Remember to Plant Non-Bt Corn Refuges

In reviewing a few other states’ weekly newsletters and visiting with some people by telephone, I realized that we have been remiss in not reminding corn growers to plant a refuge of non-Bt corn in or adjacent to fields of Bt corn. The use of Bt corn for insect management has become so commonplace that it’s easy to overlook some of the simplest, and most important, recommendations (i.e., planting a non-Bt refuge for insect resistance management, a strategy endorsed and explained thoroughly by the National Corn Growers Association [http://www.ncga.com] and all state corn growers associations). As corn planting begins in earnest with drier and warmer weather, it’s important to remember to plant non-Bt refuges to preserve Bt technology for our future.

Planting non-Bt corn refuges is required for all types of Bt corn, whether the Bt corn is intended for control of corn rootworms, European corn borers, or both, and whether the brand is YieldGard or Herculex. The basic rule is 20% non-Bt corn refuge and 80% Bt corn, again regardless of target insect or brand of corn grown. For transgenic Bt corn for rootworm control, the U.S. Environmental Protection Agency (EPA) indicates that the refuge must be placed within or adjacent to the field of Bt corn. For transgenic corn for corn borer control, the U.S. EPA indicates that the refuge must be planted within 1/2 mile of the Bt corn. We strongly encourage corn growers to plant their refuges, regardless of the target insect, in the same fields where Bt corn is planted. Planting non-Bt refuges within fields of Bt corn will more likely ensure a better mixing of the insect populations from non-Bt corn refuges with those that survive in Bt corn.

It is also important to note that one brand of Bt corn cannot be used as a refuge for another brand of Bt corn for the same target insect. In other words, Herculex RW cannot be used as a refuge for YieldGard Rootworm corn, or vice versa. However, Bt corn hybrids only for corn borer control can be used as a refuge for Bt corn for rootworm control, and vice versa, because the Bt proteins expressed in the two different types of corn are targeted for different insects.

Let’s do all that we can to keep the Bt corn technology viable for everyone for many years to come. Stewardship of the technology is everyone’s responsibility.—Kevin Steffey

Black Cutworm Flights Getting in Full Swing

During the last 10 days, we have had several reports of black cutworm moths caught in pheromone traps. Ron Hines, senior research specialist at the Dixon Springs Agricultural Center, has his trap line up and running. Black cutworm moths have been identified in four traps (Jefferson, Pope, Pulaski, and St. Clair counties), with Pulaski County recording the only intense capture thus far in the season during the week of March 27. However, reports have come in from counties farther north and west as well: moths have been captured in Coles, Cumberland, Piatt, and Adams counties.
As corn planting begins to coincide with moth flights, it’s important to scout fields that are especially attractive for egg laying. Fields or portions of fields where early-season weeds were growing when moths flew into the area are at higher risk than weed-free fields. If tillage or herbicides eliminate weeds 1 to 2 weeks before planting, any black cutworms that had been present probably starve to death. The presence of weeds only a few days before planting increases the likelihood of cutworm damage if larvae are present in the field. Begin watching emerging seedlings carefully for early signs of cutworm feeding (pinholes in the leaves) and for plants that have been cut off by larger larvae. View the black cutworm fact sheet (www.ipm.uic.edu/fieldcrops/insects/black_cutworm.pdf) for more information on injury.

Degree-days can be an effective tool to help determine when to start scouting for black cutworm larvae by predicting larval development and when the first cutting of plants may begin. The accumulation of degree-days begins when a significant moth flight occurs (nine moths caught over 2 days). After an intense capture is recorded, we can calculate degree-days to project when cutting of corn plants will occur. Black cutworm larvae are expected to begin feeding on and cutting corn plants with the accumulation of approximately 300 degree-days (base 50°F) after an intense capture. Just as another reminder, if you are monitoring a pheromone trap, you can predict cutting dates in your area by using the Degree-Day Calculator found on the IPM and WARM Web sites (www.ipm.uic.edu/degreedays; www.sws.uic.edu/warm/pestdata/).—Kelly Cook

Early Spring Insects and Weeds—Some Things Just Don’t Work Together

With the warmer temperatures across Illinois last week, the landscape has begun to change colors. Unfortunately for some, the new bright colors are not limited to yards and gardens. Traveling to St. Louis last week, we saw not only the damage left from recent storms but also carpets of green, purple, and yellow in many fields (and some of these aren’t flowers).

These lush carpets of weeds are made up of many winter annual, biennial, and perennial species common throughout most of Illinois. At this time of year, the vegetative growth of these weeds in no-till fields becomes very noticeable, especially where fall-applied or burndown herbicides have not been used. Weeds that most commonly make up these carpets include purple deadnettle (hence the purple fields), henbit, field pennycress, Virginia pepperweed, shepherd’s-purse, chickweed, dandelion, horseweed, and butterweed (which will produce bright yellow flowers in a few weeks). Occurrences of poison hemlock, downy brome, and wild carrot also can be found along field borders. Many resources are available for identifying these weeds, as mentioned in previous articles in the Bulletin (e.g., www.ipm.uiuc.edu/bulletin/article.php?id=236 [April 8, 2005, no. 3, article 7]).

For quite some time, entomologists have used degree-days to predict insect presence and development. We can use information from growing degree-day (GDDs; base 48°F) as an estimate of heat units required to reach 10% of the total emergence for a weed species. While heat units are easy to characterize, they are not the only factor that influences weed emergence; others include soil type, soil moisture, crop residue, and nitrogen.

To help determine when to scout and what weeds to scout for, along with whether to implement control tactics, midwestern weed scientists have developed a fact sheet to provide guidance on emergence timing and duration for summer annuals and certain perennial weeds. The fact sheet can be downloaded as a PDF file from the Web (weeds.cropsci.uiuc.edu/extension/Other/WeedEmergencePoster.pdf) or you can request it by e-mailing us.

The current degree-day accumulations for Illinois (Figure 1) show that the southern half of Illinois has accumulated enough heat units (150 to 300 GDDs) that folks should begin seeing weeds identified as Group 2 (Figure 2) emerge. The northern half of Illinois is beginning to see emergence of lambsquarters, Pennsylvania smartweed, and giant ragweed from Group 1.

These early-season weed species will begin to grow rapidly with an increase in air and soil temperatures; with increasing size, they are more difficult to control and they serve as food and oviposition sites for many early-season insects. In areas where weed problems are greater in the spring, the risk of early-season insect problems is also high. Several insects also utilize weeds as hosts on which to overwinter. The survival of the weeds well into the growing season gives these insect populations ample time to develop before moving to other hosts, such as corn or soybean plants.

Black cutworm flights are just beginning in most of the state. Moths have been captured in several southern and central Illinois counties, with Pulaski County recording the first, and only, intense capture of black cutworm moths in 2006 (refer to “Black Cutworm Flights Getting into Full Swing” in this issue). As black cutworm moths migrate into our region, they are attracted to fields with significant weed cover. Winter annuals, such as chickweed and henbit, provide a welcome oviposition site for black cutworm females at the time of peak egg laying. Cutworm larvae survive on these weeds before moving to corn stands. Another migratory moth, the armyworm, also lays eggs in weedy fields. Severe armyworm infestations are generally associated with no-till corn planted into grassy areas. If herbicides are used to control these grasses, larvae will move from the dead grasses to the corn. With the concern of armyworm flights (refer to “True Armyworm Moth Captures Reach Impressive Levels in Kentucky” in this issue), armyworm moths could benefit
The presence of weeds in early spring and emergence of summer annuals is important to remember that these weeds are a suitable host for many early-season insects. This may allow for the buildup of these insect populations before the crops emerge this spring, leading to potential problems later in the season.—Kelly Cook and Dawn Nordby

Doug Johnson, extension entomologist, University of Kentucky Research and Education Center, reported that true armyworm moth captures were very large for the first week of April. Captures in two pheromone traps were 290 and 252 moths per trap for the week that ended April 6. Doug also indicated that these totals are greater than observed during the past 4 years and similar to captures that took place in 2001, an armyworm outbreak year. That year, pheromone traps at the Kentucky Research and Education Center were averaging about 400 moths per trap per week by mid-April. These captures do not confirm that an outbreak of true armyworms will occur once again; however, it does make an increased weed presence in area fields as they are searching for suitable egg-laying sites.

Other insects overwinter on or near many weed hosts. Corn flea beetles overwinter in the soil in fencelows, roadsides, and edges of woodlands. They become active when soil temperatures near 65°F. Though corn is their primary host, you will often find corn flea beetles feeding on secondary hosts (such as orchardgrass, crabgrass, fall panicum, red top, Kentucky bluegrass, yellow foxtail, and giant foxtail) until corn becomes available. Though mainly a late-spring and early-summer pest, the stalk borer is very dependent on weed populations. Stalk borers overwinter as eggs on grasses (smooth brome, quackgrass, woolly cupgrass, and wiestreem muhly) and giant ragweed. Larvae hatch and will feed on weed hosts and continue moving to larger-stemmed hosts, including corn, as they continue to grow.

Twospotted spider mites mostly overwinter in sheltered areas of field margins and generally cause economic damage during years of drought. Infestations usually begin at field edges as the mites move from the weeds on which they overwintered into soybean fields. However, during the summer of 2005, we learned that infestations of spider mites in many areas began within fields because the females had overwintered on weeds such as henbit and chickweed. The presence of these weeds throughout the winter and early spring gave the spider mite populations a host to survive on during dry conditions. In fields that were sprayed with glyphosate just as soybean seedlings were emerging, spider mite populations moved from the dying weeds to healthy soybean seedlings.

We can utilize degree-day accumulations to predict both insect activity and emergence of summer annuals. The presence of weeds in early spring can be easy to control with the use of burndown herbicides (see the Bulletin April 15, 2005, no. 4, article 9, “Considerations for Controlling Existing Vegetation Before Planting”). It is important to remember that these weeds are a suitable host for many early-season insects. This may allow for the buildup of these insect populations before the crops emerge this spring, leading to potential problems later in the season.

Figure 1. Current degree-days (base 48°F) from January 1 to April 10, 2006.

Figure 2. Relative emergence of weeds based on GDDs (base 48°F).

true armyworm moth captures reach impressive levels in kentucky
sense to become more familiar with scouting procedures and economic thresholds for armyworm larvae in pastures, small grains, and seedling corn. Doug anticipates finding armyworm caterpillars as early as April 18; however, he believes armyworm larvae will become much more “detectable” by April 27. For producers in southern Illinois, these dates suggest that scouting is just around the corner.

Ron Hines, Dixon Springs Agricultural Center, reported that the first true armyworm moths were captured on March 16 in Pope County and on March 17 in Fayette County. On April 4, 16 true armyworm moths were captured, so the flight intensity of this insect pest appears to be increasing. So far, the captures in Illinois are still well below those reported by Doug Johnson. By going to www.ipm.uiuc.edu/pubs/hines_report/index.html, you can keep informed weekly of the true armyworm flight this spring across southern Illinois. Trap captures for other insects, such as black cutworms, also are reported by Ron. By going to another useful Web site—www.sws.uiuc.edu/warm/pestdata/—you can keep track of accumulating pest degree-days and optimize your scouting efforts for true armyworms and other insect pests.

Many readers may recall how widespread armyworm infestations were in 2001. Pastures in many areas of the Midwest suffered significant damage that year. Armyworm moths migrate into Illinois on the same prevailing winds and storm fronts that are used by black cutworm moths. Moths seek rank grass on which to deposit eggs, so wheat fields and corn planted into a grass cover crop or into grassy weeds are prime candidates for armyworm infestations. Corn planted no-till into a rye cover crop is especially prone to severe armyworm problems.

True armyworm larvae often go unnoticed until the injury is obvious. However, the small, young larvae can be found if you look for them carefully. Young larvae are pale green, although longitudinal stripes are apparent, and the head is yellowish brown. They move in a looping motion. Older larvae are greenish brown and more prominently striped. You can usually see a narrow, broken stripe along the center of the back and three stripes along each side of the body, at least one of which appears pale orange. The tan head is mottled with dark brown. Each proleg (one of the false, peglike legs on the abdomen of a caterpillar) has a dark band.

Insecticide products for armyworm control in pastures are limited. The 2006 Illinois Agricultural Pest Management Handbook lists Sevin XLR Plus (1 quart product per acre) as an option. If an outbreak of true armyworms does occur, we will provide more information regarding scouting procedures and control options for corn and wheat. Please let us know if armyworms begin to cause significant problems in your area.—Mike Gray

Anticipating Alfalfa Weevils

For a long time now, we and entomologists throughout North America have been using degree-day accumulations to keep track of alfalfa weevil development and predict occurrences in their life cycle. In the Bulletin last week (issue no. 2, April 7, 2006), Kelly Cook provided a table showing the relationship between accumulated degree-days and alfalfa weevil development. She also encouraged readers to visit the Degree-Day Calculator at www.ipm.uiuc.edu/degree-days. I echo her encouragement.

The calculator enables anyone to obtain current and predictive information about alfalfa weevil development in any area of Illinois. Click on Degree-Day Calculator in the upper left corner, then choose between the calculator and maps to obtain different types of information. For example, we no longer publish maps of degree-day accumulations in the Bulletin because more timely maps can be obtained at the Web site. On the date that I wrote this article (April 12, 2006), the degree-day accumulations through April 21 revealed that 300 degree-days (base 48°F) had accumulated anywhere south of a line from St. Louis (west) to Carmi in White County (west). However, by the time you read this, the map will have been updated, so you can obtain more recent information. The maps for 1-week and 2-week projections also are updated as 2006 temperatures are included with historical temperature data. Obviously, if temperatures are warmer than “average,” alfalfa weevil development will accelerate, and the 1-week and 2-week projections will change accordingly.

If you prefer to obtain information for specific regions of Illinois, you can use the Degree-Day Calculator to determine actual degree-day accumulation and 1-week and 2-week projected totals for 18 different locations (indicated on the map). This information is adjusted regularly as current weather data are added.

Thus far, reports of significant alfalfa weevil activity have been few and far between. Most people have found only small instars, with evidence of their feeding identified as pinholes in the leaves. We encourage continued scouting, with tips as outlined in Kelly Cook’s article. Warmer weather will speed things up considerably.—Kevin Steffey

PLANT DISEASES

Section 18 Label Granted for the Fungicide Folicur to Control Fusarium Head Blight (Scab) on Wheat in Illinois in 2006

A Section 18 label (see p. 22) was granted by the U.S. EPA on April 5, 2006, for use of the foliar fungicide Folicur to manage Fusarium head blight (scab) on wheat in Illinois. The fungicide Folicur 3.6F (tebuconazole) is manufactured by Bayer Crop Science. Applicators must have the Section 18 label in their possession at the time of pesticide application. All application directions, restrictions, and precautions on the EPA-registered Section 18 product label must be followed.
This product can be used in Illinois only up to June 20, 2006. One application may be made per year using ground or aerial equipment at a rate of 4 fluid ounces of formulated product per acre. Application may not be made within 30 days of harvest. Straw cut after harvest may be used for feed or bedding. Timely application is critical. For Folicur to effectively manage scab and reduce the mycotoxin DON in grain, the product must be applied after full head emergence and into the beginning of flowering. Applications made prior to full head emergence and after flowering is complete will not achieve satisfactory control of scab and DON. —Suzanne Bissonnette

Winter Wheat Disease Virus Update

Some concerns have trickled in about purpling of the winter wheat in some fields. Could this be virus disease?

Early-Season Wheat Virus Disease

Varietal characteristics, nutrient imbalances, and viral diseases can all cause leaf discoloration this time of year. If viruses are going to be a problem, symptoms should be well evident by now. The most common virus diseases early in the spring are barley yellow dwarf virus (BYDV), wheat streak mosaic virus (WSMV), and soilborne wheat mosaic virus (SBWMV). Each can cause damage to the plants, with BYDV being the most damaging in Illinois.

Barley yellow dwarf virus (BYDV) and cereal yellow dwarf virus (CYDV):
Aphids spread BYD and CYD disease. Aphids carrying the virus transmit the virus to wheat plants through their saliva when they feed. The most serious yield loss results from fall infection by viruliferous aphids feeding on wheat seedlings. Fall infections typically result in stunted plants and fewer tillers when spring growth resumes. Leaf discoloration is usually the most notable early-season symptom. Leaves may be varying shades of red to purple, pinkish yellow to brown. As the plant continues to grow, older leaves typically begin to die back from the tip and may feel somewhat leathery, while the new leaves begin to discolor. Spring infections occur as well, but they commonly only discolor the flag leaf and do not cause significant yield reductions. There were three strains of BYDV: MAV (mild), PAV (serious), and RPV (more serious). However, for numerous biological reasons the BYDV-RPV strain has been renamed and put in the cereal yellow dwarf group; its acronym is now CYDV-RPV. Both BYDV-PAV and CYDV-RPV are common in Illinois. Testing of plant material for BYDV or CYDV should include tests for both BYDV-PAV and CYDV-RPV (formerly known as BYDV-RPV) to be certain that a virus is causing the symptomology and then to determine which one is responsible.

Soilborne wheat mosaic virus: The other most common disease causing leaf discoloration this time of year is SBWMV. It is usually one of the first plant diseases reported in the spring. An unusual aspect of the disease is the mode of transmission to wheat plants. The virus is transmitted to the plant by a soilborne fungus. The virus is carried in the fungus, and when the fungus enters wheat roots it transmits the virus. The fungus, a water mold, favors low, wet areas of the field, which is usually where the disease is first seen. Plants infected with SBWMV can show two types of symptoms. The first is leaf mottling, which appears as a light green and light yellow mosaic on the leaves. The mottling will only be seen very early in the season. The second symptom is stunting to the point where the wheat plant looks like a rosette when growth begins in the spring. Under good growing conditions the infected plants may recover somewhat. SBWMV is not commonly a yield-reducing disease, because higher spring temperatures inactivate the virus and symptoms do not then appear on new leaves. Yield reductions with SBWMV are uncommon except where extremely susceptible plants are present. Most wheat varieties are resistant to this pathogen, although that can vary.

Wheat streak mosaic: Initial foliar symptoms of wheat streak mosaic virus, also known as yellow mosaic virus, typically show up in the spring, too. The pattern of the disease in the field is tied to the distribution of its vector, the wheat curl mite (Aceria tulipae). Affected wheat plants are typically stunted, with mottled, streaked leaves. The streaks consist of yellow discontinuous dashes running parallel to the veins. Leaves heavily infested with mites tend to remain upright, and the margins of the leaf may roll inward. Symptoms tend to get worse as the weather warms up, and severely infected plants may produce sterile heads or die. Yield loss is related to when infection took place. Plants with fall infection can experience severe yield loss; early spring infection, light to moderate losses; and infection after jointing, minimal losses.

Life Cycle

Viral diseases of wheat usually produce symptoms in newer growth. Viruses typically cause stunting of plants as well as discoloration of leaves, with the most common colors being red or yellow. In some viruses, streaking of the leaves or a mosaic pattern also can be seen. Viruses are unusual pathogens because they neither require a food source nor do they have the typical physiological processes associated with other biotic pathogens. Viruses are vectored to plant cells, release their genetic material, and cause the plant cell to replicate more copies of the virus. Most viruses consist of only a genetic and a protective protein outer coat. Once inside plant cells, the virus sheds the protein coat, and the genetic material begins replicating the virus.

Management

The most common method of virus management is to plant resistant wheat varieties. These varieties do not allow virus replication to occur, and the infection is stopped early. Other control measures are directed at reducing the time the plants are in the field when vectors are active, which explains the recommendation to plant after the fly-
Folicur® 3.6 F Foliar Fungicide

For Use on Wheat to suppress Fusarium head blight (scab).

SECTION 18 SPECIFIC EXEMPTION

File Symbol: 06-IL-03

FOR DISTRIBUTION AND USE ONLY IN THE STATE OF ILLINOIS UNDER SECTION 18 SPECIFIC EXEMPTION

This labeling must be in possession of the user at the time of pesticide application. It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Read entire Directions for Use and Disclaimer of Warranties before using this product. Follow all applicable directions, restrictions, Worker Protection Standard requirements, and precautions on the registered product label for Folicur® 3.6 F Foliar Fungicide (EPA Registration Number 264-752).

Any adverse effects resulting from the use of Folicur® 3.6 F Foliar Fungicide under this specific exemption must be immediately reported to the State of Illinois Department of Agriculture.

EFFECTIVE PERIOD:

This labeling becomes effective 04/05/06 and expires on 06/20/06.

DIRECTIONS FOR USE

A maximum of 250,000 acres of wheat may be treated under this exemption.

RECOMMENDED APPLICATIONS

<table>
<thead>
<tr>
<th>CROP</th>
<th>DISEASES</th>
<th>RATE OF FOLICUR® 3.6 F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat (including durum)</td>
<td>Fusarium head blight (scab)</td>
<td>4 fl oz per acre</td>
</tr>
</tbody>
</table>

Apply Folicur® 3.6 F as a preventive foliar spray. For optimum disease suppression, the lowest rate of a spray surfactant should be tank-mixed with Folicur® 3.6 F. Folicur® 3.6 F may be applied in a minimum of 10 gallons of spray solution per acre by ground sprayer or in a minimum of 3 gallons of spray solution per acre by aircraft spray equipment.

Application through any type of irrigation equipment is prohibited.

A maximum of 1 application per season may be made. A maximum of 4 fl oz of Folicur® 3.6 F may be applied per acre per crop season. Folicur® may be applied up through the beginning of flowering (Feekes 10.51). Application may not be made within 30 days of harvest. Straw cut after harvest may be fed or used for bedding. Do not enter treated field for 12 hours after application.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to freshwater, estuarine and marine fish and invertebrates. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Runoff may be hazardous to aquatic organisms in neighboring areas. Do not contaminate water when disposing of equipment washwater or rinsate.

For MEDICAL And TRANSPORTATION Emergencies ONLY Call 24 Hours A Day 1-800-334-7577
For PRODUCT USE Information Call 1-866-99BAYER (1-866-992-2937)
or
Visit our worldwide web site at www.bayercropscienceus.com

As with any crop-protection product, always read and follow label directions. For additional information call toll-free 1-866-99BAYER (1-866-992-2937).
free date, when insect activity is reduced. Systemic insecticide seed treatments have also shown some success.

**Putting the Pieces Together for Diagnosis**

So which virus may be in the field? First, rule out any other problem that may have caused the symptoms, such as winterkill, nutrient imbalances, or herbicide carryover. This is probably the most important step. Next, find out what virus resistance the variety is supposed to express. There is good resistance to SBWMV in most of our varieties, whereas good resistance to BYDV and CYDV is lacking. If those things don’t help, then the pattern may help you decide. BYDV and CYDV usually first show up in the field as a typical insect-type pattern. Infected patches occur randomly or are associated with places where viruliferous aphids may have been feeding, such as grassy areas on field edges. Also, BYDV and CYDV infections depend completely on aphid movement, and symptoms can continue to spread throughout the season. SBWMV, on the other hand, will most typically be associated only with low, wet areas of a field, and symptoms will not continue to spread throughout the season. Rarely do we see virus infection all across a field or the same type of virus symptoms exhibited on both grasses and dicots in the same area.

**Testing Tissue for Virus Particles**

The Plant Clinic at the University of Illinois and our Digital Diagnostic System can only make a visual estimation of the presence of a virus in a wheat plant. We cannot tell you which virus is actually present based on the visible symptoms. To have a virus positively identified, you must send virus-infected tissue to a lab such as AgDia (www.agdia.com) for serological testing. Fresh plant material is needed for serological analysis because the tests use fresh plant sap.

**Answering the Question**

So what about the fields with the purple leaves? The fields I mentioned at the outset exhibited purpling throughout the field. Weeds in the field and near edges were purple, too. Low areas seem worse and unpurpling doesn’t seem to be happening very fast as temperatures warm up. Of our viruses in Illinois that might cause that type of leaf symptom, BYDV and CYDV would be the top suspects. To be absolutely certain a virus isn’t involved, a tissue sample would need to be tested. However, the symptomology suggests not virus infection but rather an environmental or nutrient issue.—Suzanne Bissonnette

---

**WEEDS**

**The Illinois Outlook: Can It Happen Here?**

Since the commercialization of glyphosate-resistant crops, the question of whether glyphosate-resistant weeds will be selected has been extensively bandied around by individuals involved in virtually all phases of production agriculture. Those in academia have (generally) agreed on at least two points: (1) the potential for selecting weed biotypes resistant to glyphosate is less than that associated with selecting biotypes resistant to other herbicide families, and (2) never say it will never happen. Many agrichemical retailers initially expressed high satisfaction with the weed control provided by glyphosate, but some are currently very concerned with what may be described as a “reduced consistency” of performance. Some manufacturers of glyphosate initially expressed confidence that glyphosate-resistant weeds would not become an issue farmers or agrichemical retailers would have to contend with, whereas others voiced near-apocalyptic concerns about the likely consequences of overreliance on a single active ingredient. Whichever position you might have taken on this question during the early years of glyphosate use in-crop, the facts are as follows: Glyphosate-resistant weed populations have been selected; these resistant populations represent more than one weed species; several states, from the East Coast to the West Coast, have reported instances of glyphosate-resistant weeds; and we have no evidence to suggest that Illinois will be immune to this phenomenon (see Table 1).

**Table 1. Chronology of glyphosate-resistant weeds around the world**

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Location and year identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rigid ryegrass</td>
<td>Lolium rigidum</td>
<td>Australia (Victoria) 1996</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Australia (New South Wales) 1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>California 1998</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Australia (South Australia) 2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South Africa 2001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Malaysia 1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delaware 2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kentucky, Tennessee 2001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Missouri, Indiana, Maryland,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New Jersey, Ohio 2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arkansas, Mississippi, North</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carolina, Ohio, Pennsylvania</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2003</td>
</tr>
<tr>
<td>Italian ryegrass</td>
<td>Lolium multiflorum</td>
<td>California 2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chile 2001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brazil 2003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oregon 2004</td>
</tr>
<tr>
<td>Buckhorn plantain</td>
<td>Plantago lanceolata</td>
<td>South Africa 2003</td>
</tr>
<tr>
<td>Hairy fleabane</td>
<td>Conyza bonariensis</td>
<td>South Africa 2003</td>
</tr>
<tr>
<td>Common ragweed</td>
<td>Ambrosia artemisiifolia</td>
<td>Missouri, Arkansas 2004</td>
</tr>
<tr>
<td>Palmer amaranth</td>
<td>Amaranthus palmeri</td>
<td>Georgia 2005</td>
</tr>
</tbody>
</table>
An important step in avoiding the problems caused by herbicide-resistant weeds is to understand how a resistant weed population develops. Evidence suggests that herbicide-resistant weeds are naturally occurring biotypes that initially exist in very low numbers within the population of a particular weed species. Plants that possess certain traits or characteristics not common to the entire species are referred to as biotypes. When a particular herbicide effectively controls the majority of susceptible members of a species, only those plants that possess a resistance trait can survive and produce seed for future generations. This is often referred to as the selection theory, or (to borrow a phrase from Darwin) “survival of the fittest.” Biological organisms (e.g., people, plants, animals) are diverse. The plants in a population that possess characteristics enabling them to survive under a wide range of environmental and other adverse conditions (such as herbicide applications) will be able to produce seed that maintains these survival characteristics. Plants less adapted generally do not survive, and hence only the fittest plants reproduce.

What, then, is meant by the phrase “selection pressure” with respect to herbicide-resistant weeds? Most herbicides are used to control a broad spectrum of weeds. By controlling susceptible members of a weed population, we are essentially using herbicides as agents to select for biotypes that are naturally resistant to the herbicide. These resistant biotypes are better adapted to survive in the environment created by controlling susceptible members of the population. The seed produced by the resistant biotypes ensures that the resistance trait will carry on to future generations. If the same or a similar herbicide is used repeatedly (year after year or several times during the growing season), the resistant biotypes continue to thrive, eventually outnumbering the normal (susceptible) population. In other words, relying on the same herbicide for weed control creates a selection pressure that favors the development of herbicide-resistant weeds.

The development of herbicide-resistant weed populations may thus be summarized by the following sentence: The appearance of herbicide-resistant weeds is the consequence of repeatedly using the same or similar herbicides (usually a herbicide with a single site of action) to control a specific weed species not controlled by any other herbicide or in any other manner. The process of selection for herbicide-resistant biotypes begins the first time a particular herbicide active ingredient is applied to any given field.

In April 2005, we reported on three horseweed (Conyza canadensis) populations from Illinois that were not controlled with glyphosate in greenhouse experiments. The populations we have examined originated from three counties: Douglas, McLean, and Schuyler. Only one of these populations was sent to us by a concerned farmer who noted poor control of horseweed after a burndown application of glyphosate in 2004. The other two populations were collected during weed survey and collection campaigns in 2004. The geographic dispersion of these populations suggests there may not be a “concentrated” area of concern in the state but rather that farmers and applicators across Illinois should remain vigilant. Glyphosate-resistant horseweed was first identified in Delaware in 2000. Since that initial discovery, glyphosate-resistant horseweed populations have been identified in 11 other states, including our neighbors Indiana and Missouri. Weed scientists in the 12 states where the populations are known to exist have conducted extensive field, greenhouse, and laboratory experiments to further our understanding of the mechanism the plants use to survive glyphosate as well as how best to manage these resistant populations under field conditions.

To date, horseweed has been the only weed species we have identified from Illinois fields with resistance to glyphosate. Arguably, farmers have many viable alternative herbicides for control of glyphosate-resistant horseweed (at least before soybean planting). But will there be viable alternatives for control of other glyphosate-resistant species? What if glyphosate resistance became predominant in another annual weed species? If glyphosate-resistant species are not common in Illinois at this time, should Illinois farmers be concerned? Are there “new” instances of glyphosate resistance Illinois farmers should be aware of?

At least one biotype of Palmer amaranth (Amaranthus palmeri) in Georgia demonstrates resistance to glyphosate. This population was identified growing in a field of glyphosate-resistant cotton, and weed scientists at the University of Georgia estimate this biotype currently infests approximately 500 acres. Palmer amaranth is a summer annual species of pigweed. It is an aggressive species that can reach heights of 4 to 7 feet and produce large amounts of seed. Research has demonstrated that among the pigweed species common to the Midwest, Palmer amaranth has the fastest growth rate and is the most competitive with row crops. The occurrence of glyphosate-resistant Palmer amaranth in Georgia (and suspected cases in other states) should raise awareness among Illinois farmers because (1) this example illustrates resistance to glyphosate can occur in a summer annual weed species that is very competitive with corn and soybean and (2) Palmer amaranth is indigenous to Illinois. If glyphosate-resistant Palmer amaranth can occur in other states, it seems likely that it can occur in Illinois.

The example of glyphosate-resistant Palmer amaranth may not elicit great concern or provide sufficient evidence to justify a significant change in weed management practices in Illinois because the species is not tremendously widespread here. Horseweed resistant to glyphosate may cause some level of concern, but that species is generally more of a problem before planting than after crop emergence, and preplant tillage remains an effective man-
agement option. What if some other summer annual weed species with resistance to glyphosate were to be discovered? Would glyphosate-resistant waterhemp be more of a concern? Is it at all possible that glyphosate-resistant waterhemp could become a problem for Illinois farmers? Farmers in Missouri may face this scenario before Illinois farmers do. Researchers at the University of Missouri have reported two populations of waterhemp that have consistently survived after glyphosate applications under field and greenhouse conditions. News releases from Missouri reported that some of these waterhemp plants survived up to 6 lb a.e. glyphosate (a rate approximately equivalent to 170 fluid ounces of Roundup Original Max). If glyphosate-resistant waterhemp can occur in other states, it seems likely that it can occur in Illinois.

Will these “new” cases of glyphosate-resistant weeds be sufficient to persuade changes to weed management programs in Illinois, especially in soybean production? Only time will provide an accurate answer. However, we continue to stress several points related to glyphosate-resistant weeds and glyphosate stewardship:

1. A selection pressure for herbicide-resistant weeds occurs each time the same herbicide is applied to a particular field. Slogans such as “dead weeds don’t make seeds” or “use the right rate at the right time” could be interpreted as overlooking the fact that simply using the herbicide results in selection for herbicide-resistant weeds.

2. Increased adoption of glyphosate-resistant corn hybrids, with a concomitant use of glyphosate to the exclusion of other weed management tools, will speed the selection of glyphosate-resistant weeds.

3. Rotating herbicides (sites of action) or tank-mixing herbicides will help slow the selection of glyphosate-resistant weeds, but it is unlikely to completely prevent their selection. Keep in mind that it’s nearly impossible to make blanket statements about how effective a particular alternative herbicide or tank-mix partner will be in slowing the selection of glyphosate-resistant weeds.

4. Stewardship of glyphosate herbicide is a concept easy to discuss but more difficult to implement. Manufacturers often have differing messages about stewardship, but it may be wise to ask yourself why a particular manufacturer seems to be concerned with stewardship of glyphosate.

In summary, the preponderance of evidence suggests it is only a matter of time until glyphosate-resistant weeds begin to occupy additional places in the Illinois agronomic landscape. The pace of introduction of new herbicide active ingredients has slowed considerably since the commercialization of glyphosate-resistant crops, so there may not be a novel herbicide solution available to farmers should glyphosate-resistant weeds become increasingly common and problematic. Farmers and retailers alike will likely experience adverse financial consequences as a result of continued heavy reliance on a single herbicide active ingredient.—Aaron Hager and Dawn Nordby

Know What’s Planted Where

The adoption of corn hybrids with resistance to various herbicide classes undoubtedly will increase during 2006. These hybrids may offer several advantages for weed management, but farmers should remember there are few silver bullets or cure-alls, if any, for managing weeds. We offer these reminders early in the season with the hope that certain problems (nowadays generally referred to as “opportunities” instead) can be avoided later in the season.

1. Know which hybrid has resistance to which herbicide(s) and where it’s planted. In other words, remember to match the herbicide to the herbicide-resistance trait of the particular hybrid in a given field. The three most common herbicide-resistance traits in today’s corn hybrids are glyphosate resistance (RR), glufosinate resistance (LL), and imidazolinone resistance (CF). While the names glyphosate and glufosinate may look and perhaps sound similar, the herbicides are dissimilar enough that a farmer will not be pleased should a field of glufosinate-resistant corn be treated with glyphosate, or vice versa. Some corn hybrids are resistant to both glyphosate and glufosinate, but be certain to check the seed-bag tag to know if the hybrid you are planting has resistance to one or both of these herbicides.

2. If you are planting a hybrid with resistance traits for corn rootworm and herbicide(s), take care to record what hybrid is planted as the refuge. For example, if a rootworm/glyphosate-resistant hybrid is planted, will the refuge be planted with a glyphosate-resistant or conventional hybrid? If a glyphosate-resistant hybrid is planted as the refuge, the entire field can be treated with a postemergence application of glyphosate. However, if the refuge is planted with a conventional hybrid and a postemergence herbicide application becomes necessary, a nonglyphosate-containing product must be used.

3. Plan ahead for the control of volunteer herbicide-resistant corn in herbicide-resistant soybean. For example, if a glyphosate-resistant corn hybrid was planted in a particular field in 2005 and that same field will be planted with a glyphosate-resistant soybean variety in 2006, volunteer glyphosate-resistant corn will not be effectively controlled with glyphosate. Control of volunteer glyphosate-resistant corn in soybean can be achieved with certain soil-applied herbicides or with postemergence herbicides such as clethodim, quizalofop, and so on.—Aaron Hager and Dawn Nordby

When Corn Follows Corn

If the drop in corn acreage and increase in soybean acreage in Illinois
take place as expected this year, there will be less corn following corn in Illinois than there was in 2005. Still, some producers have continuous corn on a major part of their acreage now, and as long as there are more corn acres than soybean acres, some corn will follow corn.

While there is considerable debate about the yield consequences of corn following corn compared to corn following soybean, most planned, direct comparisons of these two systems continue to show some yield penalty when corn follows corn. This is not very consistent—there is little or no penalty in some years and a large one in others. Agronomists have spent decades trying to explain and alleviate this penalty, but to date no one has found the magic answer. Over the past decade, all of my research shows that corn following corn has yielded about 10 percent less than corn following soybean. That “rule of thumb” yield penalty has remained about the same for decades, and though we know that this average covers a range from 0 to 100 bushels per acre, it still is the yield loss that a producer should expect on average when making the conversion from corn following soybean to corn following corn.

At the same time, many (probably most) producers and consultants are absolutely convinced that there is no such yield penalty and that researchers simply don’t know how to manage to get the same or even higher yields when corn follows corn. Such a contention gets support from the fact that many corn-yield contest winners use the same field year after year, which suggests to many people that corn in such fields actually gets better the more years the field is in corn. In none of our studies have we seen a consistent improvement in yield of corn following corn as compared to corn following soybean, so if this actually happens, it is masked completely by year-to-year variation. Nor do we see this penalty strongly correlated to yield level, meaning that a high yield of corn following soybean does not automatically mean less yield penalty for corn following corn.

How do we explain what seems to be a serious gap in understanding of such a common system of corn production? We probably can’t do so yet, but one reason for this is that most producers who raise corn following corn do so first on their more productive fields, so yield expectations are already somewhat higher. The common idea that corn following corn improves with the number of years of continuous corn is to some extent reinforced by the fact that our expectations for yield change with time, and after a few years we have no real basis for comparison to corn following soybean, so there is little reason to imagine what a yield penalty might have been, especially when yields are high. But the best approach is, I think, still summed up by the producer who told me several years ago that he makes more money from corn following corn even if it does yield 10 percent less than corn following soybean.

If we are planting corn following corn in 2006, what should we do differently than if corn follows soybean? In general, not very much, but the following are some points to consider:

- Hybrid selection for corn following corn remains a rather inexact science. In the past 2 years, we have had hybrid trials of corn following corn at three locations, and in only one of the six trials did we find good correlation between yields of the same set of hybrids following corn and following soybean. Most seed companies will suggest certain of their hybrids for corn following corn, but this set of hybrids tends to overlap with the set suggested for corn following soybean, and it tends to include the best hybrids offered by the company. Given that there tends to be somewhat more stress on corn following corn (perhaps related to root growth), choosing “defensive” hybrids for corn following corn might make sense. But most producers are reluctant to “play it safe” this way if they feel that the more defensive hybrids will yield less under good conditions. Characteristics that lead to high yield are important no matter what the preceding crop was.

- If corn yields were much reduced by dry weather in 2005, corn following corn in 2006 has a few advantages. First, there is less crop residue, so there should be less underground “interference” for this year’s crop. Remember to give credit for unused nitrogen from last year: We suggest taking the difference between application rate in 2005 (include N from DAP or MAP applied in the fall of 2004) and the actual yield in 2005, then reducing the N rate this year by half this difference. If last year’s crop received 200 lb of N and yielded 100 bushels, then the credit this year would be half the difference, or 50 lb of N. It’s likely that part of this credit is due to less tie-up by the reduced crop residue.

- Because most fields with corn following corn were tilled last fall, working and planting them this spring will be slightly different from planting into less-tilled soybean stubble. Be sure to avoid working these fields when it’s too wet. We think that roots of corn following corn typically find more barriers to growth than when corn follows soybean, and some of this might be related to working deep-tilled fields sooner than they should be.

- Related to the previous point, corn following corn tends to respond more to management practices, such as protection from rootworm, that protect the roots and provide conditions for good root growth. Strong-rooted hybrids might be another way to help corn that follows corn, but this should not be the only basis for selection.

- While our new N rate guidelines are formulated using the results of research done in corn following corn, they still show higher N rates for corn following corn, especially in northern Illinois. The fact that we still see slightly more N needed when yields of corn following corn are high suggests that we use N rates in the upper part of the suggested range when we are pro-
Plant populations should not be different for corn following corn and corn following soybean. Most producers should be aiming to establish 28,000 to 32,000 plants per acre on average to above-average fields. Uniformity of seed placement is important regardless of the previous crop, though what it takes to get that might differ if the previous crop was corn. In particular, root balls or clumps of residue can be problems for seed placement. Uniformity of plant spacing down the row is not of much concern if stands are good.

- There may be reason to watch fields more closely for fungal diseases when corn follows corn, especially if there is significant residue left on the surface after planting. The severity of diseases like gray leaf spot may be affected as much by tillage method and air movement (for example, fields bordered by trees) as by previous crop, though.

Finally, the data we have collected over the past 2 years indicate some possible promise of the corn–corn–soybean rotation. We do not find that second-year corn yields less than continuous corn, and in some cases it has yielded more. For producers without highly productive fields to convert to continuous corn, using the corn–corn–soybean rotations might be a good option. Stand by for more information on this study.—Emerson Nafziger

Extension center educators, unit educators, and unit assistants in northern, west-central, east-central, and southern Illinois prepare regional reports to provide more localized insight into pest situations and crop conditions in Illinois. The reports will keep you up to date on situations in field and forage crops as they develop throughout the season. The regions have been defined broadly to include the agricultural statistics districts as designated by the Illinois Agricultural Statistics Service, with slight modifications:

- North (Northwest and Northeast districts, plus Stark and Marshall counties)
- West-central (West and West Southwest districts, and Peoria, Woodford, Tazewell, Mason, Menard, and Logan counties from the Central district)
- East-central (East and East Southeast districts [except Marion, Clay, Richland, and Lawrence counties], McLean, DeWitt, and Macon counties from the Central district)
- South (Southwest and Southeast districts, and Marion, Clay, Richland, and Lawrence counties from the East Southeast district)

We hope these reports will provide additional benefits for staying current as the season progresses.

Northern Illinois

Most of the region received about 1 to 1.3 inches of precipitation during the week ending April 9. However, field activity has been constant since early in the week, including anhydrous ammonia application, broadcast fertilizer application, applying soil-applied herbicides, and tillage operations. Also, some oat and alfalfa seeding has occurred.

Extension educators will be monitoring black cutworm moth traps throughout the region, and moth captures will be reported in future issues of the Bulletin.

Southern Illinois

Wet weather in late March and early April has kept most growers out of the field to any major extent. More progress has been made on sandier soils in the river bottoms in the southeast and southwest, but many of the poorly drained clay pan soils are still too wet. Some nitrogen has been applied to fields going into corn this spring, but the majority has yet to go on. As of April 11, drier fields in the extreme south have been planted, but fieldwork is just beginning on the better-drained soils in the northern part of the region.

Most fields have heavy infestations of winter annual weeds and will be attractive egg-laying sites for black cutworm moths. Ron Hines at the Dixon Springs Agricultural Center reported an intense capture of cutworm moths in Pulaski County the week of April 4, but activity during the past week has been low. This situation may rapidly change as heavy winds blow out of the south this week.

Wheat is at Feeke’s stage 6 in the northern part of the region and at Feeke’s stage 7 in the south. Most fields appear to be in excellent condition, although Septoria leaf blotch is prevalent in many fields. Winter annual weed infestations are also high, indicting that spring herbicide applications have not yet been made.

Alfalfa growth is around 6 to 10 inches. Alfalfa weevils have hatched throughout the region, and growers should begin scouting fields for this pest now.

West-Central Illinois

Recent warm weather has started to get the wheat really growing. Most is in the late tillering stage and looking very good. Corn planting has started in the river bottoms on the western side of the state and should be in full swing starting April 15. Most farmers have been reluctant to start planting until the last few days, as temperatures were still very cool and frequent rains prevented many from getting started. Main activities this week seem to be applying spring anhydrous, dry fertilizer, and chemicals.

The first black cutworms have been caught in a few traps this past week.
Contributing Authors

Suzanne Bissonnette (sbissonn@uiuc.edu), Champaign Extension Center, (217)333-4901

Kelly Cook (kcook8@uiuc.edu), Extension Entomology, (217)333-6651

Mike Gray (megray@uiuc.edu), Extension Entomology, (217)333-6652

Aaron Hager (hager@uiuc.edu), Extension Weed Science, (217)333-4424

Emerson D. Nafziger (ednaf@uiuc.edu), Crop Sciences, (217)333-4424

Dawn Nordby (dnordby@uiuc.edu), Extension Weed Science, (217)333-4424

Kevin Steffey (ksteffey@uiuc.edu), Extension Entomology, (217)333-6652