

Grain and Cereal Crops



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2016 Update on Field Crop Insect Activity

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Like previous years, pest pressure in agronomic crops was variable across the state, but related to geographic area. Early in the season there was a typical amount of slug feeding and even a few questions on voles (which entomologists are ill-equipped answer). Some armyworm activity was observed in corn, typically following a rye cover crop. Asiatic garden beetle caused significant damage to some corn fields in the northwest part of the state, particularly where soils are sandy. Damage from other early season pests (grubs and rootworms) was on the low side, in keeping with 2015. Soybean aphids were all but absent from beans in 2016. The big story from 2016 was the presence of Lepidopteran pests such as Western bean cutworm and European corn borer. The Bt protein Cry1F appears to be losing its efficacy against Western bean cutworm in some locations in Ohio and neighboring states. European corn borer activity was largely restricted to refuge or non-GMO corn. Information on Ohio's field crop insect pests including insecticides to use is available at our Agronomic Crops Insects web site at: <http://entomology.osu.edu/ag>

Insects on Corn

Seedcorn Maggot. Although this early season pest can feed on corn, we did not observe unusual or particularly high pressure from this pest this year. See below for impact of seed corn maggot on soybean.

Asiatic Garden Beetle (AGB) and other grubs. In the past few years, corn growers in the Northwest part of OH, or corn grown in sandier soil (e.g. dry river bottoms), have been dealing with a grub called the Asiatic garden beetle. This is a grub species that is smaller, but more aggressive than other white grubs. It can feed on emerging corn, usually in the V1-V4 stages. There were some heavily damaged fields this year, and these tended to be associated with earlier plantings. In 2015 there was evidence of AGB feeding on soybean, which was very surprising. Research began in 2016 to examine this development. In fields with a history of AGB, growers might want to carefully inspect their fields for AGB if poor soybean stands are seen.

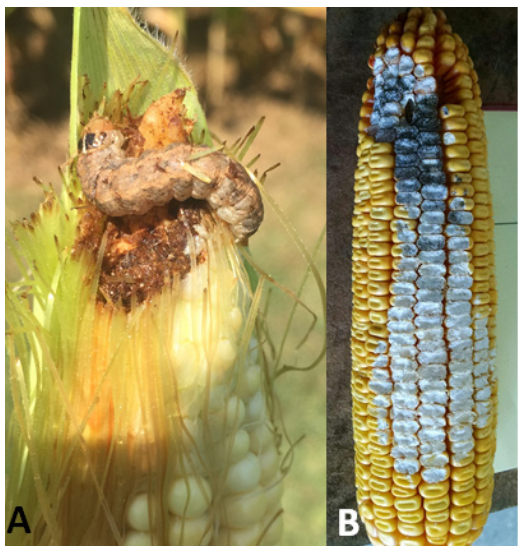


Figure 1. WBC damage on corn. Credit: A) T. Grime; B) M. Davis

Management of AGB is still difficult—high rates of insecticidal seed treatments and soil insecticide should work. However, these products may not provide full control under very high AGB pressure, and there are no transgenic varieties that control AGB or any grubs. The main course of action would be to replant. We have noticed that later plantings do seem to show less damage.

Western Bean Cutworm (WBC) in Ohio. Adult WBC will emerge in mid-June until mid-August. After mating, females will lay eggs (mostly in pre-tassel corn) and larvae will feed on the tassel, pollen and then the developing kernels (Figure 1A). WBC can also “scrape” the kernels (Figure 1B), instead of complete kernel removal. We continued to monitor for adult emergence this year, although we focused on northern Ohio counties (where past work has shown the highest risk of economic damage from this pest). In 2016, our trap collections were on par with the previous 4 years and suggest that we have a consistent and resident WBC population.



Figure 2. WBC damage in corn. The test strip shows that Cry1F was present in the ear

As in 2015, we saw more damage in northwest and northeast OH, and some fields likely reached economic damage. The damage appeared to be concentrated in late-planted corn (fields that were delayed due to the rainy spring) or corn not expressing the genes Cry1F or Vip3A, which are the only genes that offer control for WBC.

Another important development in 2016 was a rise in the amount of damage on corn containing the Cry1F protein, suggesting that this type of Bt is losing its

efficacy against WBC. Similar trends were noted in MI, IN, NY, and Ontario. Based on past years, the impact of this pest appears to be expanding, and we are concerned we will see more damage next year. At this time, however, preventive control (e.g., tank mixing with fungicides) is still not warranted. Scouting and trapping is still the best management option for Ohio, especially in the northern counties.

European Corn Borer (ECB). It is not often that we talk about this pest since the popularity of transgenics has nearly wiped out ECB. However, ECB is still around and populations in fields can still occur. As in 2015, we were able to find fields with ECB present, either in refuge corn or untreated fields. While this may be due to natural cycles in ECB populations, delayed corn planting or a slight increase in non-transgenic acreage, it is a good reminder that ECB can still be an important pest of corn in Ohio and scouting is still necessary if not using above-ground GMO varieties.

Western Corn Rootworm. Rootworm was almost absent in 2016, probably due to carryover (or, rather, a lack of carryover) from very low populations in 2015 which were affected by heavy rain early in that season. In addition, we did not observe or receive any reports of resistance to Cry3Bb1 or mCry3A—these are Bt genes to which some WCR populations have evolved resistance. There has only been 1 suspected case of WCR resistance reported in Ohio (in 2014). No evidence of resistance was seen in 2016. Neither did we see any indication of the western corn rootworm variant that lays its eggs in soybean fields only to cause problems the following year in first year corn. The decreased presence of this variant was also seen in other states to our west.

Insects on Soybean

Seedcorn Maggot. These are tiny, wormlike larvae that will feed on both corn and soybean seed (Figure 5A, dotted circle). The presence of seedcorn maggot is rare, but predictable. Normally, seedcorn maggots are only a problem in fields with heavy organic matter, for example tilling under a green cover crop or heavy manure applications. The highest risk comes when planting about 5-7 days later after heavy organic matter is present. Adult flies will be attracted to the decomposing organic matter and lay eggs. These eggs then hatch 5-7 days later (depending on temperature) and the larvae begin to feed on emerging seed (Figure 3A). However precipitation patterns may alter planting times which also changes risk to seedcorn maggot. Fortunately, seedcorn maggot can be easily controlled with clothianidin or thiomethoxam seed treatments (Figure 3B). The only other recourse would be replanting, and, fortunately, subsequent generations of seedcorn maggot are typically not as damaging.

Soybean Aphid on Soybean. Historically, large populations of soybean aphids used to occur only in the odd numbered years. In 2015 we observed some soybean activity late in the season (after the point where it can do much damage) and in 2016 they were almost entirely absent. However, the Midwest Suction Trap Network which monitors soybean aphid flight has shown a general breaking-down of the every-other-year pattern in most parts of the country. The safest course of action is to scout for this pest every year rather than relying on an even/odd year plan. This scouting can be combined with scouting soybeans for stink bugs, which we highly recommend (see next page).

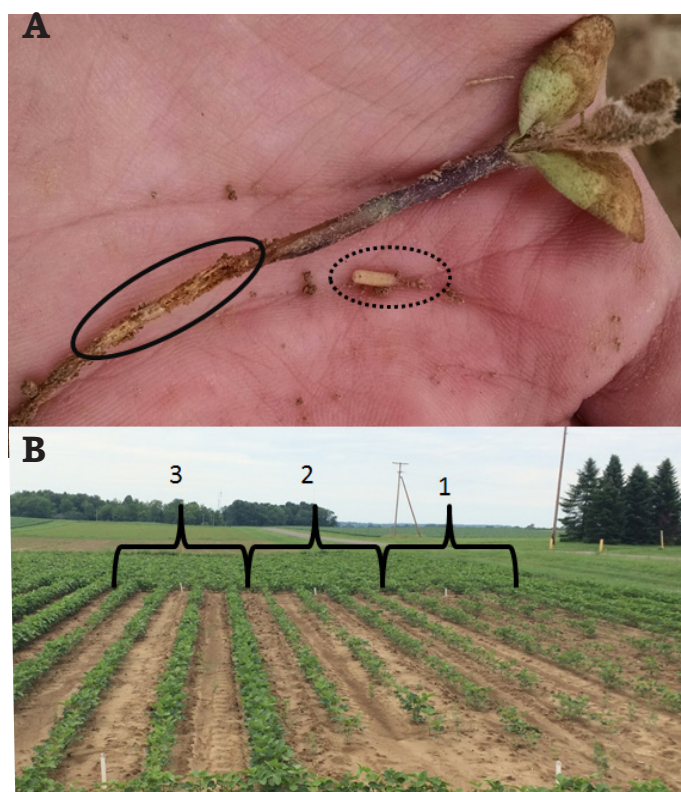


Figure 3. Seedcorn maggot. A) Feeding on soybean in solid circle, with larvae in dotted circle; B) poor stands in untreated (1), low rate; (2) imidacloprid; (3) thiomethoxam

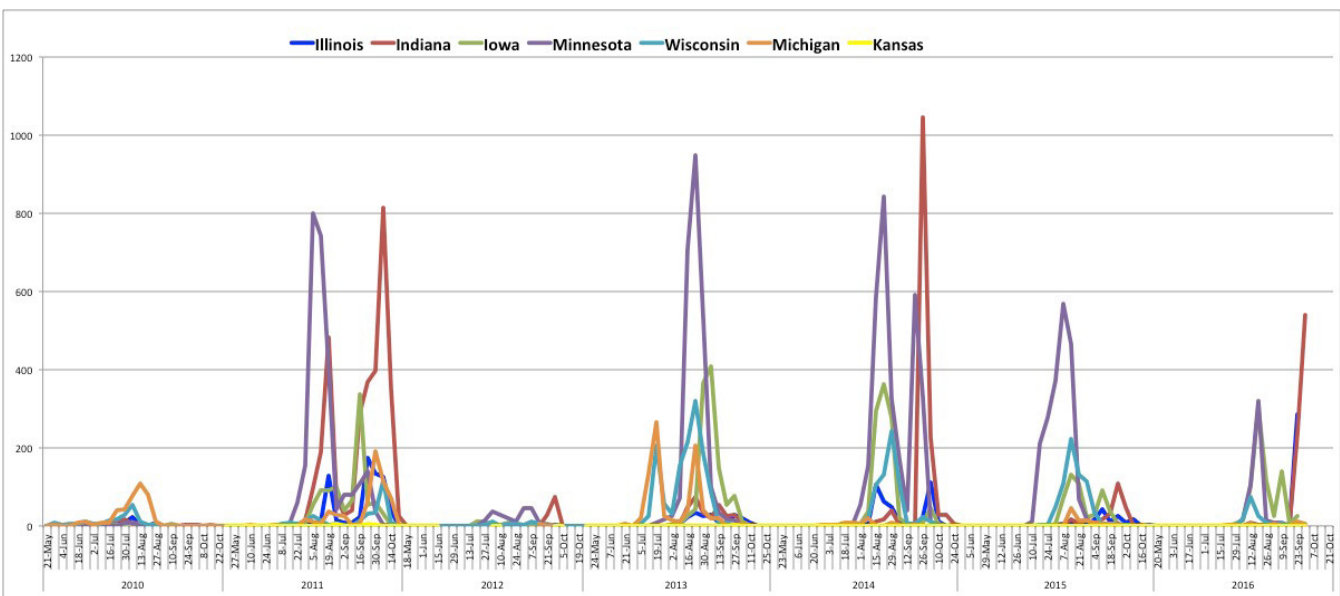


Figure 4. Population dynamics of the soybean aphid from 2010 to 2016, from the Midwest Suction Trap Network.



Figure 4. Harvested grain showing stink bug feeding damage in soybean.

Stink Bugs on Soybean. In some locations high populations of stink bugs were observed in Ohio soybeans, including a larger number of green and brown stink bugs, as well as the presence of a new invasive, the brown marmorated stink bug (BMSB). However, we did not experience an unusual number of calls or reports about stink bugs in soybean during the summertime. On the other hand, though, we received an unusual number of reports at harvest time of seed that showed significant stink bug damage. This suggests that many fields had stink bug problems during the R1-R6 stages that were undetected. On soybeans, all stink bugs cause their damage when they insert their piercing, sucking mouthparts into the pods. They will feed directly on individual seeds, causing them to shrivel if feeding begins during seed formation. If feeding is started later in seed development, you will get smaller, misshapen, and discolored seeds which will affect seed quality and can lead to penalties at the elevators when selling the seed. Stink bugs can be seen as early as mid July (about the R1 stage) and can feed up until harvest.

The current threshold for all stink bugs is relatively low compared with other insect pests. Currently, most states use two stink bugs per foot of row to determine when treatment is necessary. In narrow rows in Ohio, we use a threshold of four stink bugs per 10 sweep sample for regular soybeans, and, if the soybeans are being grown for seed or food grade purposes, the threshold should be lowered to only two stink bugs. When counting stink bugs, growers should group all stink bugs and also count and total the numbers of adults and nymphs together.

Bean Leaf Beetle (BLB). While BLB can damage soybean all throughout the year, the most important damage occurs late in the season, after the pods have formed. We continue to see a moderate to high amount of pod feeding. Especially in late planted soybean, BLBs can congregate and do significant damage to the pods. Some of this damage can be very high, especially when stink bugs are also present in the field. BLBs chew through the pods, and also the seed (Figure 5)—the damage on the pods can lead to secondary infection from diseases like Phomopsis. On some of our surveys, we have seen more than 10% of all pods showing damage, which is the suggested threshold. It is imperative to continue insect scouting in soybean through the R6 stage to gauge the level of pod feeding.



Figure 5. BLB pod feeding on soybean..

Weed Management Update – Agronomic Crops – 2017

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Where to find OSU information

Season-end surveys of soybean fields conducted by the OSU weed science group and OSU Extension educators continue to show giant and common ragweed, marehail, and volunteer corn to be the weeds most frequently escaping herbicide programs. The frequency of Palmer amaranth and waterhemp is also increasing, although they still occur much less frequently than in states to our west. All of these weeds are problematic due to their tendency to develop herbicide resistance, and also other characteristics that include extended windows of emergence, adaptation to conservation tillage, rapid growth, and/or prolific seed production. Most effective control occurs through use of a comprehensive strategy that employs multiple herbicide applications using a diversity of herbicide sites of action, based on the type of resistance in the population. More information on weed and herbicide management can be found in numerous publications available at no charge on the OSU Weed Management website, <http://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

(<http://estore.osu-extension.org/index.cfm>), or from the OSU publications office - 614-292-1607 (online pdf is free).

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. <http://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 marehail, 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. All for free!

Corn Herbicides

Acuron (Syngenta) is a premix of S-metolachlor, atrazine, mesotrione (Callisto) and bicyclopyrone that is similar to Lexar/Lumax in use and spectrum of control. Bicyclopyrone is an HPPD inhibitor (site

27) that may improve activity on large-seeded weeds such as giant ragweed compared with Lexar, but any differences in control between these products are minor. Fields with more than a low population of giant ragweed will still require a follow-up postemergence application for effective control. Acuron Flexi is a premix of S-metolachlor, mesotrione, and bicyclopyrone that is similar to Zemax in use and spectrum of control. Both products can be used preplant or preemergence on field corn, sweet corn, and yellow popcorn, and postemergence on field corn.

Revulin Q (DuPont) is a premix of nicosulfuron (Accent), mesotrione, and isoxadifen, the safener that is in the other DuPont “Q” products. Isoxadifen reduces the risk of corn injury from the nicosulfuron. This product controls grass and broadleaf weeds, and is geared for use primarily on corn that is not resistant to glyphosate or glufosinate. It can be used on field corn, seed corn, yellow popcorn and sweet corn, although users should check with seed companies for tolerance information before use on popcorn and sweet corn.

Resicore (Dow AgroSciences) is a premix of acetochlor, mesotrione, and clopyralid for preemergence and early postemergence (up to 11-inch corn) use in corn. This product controls most grass and broadleaf weeds, and is one of the better products for control of giant ragweed (similar to Acuron). Atrazine can be added to further improve control of ragweeds, burcucumber, etc.

Soybean Herbicides

Warrant Ultra (Monsanto) is a premix of acetochlor and fomesafen for preplant, preemergence, and postemergence use in soybeans. Similar in activity to Prefix/Vise/Statement, which are premixes of fomesafen and metolachlor/S-metolachlor. Residual control of marehail is negligible from this product.

Zidua Pro (BASF) replaces Optill PRO, by exchanging the grass control component – pyroxasulfone replaces dimethenamid. Other components of the premix are still Pursuit and saflufenacil (equivalent to 1 oz/A of Sharpen). Residual control of marehail and any ALS-resistant weeds requires the addition of a metribuzin-containing product that provides the equivalent of 6 to 10 oz/A of metribuzin 75DF. The saflufenacil contributes to burndown, especially of marehail, but glyphosate and 2,4-D should be included for more comprehensive burndown activity where possible. Apply with MSO plus AMS or 28%, using volume of at least 15 gpa.

Scepter (AMVAC) has returned, with the same formulation and label it had when discontinued several years ago. The active ingredient, imazaquin, is an ALS inhibitor, and will not control marehail or other ALS-resistant broadleaf weeds. It's possible to create a broader spectrum approach with Scepter, similar to premixes such as Valor XLT and Envive by mixing it with metribuzin, or a Valor product, or a Boundary type product. See the OSU weed control guide for more specific information.

Current Saflufenacil Herbicide restrictions

Labels for all saflufenacil products, Sharpen, Verdict, and Optill PRO, currently still prohibit mixtures with other site 14 herbicides when applied less than 14 days prior to planting. This includes flumioxazin (Valor, Envive/Enlite, Gangster, Fierce, etc), sulfentrazone (Authority products, Sonic), and fomesafen (Prefix, Vise, Torment, etc). In addition, applications of Verdict and Zidua PRO should be separated from application of the other PPO inhibitors by at least 30 days. However, the Sharpen label was changed to allow mixtures of Sharpen at 1 oz/A with any of these products when applied 14 or more days before planting, with the exception of coarse-textured soils with less than 2% organic matter.

Sharpen can be applied at rates up to 2 oz/A in soybean burndown programs when mixed with anything besides site 14 herbicides. For soils with more than 2% organic matter, the minimum delay between Sharpen application and planting: 1 oz – anytime before emergence; 1.5 oz – 14 days; 2 oz – 30 days. Verdict has similar labeling. The 5 oz Verdict rate can be applied anytime before crop emergence, while rates of 7.5 and 10 oz/A must be applied 14 and 30 days before planting, respectively. On coarse-textured soils with 2% or less organic matter, the minimum interval between Sharpen or Verdict application and planting is 30 or 44 days even at lower rates. In OSU research, the higher rates of Sharpen can substantially improve residual marehail control along with burndown, when mixed with another effective residual herbicide, even if applied 14 days or more before planting.

Generic glufosinate

Glufosinate (Liberty) will be available in two Nufarm products in 2016, Cheetah (glufosinate) and Cheetah Max (glufosinate + fomesafen), and a UPI product, Interline, and probably several other generic equivalents. The Cheetah and Interline formulations have loading (lbs ai/gal) and rates similar to Liberty, and the burndown and POST recommendations on LibertyLink crops are similar among the three products. Cheetah Max has a fit primarily in areas where Palmer amaranth and waterhemp are a

problem. The mixture of glufosinate and fomesafen can improve postemergence control of these weeds, especially when they are more than a few inches tall, and provide some residual control. Fomesafen has no activity on marehail, and in OSU research on giant ragweed, the mixture of fomesafen and glufosinate was not more effective than glufosinate alone. In fields or areas of fields with moderate to high giant ragweed populations, applying glufosinate POST twice is a more effective strategy to reduce populations over time than mixing something else with the glufosinate. The primary reason to mix another herbicide with POST glufosinate applications is to improve control of volunteer corn or grasses that glufosinate is weak on, which usually involves the use of clethodim, Fusion, or other grass herbicide.

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 over the past several years found significant populations of Palmer in fields in at least 13 Ohio counties – Columbiana, Fayette, Highland, Lorain, Madison, Mahoning, Putnam, Ross, Sandusky, Scioto, Warren, Wayne, and Williams. Some of these have since been remediated, but the number of infested fields increased in some over the past year also. Our concern is that the frequency of infested fields is likely to increase greatly in certain areas over the next several years. 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) 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 3) the contamination of seed originating from farther west and south that is used to establish CREP or wildlife areas. (Note – ODA will screen any seed used for these purposes for the presence of Palmer amaranth seed at no charge. 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.)

The most important advice we can provide on Palmer amaranth is – do not let it get established in the fields that you farm. Aside from being careful about the possible sources of infestation outlined above, essential steps include the following:

- know if Palmer infestations occur near any of the fields that you farm, and be aware of any

movement;

- use broad-spectrum residual herbicides in both corn and soybeans, which control the early-emerging Palmer amaranth plants and can prevent the chances of a disaster occurring within one growing season;
- If Palmer plants are evident before the field is treated with postemergence herbicides, modify the herbicides used to address glyphosate-resistant Palmer amaranth;
- scout fields in late July/August for the presence of Palmer 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 while harvesting. Avoid harvesting through areas of Palmer with mature seed.

Additional information on Palmer amaranth can be found at the resources listed above.

Waterhemp is also increasing – know the control strategies

The rate of increase of herbicide-resistant waterhemp populations in the state makes it a more immediate and widespread problem than Palmer amaranth. 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 in the previous section. Growers with established infestations need to be aware that the control strategies for this weed are substantially different than for marehail 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 readily obtained by sending leaf samples to the University of Illinois for testing (<http://bulletin.ipm.illinois.edu/?p=3619> - \$50 per population). See the USB waterhemp fact sheet in the OSU weed control guide for additional information on control.

What is “overlapping residual” and do you need it?

The Palmer amaranth problem has 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, this is driven by the need to apply postemergence herbicides when Palmer amaranth is very small, and also control the plants that can emerge after and early postemergence application since Palmer has a wide window of emergence. 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 Flexstar 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.

Enlist soybeans/corn and Enlist Duo herbicide

The approval of Enlist soybeans and corn (Dow AgroSciences), and the accompanying Enlist Duo herbicide, occurred in late 2014. Commercial use is still contingent upon complete export approvals, which had not occurred as of November 2016. The soybeans are largely not being sold for 2017, but there is apparently some planned use of corn in operations where the grain would be fed internally and not sent into trade. The Enlist soybeans are resistant to glyphosate and 2,4-D, and also glufosinate (Liberty/Cheetah/Interline). Enlist corn is resistant to glyphosate and 2,4-D, and also the “fop” herbicides (fluazifop, quizalifop). Enlist Duo, a premix of glyphosate and 2,4-D choline from Dow, is the only 2,4-D product 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 Duo 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 Duo 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, although apparently Dow and the sellers of Enlist soybeans cannot promote this. Mixing glufosinate and 2,4-D would be an effective way to use two different sites of action on weeds already resistant to glyphosate, but at this time there is no premix of these nor is 2,4-D choline available by itself for use in mixtures. The 2,4-D choline formulation in Enlist Duo has reduced volatility compared with other available 2,4-D products.

Xtend soybeans and Xtendimax/Engenia herbicides

The Xtend soybeans have received full export approvals, and are being heavily marketed for planting in 2017. The Xtend soybeans are resistant to glyphosate and dicamba, and there will be several dicamba products available for use in Xtend soybeans, although only one (XtendiMax) had been federally approved at the time this was written in early November. We assume that these will probably be the only dicamba herbicides approved for POST use in Xtend soybeans, or any preplant/preemergence use that is not currently allowed on other dicamba products. The products include Engenia (BASF) and Xtendimax (Monsanto), which contain dicamba, and Xtend (Monsanto), a premix of dicamba and glyphosate. Engenia contains a dicamba salt (BAPMA) with inherently lower volatility than dicamba DGA (Clarity). Xtend and XtendiMax herbicides use the dicamba DGA, but contain a “Vapor Grip” component to reduce volatility. We do not have other specifics on use since labels were not available at the time this article was written, even for the one approved product.

Resistance and other issues with Enlist and Xtend

The Enlist and Xtend systems can be effective tools for the weeds that have become problematic and herbicide-resistant in Ohio soybean production - marestail, ragweeds, waterhemp, and now also Palmer amaranth. Our concern is that use of the Enlist or Xtend system continuously throughout a crop rotation, and using just multiple applications of Enlist Duo or a dicamba herbicide, will cause weeds to develop 2,4-D or dicamba resistance. Stewardship that reduces the risk of resistance will require the integration of dicamba and Enlist Duo applications with other practices: fall herbicide applications; residual herbicides; inclusion of postemergence herbicides other than just glyphosate and 2,4-D;

rotation with other technologies; and of course use of non-chemical weed control methods where possible. The Enlist label does not specifically address the issue, other than to make general suggestions about practices that could be integrated “where practical”, and it remains to be seen whether the labels for Xtend or Engenia products will be any more comprehensive. OSU and other land grant universities will be attempting to provide more comprehensive information on appropriate stewardship of this system in the near future as more widespread adoption occurs.

The Enlist Duo label contains other directions/restrictions that are novel or atypical, and we assume the Xtend/Engenia labels will have some of the same when they are approved. These include the following:

- when a field of Enlist soybeans is being treated with Enlist Duo, and the wind is blowing in the direction of a sensitive crop or area, the applicator must leave a 30 foot buffer between the Enlist Duo and the sensitive crop.
- the label specifies the nozzles that can be used for application, and the pressure ranges that should be used for each nozzle. Use of nozzles not on this list is prohibited.
- Fields should be scouted within 14 days after application to determine if there was inadequate performance due to weed escapes or weed species shifts. Report incidence of non-performance to retailer, Dow rep, or call 1-855-Enlist. If resistance is suspected, treat escapes with herbicide other than group 4/9 to prevent seed production. Dow has to keep records and report on this to EPA (I think), with the goal of preventing development/spread of resistant populations.

Palmer amaranth Fact Sheet

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Palmer amaranth - what it is and what to do now

What is Palmer amaranth and where is it coming from?

- Palmer amaranth is an *Amaranthus* (pigweed) species that has become a devastating glyphosate-resistant weed problem in the South and parts of the Midwest over the past decade. It has caused substantial losses in crop yield and farm income, and a permanent increase in the cost of herbicide programs.
- There are several mechanisms for the movement of Palmer amaranth into Ohio:
 - movement of equipment from Palmer-infested areas into Ohio;
 - the presence of palmer seed in cotton-derived feed products that are transported directly from the south into Ohio;
 - and the presence of Palmer seed in cover crop and wildlife seed that originates in areas infested with Palmer amaranth, such as Kansas and Texas.
- Preventing additional Palmer infestations in Ohio is a primary goal of the OSU weed science program, and will require efforts from the entire Ohio agricultural community.



Why makes Palmer amaranth such a problem?

- Prolific seed production. Female Palmer plants produce 100,000 to 500,000 seeds.
- Broad period of emergence - April to August.
- Small seed that is well adapted to minimum and no-tillage.
- Rapid growth - up to 3 inches per day.
- Most populations are resistant to glyphosate and ALS inhibitors (site 2).
- Timing of herbicide application is critical. Postemergence herbicides must be applied when Palmer plants are less than 3 inches tall.
- Dioecious reproductive system (male and female plants). Obligate outcrossing results in rapid spread of herbicide resistance.



Palmer amaranth distribution in Ohio (late 2016)

- Most counties shown on the map as “infested” (red square) have only a few populations of Palmer amaranth. In some cases only a few plants were found and the “infestation” has been completely remediated.
- Palmer is more widespread in several areas:
 - an area near two dairies along the Madison-Fayette county line north of Jeffersonville
 - Wayne County east of Orrville
 - Mahoning and Columbiana Counties

Herbicide resistance in Palmer amaranth

- Most populations of Palmer amaranth in Ohio are resistant to glyphosate (group 9) and ALS inhibitors (group 2). Palmer will not be controlled by burndown or postemergence applications of glyphosate alone. The addition of ALS inhibitors such as Classic and Pursuit will not improve control.
- Populations in the South have developed resistance to site 14 herbicides (fomesafen, Cobra, etc), and appear to be developing resistance to glufosinate (Liberty, Cheetah, Interline).



Palmer amaranth population surviving treatment with glyphosate:

far left - untreated plant;

middle - 20 lbs ae/A;

right - 10 lbs ae/A

Bottom line - steps to take for prevention

- Know what Palmer amaranth looks like and if there is any in the neighborhood..
- When purchasing used equipment, know where it has been previously. Avoid purchase of combines that come from Palmer-infested areas.
- Scout recently seeded CREP, wildlife, and similar areas for the presence of Palmer. For any intended seedings of this type, ODA will test seed lots for the presence of Palmer seed at no charge. They must pick it up from your operation (do not mail or drop off). Contact ODA for more information - 614-728-6410.
- Avoid use of cotton feed products that might contain Palmer amaranth seed - check with feed supplier for more information. When using manure from another animal operation, know whether they are using cotton feed products.
- Include residual herbicides in corn and soybean programs to control the early-emerging Palmer amaranth plants.
- If Palmer plants are evident at the time of postemergence treatment, modify the herbicide program appropriately.
- Scout fields starting in mid July for the presence of Palmer that escaped herbicide programs. Get help with identification if in doubt.
- Plants without mature seed (black) should be pulled out (uprooted) or cut off just below soil and removed from field, and then burned or buried at least a foot deep or composted. Plants with mature seed should be bagged and removed from field.
- Do not run the combine through Palmer patches that are discovered during harvesting.
- Consult OSU and USB Take Action resources for additional information on management of established populations.
- <http://u.osu.edu/osuweeds/>; <http://takeactiononweeds.com>



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Authors

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OSU Weed Science
<http://u.osu.edu/osuweeds/>

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11/16

Corn and Wheat Pathology Update 2016

Pierce Paul

Department of Plant Pathology, Ohio State University Extension

Wheat Disease Update – Strip Rust was the biggest problem in 2016

During the 2016 growing season, wheat stripe rust was reported in several counties, including Auglaize, Darke, Delaware, Clark, Crawford, Wood, Wayne, Ross, Pickaway, Fayette, Madison, Clinton, Sandusky, Greene, Defiance, Paulding, Licking, Holmes, Ashland, Tuscarawas, Union, and Franklin. Mild winter conditions likely favored the survival of the rust fungus in 2015-2016, leading to early disease onset in the spring. This disease develops best and spreads quickly under cool, rainy conditions, and early and widespread development (before heading) on susceptible varieties under favorable weather conditions often lead to substantial grain yield and quality losses. However, in most of the affected fields, the disease was restricted to a few hot-spots, which minimized its impact of grain yield. Stripe rust can be effectively managed by planting resistant varieties and applying a fungicide, but applications have to be well-timed in order to be effective - once symptoms are seen, the earlier, the better in most cases. Refer to the updated factsheet # PLPATH-CER-12 for more on rusts diseases of wheat (<http://ohioline.osu.edu/factsheet/plpath-cer-12>) and to the efficacy chart below for a list of recommended fungicides.



Wheat Stripe Rust – Field view on the left and close-up of leaves with typical symptoms in the center and on the right

Corn Disease Update 2016 – Ear Rots and Mycotoxins

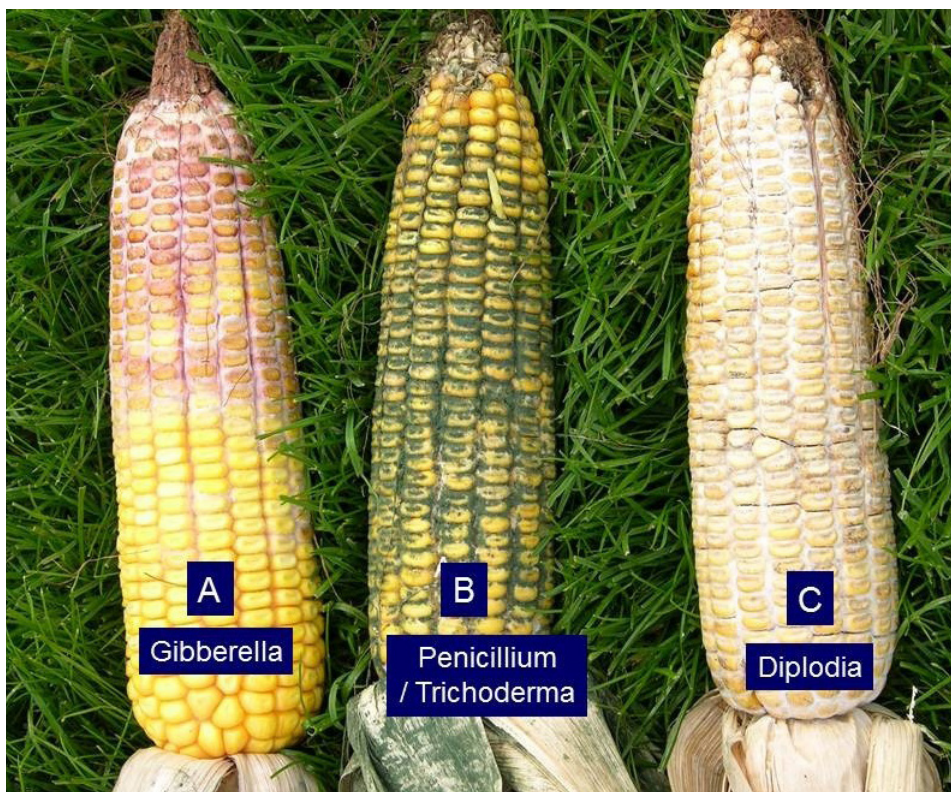
During the 2016 growing season, we received several samples of at least three four ear rots, *Diplodia*, *Trichoderma*, *Fusarium*, and *Gibberella*. Of these, *Trichoderma* was the most prevalent and severe, although *Diplodia* and *Gibberella* ear rots were also found in multiple fields and at fairly high levels in some cases. Ear rots differ from each other in terms of the damage they cause (their symptoms), the toxins they produce, and the specific conditions under which they develop. So, a good way to determine whether you have an ear rot problem is to quantify the disease and get suspect samples tested for mycotoxins. And the best way to tell the difference among the ear rots is to know the types of symptoms they produce.

TRICHODERMA EAR ROT - Abundant thick greenish mold growing on and between the kernels make *Trichoderma* ear rot very easy to distinguish from *Diplodia*, *Fusarium*, and *Gibberella* ear rots. However, other greenish ear rots such as *Cladosporium*, *Penicillium* and *Aspergillus* may sometimes be mistaken for *Trichoderma* ear rot. Like several of the other ear rots, diseased ears are commonly associated with bird, insect, or other types of damage. Another very characteristic feature of *Trichoderma* ear rots is sprouting (premature germination of the grain on the ear in the field). Although some species of *Trichoderma* may produce mycotoxins, these toxins are usually not found in *Trichoderma*-affected ears under our growing conditions.

DIPLODIA EAR ROT - Diplodia causes a thick white mass of mold to grow on the ear, usually initiating from the base of the ear and growing toward the tip. Eventually the white mold changes to a grayish-brown growth and infected kernels appear glued to the husk. Infected ears are usually lightweight and of poor nutritional value. When infections occur early, the entire ear may become moldy. When infections occur late, only a fine web of fungal growth appears on and between the kernels. See my previous article for more on Diplodia ear rot: <http://agcrops.osu.edu/newsletter/corn-newsletter/2016-30/diplodia-ear-rot>.

GIBBERELLA EAR ROT - When natural early-season infections occur via the silk, Gibberella ear rot typically develops as white to pink mold covering the ear tip to the upper half of the ear. However, infections may also occur at the base of the ear, causing the whitish-pink diseased kernels to develop from the base of the ear upwards. This is particularly true if ears dry-down in an upright position and it rains during the weeks leading up to harvest. The Gibberella ear rot fungus may also infect via wounds made by birds or insects, which leads to the mold developing wherever the damage occurs. When severe, Gibberella ear rot is a major concern because the fungus produces several mycotoxins, including deoxynivalenol (vomitoxin), that are harmful to livestock. Once the ear is infected by the fungus, these mycotoxins may be present even if no visual symptoms of the disease are detected. Hogs are particularly sensitive to vomitoxin. Therefore the FDA advisory level for vomitoxin in corn to be fed to hogs is 5 ppm and this is not to exceed 20% of the diet.

FUSARIUM EAR ROT. Fusarium ear rot is especially common in fields with bird or insect damage to the ears. Affected ears usually have infected kernels scattered over the ear among healthy-looking kernels or are confined to kernels that are damaged. The fungus appears as a white mold and infected kernels sometimes develop a brown discoloration with light colored streaks. Several different Fusarium species are involved with Fusarium ear rot. One common species produces a toxin called Fumonisin. Horses are particularly sensitive to Fumonisin, but cattle and sheep are relatively insensitive.



Side-by-side comparison of three ear rots – Gibberella, Trichoderma (or Penicillium), and Diplodia. Note the different colors and patterns of mold growth on the ears.

Sources: <http://www.omafra.gov.on.ca/english/crops/field/news/crop-talk/2014/ct-1114a9.htm>

Management of Small Grain Diseases Fungicide Efficacy for Control of Wheat Diseases (Draft Revised 3-30-16)

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.

Efficacy of fungicides for wheat disease control based on appropriate application timing

Class	Active ingredient	Fungicide(s)		Powdery mildew	Stagonospora leaf/glume blotch	Septoria leaf blotch	Tan spot	Stripe rust	Leaf rust	Stem rust	Head scab	Harvest Restriction
		Product	Rate/A (fl. oz)									
Strobilurin	Picoxystrobin 22.5%	Approach SC	6.0 – 12.0	G ¹	VG	VG ²	VG	E ³	VG	VG	NL	Feekes 10.5
	Fluoxastrobin 40.3%	Evito 480 SC	2.0 – 4.0	G	--	--	VG	--	VG	--	NL	Feekes 10.5 and 40 days
	Pyraclostrobin 23.6%	Headline SC	6.0 - 9.0	G	VG ²	VG ²	E	E ³	E	G	NL	Feekes 10.5
Triazole	Metconazole 8.6%	Caramba 0.75 SL	10.0 - 17.0	VG	VG	--	VG	E	E	E	G	30 days
	Propiconazole 41.8%	Tilt 3.6 EC ⁴	4.0	VG	VG	VG	VG	VG	VG	VG	P	Feekes 10.5
	Prothioconazole 41%	Proline 480 SC	5.0 - 5.7	--	VG	VG	VG	VG	VG	VG	G	30 days
	Tebuconazole 38.7%	Folicur 3.6 F ⁴	4.0	NL	NL	NL	NL	E	E	E	F	30 days
	Prothioconazole 19% Tebuconazole 19%	Prosaro 421 SC	6.5 - 8.2	G	VG	VG	VG	E	E	E	G	30 days
	Tebuconazole 22.6% Trifloxystrobin 22.6%	Absolute Maxx SC	5.0	G	VG	VG	VG	VG	E	E	VG	NL
Mixed modes of action ⁵	Fluoxastrobin 14.8% Flutriafol 19.3%	Fortix	4.0 - 6.0	--	VG	VG	VG	E	VG	--	NL	Feekes 10.5 and 40 days
	Benzovindiflupyr 10.3% Propiconazole 11.7% Azoxystrobin 13.5%	Trivapro A EC + Trivapro B SE	4.0 + 10.5	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5.4
	Metconazole 7.4% Pyraclostrobin 12%	TwinLine 1.75 EC	7.0 – 9.0	G	VG	VG	E	E	E	VG	NL	Feekes 10.5
	Fluxapyroxad 14.3% Pyraclostrobin 28.6%	Priaxor	4.0 - 8.0	G	VG	VG	E	VG	VG	G	NL	Feekes 10.5
	Propiconazole 11.7% Azoxystrobin 13.5%	Quilt Xcel 2.2 SE ⁴	10.5 - 14.0	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5
	Prothioconazole 10.8% Trifloxystrobin 32.3%	Stratego YLD	4.0	G	VG	VG	VG	VG	VG	VG	NL	Feekes 10.5 and 35 days
	Cyproconazole 7.17% Picoxystrobin 17.94%	Approach Prima SC	3.4-6.8	VG	VG	VG	VG	E	VG	--	NR	45 days

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 Multiple generic products containing the same active ingredients also may be labeled in some states.

⁵ Products with mixed modes of action generally combine triazole and strobilurin active ingredients. Priaxor and the Trivapro copack include carboxamide active ingredients.

Rust Diseases of Wheat

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There are three different rust diseases that affect wheat - leaf rust (also known as brown rust or orange rust), stripe rust (commonly known as yellow rust), and stem rust (commonly referred to as black rust or black stem rust). Of these, leaf rust is the most frequently occurring in Ohio, but in any given year, any of these diseases can infect and cause substantial yield losses if not adequately managed. Rusts are notorious for their ability to spread rapidly and reduce wheat yield and quality. It all depends on the susceptibility of the variety, race of the pathogen present, timing of infection, and the weather conditions. Damage to wheat depends on the growth stage at the time of infection and the overall level of rust severity. High levels of disease before or during flowering usually have the greatest impact on yield. Rust causes losses by reducing the number of kernels per head and the size of the kernels, and by lowering test weight and the protein content of the grain. In the case of stem rust, additional losses may result from girdling of the stems which cause plants to lodge. However, for years, the widespread use of rust-resistant varieties has substantially reduced losses caused by leaf, stripe and stem rust. In addition, since none of the rust fungi typically overwinter in Ohio and other parts of the Midwest, spores have to be blown up from the south in order for these diseases to develop, and in most years, this usually occur very late in the season, towards the end of grain development. Some leaf rust can be found on volunteer plants in the fall, but these fall infections appear to be of limited importance for the occurrence and spread of the disease in the spring. In Ohio, late May and early June are times when rust infection becomes critical and rust is more damaging on late-maturing varieties in years when cool, moist weather persists into mid-summer, extending the growing season.

The Rust Fungi

Leaf, stripe, and stem rust are caused by *Puccinia recondita* f. sp. *tritici*, *Puccinia striiformis* f. sp. *tritici*, and *Puccinia graminis* f. sp. *tritici*, respectively. These pathogens are specialized into numerous physiologic races that are identified by their reactions on an established set of differential wheat varieties. A complex system has been developed to keep track of the hundreds of known races. Any

given variety may be immune, resistant or susceptible to a race of rust, but no variety is resistant to all races of any of the three rusts. Every few years new races of these fungi arise, causing previously resistant varieties to become infected and diseased. The life span of a rust resistant variety is usually from 2 to 4 years.



Fig. 1. Leaf rust. Image courtesy of E DeWolf

Symptoms

All rusts are typified by the presence of rusty-colored pustules erupting through the plant surface. They can be distinguished from other leaf diseases by rubbing or smearing the rust spores on the leaf surface with your finger. On wheat, leaf, stripe, and stem rusts are distinguished from each other based on the color, size, and arrangement of the pustules on the plant surface and the plant part typically affected.

<http://www.oardc.ohio-state.edu/ohiofieldcropdisease>



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Pustules of leaf rust, found predominantly on the leaf blade and sheath, are small, up to 1/16 inch long, round to oval fruiting bodies (uredinia) of the rust fungus (**Fig. 1**). Reddish-orange urediospores develop within the uredinia and rupture the epidermis of the leaf surface as the spores mature. Pustules can be either scattered or clustered on the leaves and leaf sheaths of infected plants. Each pustule contains thousands of spores. Leaf rust developing from fall infections usually appears first on the lower leaves and progress up the plant to the upper leaves by mid-June. However, infections usually occur first on the upper leaves due to the fact that wind-blown spores are deposited out of the air during spore showers. Under severe epidemics, pustules may develop on the awns and glumes of the heads or occasionally on the stem below the head.



Fig. 2. Stripe rust

Strip rust pustules are yellowish-orange, much smaller than those of leaf rust, and are neatly arranged in groups forming distinct stripes on the leaf surface (**Fig. 2**). For stem rust, on the other hand, pustules are much larger, orange-red, oval to elongated, and develop predominantly on the stem, leaf blade and sheath, and occasionally on parts of the spike. One of the most characteristic features of stem rust that helps to separate it from the other two rusts is the fact that the uredinia tear the plant tissue, giving the affected stem and leaf a distinctly tattered appearance (**Fig. 3**).

Disease Cycle and Epidemiology

Wheat rusts have very complex life cycles that include two hosts (wheat, the primary host, and an alternate host) and



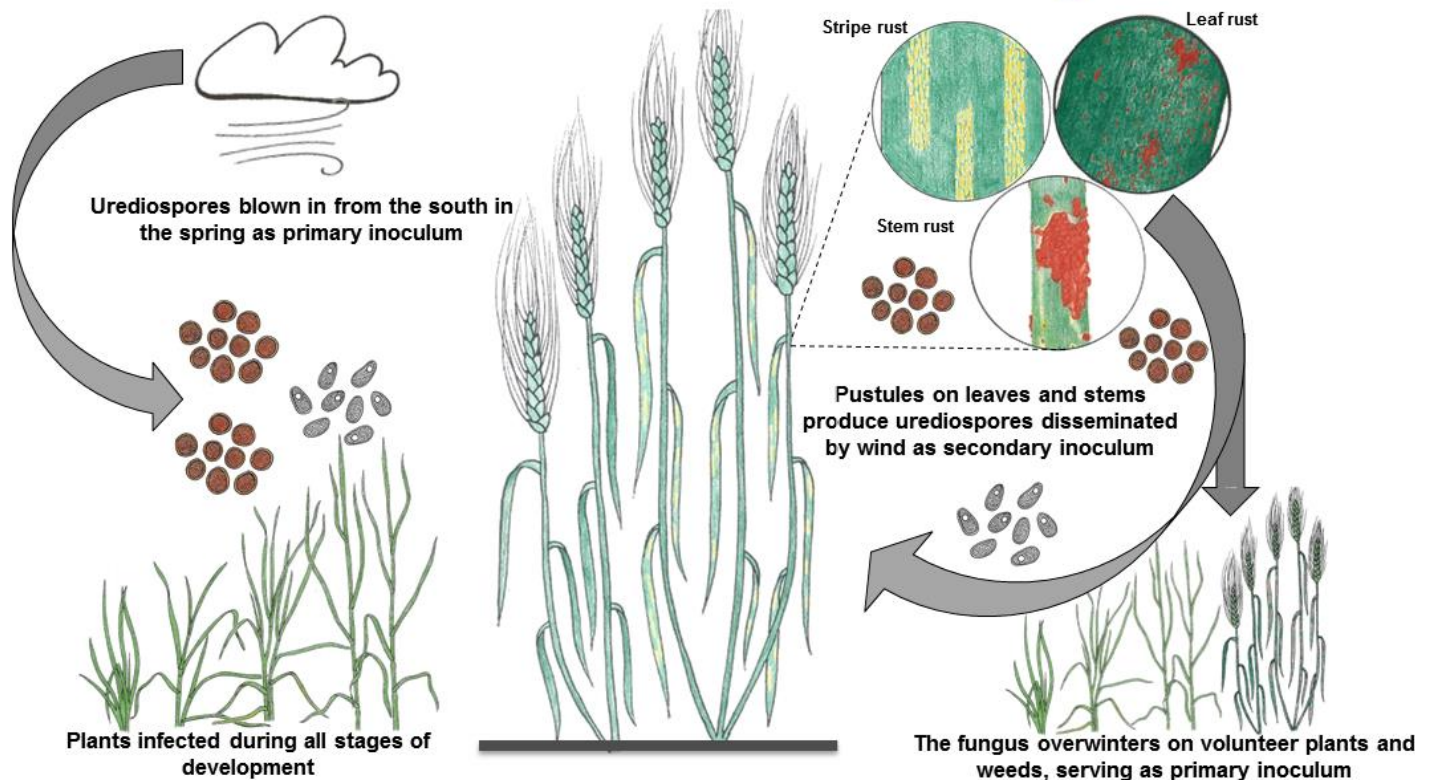
Fig.3. Stem rust. *Image courtesy of E DeWolf*

five different spore stages. However, the in-season rust cycle in Ohio is fairly simple, since the alternate host and three of the five spore stages are of little importance for in-season rust development. In Ohio and other parts of the Midwest, the urediospore stage is the spore type responsible for dispersal and infection of the wheat crop. Urediospores overwinter on infected wheat in the more moderate climate of the southern states and Mexico, and are carried northward by the wind. Under favorable temperature and moisture conditions, urediospores germinate and infect leaves within 6 to 8 hours after landing on the plant surface. Once established, a new crop of urediospores may be produced every 7 to 14 days if environmental conditions are favorable. The earlier rust develops, the more spore and disease cycles are likely to occur during the season and the greater the risk of severe epidemics and yield loss. Frequent heavy dew, light rain, or high humidity and temperatures of 77 to 86°F are ideal for leaf rust development. Stem rust has a similar optimum temperature range, but stripe rust develops best under much cooler conditions (50 to 64°F). All three diseases are spread by wind blown urediospores from plant to plant and from field to field until the crop matures. As the plant matures, black, submerged pustules develop on the leaves, leaf sheaths, stems, and spikes, depending on the rust. These pustules (telia) contain the winter spores (teliospores). Teliospores do not infect wheat. Telia may not develop when plants become infected very late in the season (close to maturity). In the fall urediospores are blown southward and infect wheat and overwinter as urediospores or mycelium on volunteer wheat plants.

Management

1. Plant rust-resistant varieties adapted to Ohio conditions. Be willing to change varieties when rust epidemics occur.
2. Plant after the Hessian fly-safe date recommended for your area. Early planting increases the chance of fall infections. Severely infected seedlings are stressed and are more prone to winter injury.
3. Adequate, balanced fertilization based on a soil test should reduce the possibility of severe yield loss due to rust. High N rates without sufficient P and K may increase rust severity, reducing grain yields.
4. Fungicides are available for control of leaf rust on wheat. Application of a fungicide is often recommended when the variety is susceptible, the disease started early and the flag leaf is in danger of becoming infected.

In-Season Wheat Rust Cycle



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Bruce McPheron, Ph.D., Vice President for Agricultural Administration & Dean

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