems.
- **Timing of planting**—Ideally, plant cereal rye as soon after harvest as possible. In northern Ohio, this would be before November 1; in southern Ohio, before November 15. Use the Selector Tool (in Resources section) for more precise dates for your county.
- **Seeding rate**—Drilled seeding rate: 40–60 lbs./acre PLS. Broadcast with shallow incorporation: 45–65 lbs./acre PLS. Ohio NRCS approves broadcasting without incorporation if PLS rate is increased by 20%. (See Section on Calculating Pure Live Seed)
- **Planting method**—Drill to 0.75–1.50 inch deep, broadcast with shallow incorporation, or surface broadcast. An air-seeder mounted on a vertical tillage tool can also be used. Seed to soil contact is important with cereal rye stands.
- **Fertility or liming**—If applying P, K, or lime, complete the application prior to the seeding operation or apply to the growing rye before the ground freezes. If it is necessary to inject manure, low-disturbance injectors are available that will cause minimal damage to the cereal rye. The surface application of liquid manure on top of the rye is not recommended until the rye is 3 inches tall. See the current NRCS Standard Practice 590 for manure application rates. Surface broadcast of dry manure or litter should be done prior to seeding, but 4 tons or less can be applied to growing cereal rye with minimal damage by using modern spreading equipment that provides even distribution.

Spring Work
- **Early Season Scouting**—In the spring, scout your growing cereal rye cover crop to determine how well it is growing and its coverage. But if rainfall is below normal, scout also to monitor soil moisture in case earlier termination is needed. Watch for vole and/or slug damage.
- **Termination timing**—Terminate the cereal rye in the spring when plants are 6 to 12 inches tall and
actively growing or about two weeks before planting soybean—whichever comes first. Many growers will successfully plant soybean into terminated cereal rye much taller than 12 inches or even terminate after planting, especially if weed control is a primary purpose, but new cover crop users should terminate when the cereal rye is smaller.

- **Termination herbicide**—Cereal rye can easily be terminated with a full rate of glyphosate (minimum of 1 lb. acid equivalent [ae]/acre) after dormancy breaks in the spring. Effectiveness and rapidity of termination improves if rye is rapidly growing and air temperatures are consistently above 40°F. Larger rye, rye past the boot stage, or rye sprayed during cooler weather can be more difficult to kill or will die more slowly.

- **Termination modifications for dry weather**—Watch the weather and be ready to modify your termination plans. In a dry spring, the cereal rye cover crop has the potential to use moisture that the cash crop will need, so terminate cover crops sooner.

- **Termination modifications for wet weather**—In a wet spring, when it has been very difficult to get into the fields to spray, be ready to take advantage of any break in the weather and/or use low-axle weight sprayers. If projected soybean planting is less than 10 days away and the rye is tall, then it often works better to spray within a day or two of planting. It is usually better to plant either into brown, dead rye plants or into standing green plants rather than into large, dying, yellow/green (“rubbery”) cereal rye plants that have fallen on the soil surface and formed a mat. See publication AY-353-W (in Resources section) for more details.

- **Soybean planting**—It is usually best to no-till soybeans into the dead/dry or standing cereal rye cover crop. Almost all modern planters and no-till drills are fully capable of planting soybean into a cereal rye cover crop. Check planting depth and seed furrow closure as some adjustments may be needed. Avoid drilling soybeans if the seed slot will not close due to wet soils.

- **Scouting after planting**—After soybean planting, scout for soybean emergence and population. Additionally, scout for weeds since substantial cereal rye residue can often delay the emergence of annual weeds, which may delay the application of post-emergence herbicides.

**Calculating Pure Live Seed**

Pure live seed (PLS) indicates the amount of seed in the container that is capable of developing into seedlings. To calculate PLS, the percentage of pure seed listed on the seed label of a cultivar is multiplied by the percent germination (also listed on the seed label), and the product is divided by 100. For example, 90% pure seed of the cultivar x 80% germination / 100 = 72% PLS. To determine how much seed to plant, divide 100 by the percentage PLS (72% in this case). In this example 100/72 = 1.4. Therefore, 1.4 pounds of see with a purity of 90% and a germination of 80% would be needed for each pound specified in the desired seed mixture.

**Resources**


(Note: This publication was adapted with consent from MCCC under a joint project to produce customized introductory guidance about cover crops for all member states/provinces.)

**Reviewers and Contributors**

Eileen Kladivko, Purdue University; Anna Morrow, Midwest Cover Crops Council; Jason Hartschuh, Ohio State University Extension; Eric Richer, Ohio State University Extension; Alan Sundermeier, Ohio State University Extension.

The Midwest Cover Crops Council (www.mccc.msu.edu) aims to facilitate widespread adoption of cover crops throughout the Midwest by providing educational/outreach resources and programs, conducting new research, and communicating about cover crops to the public.

Funding for this project was provided by McKnight Foundation.
Ohio Cover Crop Recipe

Post Soybean, Going to Corn: Use Oats/Radish

This publication is intended to provide a starting point for farmers who are new to growing cover crops. With experience, farmers may fine-tune the use of cover crops for their systems.

Introduction
The following recipe provides an introductory approach to integrating a cover crop into a soybean-corn rotation. Often the easiest place to begin is to plant a cover crop ahead of a soybean cash crop following corn, so consider starting with the companion recipe titled Post Corn, Going to Soybean (see Resources).

Planning and Preparation
• **Planning**—Educate yourself. Start small. Be timely. Prioritize management based on your purpose and objectives.
• **Soybean variety and planting**—If possible, plant the preceding soybean crop early and use an early maturity soybean cultivar. One strategy is to use your earliest-maturity-group soybeans on the fields where you plan to seed cover crops and plant those beans first.
• **Residual soybean herbicides**—Because oats are very tolerant of most soybean residual herbicides, few restrictions apply unless grazing is being considered. Radish is more sensitive and will likely be harmed if ALS-type (group 2) or PPO-type (group 14) herbicides are used in the soybean cropping season. (See Resources.)
• **Seed purchase**—Order cover crop seed early. Named oat varieties grow well but are more expensive than VNS (variety not stated) seed. Start with VNS seed with a good germination rate purchased from a reputable seed dealer. Note that this means the seed has been cleaned and has a certified lab tested germination tag. Spring barley may be more expensive but can be used instead of oats. For cover crop radishes (daikon type), be sure to purchase a single variety from a reputable seed dealer. Additionally, seeding rate calculations are based on one of two factors, pure live seed (PLS) or seed count. Natural Resource Conservation Service (NRCS) calculations are based on pure live seed for compensation.

Fall Work
• **Soybean harvest**—Harvest fields where a mix of spring oats/radish are to be planted as early as possible.
• **Timing of planting**—Ideally, plant oats/radish immediately after harvest. In most of Ohio, this should occur by the third week in September. See Selector Tool (in Resources section) for more precise dates for your county.
• **Planting method**—Drill to a depth of 0.25–0.50 inch or broadcast, but note that incorporation of the seed, if any, should be light since excessive disturbance of soybean stubble may negate any benefit of the cover crop. See Resources for more details on seeding methods.
• **Seeding rate in oats/radish mix**—Drilled: oats, 30–60 lbs./acre PLS; radish, 2–4 lbs./acre PLS. Broadcast: oats, 33–60 lbs./acre PLS; radish, 3-5 lbs./acre PLS. (see Section on Calculating Pure Live Seed)
• **Aerial seeding or overseeding**—An alternative to seeding after harvest is to do aerial seeding with a plane or helicopter or overseeding with a ground-based vehicle. In most of Ohio, seeding should take place in late August or by the first week of September and before 25% of the soybean leaves have yellowed and dropped. Rainfall after seeding is essential for establishment.
• **Seeding rate for overseeding**—For oats: 40–60 lbs./acre PLS; for radish: 4-6 lbs./acre PLS.
• **Tillage or no-tillage**—To allow for adequate cover crop growth, it is best if no full-width tillage takes place until spring after the oats/radish have been killed by freezing temperatures. It is best to maintain surface cover to prevent erosion and nutrient runoff.
• **Fertility or liming**—If applying P, K, or lime, complete the application prior to the seeding operation or apply to the growing oats/radish before the ground freezes. If it is necessary to inject N fertilizer or manure in the fall, a low-disturbance applicator should be used to minimize the reduction in surface residues.
Fall Work

- Soil Testing and Nutrient Management: Test soil for nutrients and perform bulk hauling. Lime and/or fertilizer may be applied as needed. Aim for a balanced nutrient program to support sustainable plant health.
- Plow-down: Consider plow-down if residues are not desired or if previous residues have become problematic. Plow-down can help reduce corn rootworm populations, however, it may take extra time and effort.

Winter Work

- Soil Management: Consider soil management practices during the winter to improve soil health for the upcoming growing season.
- Crop Rotation: Plan and execute crop rotations to improve soil health and reduce pest pressure.
- Controlling Snow and Ice: Implement strategies to manage snow and ice accumulation, such as using selective herbicides or other practices to prevent crop damage.

Spring Work

- Starter fertilizer—Strongly consider equipping your corn planter with 2x2 starter fertilizer, and aim for a starter fertilizer rate between 30–50 pounds of actual nitrogen (N) per acre. Extra nitrogen is needed in the spring to decompose the additional cover crop residue.
- Scouting – If corn color is light green or slightly off-color, N deficiency may be an issue and extra N should be applied. Tissue test for N sufficiency (Refer to Resources). Scout for true armyworm, cutworm, slug and vole damage.

Calculating Pure Live Seed

Pure live seed (PLS) indicates the amount of seed in the container that is capable of developing into seedlings. To calculate PLS, the percentage of pure seed listed on the seed label of a cultivar is multiplied by the percent germination (also listed on the seed label), and the product is divided by 100. For example, 90% pure seed of the cultivar x 80% germination / 100 = 72% PLS. To determine how much seed to plant, divide 100 by the percentage PLS (72% in this case). In this example 100/72 = 1.4. Therefore, 1.4 pounds of see with a purity of 90% and a germination of 80% would be needed for each pound specified in the desired seed mixture.

Resources


Authors

Sarah Noggle, Ohio State University Extension; James Hoorman, USDA-NRCS.

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Ticks on the Farm
Dr. Tim Mcdermott, DVM
Extension Educator, Hocking County, Ohio State University Extension

Ticks and the diseases that they vector to livestock, companion animals and humans have become an increasingly larger public health risk. Making sure that the producer is aware of this threat and the ways that can be used to protect their farm and their families is a priority outreach opportunity.

There are several different ticks that are primary threats for disease transmission. These fall under the category of hard shell ticks. Most common in Ohio include the Brown Dog Tick, American Dog Tick, Black Legged or Deer Tick, and the Lone Star tick. There are also two tick species that have not yet been identified in Ohio but have expanded their host range or are a new invasive and have the potential to invade Ohio in the close future: The Gulf Coast Tick and East Asian or Longhorned Tick.

Brown Dog Tick
- The Brown Dog tick can live its whole lifespan on the host without a secondary environment.
- They are distributed across the entire United States.
- They transmit multiple diseases to dogs, and occasionally humans, including Rocky Mountain Spotted Fever, Canine Ehrlichiosis, and Babesia.
American Dog Tick

- The American Dog Tick has a large host range in the United States.
- While many ticks prefer a wooded habitat, this tick can also be commonly found in grassy areas including meadows, pastures and lawns.
- This tick is a prominent vector of Rocky Mountain Spotted Fever Tularemia.

Black Legged (Deer) Tick

- This species of tick prefers to live in deciduous forest areas and has been found in most counties in Ohio.
- This tick is the primary vector for Lyme disease. The Black Legged or Deer Tick can also vector Babesia and Anaplasma to humans, companion animals and livestock.
- It is estimated that over 300,000 cases of Lyme disease occur in the United States each year.
Lone Star Tick

- This tick is an aggressive feeder and prefers wooded habitat.
- This tick is a prominent vector of Rocky Mountain Spotted Fever as well as Ehrlichia and STARI.
- This tick is the reported causative agent for the Alpha-gal or Mammalian Muscle allergy reaction that causes the affected to become allergic to eating non-primate mammalian meat.

The Gulf Coast Tick is slowly spreading towards Ohio. This tick is worrisome as it is able to vector the zoonotic disease, Leptospirosis, to multiple species.

The East Asian or Longhorned Tick, is an invasive tick that has been recently discovered in the United States, but not yet seen in Ohio. This tick has the potential to spread across a large host range and is unique in that it reproduces via parthenogenesis, meaning the female does not need a male to breed.
Prevention Strategies List – A Personal and Family Biosecurity Plan

- Wear light colored long sleeve clothing when entering tick habitat
- Make sure to wear permethrin treated clothing and use DEET as labelled for prevention.
- Do a thorough tick check after exiting tick habitat
- Familiarize yourself with the proper removal methods for embedded ticks.
- Save and submit any removed embedded ticks for testing to Tick Report
- Make sure to add companion animals to your personal biosecurity plan – Talk to your veterinarian about what products you can use.

Submission for Testing plus Links

- Ohio State fact sheet on ticks → https://ohioline.osu.edu/factsheet/HYG-2073
- https://tickencounter.org/— good resource for ID and biosecurity
- To submit your tick for testing → https://www.tickreport.com/
Fruit and Vegetable Crops

Photo Credit: Robert Nathan Garlington
New products:

- **PQZ**, with the active ingredient pyrifluquinazon, IRAC group 9B, the same group as Fulfill ( pymetrozine). Controls aphids, whiteflies, and leafhoppers. Allowed on Brassica head and stem vegetables (1-day PHI), cucurbits (1-day PHI), fruiting vegetables (1-day PHI), leaf petiole vegetables (1-day PHI), leafy vegetables (1-day PHI), tuber and corm vegetables (14-day PHI), pome fruit (14-day PHI), stone fruit (7-day PHI), grapes (3-day PHI). From Nichino America. Registered since August 2018.

- **Ethos-3D** contains bifenthrin (the same AI as in Brigade; IRAC group 3A) as the insecticidal component, and *Bacillus amyloliquefaciens* as the fungicidal component. For use on sweet corn for application at-planting for control of corn rootworm larvae, Asiatic garden beetle, wireworms, grubs, seedcorn maggot, cutworms, and armyworms. From FMC. Registered since 2018.

Products with registration expanded to additional crops or modified uses:

- **Harvanta 50SL** (cyclaniliprole, IRAC group 28). Now allowed on potatoes and tuber/corm veg and strawberries, for control of caterpillars, potato beetle, Japanese beetle. Since October 2019. From Summit Agro.

- **Closer SC** and **Transform WG** (sulfoxaflor, IRAC group 4C). Use on cucurbits and strawberries is allowed once again, after having been cancelled in 2016. Controls aphids, whiteflies, plant bugs, and suppresses thrips. Since July 2019. From Corteva.

- **Magister SC Miticide** (fenazaquin, IRAC group 21A, the same group that contains Nexter, Portal, Torac, Apta). Has been registered for use on cherries and hops, but since April 2019 is registered for use on cucurbits, fruiting vegetables, legumes, pome fruit, stone fruit, blueberries, caneberrys, strawberries, grapes. Controls spider mites and rust mites, and some insects (psyllids and whiteflies), as well as powdery mildew on some crops. Kills mite eggs by contact; kills mite adults and immatures by contact and ingestion. For fungicidal activity, it is in FRAC group 39. Highly toxic to bees, so care must be taken to not spray it on blooming crops or weeds. From Gowan Company.

- **Torac SC** (tolfenpyrad, in IRAC group 21A). Since March 2019, new crops on the new Torac label are onions and other bulb vegetables. Torac controls thrips, aphids, leafhoppers, flea beetles, and some caterpillars. From Nichino America.

- **Apta SC** (tolfenpyrad, in IRAC group 21A). Since February 2019, new crops on supplemental labels are strawberry and other low growing berries, raspberries and other canebberries, and blueberries and other bushberries. At the lower end of its rate range, Apta controls leafhoppers and aphids. At higher rates, it controls thrips, Lygus (tarnished plant bug), plum curculio, apple maggot, pear psylla, pear rust mite and other eriophyid mites, and leafrollers and some other caterpillars, and it suppresses spotted-wing Drosophila, codling moth, and stink bugs. From Nichino America.

- **Versys ‘Inscalis’ Insecticide; 0.83 DC** (dispersible concentrate) with the active ingredient afidopyropen; IRAC group 9D, and the only current member of that group. Versys is one of several products with the common name of ‘Inscalis’. For knockdown and residual control of aphids. On the initial label in October 2018, the target pests were only aphids, as controlled at a low rate of product. A newer label includes control of whiteflies at a higher rate of product. It is allowed on cabbage and other Brassica crops, celery and related crops, lettuces and other leafy crops, pome fruit and stone fruit. From BASF.

- **Exirel** (cyantraniliprole, in IRAC group 28) is now allowed on raspberries and other canebberries, as shown on a supplemental label from November 2018. Use on canebberries is with a 1-day pre-harvest interval, for control of spotted-wing Drosophila and adult root weevils. Exirel is now from FMC, not from DuPont.

- **Movento** (spirotetramat, IRAC group 23, same group as Envidor and Oberon) is allowed for use on blueberries, as specified on a supplemental label since June 2017. For control of aphids, thrips larvae, and gall midge, and suppression of blueberry maggot and leafhoppers. From Bayer.

Insect pests of recent concern:

- **spotted lanternfly**: not yet found in Ohio, but causing problems in eastern PA in grapes, hops, and tree fruit.
- **spotted wing drosophila**: on raspberries, blackberries, blueberries. Small worms in ripening fruit.
- **brown marmorated stink bug**: on peach, apple, raspberry, sweet corn, pepper, tomato.
- **western bean cutworm**: on sweet corn. Similar to corn earworm but with many worms per ear.
- **eastern flower thrips**: on strawberries and on high-tunnel peppers.
- **corn earworm (= tomato fruitworm)**: extra early and extra abundant in 2019; pyrethroids losing efficacy.

Summary of Vegetable & Fruit Insecticide Changes, 2015-2019 (not including pre-mixes)

**NEW REGISTRATIONS:**

- **sweet corn**
  - Ethos-3D (2018)
  - Fortenza (5/2017)
  - Agri-Mek SC (2017)

- **tomato, pepper, & eggplant**
  - Magister (4/2019)
  - PQZ (8/2018)
  - Sefina (10/2018)
  - Torac (5/2018)
  - Harvanta (9/2017)
  - Trident (11/2016)
  - Closer (5/2013; 10/2016)
  - Sivanto (1/2015)

- **cucurbits**
  - Closer (7/2019)
  - Transform (7/2019)
  - Magister (4/2019)
  - PQZ (8/2018)
  - Sefina (10/2018)
  - Torac (6/2018)
  - Harvanta (9/2017)
  - Sivanto (1/2015)

- **Brassica head, stem & leafy**
  - PQZ (8/2018)
  - Versys (10/2018)
  - Torac (5/2018)
  - Harvanta (9/2017)
  - Closer (5/2013; 10/2016)
  - Hero (10/2015)
  - Sivanto (1/2015)
  - FarMore FI400 (2016)

- **beans & peas**
  - Magister (4/2019)
  - Exirel (5/2017)
  - Verimark (5/2017)
  - Agri-Mek SC (2017)
  - Sivanto (1/2015)

- **beans only**
  - Transform (5/2013; 10/2016)

- **root veg (radish, beets, carrot)**
  - Exirel (5/2017)
  - Verimark (5/2017)
  - Transform (5/2013; 10/2016)
  - Sivanto (1/2015)

- **lettuces, endive, spinach, parsley (leafy veg.)**
  - PQZ (8/2018)
  - Versys (10/2018)
  - FarMore FI400 (2018)
  - Harvanta (9/2017)
  - Closer (5/2013; 10/2016)
  - Sivanto (1/2015)

- **celery**
  - PQZ (8/2018)
  - Versys (10/2018)

- **asparagus**
  - (none)

- **herbs &/or minte**
  - (none)

- **hops**
  - Magister (5/2017)

- **strawberries**
  - Harvanta (10/2019)
  - Closer (7/2019)
  - Transform (7/2019)
  - Magister (4/2019)
  - Apta (2/2019)
  - Exirel (5/2017)
  - Sivanto (1/2015)

- **blackberries /canesberries**
  - Apta (2/2019)
  - Exirel (11/2018)
  - Magister (4/2019)
  - Agri-Mek SC (2017)
  - Sivanto (9/2016)

- **potato**
  - Harvanta (10/2019)
  - PQZ (8/2018)
  - Torac (5/2018)
  - Trident (11/2016)
  - Exirel (5/2017)
  - Transform (5/2013; 10/2016)
  - Sivanto (1/2015)

- **blueberries**
  - Magister (4/2019)
  - Apta (2/2019)
  - Movento (6/2017)
  - Sivanto (1/2015)

- **grapes**
  - Magister (4/2019)
  - PQZ (8/2018)
  - Closer (5/2013; 10/2016)
  - Sivanto (1/2015)

- **peach, plum, & cherry**
  - PQZ (8/2018)
  - Versys (10/2018)
  - Agri-Mek (2017)
  - Closer (5/2013; 10/2016)
  - Sivanto (9/2016)

- **apples & pears**
  - Magister (4/2019)
  - PQZ (8/2018)
  - Apta (6/2018)
  - Versys (10/2018)
  - Closer (5/2013; 10/2016)
  - Sivanto (1/2015)

- **All crops**
  - BeetleGONE! ag (2016?)

**CANCELLATIONS:**

- **tomato, peppers, eggplant**
  - Belay (4/2017)

- **pome fruit, stone fruit, grape, strawberry, sweet corn**
  - Endosulfan, Thionex (7/31/2016)

- **Brassica, fruiting veg, leafy veg, legume veg, cucurbits**
  - Belt (8/2016)

- **pome fruit, stone fruit, grape**
  - Tourismos (8/2016)

- **strawberry (perennial)**
  - Endosulfan, Thionex (7/31/2016)

- **apple, blueberry, pepper, potato, pumpkin, sweet corn, tomato, winter squash**
  - Endosulfan, Thionex (7/31/2015)

- Celeste Welty, 11/8/2019
## Common Pests in Ohio Home Fruit Gardens

<table>
<thead>
<tr>
<th>Crop</th>
<th>Pest</th>
<th>Damaging stage</th>
<th>Part attacked</th>
<th>Non-chemical management</th>
<th>Insecticide options</th>
</tr>
</thead>
</table>
| grape, raspberry, blueberry, peach, & plum | Japanese beetle | adult | leaves, also fruit | netting to block access; trap-out away from plants | spray as soon as adult beetles invade area, usually in early July | O: azadirachtin  
   C: carbaryl, or pyrethrins+PBO |
| berries | spotted wing Drosophila | larva | fruit | fine netting | spray once per week as soon as fruit turning color | O: spinosad, Grandevo  
   C: permethrin or malathion |
| strawberry & peach | tarnished plant bug | adult & nymph | fruit | keep flowering weeds out | O: azadirachtin  
   C: spray permethrin or pyrethrins+PBO before and after bloom |
| strawberry | slugs | adult & juvenile | fruit | trapping with shingle traps | sprinkle bait under plants: | O: iron phosphate bait  
   C: metaldehyde bait |
| apple & pear | codling moth | larva | fruit | trap pupae in trunk bands; bag fruit | 2 sprays in May/June; 2 sprays in July/August | O: spinosad  
   C: acetamiprid or pyrethrins+PBO |
| apple | apple maggot | larva | fruit | trap-out with red sticky balls (1 ball per 100 fruit) | spray in July & August | O: spinosad  
   C: carbaryl or acetamiprid |
| peach | peachtree borer | larva | trunk at soil line | ‘worming’ (poke knife in trunk holes) in early spring | bark drench in early August | O: spinosad  
   C: permethrin |
| Oriental fruit moth | larva | fruit & twigs | prune wilting shoots in May | spray at petal-fall and biweekly in June, July, August | O: spinosad  
   C: permethrin |
| peach & apple | plum curculio | adult & larva | fruit | allow ducks or geese or pigs to forage below trees | spray several times starting at early petal-fall | O: kaolin  
   C: permethrin |
| San José scale | adult & nymph | bark, fruit | - | O & C: spray dilute horticultural oil before buds swell, in March |
| cherry | cherry fruit flies | larva | fruit | use baited yellow sticky traps | spray in early June: | O: spinosad  
   C: carbaryl or malathion |
<table>
<thead>
<tr>
<th>Crop</th>
<th>Pest name</th>
<th>Appearance</th>
<th>Damage</th>
<th>Non-chemical management tactics</th>
<th>Insecticide options</th>
</tr>
</thead>
<tbody>
<tr>
<td>asparagus melon &amp; squash</td>
<td>cucumber beetles</td>
<td>holes in leaves or fruit surface</td>
<td>row covers; plant late; early squash trap crop; remove by aspirator</td>
<td>O: Entrust + CideTrak-D, C: imidacloprid (soil drench at-plant); or spray permethrin, esfenvalerate, carbaryl, or pyrethrins+PBO</td>
<td></td>
</tr>
<tr>
<td>squash</td>
<td>squash vine borer</td>
<td>plant wilts from larva inside stem</td>
<td>row covers; plant late</td>
<td>C: pyrethrins+PBO or permethrin or esfenvalerate (weekly in June &amp; July)</td>
<td></td>
</tr>
<tr>
<td>squash</td>
<td>squash bug</td>
<td>leaves die from sap-sucking</td>
<td>hand pick; row covers; shingle traps; destroy crop remnants</td>
<td>O: spinosad (for nymphs) C: carbaryl (for nymphs); pyrethrins+PBO or esfenvalerate (for adults)</td>
<td></td>
</tr>
<tr>
<td>beans</td>
<td>bean leaf beetle</td>
<td>holes in pods &amp; leaves</td>
<td>row covers; remove by aspirator</td>
<td>O: azadirachtin (daily sprays) C: carbaryl, permethrin, or pyrethrins+PBO</td>
<td></td>
</tr>
<tr>
<td>potato</td>
<td>potato leafhopper</td>
<td>leaves turn brown along edges</td>
<td>row covers; remove by aspirator</td>
<td>C: pyrethrins+PBO or carbaryl</td>
<td></td>
</tr>
<tr>
<td>2-spotted spider mite</td>
<td>2-spotted spider mite</td>
<td>white stippling on leaves</td>
<td>encourage ladybugs &amp; other predators; hose off with water</td>
<td>O: soap or oil</td>
<td></td>
</tr>
<tr>
<td>broccoli, cabbage, kale, &amp; other cole crops</td>
<td>cabbage-worms</td>
<td>irregular holes in leaves</td>
<td>encourage parasitoids by flowering borders</td>
<td>O: B.t. or spinosad C: acetamiprid</td>
<td></td>
</tr>
<tr>
<td>flea beetles</td>
<td>flea beetles</td>
<td>small pits or holes in leaves</td>
<td>row covers; remove by aspirator</td>
<td>O: azadirachtin (daily sprays) C: imidacloprid (soil drench); or spray of carbaryl, pyrethrins+PBO, permethrin, or esfenvalerate</td>
<td></td>
</tr>
<tr>
<td>root maggots</td>
<td>root maggots</td>
<td>plant wilts from tunnels in roots</td>
<td>stem collar; adjust planting time</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>eggplant</td>
<td>eggplant flea beetle</td>
<td>many small round holes in leaves</td>
<td>row covers; remove by aspirator</td>
<td>O: azadirachtin (daily sprays) C: imidacloprid (soil drench), or spray carbaryl, pyrethrins+PBO, permethrin, or esfenvalerate</td>
<td></td>
</tr>
<tr>
<td>tomato</td>
<td>potato aphid</td>
<td>young leaves wilt due to sap-sucking</td>
<td>encourage ladybugs, lacewings, and other predators</td>
<td>O: soap, oil C: pyrethrins+PBO, acetamiprid</td>
<td></td>
</tr>
<tr>
<td>whitefly</td>
<td>whitefly</td>
<td>leaves wilt due to sap-sucking</td>
<td>trap with sticky yellow cards</td>
<td>O: soap C: pyrethrins+PBO</td>
<td></td>
</tr>
<tr>
<td>potato, tomato, eggplant</td>
<td>Colorado potato beetle</td>
<td>irregular holes in leaves</td>
<td>hand pick; plant early or late, not both</td>
<td>O: spinosad (for larvae) C: permethrin or esfenvalerate (for adults)</td>
<td></td>
</tr>
<tr>
<td>spinach</td>
<td>spinach leafminer</td>
<td>blotsches in leaves</td>
<td>row covers; hand pick first infested leaves and destroy</td>
<td>O: spinosad C: permethrin, pyrethrins+PBO</td>
<td></td>
</tr>
<tr>
<td>lettuce</td>
<td>aphids</td>
<td>leaves wilt from sap-sucking</td>
<td>encourage ladybugs, lacewings, and other predators</td>
<td>O: soap C: pyrethrins+PBO</td>
<td></td>
</tr>
<tr>
<td>onion</td>
<td>onion thrips</td>
<td>pale streaks in leaves</td>
<td>hose off with water</td>
<td>O: lambda-cyhalothrin</td>
<td></td>
</tr>
<tr>
<td>asparagus</td>
<td>asparagus beetle</td>
<td>distorted shoots</td>
<td>hand pick</td>
<td>C: pyrethrins+PBO, carbaryl, or permethrin</td>
<td></td>
</tr>
<tr>
<td>sweet corn</td>
<td>European corn borer</td>
<td>chewed kernels in corn ears (also in pepper fruit)</td>
<td>avoid very early planting</td>
<td>O: B.t., spinosad C: permethrin (once per week during silking in June &amp; August)</td>
<td></td>
</tr>
<tr>
<td>corn earworm</td>
<td>corn earworm</td>
<td>chewed kernels in corn ears (also in tomato fruit)</td>
<td>avoid late planting</td>
<td>O: inject corn oil + B.t. (20:1) in ear tip at full silk; or spray silk with spinosad C: spray silk with esfenvalerate</td>
<td></td>
</tr>
</tbody>
</table>

-Celeste Welty, Extension Entomologist, The Ohio State University, September 2006, revised March 2013, June 2017.
Managing Powdery Mildew on Cucurbits
Sally Miller
Department of Plant Pathology, The Ohio State University
miller.769@osu.edu  @OhioVeggieDoc

Powdery mildew arrived in much of Ohio in late July in 2018 on squash, pumpkins and other cucurbits throughout Ohio. The fungus that causes cucurbit powdery mildew does not overwinter in Ohio, so the disease does not appear until spores arrive on wind currents from warmer growing areas. This fungus is an unusual plant pathogen in that it is inhibited by free water - so frequent rains may delay powdery mildew’s appearance, at least to a notable level. Signs of infection are small circular powdery growths (mycelium and spores of the pathogen) on either side of the leaf. These spots enlarge and can eventually cover most of the leaf surface and kill the leaves. Stems and leaf petioles are also susceptible, but the disease is not observed on fruit. In pumpkins, powdery mildew may also attack the “handles”, which can be further damaged by secondary pathogens.

Our evaluations of efficacy of powdery mildew fungicides at three locations (Wooster, Columbus, South Charleston) in Ohio in 2017 indicated that Procure, Quintec, and Rally consistently provided very good control of powdery mildew on pumpkins in all three locations (see table). Approvia Top and Inspire Super were very good in two locations but fair in a third; and Merivon Xemium, Fontelis and Torino were very good in one location and fair in two. Both Bravo and Pristine performed poorly in all three locations.

Organic Options for Cucurbit Powdery Mildew Management

Powdery mildew is a scourge of summer for squash, pumpkins, and other cucurbits. Organic growers should always start with varieties with some degree of resistance to powdery mildew – seed catalogues often call partial resistance “tolerance”. Although resistance will generally not be complete, efforts to manage powdery mildew with organic-acceptable products will be more productive if growers start with a variety that can put up a fight on its own than one that is highly susceptible.

Dr. Meg McGrath, Cornell University, has summarized field research results throughout the US for organic-approved products tested against various diseases of vegetables and herbs. Her summary for zucchini powdery mildew research in NY includes the following:
Best results are obtained when these products are used preventatively or at the very first signs of powdery mildew, usually in mid-July in Ohio. If you wait until powdery mildew has progressed to the stage you see in the photo above, it will probably be too late to get it under control.

**Managing Phytophthora Blight in Peppers**

Heavy rains and periods of high temperatures likely contributed to an early appearance of Phytophthora blight in 2018. Both peppers and cucurbits are susceptible to Phytophthora blight; typical symptoms are shown in OSU Vegetable Disease Facts. Phytophthora is a water mold that thrives under conditions of high moisture and high temperature. It produces motile spores (zoospores) that are attracted to plants, then form a structure that allows them to infect, and aggressively attack any type of plant tissue. Zoospores can be splashed onto leaves, stems and fruits during rain events and overhead irrigation. Phytophthora blight is often seen first in low spots or other poorly drained areas of production fields, but the disease also occurs on well-drained, even sandy soils if the environmental conditions are right. An integrated, preventative program to manage Phytophthora blight is more effective than in-season rescue treatments with fungicides. During the growing season, fungicide application is the main option for management of Phytophthora blight (see below). In small plantings prompt removal of diseased plants is also recommended.

Effective management of Phytophthora blight in peppers requires an integrated approach:

- **Crop rotation.** Phytophthora produces structures called oospores that can survive for a number of years in the soil. Plan to rotate out of peppers, cucurbits or green beans for 4-5 years if Phytophthora blight has been a problem.

- **Resistant varieties.** A few pepper varieties are resistant to the root rot phase of the disease. In general, these varieties are susceptible to the crown rot phase, which affects foliage and fruits. Varieties with moderate to good resistance to Phytophthora blight are: Paladin, Aristotle, Declaration, Intruder, Vanguard (bell); Hechicero (jalapeño); and Sequoia (ancho).

- **Well-drained soil.** Avoiding standing water is critical to limiting the movement of Phytophthora from plant to plant.

- **Avoid surface water for irrigation.** We have found Phytophthora in irrigation ditches and ponds as early as late June in vegetable production-intensive areas in Ohio. Using surface water for irrigation is risky, especially if Phytophthora is present in fields near surface water sources.

- **Plant on raised beds.** Prepared properly, raised beds will help prevent standing water near pepper plants. If possible beds should be domed, and there should be no depressions in the soil surrounding the plants.

- **Sanitation.** Phytophthora can be moved from an infested field to a clean one on soil clinging to boots, equipment, etc. Power washing to remove soil is a good first step, followed by rinsing with a sanitizer. Do not build cull piles containing discarded peppers or cucurbits - plant material needs to be disposed of, preferably by burying, far from fields and surface waters.

- **Fungicides.** There are a number of fungicides labeled for use on peppers to manage Phytophthora blight (see table below). The newest product, Orondis, has very good efficacy against this disease. It is available as

<table>
<thead>
<tr>
<th>Product</th>
<th>Effectiveness</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur</td>
<td>Most effective</td>
<td>NY 2016; preventative</td>
</tr>
<tr>
<td>MilStop 2.5 lb/A</td>
<td>very effective</td>
<td>NY, 2011-12; best in 2 yrs.</td>
</tr>
<tr>
<td>MilStop 2.5 lb/A</td>
<td>effective</td>
<td>NY, 2016; preventative</td>
</tr>
<tr>
<td>Regalia 1 gal/A</td>
<td>effective</td>
<td>NY, 2016; preventative</td>
</tr>
<tr>
<td>Actinovate 12 oz/A</td>
<td>moderately effective</td>
<td>NY, 2016; preventative</td>
</tr>
<tr>
<td>Regalia + Actinovate</td>
<td>effective</td>
<td>NY, 2016; preventative</td>
</tr>
<tr>
<td>M-Pede 2%</td>
<td>very effective</td>
<td>NY, 2011</td>
</tr>
<tr>
<td>Sonata 4 qt/A</td>
<td>very effective</td>
<td>NY, 2011</td>
</tr>
<tr>
<td>OxiDate 128 oz/A</td>
<td>moderately effective</td>
<td>NY, 2011-12, 2016, w/ w/out Yucca Ag Aide</td>
</tr>
<tr>
<td>Serenade Max 3 lb/A</td>
<td>moderately effective</td>
<td>NY, 2011</td>
</tr>
<tr>
<td>Sporac 3 pt/A</td>
<td>moderately effective</td>
<td>NY, 2011</td>
</tr>
<tr>
<td>Double Nickel 2 qt/A</td>
<td>moderately effective</td>
<td>NY, 2016; preventative</td>
</tr>
</tbody>
</table>

Pesticide Safety Education Program, Ohio State University Extension
a pre-mix with either Revus (Orondis Ultra), Ridomil (Orondis Gold) or Bravo (Orondis Opti). There are many restrictions on the use of Orondis - including the number of applications (no more than 1/3 of total applications for Phytophthora blight) and when it can be applied (to the soil or to the foliage but not both). Orondis Ultra and Orondis Gold can be applied in transplant water or through the drip, although Orondis does not move much in soil and emitters need to be right next to the plant. If the pepper variety is susceptible to Phytophthora blight, it may be a good idea to apply Orondis Gold or Orondis Ultra at planting, and follow up later with a program containing at least two other fungicides with activity against Phytophthora (see table). If the pepper variety is resistant to Phytophthora, any of the three Orondis products can be used in a foliar fungicide program that includes other effective fungicides. The Bravo component of Orondis Opti will not help with Phytophthora blight, but will control anthracnose. Orondis Gold is considerably more expensive than Orondis Ultra and Orondis Opti, and resistance in Phytophthora to the Ridomil component of Orondis Gold has been found in numerous locations.

For in-season control where an at-plant application of one of the Orondis products has not been made, foliar applications can be very effective if undertaken preventatively. Results of our research in 2016/2017 on squash indicated that foliar applications of Orondis Ultra could be alternated with Presidio, Ranman or Tanos + Kocide with equivalent results.

<table>
<thead>
<tr>
<th>Product</th>
<th>PHI (days)</th>
<th>FRAC Code</th>
<th>Rel. Eff.</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orondis</td>
<td>0</td>
<td>U15</td>
<td>++++</td>
<td>NEW – most effective against Phytophthora blight</td>
</tr>
<tr>
<td>Ranman 400SC</td>
<td>0</td>
<td>21</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>Forum 4.18SC</td>
<td>0</td>
<td>40</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>Tanos 50WG</td>
<td>3</td>
<td>11 + 27</td>
<td>+++</td>
<td>Foliar/fruit phase only</td>
</tr>
<tr>
<td>Gavel 75DF</td>
<td>5</td>
<td>22 + M3</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>Zing!</td>
<td>0</td>
<td>22 + M5</td>
<td>+++</td>
<td>Efficacy data not available</td>
</tr>
<tr>
<td>Presidio 4SC</td>
<td>2</td>
<td>43</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>Revus</td>
<td>1</td>
<td>40</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>Ridomil Gold SL</td>
<td>7</td>
<td>4</td>
<td>+++</td>
<td>Insensitivity to Ridomil occurs in some locations</td>
</tr>
<tr>
<td>Zampro</td>
<td>0</td>
<td>40 + 45</td>
<td>+++</td>
<td></td>
</tr>
</tbody>
</table>
Hop Downy Mildew

Melanie L. Lewis Ivey, Assistant Professor, Department of Plant Pathology, The Ohio State University-Ohio Agricultural Research and Development Center, Wooster, OH.

Sally A. Miller, Professor, Department of Plant Pathology, The Ohio State University-Ohio Agricultural Research and Development Center, Wooster, OH.

Downy mildew is the most widespread and destructive disease of hops (Humulus lupulus) in the Midwest and Northeastern United States. Downy mildew is caused by the fungal-like pathogen Pseudoperonospora humuli and is most severe during wet weather and mild temperatures. The disease is systemic and can cause significant yield and quality losses annually.

Disease Development and Symptoms
The downy mildew pathogen survives the winter in dormant buds, crowns or plant debris in the soil and can move systemically into the basal spikes in the spring. Diseased spikes are stunted, pale green and brittle (Figure 1). On the upper side of the leaves angular chlorotic (yellow) spots (Figure 2A) form and these spots eventually turn brown and have a crusty appearance. Dark purple to black colored spores (sporangia) are produced on the underside of leaves (Figure 2B and 2C) during wet or foggy weather and when temperatures are between 60-70 °F. Spores are wind dispersed and can initiate new infections on new leaves, aerial spikes (Figure 2D), flowers, and cones. On the upper side of the leaves angular chlorotic (yellow) spots form and these spots eventually turn brown and have a crusty appearance. Infected flower clusters shrivel, turn brown and dry out. Cones begin to turn brownish grey at the base of the bracteoles.

Hop Downy Mildew Management
Hop downy mildew is best managed by integrating resistant varieties, cultural practices, and chemical control.

Variety selection
Selecting cultivars that are highly or moderately resistant to downy mildew is the ideal method for controlling hops downy mildew. Backyard and organic growers are strongly encouraged to plant resistant cultivars in order to reduce or eliminate the need for fungicide applications. There are many public hop cultivars that are resistant or moderately resistant to downy mildew (Table 1). However, some of the more popular cultivars grown in the Midwest including ‘Cascade’, ‘Chinook’, ‘Nugget’, and ‘Galena’ are susceptible to downy mildew. Purchase rhizomes or starter plants from a reputable propagator or nursery that uses best propagation, sanitation and other integrated disease management strategies.
Cultural practices
In the spring, basal foliage should be cut off of the crown, removed from the hop yard and destroyed. Basal tissue can also be burned back before training to kill infected spikes and reduce the spread of spores. Bines should be trained early to prevent them from coming into contact with the soil and diseased aerial spikes should be removed and destroyed. Remove lower leaves (up to 4 ft), suckers and weeds beginning in early spring and continuing throughout the season to promote air movement through the canopy and reduce humidity within the canopy. If cones were not harvested (i.e. first year hops), bines and leaves should be removed and destroyed after a hard frost. Composting diseased plant tissue is not recommended unless proper composting techniques are used.

Chemical and biological control
The season long application of fungicides is the primary method to manage hop downy mildew in susceptible and some moderately resistant cultivars. Begin applications as soon as basal foliage appears in the spring and continue on a 7-to 10-day schedule throughout the season. The time between applications can be extended to 14 days when the weather is hot and dry, however the time between applications should not extend past 14 days. Critical periods in the season for managing downy mildew include immediately before and after training and burr and cone development. Post-harvest fungicide applications may also be needed, especially if warm and wet weather persists into the fall.

Commercial growers can consult the Ohio Hop Disease Management Guide (Plant Pathology Series No. 155) for current fungicide recommendations and spray schedules. Backyard and organic growers have few options for controlling downy mildew using fungicides or biocontrol products. Copper-based products can be applied early in the season to prevent infections but are not effective once infections occur. Additional organic products including Actinovate AG, Regalia (extract of Reynoutria sachalinensis) and Sonata are labeled for use on hops but the efficacy of these products in Ohio is not known.

Table 1. Cultivars with resistance to downy mildew.

<table>
<thead>
<tr>
<th>Resistance</th>
<th>Hall Gold, Hall Magnum, Hall Tradition, New Port, Perle, Spalter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate resistance</td>
<td>Columbia, Fuggle, Sterling, Teamaker, U.S. Tettnanger, Wilamette</td>
</tr>
<tr>
<td>Low resistance</td>
<td>Olympic, Saazar, Saazar 36</td>
</tr>
</tbody>
</table>

Figure 2. Downy mildew symptoms. Angular yellow spots on the upper side of a leaf (A), dark purple colored spores on the underside of a leaf (B), close up of spores (C) and aerial spike with downy mildew (D).
Nursery and Forest Crops
“Key” Pests?

In Landscapes:
Cause death
Major aesthetic damage

In Nurseries & Christmas Trees
Cause death
Major aesthetic damage
Cause a quarantine!!

“Key” Pests of Trees & Shrubs

- Quarantine pests – gypsy moth, Japanese beetle grubs, hemlock woolly adelgid, thousand cankers (walnut bark beetle)
- Asian ambrosia beetles
- Scales (both traditional and new ones – Japanese maple scale)
- Some old friends! – Black vine weevil, white pine weevil, clearwing borers, flatheaded borer.

Key Borers

Beetles
Ambrosia/bark beetles
Flatheaded borers
Agrilus Borers
White Pine Weevil

Clearwings (moths)
Dogwood Borer
Peachtree Borer

“Key” Pests?

Cause death?
Borers!
Conifer defoliators!
Scales?

Major aesthetic damage?
Defoliators
Honeydew producers

Cause a quarantine?
Up to the inspector!
Ambrosia Beetle Issues

- Over 20 Asian species discovered since 1990 (many are now in Ohio)!
- Asian species attack young plant stock, often killing them!
- Curative insecticides don’t work!
- Most damage occurs when adults become active but plant buds haven’t broken!

Ambrosia Beetle Monitoring

- Use alcohol traps (ethanol only!).
- Set out EARLY, before bud break!

Flatheaded Appletree Borer

- Wide range of hardwood trees
- Prefers grafted trees!
- Most successful in stressed trees, and recent transplants.

Common Ohio Agrilus Borers

- Bronzed birch borer
- Honeylocust borer
- Twolined chestnut borer
- Emerald ash borer
Bronze birch borer females tend to lay their eggs in bark fissures or under flaps of bark. Therefore, if a preventive insecticide is used, thorough coverage is essential for success.

White pine weevil adult laying eggs. White pine weevil larva burrowing down leader. Leader killed by white pine weevils.

Clearwing Borers (Sesiidae)
This group is commonly listed as the Aegeriidae

Lesser peachtree borer adult.

Ash/lilac borer larva in lilac branch.

Maple callus borer adult.

Peachtree borer larva in sand plum.

Borer Nursery Insecticides

Traditional
- Chlorpyrifos
- Carbaryl (bark beetle prevention)
- Pyrethroids
  - Onyx pro
- Dimethoate
- Diflubenzuron
- Endosulfan

Alternatives
- Imidacloprid (beetles only)
- Thiamethoxam?
- Dinotefuran (beetles & some leps)

Conifer defoliators can kill conifer branches and trees!

Bagworm

Bagworms attack over 100 species of plants, most of which are deciduous!

Pesticide Systemicity

- Translaminar
- Translocated
  - Basipetal
  - Acropetal

Warnings on current imidacloprid label!

APPLICATION RESTRICTIONS

PROTECTION OF POLLINATORS

Look for the bee icon in the Directions box for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.

This product is not for sale to or use by beekeepers, their helpers or sole proprietors.

See the Directions for use for specific use restrictions and instructions to protect bees and other insect pollinators.

If you find a pollinator icon, take the following actions:
1. Do not apply this product to any plant in flower.
2. Do not apply this product to any plant that is blooming.

SEE INSTRUCTIONS FOR USE, UNDER THE SPECIFIC SITE, FOR OUTDOOR FOLIAR APPLICATIONS. FOLLOW THESE APPLICATION DIRECTIONS.

RESTRICTIONS:
- Follow application restrictions for Non-Agricultural Uses on page 1 to protect bees and other insect pollinators.
- Do not apply more than 0.33 oz (0.4 lbs of active ingredient) per acre per year.
- Keep children and pets off treated areas until dry.
- Do not apply this product, by any application method, to honeybees, bees, or any other pollinating insects or pollinator habitat.
Calico scale adults on honeylocust (can be found on many deciduous landscape trees).

Calico scale nymphs on leaf undersurface.

Pine needle scale females. Note pinkish eggs at end of scale test (shell) and a settled crawler at upper left.

Group of pine needle scale settled crawlers (tan) and a couple of fresh crawlers (pinkish) in color.

Oystershell Scales

Looks like small oystershell scale except more white and with pointed test.

Infests maple, Kousa dogwood, holly, privet, crabapple, pear, cotoneaster.

Scale Nursery Insecticides

Traditional
- Acephate
- Chlorpyrifos
- Carbaryl
- Pyrethroids
- Dimethoate

Alternatives
- Imidacloprid, Thiamethoxam (soft scales)
- Dinotefuran (armored and soft scales)
- Flonicamid
- Soaps & Oils

Be Mindful of Interstate Pests! (and harmonization programs)

Gypsy moth & egg masses

Japanese Maple Scale

Looks like small oystershell scale except more white and with pointed test.

Infests maple, Kousa dogwood, holly, privet, crabapple, pear, cotoneaster.

Let's help the bees!

- Watch for Bee Warning Logo on labels!
- Avoid using neonics a month before attractive plants may bloom!
- Generally, not an issue on conifers and other specific plants (i.e., oaks, honeylocust trees).
- Encourage wildflower growth on unused lands.
- Review ODA maps of bee keeper locations and notify bee keepers when using pesticides known to have bee hazards.

Being Bee Friendly!

Be Mindful of Interstate Pests! (and harmonization programs)
Boxwood Blight

Gail Ruhl
Tom Creswell
Janna Beckerman

Purdue Botany and Plant Pathology — ag.purdue.edu/BTNY

Introduction
Boxwood blight is a fungal disease caused by Calonectria pseudonaviculata (previously called Cylindrocladium pseudonaviculatum or Cylindrocladium buxicola).

This fungus is easily transported in the nursery industry and can be moved on infected plants that do not show any symptoms at the time of shipment as well as on shoots of infected boxwood greenery tucked into evergreen Christmas wreaths. Boxwood blight has become a serious threat to nursery production and to boxwoods in the landscape, which has prompted several states to take regulatory action.

This publication provides information about boxwood blight and management options.

Disease Distribution
Boxwood blight was first reported in the United Kingdom in the mid 1990s. It is now widespread throughout most of Europe and in the Republic of Georgia. The pathogen was also discovered in New Zealand in 1998.

Boxwood blight was confirmed for the first time in North America in October 2011 on samples collected in North Carolina and Connecticut. Since this first U.S. detection, boxwood blight has been reported in more than 20 states and three Canadian provinces. Boxwood blight has not been detected in Indiana landscapes or nurseries.

Symptoms and Signs
The fungus that causes boxwood blight can infect all aboveground portions of the shrub. Symptoms begin as dark leaf spots that coalesce to form brown blotches (Figure 1). The undersides of infected leaves will show white sporulation of the boxwood blight fungus.
Boxwood Blight

following periods of high humidity (Figure 2). Boxwood blight causes rapid defoliation, which usually starts on the lower branches and moves upward in the canopy (Figure 3).

A key symptom that differentiates boxwood blight from other boxwood diseases is that narrow black streaks (cankers) develop on green stems (Figure 4). During periods of high humidity, white, fuzzy masses that consist of numerous clumps of spores will emerge from these black stem cankers (Figure 5). The spores can be observed on infected stems and leaves with a hand lens. The pathogen does not attack roots, but repeated defoliation and dieback from stem cankers can kill young plants in nurseries. Larger plants lose ornamental value as defoliation becomes severe (Figure 6).

Transmission and Disease Cycle

The fungus that causes boxwood blight can overwinter on infected plants and in infected leaf litter. The spores produced on infected leaves and stems during the growing season can be splash-dispersed through irrigation or rainfall. This can spread the disease within a plant or to nearby boxwood shrubs.

The disease can also be spread greater distances. This primarily involves moving infected plants through nursery trade and using contaminated tools and transport vehicles that contain fallen, infected leaves.

Hosts

Hosts of the fungus include plants in the Buxaceae family — including species in the genera Buxus, Pachysandra (Japanese spurge), and Sarcococca (sweetbox). American, English, and Korean boxwoods are all susceptible, although there have been reports of varying disease severity among cultivars (Ganci 2013; Shishkoff 2014).

Table 1 on page 3 shows the relative susceptibility of several boxwood cultivars to the boxwood blight fungus.

Disease Management

The best way to manage boxwood blight is to avoid introducing the disease into the nursery or landscape. There are a number of best management practices that have been developed for the nursery and landscape industry.
Boxwood Blight

Here are some best management practices to help prevent introducing the boxwood blight fungus:

- **Purchase boxwood plants from reputable nurseries that participate in a boxwood blight compliance agreement.** Ideally, plants should be separated from existing nursery stock and not sprayed with fungicides for one month before installation to watch for any typical symptom development. Be sure to also include pachysandra and sweetbox in your scouting program.

- **Do not shear boxwoods when they are wet to reduce the chance of spreading disease.** Clean and disinfect shearing tools (used on an infected planting) with bleach, ethanol, Lysol, or quaternary ammonia before moving to a new area.

- **Collect and remove debris from pruning or shearing operations that involve infected plants; do not compost debris close to boxwood plants.**

- **Avoid introducing new boxwood plants to landscapes that already have large, historically important boxwoods.**

Once the disease is detected, sanitation is critical for management. Remove and bag any diseased plants and fallen leaves and dispose them in municipal waste or bury them. Where permitted, you may burn infected plants.

Do not compost infected plants or plant debris. It is important to realize that the fungus that causes this disease can persist in the soil for five years or more, which means any replacement boxwood planted in the same site is likely to become infected.

Fungicides are effective at protecting plants from boxwood blight infection, but do not cure plants with the disease. The goal of successful chemical applications is to prevent disease. You should apply fungicides when temperatures exceed 60°F and rainfall is expected.

For professional applicators in Indiana, effective products include a rotation of Daconil® (chlorothalonil) or Medallion® (fludioxonil). Other fungicides include Heritage® (azoxystrobin), Pageant® (pyraclostrobin and boscalid), Compass® (trifloxystrobin), Torque® (tebuconazole), and Cleary’s 3336® (thiophanate-methyl). You will need to apply fungicides every seven to 14 days to protect susceptible boxwood. More resistant varieties require fewer applications.

An accurate diagnosis is very important in managing this disease. If you suspect boxwood blight, send samples of the suspected plant to the Purdue Plant and Pest Diagnostic Laboratory (PPDL) for diagnosis. Nursery growers who suspect the disease is present should also contact an Indiana Department of Natural Resources Division of Entomology and Plant Pathology nursery inspector at 1-866-NOEXOTIC.

To submit a sample to the PPDL, wrap symptomatic leaves and stems in dry newspaper and seal them in two layers of plastic bags. Submission information can be found at ppdl.purdue.edu.

Table 1. Relative susceptibility of several boxwood cultivars to the boxwood blight fungus.

| Highly Susceptible | B. sempervirens ‘Suffruticosa’  
|                    | B. sinica var. insularis ‘Justin Brouwers’  
| Susceptible        | B. microphylla var. japonica ‘Morris Dwarf’  
|                    | B. microphylla var. japonica ‘Morris Midget’  
|                    | B. sempervirens ‘Jensen’  
|                    | B. sempervirens ‘Marginata’  
|                    | Buxus X ‘Glencoe’ (Chicagoland Green)  
|                    | B. sempervirens ‘American’  
|                    | B. sempervirens ‘Elegantissima’  
| Moderately Susceptible | Buxus X ‘Green Mound’  
|                      | Buxus X ‘Conroe’ (Gordo)  
|                      | B. microphylla ‘Green Pillow’  
|                      | B. microphylla ‘Grace Hendrick Phillips’  
|                      | B. microphylla ‘Jim Stauffer’  
|                      | Buxus X ‘Green Mountain’  
| Moderately Resistant | B. microphylla ‘Winter Gem’  
|                     | B. sempervirens ‘Dee Runk’  
|                     | B. sempervirens ‘Fastigiata’  
|                     | Buxus ‘Green Gem’  
|                     | B. microphylla ‘John Baldwin’  
| Most Resistant (recommended for new plantings) | B. microphylla ‘Golden Dream’  
|                        | B. harlandii  
|                        | B. sinica var. insularis ‘Nana’  
|                        | B. microphylla var. japonica ‘Green Beauty’  

Table compiled from research by Ganci, Benson, and Ivars, North Carolina State University, 2012. The most recent cultivar trial results are available at plantpathology.ces.ncsu.edu/pp-ornamentals.
Boxwood Blight

Find Out More
These websites provide additional information about boxwood blight.

Virginia Boxwood Blight Task Force
ext.vt.edu/agriculture/commercial-horticulture/boxwood-blight.html

Horticultural Research Institute
hireresearch.org/HRI/Research_Results/Outside_The_Boxwood.aspx

Connecticut Agricultural Experiment Station
www.ct.gov/caes/cwp/view.asp?a=3756&q=500388

References


Suggested best management practices (BMP’s) for boxwood blight Version 2.0 Revised September 2017. hortknowledgecenter.org/getattachment/7068c31f-fee0-4541-bf4a-ac89350be97b/BoxwoodBlightBMPs2017.pdf?lang=en-US.

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Relative Effectiveness of Herbicides Commonly Used to Control Woody Vegetation in Forest Stands

Randall B. Heiligmann, School of Natural Resources, The Ohio State University
Dave Krause, Arborchem Products Company

Forest stand improvement is the selective removal or deadening of less desirable trees, shrubs, and vines in a forest stand to improve the stand’s species composition, age structure, condition, health, and growth. It is an important forest management practice to help woodland owners and forest managers achieve management objectives. Deadening is most often the method of choice when the removal of the less desirable trees, shrubs, and vines is not economically feasible. The most commonly used methods of deadening undesirable trees, shrubs, and vines are girdling, frilling, herbicide injection, basal herbicide spraying, and cut stump herbicide application. These techniques are described in a variety of publications, including Ohio State University Extension (OSUE) Fact Sheet F-45.

Several of these techniques require the use of an herbicide while with others the use of an herbicide is optional. When use of an herbicide is desired, the selection of a specific herbicide is usually based on a number of considerations. The first consideration is the technique being utilized. Herbicides are labeled for specific uses. An herbicide may, for example, be labeled for girdling or injection but not for basal spraying. It is important that herbicides be used only for their labeled purposes. This information is clearly stated on the herbicide label and is summarized in OSUE Fact Sheet F-45 for many of the more commonly used herbicides.

Other important considerations when selecting an herbicide include ease of use, relative availability, worker exposure, environmental safety, personal experience, and the relative effectiveness of the herbicide in controlling the target plant species. While the relative importance of these considerations may vary with the situation and the individual, it is always important to select an herbicide that will effectively control the target species.

Unfortunately, there are few published evaluations of the effectiveness of herbicides in deadening specific species of woody plant. Too often woodland owners and forest managers select an herbicide because it is readily available or is the least expensive, only to be disappointed later when control is unacceptable. Certainly cost and availability are important considerations. However, it is important to select an herbicide that will be effective, even if it is not the least expensive.

This publication contains two tables that provide estimates of the relative effectiveness of several commonly used herbicides in controlling specific woody species. The evaluations were developed from several sources, including personal experience, manufacturers’ recommendations, and several publications.

The evaluations are not absolutes; many factors other than species determine how effective a particular herbicide is in controlling a particular plant (e.g., the health and vigor of the plant, the amount and concentration of herbicide used, the method and season of application, etc.). The evaluations can, however, provide important guidance when personal experience with a particular plant species and/or herbicide is lacking.

Table 1 should be used as a guide to the relative effectiveness of all of the listed herbicides when frilling or girdling (or injecting, if so labeled). It can also be used as a guide to the effectiveness of the water-soluble herbicides in the table (all but 2,4-D + 2,4-DP) in preventing sprouting when applied to a stump immediately after cutting. Table 2 should be used as a guide to the relative effectiveness of the oil soluble herbicides listed when applied as basal sprays or as cut stump treatments to prevent sprouting.

In both tables relative control is categorized as susceptible (S), intermediate (I), and resistant (R), or occasionally borderline between two categories (e.g., S-I). A ranking of Susceptible means that the particular species is usually susceptible to the herbicide, and little if any retreatment should be necessary. A ranking of Intermediate means that while not usually as effective as an herbicide ranked S, the herbicide will kill a high proportion of the
treated stems. When an herbicide ranked I is used, a portion of the stems may require retreatment. A ranking of Resistant means that the herbicide will usually provide relatively poor control of that particular species. Where no estimate is provided (a blank in the table), no evaluation is implied. The blank simply means we do not have enough information or experience to provide a reasonable estimate of control.

When using an herbicide the importance of careful, proper application according to label directions cannot be over stressed. Not only will this minimize personal and environmental risks, but it will maximize herbicide effectiveness. In particular, the care and skill with which herbicides classified as I or S-I are applied can dramatically impact their effectiveness.


Table 1. Relative effectiveness in controlling woody vegetation of selected herbicides injected or applied to a frill or girdle according to label recommendations. Also the relative effectiveness of all of the water soluble herbicides in the table (all except 2,3-D + 2,4-D) when applied to stumps immediately after cutting to prevent sprouting. Note that specific example products may be labeled for only some of the listed applications. Be sure to check the label of the individual product to verify that it is labeled for your intended use.

S=Susceptible, I=Intermediate, R=Resistant

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>TRICLOPYR (e.g., Garlon 3A)</th>
<th>PICLORAM (e.g., Tordon &amp; Pathway)</th>
<th>IMAZAPYR (e.g., Chopper, Stalker, &amp; Arsenal)</th>
<th>2,4-D + 2,4-DP (e.g., Patron 170)</th>
<th>GLYPHOSATE (Accord, Roundup Rodeo, Glyphos, Glypro, &amp; Glyphomax Herbicides, and many others)</th>
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Table 1 (continued). Relative effectiveness of selected herbicides.

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<td>S</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Sycamore</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Tree of Heaven</td>
<td>S</td>
<td>S-I</td>
<td>S</td>
<td>R</td>
<td>I</td>
</tr>
<tr>
<td>Trumpet creeper</td>
<td>R</td>
<td>I-S</td>
<td>S</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Virginia Creeper</td>
<td>I</td>
<td>S-I</td>
<td>S</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Walnut, Black</td>
<td>S</td>
<td>S</td>
<td>S-I</td>
<td>S-I</td>
<td>S-I</td>
</tr>
<tr>
<td>Willow</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>I</td>
<td>I</td>
</tr>
</tbody>
</table>

Table 2. Relative effectiveness in controlling woody vegetation of selected oil-soluble herbicides applied as a basal spray or cut stump treatment according to label recommendations.¹

S=Susceptible, I=Intermediate, R=Resistant

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>TRICLOPYR (e.g., Garlon 3A)</th>
<th>IMAZAPYR (e.g., Chopper, Stalker, &amp; Arsenal)</th>
<th>2,4-D + 2,4-DP (e.g., Patron 170)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alder</td>
<td>S</td>
<td>S</td>
<td>I-R</td>
</tr>
<tr>
<td>Ash, White</td>
<td>S</td>
<td>S</td>
<td>R</td>
</tr>
<tr>
<td>Aspen</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>Balsam Poplar</td>
<td>S</td>
<td>S</td>
<td>S-1</td>
</tr>
<tr>
<td>Beech, American</td>
<td>S-I</td>
<td>I-S</td>
<td>S-I</td>
</tr>
</tbody>
</table>
Pest Alert

Spotted Lanternfly (Lycorma delicatula)

The spotted lanternfly is an invasive pest, primarily known to affect tree of heaven (Ailanthus altissima). It has been detected on many host plants, including apples, plums, cherries, peaches, nectarines, apricots, almonds, and pine. It also feeds on oak, walnut, poplar, and grapes. The insect will change hosts as it goes through its developmental stages. Nymphs feed on a wide range of plant species, while adults prefer to feed and lay eggs on tree of heaven (A. altissima).¹ If allowed to spread in the United States, this pest could seriously harm the country’s grape, orchard, and logging industries.

Distribution and Spread

The spotted lanternfly is present in China, India, Japan, South Korea, and Vietnam. The insect was detected in Pennsylvania in September 2014. This was the first detection of spotted lanternfly in the United States.

Spotted lanternflies are invasive and can spread rapidly when introduced to new areas. While the insect can walk, jump, or fly short distances, its long-distance spread is facilitated by people who move infested material or items containing egg masses.

Damage

Both nymphs and adults of spotted lanternfly cause damage when they feed, sucking sap from stems and leaves. This can reduce photosynthesis, weaken the plant, and eventually contribute to the plant’s death. In addition, feeding can cause the plant to ooze or weep, resulting in a fermented odor, and the insects themselves excrete large amounts of fluid (honeydew). These fluids promote mold growth and attract other insects.

Description

Adult spotted lanternflies are approximately 1 inch long and one-half inch wide, and they have large and visually striking wings. Their forewings are light brown with black spots at the front and a speckled band at the rear. Their hind wings are scarlet with black spots at the front and white and black bars at the rear. Their abdomen is yellow with black bars. Nymphs in their early stages of development appear black with white spots and turn to a red phase before becoming adults. Egg masses are yellowish-brown in color, covered with a gray, waxy coating prior to hatching.

Life Cycle

The spotted lanternfly lays its eggs on smooth host plant surfaces and on non-host material, such as bricks, stones, and dead plants. Eggs hatch in the spring and early summer, and nymphs begin feeding on a wide range of host plants by sucking sap from young stems and leaves. Adults appear in late July and tend to focus their feeding on tree of heaven (A. altissima) and grapevine.

¹ In Pennsylvania, adult spotted lanternflies have also been found feeding and egg laying on willow, maple, poplar, and sycamore, as well as on fruit trees, like plum, cherry, and peach.
(Vitis vinifera). As the adults feed, they excrete sticky, sugar-rich fluid similar to honeydew. The fluid can build up on plants and on the ground underneath infested plants, causing sooty mold to form.

**Where To Look**

Spotted lanternfly adults and nymphs frequently gather in large numbers on host plants. They are easiest to spot at dusk or at night as they migrate up and down the trunk of the plant. During the day, they tend to cluster near the base of the plant if there is adequate cover or in the canopy, making them more difficult to see. Egg masses can be found on smooth surfaces on the trunks of host plants and on other smooth surfaces, including brick, stone, and dead plants.

**Report Your Findings**

If you find an insect that you suspect is the spotted lanternfly, please contact your local Extension office or State Plant Regulatory Official to have the specimen identified properly.

Greenhouse Crops

Photo Credit: thetravelnook
**Foliar Diseases of Greenhouse Ornamentals**

Dr. Francesca Hand  
*Department of Plant Pathology, Ohio State University Extension*

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**FOLIAR DISEASES OF GREENHOUSE ORNAMENTALS**

Dr. Francesca Hand  
*Department of Plant Pathology*

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**BOTRYTIS BLIGHT (GRAY MOLD)**

- Most commonly encountered disease of herbaceous ornamentals
- Economically destructive - attacks crops at any stage of growth (including post-harvest) and can infect all plant parts
- Ubiquitous pathogen – Tricky diagnosis!
- *B. cinerea* has the largest host range but not the only species on ornamentals:
  - *B. tulipae* – tulip
  - *B. paeoniae* – peony
  - *B. elliptica* – lily
  - *B. narcissicola* – narcissus
  - *B. gladiolorum* – gladiolous

---

**Inoculum:**

- Sclerotia (overwintering structures in soil & plant debris)
- Mycelium or conidia (spores)

**Inoculum dispersal:**

- Can be airborne or water-splashed

**Infection & Colonization:**

- Penetration of tissues can be direct, or through wounds or natural openings
- Pectinolytic enzymes cause tissue to collapse

**Favorable environment:**

- Low temperatures (44-60°F)
- Condensation on leaf surface
- High RH (>85%)
**BOTRYTIS BLIGHT (GRAY MOLD)**

- **Management:**
  - Reduce RH by heating and ventilating
  - Avoid formation of free water on plant surfaces
  - Avoid overhead watering - or water early in the day
  - Keep RH <85% - Do not allow leaves to stay wet more than 3-4 hours
  - Space plants to allow good air circulation
  - Be obsessive compulsive about sanitation – key to prevention!
  - Apply protective fungicides

**BOTRYTIS BLIGHT (GRAY MOLD) - FUNGICIDES**

<table>
<thead>
<tr>
<th>Common name</th>
<th>FRAC code</th>
<th>Trade name</th>
</tr>
</thead>
<tbody>
<tr>
<td>polyoxin D zinc salt</td>
<td>19</td>
<td>Affirm WDG</td>
</tr>
<tr>
<td>chlorothalonil</td>
<td>M5</td>
<td>Daconil</td>
</tr>
<tr>
<td>iprodione</td>
<td>2</td>
<td>Hidrolin 240/19</td>
</tr>
<tr>
<td>fenhexamid</td>
<td>17</td>
<td>Deconex</td>
</tr>
<tr>
<td>pyraclostrobin + boscalid</td>
<td>11 + 7</td>
<td>Pageant Intrinsic</td>
</tr>
<tr>
<td>trifloxystrobin</td>
<td>11</td>
<td>Compass O</td>
</tr>
<tr>
<td>azoxystrobin</td>
<td>11</td>
<td>Heritage</td>
</tr>
<tr>
<td>pyraclostrobin</td>
<td>11</td>
<td>Insignia</td>
</tr>
<tr>
<td>fluxapyroxad + pyraclostrobin</td>
<td>7 + 11</td>
<td>Orkestra Intrinsic</td>
</tr>
<tr>
<td>cyprodinil + fludioxonil</td>
<td>9 + 11</td>
<td>Palladium</td>
</tr>
</tbody>
</table>

**MILDEWS IN A SNAPSHOT**

- **Powdery Mildews**
  - True Fungi (Ascomycetes)
  - obligate parasites
  - moderate temperatures (70-80°F)
  - high humidity (>85%)
  - no free water on leaf surfaces
  - not necessary to prevent disease with fungicides
  - produce many spores – can rapidly develop resistance to fungicides

- **Downy Mildews**
  - Oomycetes
  - obligate parasites
  - cool temperatures (50-75°F)
  - high humidity (>85%)
  - needs free water to germinate
  - necessary to prevent disease with fungicides - very difficult to control!
  - produce many spores – can rapidly develop resistance to fungicides
ALL MILDEWS MANAGEMENT

- Maintain smooth airflow over leaf surface to prevent localized areas of high RH
- Heat and ventilate to maintain dry and warm crop environment
- Space plants to improve air circulation
- Use resistant cultivars when available

DOWNY MILDEW SPECIFIC RECOMMENDATIONS

- Purchase from reputable sources and inspect plants before introducing them in production areas
- Scout plants carefully for symptoms of the disease especially the undersides of leaves
- Immediately remove and discard infected plants, infected debris and soil
EXAMPLES OF AVAILABLE FUNGICIDES

<table>
<thead>
<tr>
<th>Common name CFAC code</th>
<th>Trade name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piperalin 1 Piprin</td>
<td></td>
</tr>
<tr>
<td>Chlorothalonil M5</td>
<td>Daconil</td>
</tr>
<tr>
<td>Myclobutanil 3 Eagle</td>
<td>Camelot</td>
</tr>
<tr>
<td>acibenzolar 11 Heritage</td>
<td></td>
</tr>
<tr>
<td>ammonium methyl 11 Cygnus</td>
<td></td>
</tr>
<tr>
<td>fludioxonil 43 Adorn</td>
<td></td>
</tr>
<tr>
<td>cyazofamid 21 Segway</td>
<td></td>
</tr>
<tr>
<td>mepanipyrim 11 Compass</td>
<td></td>
</tr>
<tr>
<td>boscalid 33 Aliette</td>
<td></td>
</tr>
<tr>
<td>dimethomorph 40 Acrobat, Stature</td>
<td></td>
</tr>
<tr>
<td>fosetyl-Al 33 Aliette</td>
<td></td>
</tr>
<tr>
<td>pyraclostrobin 11 Insignia</td>
<td></td>
</tr>
<tr>
<td>pyraclostrobin + boscalid 11 + 7 Pageant</td>
<td></td>
</tr>
<tr>
<td>fluopicolide 43 Adorn</td>
<td></td>
</tr>
<tr>
<td>cyazofamid 21 Segway</td>
<td></td>
</tr>
<tr>
<td>fenamidone 11 Fenstop</td>
<td></td>
</tr>
<tr>
<td>mefanoxam 4 Subdue MAXX</td>
<td></td>
</tr>
<tr>
<td>dimethomorph 40 Acrobat, Stature</td>
<td></td>
</tr>
<tr>
<td>fenpyroximate 30 Aegea</td>
<td></td>
</tr>
</tbody>
</table>

Downy Mildews

- Caused by Xanthomonas hortorum pv. pelargonii
- Single most important disease of geraniums
- Restricted to Pelargonium and Geranium
- Serious and frequent problem
- Cuttings of asymptomatic infected stock plants most important means of spread

BACTERIAL BLIGHT

- Temperature influences symptoms development:
  - 7 days at 80°F
  - 21 days at 60°F
  - <50°F or >89°F suppress symptoms
- High RH
- Require film of water for infection
- Enter plants through roots or leaves
- Spread by:
  - cutting knife
  - splashing irrigation water including water dripping from infected hanging baskets
  - white flies
- Survives in plant debris in soil for up to 1 year

BACTERIAL BLIGHT - EPIDEMIOLOGY

- Purchase stock from reputable sources
- Keep incoming material from different propagators separate
- Do not place hanging baskets above geranium crops
- Rogue infected plants promptly

BACTERIAL BLIGHT - MANAGEMENT

- Very simple organisms: RNA or DNA surrounded by a protein coat
- Can only multiply inside a living cell
- Once inside the plant cell, organize the cell to produce more virus disrupting normal activity of the cell = symptoms development
- Do not usually kill plants but reduce their ornamental value
- Name of the virus refers to the plant in which it was first found + at least one typical symptom
- It is not an indication of what other plants might be susceptible to it
- Some can infect hundreds of genera, while other can infect only a few species

VIRUS DISEASES

- Plant to plant spread:
  - mechanically: plant sap on workers’ hands or tools
  - by aphids, thrips, whiteflies, leafhoppers, mites
  - by nematode feeding
  - through grafting
  - by pollen
  - through infection by certain soil fungi
  - through shared water in recirculating irrigation systems
  - through seed
  - through vegetative propagation

VIRUS DISEASES
**TMV**
- Worldwide distribution
- Can infect more than 350 plant species
- Commonly affected ornamentals: petunia, calibrachoa, impatiens, geraniums, lobelia, verbena, chrysanthemum
- Very infectious - forms stable crystals that are easily transmitted when plant material is handled
- Symptoms can vary depending on:
  - the particular strain of the virus
  - the host
  - the environmental conditions

**INSV**
- Most important virus of greenhouse floral crops, particularly:
  - begonia, impatiens, petunia, snapdragon
- Wide host range, including many weeds
- Transmitted by Western Flower Thrips
- Virus multiplies in plant and vector
- Can overwinter in weed hosts and vector
- Cause very wide range of symptoms

**TMV**
- Can multiply only inside a living cell but can survive in a dormant state in dead tissue or dry sap on surfaces for years
- Spread:
  - Mechanical transmission during plant handling - workers' hands, tools, clothing
  - Vegetative propagation
  - splashing water
  - tobacco products
  - NOT vectored by aphids, thrips or leafhoppers
CONTROL OF VIRUS DISEASES

- First rule: know what virus you are dealing with!
  - how the particular virus spreads
  - what crops or weeds in the vicinity may be harboring it
  - what other crops may be susceptible to it

CONTROL OF VIRUS DISEASES

- Purchase virus-free plants
- Do not use virus-infected stock plants for vegetative propagation
- Weed removal in and around planting - may harbor viruses and vectors
- Monitor and control insect vectors
- Remove all crop debris from the greenhouse to minimize chance of spread
- Space plants to avoid mechanical transmission
- Set aside plants with suspicious symptoms and obtain a diagnosis from a lab
- Disinfect tools, benches, pots
- Restricted entry to personnel
- Inspect/quarantine new shipments

THANK YOU!

For questions: hand.81@osu.edu
Fumigation

Photo Credit: James Louden
Soil Fumigation Additional Training Requirement

Any applicators who are applying soil fumigants are required to complete U.S. EPA approved training. This training is in addition to requirements for the Ohio Private Pesticide Applicator License.

Below is the front page of the web-based training required for licensed Ohio applicators who are planning to use the following soil fumigants: methyl bromide, chloropicrin, chloropicrin, and 1,3-dichloropropene, dazomet, and meta sodium and meta potassium.

The website is www.fumiganttraining.com

Information about training for other products is available at:
www.epa.gov/pesticides/reregistration/soil_fumigants
Fumigation Management Plan

A Fumigation Management Plan (FMP) is an organized, written description of the required steps involved to help ensure a safe, legal and effective fumigation. It will also assist you and others in complying with pesticide product label requirements. The guidance that follows is designed to help assist you in addressing all the necessary factors involved in preparing for and fumigating a structure and/or area.

This guidance is intended to help you organize any fumigation that you might perform, PRIOR TO ACTUAL TREATMENT. It is meant to be somewhat prescriptive, yet flexible enough to allow the experience and expertise of the fumigator to make changes based on circumstances which may exist in the field. By following a step-by-step procedure, which allows for flexibility, an effective fumigation may be performed.

Before any fumigation begins, carefully read and review the label which includes the container label and Applicator’s Manual. This information must also be given to the appropriate company officials (supervisors, foreman, safety officer, etc.) in charge of the site. Preparation is the key to any successful fumigation. If you do not find specific instructions for the type of fumigation that you are to perform listed in this Guidance Document, you will want to construct a similar set of procedures using this document as your guide or contact DEGESCH AMERICA, INC. for assistance. Finally, before any fumigation begins, you must be familiar with and comply with all applicable federal, state and local regulations. The success of the fumigation is not only dependent on your ability to do your job but also upon carefully following all rules, regulations, and procedures required by governmental agencies.

The following is a list of questions that must be filled out prior to the start of the fumigation.

I) Planning and Preparation

1) Person(s) in charge of the fumigation:

2) Customer name:

3) Facility Address:

4) Contact Name/Title:

5) Contact Telephone Number:

6) Reason for fumigation:

7) Commodity:

8) Fumigant Formulation:

9) Type of Structure/Enclosure:

10) Identification: (Examples: Bin Number, Container Number)

11) Planned Date of Application:

12) Duration of Fumigation: hours

13) Desired Concentration: ppm

14) What is the location of the nearest phone to be used in case of emergency?

15) What is the emergency phone number for:

   A) Fire?

   B) Police?

   C) Ambulance?
II) Site Preparation
1) Have you fumigated this structure before?
   A) When was last fumigation:
   B) Does this structure have a history of problems with fugitive emissions?
      (1) What action will be taken to mitigate these problems?
   C) Were any other problems noted?
      (1) What action will be taken to mitigate these problems?

2) If not previously fumigated, has the site been surveyed for fumigation?
   A) Who performed the survey?
   B) When:

      If yes, attach any survey documentation to this FMP

3) Are there any unusual sealing requirements?
   A) Explain the procedures necessary:

III) Personnel
1) List any persons who received HazCom Training:
   A) When did the training take place?
   B) What topics were covered?

2) Have all employees been trained in the tasks they will be expected to perform?
   A) Are these records on file and up to date?

IV) Notification
1) Has everyone in the area of the fumigation been notified?

2) Has the local fire department been notified?
   A) When?
   B) Who?
   C) How were they notified (Phone, Fax, In Person, etc.)?
   D) Is a permit required?
   E) If so, has it been posted?

3) Were any other official notifications made (Police, Sheriff, etc.)?
   A) When?
   B) Who?
   C) How were they notified (Phone, Fax, In Person. etc.)?

4) Has the complex manager been notified?
   A) Complex Manager Name?

5) Is everyone in the immediate area of the fumigation aware of how to contact the fumigation supervisor in case of an emergency?
   A) What contact number was given?
V) Application and Period of Fumigation
1) Who is in charge of applying the fumigant?
2) List applicators (Include Name, License/Certificate Number and Issuing State)?
3) Have warning signs been properly labeled and posted on the structure?
4) How is the fumigation site to be secured?
5) Is there appropriate safety equipment on site?
   A) List by type and quantity:
6) Is the structure considered a confined space?
   A) Is a permit required?
   If yes, attach a copy to this FMP
7) Is this a farm storage bin or tank?
   If yes, attach a copy of the Grain Handling Facility Job Site Evaluation and Fumigation
   Pre-survey Profile to this FMP

VI) Monitoring
1) At what intervals is the fumigation to be monitored (12 hr, 24 hr, etc.)?
2) What is to be monitored (space, commodity)?
3) What type of equipment is to be used?
4) At what intervals are Industrial Hygiene readings to be taken?
5) Where are IH readings to be taken?
6) What type of equipment is to be used?
7) Where are the IH records to be kept?
8) In the event the fumigant levels exceed the TLV of 0.3 ppm outside the structure:
   A) Who is to be contacted first?
      (1) Contact Number(s):
         (a) Home:
         (b) Pager:
         (c) Cellular:
   B) Second contact?
      (1) Contact Number(s):
         (a) Home:
         (b) Pager:
         (c) Cellular:

VII) Post Application
1) How is the structure to be ventilated?
2) What detection equipment will be used to monitor the aeration process?
3) How will the structure be cleared (commodity, space, both)?
How to Determine the Correct Respiratory Protection Requirements For Phosphine

(Hydrogen Phosphide, PH₃, Phostoxin®)

Step 1:
Establish and document the phosphine concentration to which you will be exposed. This can be done with an electronic instrument or detector tubes. If the phosphine concentration cannot be established or is unknown, go immediately to Step 4.

Step 2:
If the phosphine concentration is 0.3 parts per million (ppm) or less, respiratory protection:

- Is not Required

Step 3:
If the phosphine concentration is above 0.3 parts per million (ppm) and not more than 15 parts per million (ppm) a Full Face Canister Gas Mask:

- Must be Worn

Step 4:
If the phosphine concentration cannot be established, is unknown or is above 15 parts per million (ppm) a Self Contained Breathing Apparatus (SCBA):

- Must be Worn

*** The Short Term Exposure Limit (STEL) for Phosphine (Hydrogen Phosphide, PH₃, Phostoxin®) is 1 ppm ***

www.degeschamerica.com
DEGESCH America, Inc.
info@degeschamerica.com
Fertilizer

Field Crop Fertility Update
Phosphorus Placement Effects on Crop Production and Water Quality

Where phosphorus fertilizer is placed in relationship to the soil surface can have potential consequences for both crop production and water quality. Nutrient stratification is a term used to describe nutrient concentration changes seen at different soil profile depth increments. For non-mobile nutrients like phosphorus (P) and potassium (K), or soil characteristics like pH, soil test levels found on the surface (0-2 inch) can be different than deeper (8-12 inch) in the profile. A summary of 1526 soil samples from the Sandusky watershed showed P levels at 0-2 inch depth of 59 ppm while the 2-8 inch depth averaged 35ppm. (Baker, 2017)

Nutrient stratification for two Ohio fields at three depth increments can be found in Table 1. Reduced tillage systems, surface applications of nutrients, and nutrient released from decomposing residue increase the concentrations of P and K on the soil surface. Soil pH is influenced by previous liming history and soil formation. Subsoil materials in western Ohio soils are limestone resulting in a more basic subsoil (pH > 7) while eastern Ohio with shale underlayment typically are more acidic (pH < 7).

What consequences could stratification pose for nutrient placement in crop production and water quality?

Crop Production Consequences

Table 1. Soil test values P, K and pH at 3 soil profile depth increments.

<table>
<thead>
<tr>
<th>Field 1 (Fulton Co)*</th>
<th>Field 2 (Henry County)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>P 66 PPM</td>
<td>P 16 PPM</td>
</tr>
<tr>
<td>K 201 PPM</td>
<td>K 136 PPM</td>
</tr>
<tr>
<td>pH 6.5</td>
<td>pH 6.8</td>
</tr>
<tr>
<td>0-4 inch</td>
<td>4-8 inch</td>
</tr>
</tbody>
</table>

| P 47 PPM             | P 10 PPM               |
| K 130 PPM            | K 86 PPM               |
| pH 6.9               | pH 6.6                 |
| 4-8 inch             | 8-12 inch              |

| P 17 PPM             | P 4 PPM                |
| K 113 PPM            | K 77 PPM               |
| pH 7.2               | pH 6.9                 |
| 8-12 inch            |                        |

Although plant roots are flexible in obtaining nutrients throughout the soil profile, crop production advantages may occur with subsurface placement.

1. Under drought conditions shallow plant roots may dry out resulting in temporary nutrient deficiency symptoms.

Under dry conditions, temporary leaf potassium deficiency symptoms have been observed where soil test indicate adequate potassium. An incremental soil test to determine nutrient status at different soil depths can be helpful for diagnosing if temporary deficiencies maybe from low soil test nutrient values deeper in the profile.

2. Banded fertilizer can improve fertilizer availability in low P & K testing soils.

At soil test values below the critical level, banded fertilizer applications have the benefit of reducing fertilizer to soil fixation by concentrating in a band with less surface area. For example,
phosphorus availability was measured fertilizer band at 3.4 to 17.1 times the soil background level. (Stecker, 2001)

3. Fertilizer rates may be reduced with banding.

Banded fertilizer rates may be reduced by 25-50% over surface applied rates. The goal of fertilizer addition is to maintain sufficient soluble soil nutrient levels for plant uptake. Banded applications have the characteristic described above (Stecker, 2001) of less fixation of nutrient thus increased availability even 18 months after application.

4. Fertilizer deep placement >4 inches.

Deep banded placement is associated with strip tillage. These tillage systems place nutrients 4-6 inch deep. Two studies, in Iowa and Illinois, provide yield results for deep placed P & K studies. Corn yields increased 5 bushel per acre in the Iowa studies (Mallarino, 2000). Corn increased 8% (Fernandez, 2012) and soybean yields increased 5 bu per acre (Farmaha, 2011) in Illinois. The effect was primarily attributed to potassium. The Illinois soybean study also noted a concern of K salting injury under certain conditions.

The potential for salt injury from starter fertilizers does limit nitrogen and potassium recommended rates depending on how close the fertilizer is placed to the seed. For corn pop-up (placed in the row), the limit of N+K₂O is based on soil cation exchange capacity (CEC). Soils with a CEC of 7meq/100g or less limit pop-up fertilizer to 5 pounds of N+K₂O, and soils with a CEC of 8meq/100g or greater, apply no more than 8 pounds N + K₂O. In a 2 by 2 placement, do not exceed 100 pounds total N+K₂O for corn or 70 pounds total N+K₂O for soybeans.

Water Quality Consequences

The higher concentration of phosphorus near the surface does have consequences for water quality. Higher concentrations of P measured in soil test results in higher levels of soluble nutrients. Water moving across the soil surface to surface drains or directly to ditches or stream will have a higher concentration of P.

Figure 1. Surface application and P loss paths.

Preferential flow from macropores is the result of "biological activity (root channels, worm holes, etc), geological forces (subsurface erosion, desiccation cracks and fractures) or soil treatments (plowing, bores, and wells). Surface cracks and channels that bypass the root zone are also responsible for rapid transport of moisture and chemicals through the unsaturated zone." (from Cornell University) Preferential flow results in rapid movement of surface water through the soil profile to the tile system. Surface application of phosphorus only increases the surface P concentration from stratification, if present, and can result in increased P losses. Figure 1 illustrate these potential loss paths.
Observations in Edge of Field (Figure 2) monitoring studies in Ohio have noted a 4 times greater nutrient loss from surface applied verses incorporated nutrients with a Mono Ammonium Phosphate (MAP) application of 175 pounds. The total loss amounts to 1% of the applied P. A rainfall simulator study (Smith, 2016) indicated that loss as high as 17% of the application rate might be possible.

**Figure 2. Effect of placement on phosphorus transport**

**Soil type:** Silt loam  
**Tile depth:** 3 ft  
**Soil test P:** 30 ppm  
**Mehlich-3P**  
**Tillage:** No-till

2014 management  
May 6th – Applied 175 lb/ac of MAP  
May 8th – TD1 tilled with disk TD2 no-till

**Study Objective**  
Compare P transport before and after tillage on tilled and no-till fields

Additional research on fertilizer placement with tillage practices was conducted in Ohio (2015-2017). Figure 3 compares surface P losses from surface fertilizer application under different tillage placements and residue covers. Results of the rainfall simulator study show surface applied Runoff Dissolved Phosphorus (RDP) losses (35a) of 36 ppm versus banded, chisel or field cultivator placed nutrients at less than 2 ppm. Runoff Total Phosphorus (RTP) losses (35b) increased with tillage indicating some increased erosion but losses were not very different from RDP losses. Tillage treatments are SB=Surface Broadcast, SBfc=Surface Broadcast Field Cultivator, SBch=Surface Broadcast Chisel. (Dayton, 2016)

Figure 3. Dissolved (35a) and Total P (35b) concentrations of water under 4 different placement methods and 3 different residue covers from a rainfall simulator study.
Summary

Stratification is a measurable by-product of fertilizer placement, residue management and tillage. Crop production is not affected under normal conditions due to the high percentage of the root system found in the upper four inches of soil. There can be fertilizer efficiency advantages to placement of fertilizer under the soil surface. Band place fertilizer is less subject to fixation especially under low soil test conditions for both P and K. Deep banding of P or K may have yield benefits under certain conditions but yield increases are not consistent.

Higher soil surface phosphorus concentrations can result in elevated P concentrations of runoff or tile water leaving field sites. The surface placement of P nutrients at application can enhance surface concentrations. Placement of added P nutrient below the soil surface by incorporation or use of banded applications has shown improvements in water quality. If tillage is planned, apply nutrients prior to tillage. Under no-tillage conditions, using low disturbance banded application or planter placed fertilizer may be beneficial from both a yield and water quality standpoint. Increases in tillage and plowing over current production practices has the potential to result in increased risk of erosion and sediment losses which can be counterproductive to water quality, thus further evaluation of cost benefits tillage should be evaluated by the farmer. Farmers may want to identify a few select fields to do a stratified soil sample to compare a 0-2 to a 0-8 inch sample under their management system. A 0-4 inch sample recommended for lime determination in no-till and pasture situations.

References


4R Nitrogen Management

Scientists working in nitrogen management for corn production categorized N management practices during a summit on the topic. The summit goals focused on evaluating Economic, Environmental & Social factors to identify regionally appropriate suites of practices that when implemented should improve N utilization. The outcomes sought included greater recovery of applied N sources by the crop, sustained/improved soil fertility and health, cleaner water and air plus reduced nitrous oxide emissions. Table 3 summarizes non-irrigated recommendations for a corn-soybean rotation for the region that includes Ohio. (Snyder, 2016)

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Right Source</th>
<th>Right Rate</th>
<th>Right Time</th>
<th>Right Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>* Guaranteed or book value for all sources applied.</td>
<td>* Rate based on evidence recognized by regional soil fertility extension.</td>
<td>* Spring; not on frozen soil.</td>
<td>* Broadcast and incorporated, injected or subsurface band.</td>
</tr>
<tr>
<td></td>
<td>* Urea, UAN (urea ammonium nitrate), anhydrous ammonia, manure.</td>
<td>* Properly accounting for legume and manure N.</td>
<td>* Apply manure according to a manure management plan.</td>
<td>* If broadcasted urea accompanied by an inhibitor.</td>
</tr>
<tr>
<td></td>
<td>* Guaranteed or known analysis for all sources applied; with nitrification inhibitor or controlled release if preplant; with urease inhibitor for urea/UAN surface applied sidedress.</td>
<td>* Rate based on evidence recognized by regional soil fertility extension, including results of local adaptive management research.</td>
<td>* Manure analysis required to determine application rate.</td>
<td>* UAN with herbicide no more than 40 lbs/A.</td>
</tr>
</tbody>
</table>

Intermediate

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Right Source</th>
<th>Right Rate</th>
<th>Right Time</th>
<th>Right Place</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>* Guaranteed or known analysis; with nitrification inhibitor or controlled release if preplant; with urease inhibitor for urea/UAN sidedress.</td>
<td>* Rate based on evidence recognized by regional soil fertility extension, or results of local adaptive management research, AND, in addition, addressing within-field and weather-specific variability using tools such as crop sensors, PSNT, models that allow adjustment of in-season N rates.</td>
<td>* Some or all N applied in-season.</td>
<td>* Broadcast and incorporated, injected or subsurface band, surface application allowed only for sidedress urea with U1 or dribbled UAN.</td>
</tr>
</tbody>
</table>

Advanced/ Emerging

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Right Source</th>
<th>Right Rate</th>
<th>Right Time</th>
<th>Right Place</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>* Guaranteed or known analysis; with nitrification inhibitor or controlled release if preplant; with urease inhibitor for urea/UAN sidedress.</td>
<td>* Rate based on evidence recognized by regional soil fertility extension, or results of local adaptive management research, AND, in addition, addressing within-field and weather-specific variability using tools such as crop sensors, PSNT, models that allow adjustment of in-season N rates.</td>
<td>* Some or all N applied in-season.</td>
<td>* Broadcast and incorporated, injected or subsurface band, surface application allowed only for sidedress urea with urease inhibitor (U1) or dribbled UAN.</td>
</tr>
</tbody>
</table>


Includes: E. Corn Belt (Indiana and Eastward - Ohio, Pennsylvania, New York, and Maryland).
Report Lead: Dr. Peter Scharf, University of Missouri.
Additional 4R nitrogen information recommended for use in Ohio crop production.

Rate
Determine N rate from the Corn Nitrogen Rate Calculator - [http://go.osu.edu/corn-n-rate](http://go.osu.edu/corn-n-rate)

<table>
<thead>
<tr>
<th>Price of Nitrogen Fertilizer ($/ lb)</th>
<th>$0.30</th>
<th>$0.35</th>
<th>$0.40</th>
<th>$0.45</th>
<th>$0.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3.25</td>
<td>185</td>
<td>176</td>
<td>168</td>
<td>162</td>
<td>155</td>
</tr>
<tr>
<td>$3.50</td>
<td>187</td>
<td>180</td>
<td>173</td>
<td>166</td>
<td>160</td>
</tr>
<tr>
<td>$3.75</td>
<td>191</td>
<td>184</td>
<td>176</td>
<td>170</td>
<td>164</td>
</tr>
<tr>
<td>$4.00</td>
<td>195</td>
<td>186</td>
<td>180</td>
<td>174</td>
<td>168</td>
</tr>
<tr>
<td>$4.25</td>
<td>199</td>
<td>190</td>
<td>184</td>
<td>177</td>
<td>171</td>
</tr>
<tr>
<td>$4.50</td>
<td>200</td>
<td>193</td>
<td>185</td>
<td>180</td>
<td>175</td>
</tr>
</tbody>
</table>

See documentation for this table at [http://go.osu.edu/nrateohiocorn](http://go.osu.edu/nrateohiocorn)

If using manure, apply when the crop can use the nitrogen
- Collect a representative sample, and test for nutrient availability
- Apply in spring – incorporate or consider an in-crop application
- Account for the available N in manure – offset commercial N applications by measuring soil available N with a Presidedress Nitrogen Test or similar soil test

Use adaptive management tools
- On farm rate trials
- Measures of in-season plant N status with an NDVI (normalized difference vegetation index) sensor
- End of season Stalk Nitrate Test

Placement
Make no surface application of nitrogen
Incorporate, inject, band
Apply an inhibitor if early application (NH4) or surface applied (UAN or urea)

Timing
Delay the application, until closer to the crop need
Apply 30 to 60 units of N at plant, then sidedress – to delay is to reduce risk of loss
Or - apply 100 N as NH4 before planting, then use a crop sensor in season and apply the last 20, 40 or 60 units of N as a sidedress application – for your total nitrogen required

Source
Prevent volatilization
Apply an appropriate inhibitor if early season application (NH4) or surface applied (UAN or urea)

If excess N is Expected at season end
Plant a grass cover crop following corn – to capture excess N
While cover crops do little to slow soluble P, they work great to slow N movement

References
Tri-State Fertilizer Recommendation Update - Ohio Research

Research in Ohio to update the Tri-State Fertilizer P & K Recommendations was coordinated by Steve Culman, OSU Soil Fertility Specialist during the 2014 to 2019 growing seasons across more than 200 sites.

One major change in this update is a move to the Mehlich-3 soil test extractant as the new default for P and K. Table 4 shows the maintenance range for phosphorus and potassium with the Mehlich-3 as the extract.

Table 4. New Mehlich-3 phosphorus maintenance range (critical level – maintenance limit) for field crops in the Tri-State Region

<table>
<thead>
<tr>
<th>Crop</th>
<th>Phosphorus Maintenance Range (Mehlich-3 P)</th>
<th>Potassium Maintenance Range (Mehlich-3 K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn, Soybean</td>
<td>20 – 40 ppm</td>
<td>90 – 130 ppm</td>
</tr>
<tr>
<td>Wheat, Alfalfa</td>
<td>20 – 40 ppm**</td>
<td>90 – 130 ppm</td>
</tr>
</tbody>
</table>

**Wheat and alfalfa require greater levels of soil test P than corn and soybean. Therefore, if growing wheat or alfalfa in rotation and soil test levels are below 30, apply maintenance rates of P fertilizer before these crops are grown.

- More information on work of establishing the critical levels can be found here: https://ohioline.osu.edu/factsheet/agf-518

Preliminary tables for the maintenance range recommendations for phosphorus (Table 5) and potassium (Table 6) are shown below based on recent work. We anticipate that these recommendations will be published as the new Tri-State Fertilizer Recommendations for Corn, Soybean, Wheat and Alfalfa later this winter.

Table 5. Fertilizer (P₂O₅) Recommendations* in pounds per acre for Corn, Soybean and Wheat when soil tests are in the Maintenance Range for P (Mehlich-3) is 20 to 40 ppm.

<table>
<thead>
<tr>
<th>Crop</th>
<th>P₂O₅</th>
<th>Nutrition removal</th>
<th>Yield Goal (bu/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.35 lb/ bu</td>
<td>125 150 175 200 225 250</td>
</tr>
<tr>
<td>Corn</td>
<td>0.35</td>
<td>44 53 61 70 79 88</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>40 50 60 65 75 85</td>
<td></td>
</tr>
<tr>
<td>Soybean</td>
<td>0.80</td>
<td>32 40 48 52 60 68</td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>0.50</td>
<td>30 38 45 50 58 63</td>
<td></td>
</tr>
</tbody>
</table>

*Recommendations = nutrient removal times yield goal.

Table 6. Fertilizer (K₂O) Recommendations* in pounds per acre for Corn, Soybean and Wheat when soil tests are in the Maintenance Range for K (Mehlich-3) is 100 to 150 ppm.
Crop | $K_2O$ | Yield Goal (bu/A) |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>nutrient removal</td>
<td>125</td>
<td>150</td>
</tr>
<tr>
<td>Corn</td>
<td>0.20 lb/bu</td>
<td>45</td>
</tr>
</tbody>
</table>

Crop | Yield Goal (bu/A) |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>nutrient removal</td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>40</td>
</tr>
<tr>
<td>Soybean</td>
<td>1.15 lb/bu</td>
</tr>
</tbody>
</table>

Crop | Yield Goal (bu/A) |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>nutrient removal</td>
<td></td>
</tr>
<tr>
<td>Soybean</td>
<td>60</td>
</tr>
<tr>
<td>Wheat</td>
<td>0.25 lb/bu</td>
</tr>
</tbody>
</table>

*Recommendations = nutrient removal times yield goal plus 20.

Tables 7 and 8 show the current crop removal rates. Due to improved efficiency of today’s crop genetics we generally see decreases in P and K removal rates on a per bushel basis when compared to the 1995 published rates.

Table 7: Phosphorus and potassium grain nutrient removal rates.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Grain Nutrient Removal Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs $P_2O_5$/ bushel</td>
</tr>
<tr>
<td>Corn</td>
<td>0.35</td>
</tr>
<tr>
<td>Soybean</td>
<td>0.80</td>
</tr>
<tr>
<td>Wheat</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Table 8: Nutrients Removed in Harvested Forage Biomass

<table>
<thead>
<tr>
<th>Crop</th>
<th>Grain Nutrient Removal Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lbs $P_2O_5$/ ton</td>
</tr>
<tr>
<td>Corn silage</td>
<td>3.1</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Additional Information

- If soil test levels for a nutrient are above maintenance range, then no nutrient application is needed to maximize crop production.
- Resample and test regularly every 3-4 years.
- Significant work was done during the recommendation update research to document crop removal rates of corn, soybean and wheat. The complete crop removal data is provided in Table 9.

Table 9. Grain nutrient removal rates (lb/bushel) and total grain nutrient removed (lb/acre) for corn, soybean and wheat. Total grain nutrient removed is based 180 bushel corn, 60 bushel soybean and 80 bushel wheat.
<table>
<thead>
<tr>
<th></th>
<th>(lb of nutrient/ bushel grain)</th>
<th></th>
<th>(lbs of nutrient/ acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>0.74</td>
<td>3.55</td>
<td>0.96</td>
</tr>
<tr>
<td>P2O5</td>
<td>0.35</td>
<td>0.79</td>
<td>0.49</td>
</tr>
<tr>
<td>K2O</td>
<td>0.20</td>
<td>1.14</td>
<td>0.24</td>
</tr>
<tr>
<td>Ca</td>
<td>0.06</td>
<td>0.22</td>
<td>0.08</td>
</tr>
<tr>
<td>Mg</td>
<td>0.05</td>
<td>0.14</td>
<td>0.07</td>
</tr>
<tr>
<td>S</td>
<td>0.05</td>
<td>0.18</td>
<td>0.07</td>
</tr>
<tr>
<td>B</td>
<td>0.0003</td>
<td>0.0023</td>
<td>0.0003</td>
</tr>
<tr>
<td>Cu</td>
<td>0.0001</td>
<td>0.0008</td>
<td>0.0003</td>
</tr>
<tr>
<td>Fe</td>
<td>0.0013</td>
<td>0.0054</td>
<td>0.0025</td>
</tr>
<tr>
<td>Mn</td>
<td>0.0002</td>
<td>0.0017</td>
<td>0.0022</td>
</tr>
<tr>
<td>Zn</td>
<td>0.0010</td>
<td>0.0023</td>
<td>0.0015</td>
</tr>
<tr>
<td>Na</td>
<td>0.0003</td>
<td>0.0008</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

Authors:
Greg LaBarge, Harold Watters, Steve Culman and Elizabeth Hawkins, Ohio State University Extension. (November, 2019)
PESTICIDE SAFETY EDUCATION PROGRAM EVALUATION

1. Date____________________
2. County____________________
3. County of residence____________________
4. # of acres owned, rented or worked____________________
5. # acres owned, rented or worked where pesticides are applied____________________
6. Have you improved your pesticide use practices as a result of pesticide education programs that you have attended over the years?

Please rate how strongly you agree with the following statements:

<table>
<thead>
<tr>
<th>As a result of Pesticide Applicator Training over the years:</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Not Applicable to me</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have improved personal safety practices.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have improved practices to protect the environment.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have improved pesticide handling practices (mixing, loading, storing, applying).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I get better control from pesticide applications.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I use pesticides more cost effectively.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The next three questions refer only to today’s training:

| I have learned how to control pests, diseases, or weeds more effectively. |               |       |         |          |                   |                       |
| I am better informed about how to apply pesticides safely.               |               |       |         |          |                   |                       |
| This program brought me up to date on current pesticide-related topics, issues, or regulations. |               |       |         |          |                   |                       |

7. What is the most important thing you learned today?

8. What topics related to pesticides were not covered today that you would like to know more about?

9. Please make any other comments you may have concerning this training on the back of this page. THANK YOU FOR YOUR INPUT!