Agronomy Day 2013

August 15 • 7 a.m.–2 p.m.

Crop Sciences Research and Education Center (South Farms)
University of Illinois Urbana, Illinois

agronomyday.cropsci.illinois.edu
LET’S GROW
It’s time to register again for 2013

What could your community do with $2,500? America’s Farmers Grow CommunitiesSM, presented by the Monsanto Fund, gives eligible farmers the opportunity to win $2,500 for their favorite community nonprofit organization. One winner will be selected in each eligible county – 1,289 counties in all.

Register at GrowCommunities.com or call 1-877-267-3332. Registration ends November 30, 2013.

PLANT YOUR IDEA

People in eligible counties have the opportunity to suggest an idea or initiative for a farmer to consider in his/her America’s Farmers Grow CommunitiesSM application.

Plant the seed on GrowCommunities.com and inspire a farmer in your community to support your nonprofit organization and its cause.
Agriculture is rapidly advancing to meet the needs of our growing world population. As our industry continues to evolve, the University of Illinois Department of Crop Sciences is prepared to educate and prepare tomorrow’s leaders while supporting and equipping current industry leaders with the latest technology and techniques to improve food and fuel production.

The 57th annual Agronomy Day provides countless opportunities for growers, industry representatives, business owners, researchers, and the general public to discover the latest research findings from the Department of Crop Sciences. From plant breeding and pest control to biomass production and horticulture, our department is leading the way in education, research, and extension.

But don’t just take my word for it. Interact with our researchers and extension specialists and enjoy their presentations. Ask the crop sciences students on site to tell you about the various courses and opportunities they are offered. When our students graduate, they often have more than one lucrative job opportunity waiting. The demand for U of I graduates is high, and the future looks even more promising.

Jonathan Baldwin Turner Hall, the home to the Department of Crop Sciences, continues to play an essential role in training the next generation of scientists, whose ingenuity and insights will address the needs of a growing global population. Given that this building is now 50 years old, structural renovations, new equipment, and technology updates are needed. An exciting new campus-wide initiative to transform classrooms and laboratories is providing seed funding to renovate and transform Turner Hall’s crops and soils classrooms into state-of-the-art teaching spaces. However, state dollars alone cannot fulfill the vision and the need. Your investment in this public-private partnership is critical. Stop by our display in the large tent to find out more, or visit the Turner Hall Project website at advancement.aces.illinois.edu/turner.

Agronomy Day is a partnership among several academic units in the College of Agricultural, Consumer and Environmental Sciences (ACES). This event is our way of reporting directly to the citizens of Illinois on the scope, value, and importance of our programs.

We are delighted to have you join us today, and we hope to see you again soon!

Best Regards,

Germán A. Bollero
Head of the Department of Crop Sciences
gbollero@illinois.edu, 217-333-9480
Welcome to the Crop Sciences Research and Education Center

Agronomic research has always been conducted on or near the University of Illinois. From 1876 to 1931, most field research was conducted on what we know as “campus proper.” This involved work on the Davenport Plots (sacrificed in 1930 to allow the expansion of Goodwin Avenue), which were located directly east of the Morrow Plots. From 1920 to 1936, the Department of Agronomy used the land west of the stadium to the Illinois Central tracks.

The development of the present research farm can be traced back to the turn of the 19th century; field operations began here in 1903. The original Agronomy Farm consisted of the 80 acres that lie directly south of the Seedhouse, completed in 1930. Since then, the area, which became known as the South Farms, has expanded slowly but steadily in size to its present 1,300 acres. The Seedhouse still serves as the headquarters for farm operations.

In 1984, the farm operations of the Department of Agronomy were combined with those of the Department of Plant Pathology. In 1995, the college reorganized, merging those two departments into one unit: the Department of Crop Sciences. The research facility received a new name at the same time: the Crop Sciences Research and Education Center (CSREC).

The CSREC’s mission is to provide land, equipment, and facilities for plant and soil research in a field laboratory setting close to campus. The CSREC assists scientists and extension personnel by providing a central place from which to plan, coordinate, and conduct field research. It supports on-campus teaching by providing field laboratory facilities for graduate students and by educating undergraduates through work and field trip experiences.

Extension and international agricultural efforts are strengthened by field days, specialized tours, and training sessions to meet the needs of the agricultural community. Agronomy Day provides a direct link between the agricultural grower, the consumer, and the research scientist.

The first Agronomy Day was held on June 27, 1957, with the same objective as the one you are attending today—to communicate research results that benefit our clientele.

Enjoy your visit today. We invite you back at any time to view ongoing research projects.

Sincerely,
Robert Dunker
Agronomist and Superintendent
Crop Sciences Research and Education Center
r-dunker@illinois.edu, 217-244-5444
MORE CHOICE, HIGHER YIELD.
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Farm Credit is proud to support Agronomy Day!

An acre of corn removes 8 tons of harmful greenhouse gas, more than that produced by your car annually.

Source: EPA

Justin Durdan family, Utica, IL

Farmers count on COUNTRY and rate us highly

As a result of our response to last year’s drought, our clients provided the highest customer service marks our company has received in recent years. We’re proud of our commitment to farmers and will continue to bring you the service you deserve at a price you can afford.
Kellogg Company’s corporate responsibility efforts aim to help create even better days and brighter tomorrows for our consumers, customers, employees, communities and environment.

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Over the past few years, we’ve sought to work more closely with the farmers who grow our grains – to build relationships with them, learn about their growing practices and the sustainability improvements they’ve already made, and work together to drive future improvements.

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Planned renovations:
- Exterior improvements
- Interior updates for classrooms and teaching labs
- Soils Laboratory
- Crops Laboratory
- Renovating teaching labs and classrooms to improve student learning environment
- $10-million project—includes exterior and interior improvements

The College of Agricultural, Consumer and Environmental Sciences would like to thank The Dow Chemical Company Foundation for its investment of $2.5 million in support of the Turner Hall and Chem Annex renovations. Competitive facilities and technology will help our faculty prepare our students to answer the most critical questions of today and tomorrow.

The university is dedicating $5 million; we are seeking $5 million more in gifts from alumni, friends, and corporations. Consider a memorial gift for an individual such as Ted Peck or A.W. Burger.

Turner Hall Project Co-Chairs: Jerry Brookhart and William F. Kirk, Jr.

We need your support!
For more information or to get involved as a volunteer or donor, please contact:

Marise Robbins-Forbes, Director of Development, mforbes@illinois.edu
Barry Dickerson, Senior Director of Development, bdickerson@illinois.edu

217.333.9355 • advancement.aces.illinois.edu/turner

Campus is investing in this public–private partnership, but state dollars alone cannot fulfill the vision.
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Increased nitrogen use efficiency (NUE) is an important factor for future maize improvement, where both higher yields with current N levels and lower N inputs are desirable. To design an effective breeding program for enhanced NUE, it is essential to understand past progress, variation among our current maize germplasm, and proper field testing for NUE. Previous research from our lab has documented variation for NUE and its component agronomic traits that represent a yield range of more than 100 bu/acre. This variation exists among a diverse collection of historical and recent elite maize inbreds and hybrids grown in field trials with different levels of soil N supply.

By examining the component traits of NUE using a comprehensive partition-based field sampling technique, we have confirmed previously reported trends for modern elite compared to historical hybrids, where grain yields have increased as a result of superior tolerance to higher plant densities, greater harvest index, and reductions in grain protein concentration (Figure 1). We have also found that past breeding has likely optimized nitrogen uptake for high grain yields but that significant opportunities exist to further improve how maize plants utilize acquired nitrogen (NUtE). However, the genetic basis for these traits is not known.

Recent advances in functional genomics have allowed us to take a targeted approach to improving N utilization. After the 2009 release of the maize genome, the Moose Functional Genomics Laboratory identified nine "NitroGenes" involved in nitrogen cycling in maize. Field testing showed that these NitroGenes impact important traits such as stover nitrogen content, grain nitrogen concentration, and kernel number. Individually, no NitroGene had a positive effect greater than 2.5
bu/acre when tested in low N environments. We reasoned that combining the favorable NitroGenes by a breeding approach may improve nitrogen utilization, grain yield, and possibly other agronomic traits.

To test this approach, 2012 field trials included the 20 lines from our population with the highest number of favorable NitroGenes across the nine regions and the 20 lines with the lowest number. Termed “enriched” and “depleted,” these populations represent the theoretical changes that could be made when selecting for changes in these nine NitroGenes simultaneously. Preliminary results indicate the hybrids "enriched" for favorable NitroGenes produced higher average nitrogen utilization when grown with either low or high levels of N supply. Enrichment can result in an 8.8% increase in NUtE within this population, corresponding to a yield increase of 6.9% (Figure 2). Low nitrogen availability enhanced the mean differential between populations by forcing the plants to rely on their efficiency to maintain a healthy plant nutrient status.

Current field trials include replication of these "enriched" and "depleted" populations as well as breeding efforts to enhance the number of favorable NitroGenes in one inbred to increase the efficiency of transfer to other corn germplasm. As we’ve shown, NUE is a trait that can have a considerable impact on grain yield, but it is not a single-gene trait that can be easily used in a breeding population. Results from our previous field season indicate that our strategy to pyramid NitroGenes is a viable option for improving NUE and nitrogen-dependent yield traits in our population, which could be translated to current elite germplasm.

Figure 1. Hybrids representative of historical maize improvement were grown in replicated field trials for three years in Champaign, Illinois, in a nitrogen-responsive field. Trends show increased grain yields (light orange bars), reduced stover biomass (blue bars) and decreased grain protein concentration (dark orange bars). Total N uptake (aqua bars) increases at high N, but it has not changed over time.

Figure 2. The chart shows yield change in bushels per acre and the change in N utilization efficiency (NUE) between the populations enriched and depleted for the nine positive NitroGenes. When grown in a low-N environment, the 20 enriched hybrids had a 6.9% increase in average yield and an 8.8% increase in NUtE over the 20 depleted hybrids.
Soybean disease and pest resistance for today and the future

Soybean (*Glycine max*) is one of the most important crops in the U.S., produced on 77.2 million acres and valued at over $43.1 billion in 2012 [nass.usda.gov](http://nass.usda.gov). Illinois is responsible for 13% of the total U.S. soybean production. Yields are limited by stresses both abiotic, including nutrient deficiency, flooding, and drought, and biotic, including those caused by pathogens and pests. In 2010, soybean diseases incurred an estimated yield loss of 478 million bushels, costing U.S. producers approximately $4.7 billion in losses.

As world population increases, so does demand for food production. Scientists are researching ways to increase crop yields while acknowledging land and climatic restraints. Reducing losses caused by pathogens and pests by implementing crop protection practices is imperative to optimize yields. Crop protection includes biological, chemical, and cultural methods. For soybeans, both host resistance and pesticide applications are commonly used to control pathogens and pests. Our research focuses on finding new sources of resistance in soybean and its wild relatives that can be used in breeding programs to develop resistant cultivars and reporting results of evaluations of commercial soybean cultivars to the public. Part of this research involves developing efficient and effective pathogen and pest resistance screening of soybean germplasm accessions and its relatives.

The USDA soybean germplasm collection at the University of Illinois houses approximately 20,000 different soybean accessions and its wild relatives from all over the world. Within these 20,000 accessions, many sources of resistance have already been discovered and genes transferred into commercial soybean cultivars; however, there is still a need to find additional resistance sources to economically important pathogens and pests. To accommodate such large-scale pathogen resistance evaluations, we are working to develop fast, accurate methods of screening in field, greenhouse, and laboratory conditions. Methods have already been established and are being applied to screen for resistance to diseases such as charcoal rot, *Phytophthora* root rot, *Sclerotinia* stem rot, *Soybean mosaic virus*, soybean rust, and sudden death syndrome, and for pests such as the soybean aphid (Figures 3A, 3B, 3C, and 3D).

**Development of resistance screening methodology**

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**Discovery of resistance in wild relatives of soybean**

Soybeans were domesticated from the wild annual *Glycine soja*. Since *G. soja* is vulnerable to pathogens that attack soybeans, accessions of this species are evaluated for resistance. Although variability exists in the *G. max* and *G. soja* germplasm, additional pathogen and pest resistance traits may be found in other soybean relatives, such as perennial species in the same genus as soybean. These relatives can be affected by many of the same pathogens and pests as soybean, and crosses can be made, though with some difficulty, between soybean and these species. For that reason they are the subject of investigation when searching for new sources of pathogen and pest resistance.
that eventually could be incorporated into commercial soybeans. We are currently developing screening techniques applicable to these species as we screen the USDA germplasm collection for sources of novel resistance to diseases and pests including soybean cyst nematode, charcoal rot, Phytophthora root rot, and soybean rust. We hope to discover traits useful to protecting soybean yields from damage caused by diseases and pests.

**Varietal Information Program for Soybeans: Pathogen and pest evaluation**

Since 1998, the Illinois Soybean Association (www.ilsoy.org) has provided funds to screen commercial soybeans for various traits, including disease and pest resistance. Known as the Varietal Information Program for Soybeans, or VIPS, this work is conducted annually at the University of Illinois as part of the Variety Testing program and provides unbiased disease and pest results to growers (www.vipsoybeans.org). VIPS provides side-by-side variety performance comparisons of soybean lines from different companies. Since 1998 VIPS has screened cultivars in 12 different pathogen and pest experiments, though not every test is performed every year. The five evaluations conducted most consistently are for Phytophthora root rot, Sclerotinia stem rot, soybean aphid, **Soybean mosaic virus**, and sudden death syndrome. These five tests, each with a unique method of inoculation, rating for resistance, and timeline, will be conducted in 2013 trials. Upon completion, data are analyzed and published as an impartial, comparative resource available to soybean growers when making variety selections for the following year.

**Acknowledgments:**

Illinois Soybean Association, North Central Soybean Research Program, United Soybean Board

**Laboratory for Soybean Disease Research website:**

www.soydiseases.illinois.edu
Managing Fusarium head blight (scab) of wheat

Fusarium head blight (FHB), also known as “scab,” is a disease of wheat that can cause loss of both yield and quality. Symptoms appear as “bleached heads” or heads with both green and bleached areas (Figure 4). The fungus *Fusarium graminearum* (aka *Gibberella zeae*) causes FHB of wheat and can cause Gibberella stalk and ear rot of corn. The fungus also produces the toxin deoxynivalenol (DON, or vomitoxin), which can contaminate grain and be a serious problem for millers. Weather is an extremely important factor in the development of FHB, especially from flowering through kernel development. Moderate temperatures (75 to 85 °F), prolonged periods of high humidity, and prolonged wet periods favor FHB development.

Successfully managing FHB requires an integrated approach, where the use of resistant varieties, better crop sequences, and fungicides can limit losses due to FHB:

**Resistant varieties.** Although no varieties are immune to FHB, some are more resistant than others. The University of Illinois Winter Wheat Breeding Program has been developing wheat varieties with partial resistance to FHB. In addition, the University of Illinois Wheat Breeding Program has been rating wheat varieties for FHB severity under high-pressure FHB environments over multiple years. These ratings are available online at the University of Illinois Variety Testing site, located in the “Small Grains” section (vt.cropsci.uiuc.edu).

**Cropping sequence.** Because corn stubble can harbor the FHB fungus (Figure 5A), wheat following soybean is at a lower risk of developing FHB than wheat following corn.

Figure 4. Symptoms of Fusarium head blight of wheat. Photo courtesy of Carl Bradley.
Foliar fungicides. Multiple fungicides are registered for use on wheat, but only a few are effective in managing FHB. Fungicides available for FHB management all belong to the triazole class: Caramba (BASF Corp.), Prosaro (Bayer CropScience), Prolin (Bayer CropScience), and products that contain tebuconazole as their solo active ingredient. Of these products, the best efficacy in multistate university field research trials has been obtained with Prosaro and Caramba. Proper application timing is critical in achieving the best efficacy. The best timing is considered to be when plants are beginning to flower (early anthesis; Feekes growth stage 10.5.1; Figure 5B). It also is important to spray with nozzles oriented to spray forward, which helps cover the wheat head. In the past, recommendations were to use nozzles that sprayed both forward and backward; however, recent research out of North Dakota State University has shown that "forward-facing" nozzles may be all that are needed.

Fungicides that contain an active ingredient in the "strobilurin" class should never be applied to control FHB. This includes products like Headline, Quadris, Quilt, and Stratego. Research has shown that strobilurin fungicides can actually increase DON levels in harvested grain. These strobilurin products are very good at controlling foliar diseases of wheat; if used, they should be applied earlier in the season.

FHB forecasting. To help with fungicide application decisions, see the Fusarium Head Blight Prediction Center at www.wheatscab.psu.edu. A "risk map," developed based on weather conditions that have occurred, shows the risk of FHB throughout Illinois (Figure 6).

Integrated management. The best control of FHB and DON occurs when all of the management practices described here are integrated.

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Application timing</th>
<th>% control of FHB*</th>
</tr>
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<tbody>
<tr>
<td>Prosaro at 6.5 fl oz</td>
<td>Feekes 10.5</td>
<td>35 b</td>
</tr>
<tr>
<td>Prosaro at 6.5 fl oz</td>
<td>Feekes 10.5.1</td>
<td>59 a</td>
</tr>
<tr>
<td>Prosaro at 6.5 fl oz</td>
<td>5 days after Feekes 10.5.1</td>
<td>37 b</td>
</tr>
<tr>
<td>Caramba at 13.5 fl oz</td>
<td>Feekes 10.5</td>
<td>38 b</td>
</tr>
<tr>
<td>Caramba at 13.5 fl oz</td>
<td>Feekes 10.5.1</td>
<td>61 a</td>
</tr>
<tr>
<td>Caramba at 13.5 fl oz</td>
<td>5 days after Feekes 10.5.1</td>
<td>36 b</td>
</tr>
</tbody>
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* Values followed by the same letter are not significantly different; 95% confidence.

Figure 5A. Fruiting bodies (perithecia, observed as “black dots”) of the wheat scab fungus on a corn stalk. Photo courtesy of Carl Bradley.

Figure 5B. Results summary of University of Illinois fungicide trials on wheat.

Figure 6. Screen capture of the Fusarium head blight prediction tool from May 9, 2013 (available at www.wheatscab.psu.edu).

Acknowledgments

Funding from the U.S. Wheat & Barley Scab Initiative supports research on Fusarium head blight at the University of Illinois.
How many corn plants do we need?

Surveys show that corn plant populations in the Corn Belt have increased steadily over the past three decades, with harvested populations now averaging about 30,000 plants per acre. Many producers in more productive fields are planting between 32,000 and 40,000 seeds per acre, and some are planting more than that in search of higher yields.

There’s a near-universal belief among corn producers, especially those on productive soils, that “high yields require high populations,” though the definitions of “high” are vague. It’s not unusual to hear statements to the effect that yields above 250 bushels per acre aren’t possible if populations are only in the low 30,000s. Even among producers already planting 36,000 to 40,000 seeds per acre, there’s a thought that high yields resulting from good growing conditions would have been even higher with more plants per acre.

The increase in corn plant populations over the past decades took place not because it took producers a long time to realize they were not maximizing yields at lower populations; rather, experience had shown that corn hybrids often reacted poorly to higher populations. Older hybrids often lodged or showed a lot of barrenness when planted at populations of 25,000 or more. Studies comparing old and new hybrids at different populations have shown clearly that both yield about the same at populations of 10,000 or so per acre, but that older hybrids do not do nearly as well as newer hybrids at 30,000 plants per acre. The conclusion is that newer hybrids are more stress-tolerant, meaning that they do not go barren or fall over at high populations, but rather continue to form grain.

Because we don’t have to worry much about today’s corn hybrids going barren or falling flat at high populations, we can concentrate on trying to find the “best” plant population. We’ll define that as the population where the yield increase from adding plants is just enough to pay for the seed needed to add them. One way to think about this is to consider how many seeds one bushel of extra yield will “buy.” At a seed cost of $3.75 per thousand seeds ($300 per 80,000-kernel unit) and corn at $6.50 per bushel, one bushel of yield will buy 1,733 seeds. So adding that many plants would have to increase yield by 1 bushel per acre just to break even.

As plant population increases, both kernel weight and the numbers of kernels per bushel decrease, but the decrease in kernel number is much greater than the decrease in kernel size (Figure 7). So yield is maximized at the point where kernel numbers per ear are dropping at the same rate that the number of ears per acre is increasing. Under high-yielding conditions, this normally occurs in the range of mid-30,000 plants per acre.

The past two years have been relatively dry in most parts of Illinois, though there have been some very good yields in places. Plant population studies that we have been conducting in the state in recent years have shown that the response to population under lower-yielding conditions tends to flatten out at populations in the high 20,000s or low 30,000s, while under higher-yielding conditions we have seen responses up to the low 40,000s (Figure 8). In a few cases, taking populations up to 50,000 plants per acre has resulted in yields lower than those at lower populations.

The average response to plant population over 20 trials in recent years shows that yield leveled off at only about 32,000 plants per acre (Figure 9). Though we know that the average contains some sites where yields responded to populations higher than this, it is clear that the population response in the mid-30,000s is relatively flat, even in high-yielding fields. This means that, while risks of having populations too high in most cases involve only the cost of seed, it is also clear that pushing populations up into the 40,000s is unlikely to increase yields, and it is even less likely to pay for the seed.
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- Food and Environmental Systems

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Western corn rootworm management in the midst of Bt resistance and surging soil insecticide use

In a US EPA memorandum on January 17, 2013, a resistance management team reported that “since 2009, reports of heavy corn rootworm damage in Cry3Bb1 fields have been recorded in at least 23 counties in the Corn Belt” (Figure 10). In July 2011, Dr. Aaron Gassmann and his colleagues at Iowa State University reported in a peer-reviewed journal article the field evolution of western corn rootworm resistance to the Cry3Bb1 protein in some northeastern Iowa continuous cornfields. This resistance confirmation was based on the use of plant bioassays in which larvae from field-collected adults obtained from heavily damaged Bt continuous corn production systems were exposed to root tissue expressing the Cry3Bb1 protein. The US EPA memorandum made this statement: “The published literature cited in the October 11, 2012, review has documented instances of field failures and has concluded that populations collected from those fields in Iowa and Illinois have resistance to Cry3Bb1 based on on-plant diagnostic assays. The IRM team concurs with those conclusions.” Because the regulatory definition of confirmed resistance has not been met, no remedial actions have been implemented (US EPA Memorandum, October 11, 2012, page 19). However, the current regulatory definition of confirmed resistance (based upon a diet bioassay approach) is “flawed” according to US EPA, and the IRM team considers the Gassmann plant bioassay “a better scientific approach.” In 2013, more results from plant bioassays will become available from cooperating land grant entomologists from several Corn Belt states, and we should have a better assessment of the scope of western corn rootworm resistance to the Cry3Bb1 protein.

Use of Bt hybrids remains very high across Illinois this season, according to producers surveyed at the Corn and Soybean Classics in January 2013. On average, some 92% indicated they would plant a Bt hybrid for corn rootworm protection this year (Figure 11). A very significant shift took place in 2013: nearly 75% of the surveyed producers (Figure 12) intended to use a seed blend (RIB, or refuge-in-a-bag) approach this season (5% RIB: 43% of producers; 10% RIB: 31%). Historically, a 20% structured refuge has been the standard. With the introduction of pyramided Bt hybrids to the marketplace, US EPA has...
consented to smaller refuges in the form of seed blends. Even though a seed blend refuge has resistance-management advantages for western corn rootworms, the reduction in refuge size has many entomologists concerned, particularly in areas of the Corn Belt where Cry3Bb1 resistance has been confirmed. The primary worry is that the effectiveness of other Cry proteins, such as Cry34/35Ab1, may be compromised more quickly in these areas.

In response to continuing concerns over Bt resistance, some producers are opting to use a soil-applied (at-planting) insecticide along with their corn rootworm Bt hybrid in 2013. Nearly 47% of producers surveyed at the 2013 Classics indicated they intended to follow this practice (Figure 13). Other factors, such as secondary insects, were cited as additional reasons for this approach (Figure 14). Approximately one in four producers indicated they view the use of a corn rootworm Bt hybrid and a planting-time soil insecticide as cheap insurance, a view enhanced by the high commodity prices in recent years.

In 2012, Preston Schrader began research in two producers’ fields (LaSalle and Whiteside counties) that had severe corn rootworm damage in 2011. Both fields were planted that year with Bt hybrids that expressed the Cry3Bb1 protein. Because this protein should have provided satisfactory root protection, the level of damage was not expected by either producer. Both producers had been using a continuous corn production system and had not rotated crops or traits for several years. In 2012, several Bt hybrids expressing different Cry proteins were planted in each of the producers’ fields. Root injury ratings (July 2012) and beetle emergence data were obtained from each field. Beetle weights and head capsule width measurements were taken on emerging male and female western corn rootworm adults from each treatment, and emergence cages were checked twice per week during the adult emergence period. These beetle parameters—weights and head capsule widths—are often used to assess any potential fitness costs that may arise in resistant beetle populations. Some of these data will be shared with producers at this year’s Agronomy Day. In addition, updates on the evolving resistance saga by western corn rootworms across the Corn Belt will be shared.
Monitoring Bt-resistant western corn rootworms in Illinois

The Multistate Rootworm Resistance Monitoring Project is supported by funding from the North Central Regional Agricultural Experiment Station Directors to J.L. Spencer and M.E. Gray.

Publication of the first scientific, peer-reviewed confirmation of field-evolved western corn rootworm (WCR) resistance to the Cry3Bb1 toxin expressed in some Bt corn hybrids (Gassman et al., 2011) initiated intense efforts to study and respond to Bt resistance. An immediate challenge facing Corn Belt scientists and growers was the lack of publicly available information about the resistance status of WCR beetles emerging from Bt cornfields with greater-than-expected damage. In addition, the absence of specific local and regional data regarding the geographical distribution of potentially Bt-resistant WCR populations made it difficult for extension personnel to deliver tailored information and IPM recommendations to growers with questions about the local risk of resistance.

Members of the USDA regional committees dealing with below-ground and above-ground pests of corn, NCCC-46 and NC-205, responded to the challenge of the rootworm resistance data gap by developing a protocol to collect objective data on the resistance status of WCR populations originating in Bt cornfields showing greater-than-expected damage. In early summer 2012, the directors of North Central Regional Agricultural Experiment Stations provided funding to support the NCCC-46 and NC-205 standardized corn rootworm resistance bioassay program. The project began immediately, with collection of WCR beetles from fields with unexpectedly high levels of damage to Bt rootworm-protected corn. Public sector corn insect research programs in Iowa, Nebraska, Minnesota, South Dakota, and Illinois are all involved in screening the corn rootworm populations for resistance; a parallel program is also underway in Ontario, Canada.

With cooperation from industry, large numbers of WCR beetles were collected from three Illinois Bt cornfields that experienced greater-than-expected injury in Sangamon, McDonough, and Mercer Counties in summer 2012. Adults were also collected from control cornfields without unexpected injury or any suspected Bt resistance. Eggs were collected from the beetles (additional eggs were also obtained from Bt-susceptible control USDA lab colonies) and stored so that the populations could be tested using the same single-plant Bt-resistance bioassay that Iowa State University researchers originally used to document Bt resistance in the WCR.

Those bioassays are now underway. The basis of the standardized bioassay is a comparison of WCR larval survival between suspected-Bt resistant and Bt-susceptible control populations when reared on a Bt hybrid expressing a specific Cry toxin and an isoline/near-isoline hybrid that does not express the specific Cry toxin. The field and control populations are all tested for their survival on Bt corn roots expressing each of the three rootworm-specific Bt toxins (Cry3Bb1, Cry34/35Ab1, or mCry3A) that are currently available on the market; industry cooperators located and helped provide these Bt and isoline corn hybrids. If larvae from a test population survive exposure to a Bt toxin in a significantly greater proportion than larvae from a control population, resistance to that Bt toxin is indicated.

The availability of these data will directly benefit growers, extension personnel, public sector researchers, EPA, and industry. Ultimately, these findings will also inform the larger discussion among all of these stakeholder groups about the practical, scientific, and regulatory definitions of resistance. Documenting where WCR Bt resistance is occurring is fundamental to understanding the circumstances leading to resistance, to developing effective strategies to predict and mitigate the spread of resistance, and to designing IPM recommendations that provide value to growers and promote long-term, sustainable management of pest rootworms.

Reference

Figure 15. Severe lodging caused by western corn rootworm larvae to Bt corn expressing the Cry3Bb1 protein (northwestern Illinois, August 16, 2011). Photo courtesy of M.E. Gray.
Evaluating the suppression of soybean diseases through the use of cover crops

Though soybean diseases cause significant annual reductions in yield, soybean production relies on only three limited disease management strategies—crop rotation, resistant varieties, and fungicides—and additional strategies are needed to supplement and prolong their usefulness. Cover crops used in corn–soybean rotations are being evaluated for their effects on weed management, soil erosion, and soil health, but they may also be useful in suppressing disease development. Some cover crops are known to produce allelopathic and glucosinolate compounds, which impact soilborne pathogen levels and soil microbial populations, resulting in increased disease suppression. In this project, growers, researchers, and extension personnel are collaborating in university and on-farm trials in western, east-central, and southern Illinois to evaluate the efficacy and feasibility of using cover crops for disease suppression in soybeans.

The three-year project was initiated in the fall of 2010 with funding from the North Central Sustainable Agriculture Research and Education (NC-SARE) program. Cover crops are planted in the fall after corn harvest. After establishment in the fall and growth in the spring, the cover crops are killed and/or incorporated into the soil several weeks before planting a soybean crop. The cover crops being evaluated in this study include cereal rye, rapeseed, canola, mustard, and a fallow control. Larger on-farm trials are comparing just the rye, rapeseed, and fallow treatments. Trials at the University of Illinois include an added dimension of intentional inoculation with two soybean pathogens, Rhizoctonia solani, causal agent of Rhizoctonia root rot, and Fusarium virguliforme, causal agent of sudden death syndrome (SDS).

The soybean plantings are evaluated for stand establishment, early season seedling blights and foliar diseases, late season diseases, and yield. Soil is also collected and evaluated for pathogen populations and the composition of the microbial community that may suppress pathogens.

Results from the 2011 and 2012 growing seasons have been somewhat mixed, but several promising outcomes have been observed. In 2011, the fallow plots at the University of Illinois that were inoculated with Rhizoctonia solani showed a significant level of preemergence damping off, while the stand counts in the inoculated plots previously planted to rye were not much different from the noninoculated control plots (Figure 16). We did not observe the same level of damping off in the 2012 growing season, but the soybean plant in the rye plots showed fewer symptoms of Rhizoctonia root rot in that season as well (Figure 17). [Continued on page 22.]

Figure 16. Stand establishment of soybeans planted into plots infested with Rhizoctonia solani following fall-planted cover crop treatments. Many seedlings in the fallow plots suffered from preemergence damping-off, while seedling emergence in the rye plots was not different from the noninoculated control. Stands in the rapeseed treatment plots were intermediate between those in the rye and fallow treatment plots. Photos courtesy of Darin Eastburn.

Figure 17. Severity of Rhizoctonia root rot on soybean plants in the 2012 U of I trial was significantly lower in the rye treatment plots than the fallow treatment plots. Severity levels in the rapeseed and canola treatment plots were intermediate.
Some suppression of the foliar disease, Septoria brown spot, was also observed in one of the on-farm trials (Figure 18).

Soils collected from the cover crop plots were evaluated in greenhouse studies to determine the level of suppression to the two soybean diseases, Rhizoctonia root rot and SDS. Differences in suppression associated with cover crop treatments were observed at some locations in some years to both pathogens. Increased suppressiveness to *R. solani* was observed in soils collected from rye plots at two different locations (central and western Illinois) in 2012. Increased suppressiveness to *R. solani* was also seen in soils collected from the rape and mustard plots in the Western Illinois University plots. Increased levels of suppressiveness to SDS were seen in soils collected from the rape and rye plots at one or more locations in 2012.

The study is currently in its third and final year. The information learned from this project will help growers in Illinois better evaluate the benefits of including cover crops in their rotation schedules. The information will also help plant pathologists design more effective and durable practices for managing problematic soybean diseases.

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**Evaluating the suppression of soybean diseases through the use of cover crops**

*Continued from page 21.*

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### Strategies to reduce nutrient loss in Illinois

We have already set some records in 2013, but not the kind we were looking for. Figure 19 shows flooded fields and high water flow in a drainage ditch following heavy rains in April. In addition, record-high levels of nitrate have been measured at several midwestern stream monitoring sites. The drought of 2012 that produced low corn yields also meant that more residual nitrate was left in the soil after harvest. The wet spring in 2013 resulted in some of the highest concentrations of nitrate recorded in long-term sampling projects. For example, water samples collected from the Embarras River at Camargo, Illinois, on May 13 had a nitrate concentration of 17 parts per million (ppm), the highest level in 20 years of monitoring. Similarly, nitrate samples from the Kaskaskia River at Atwood, Illinois, broke a 15-year record of 21 ppm. In Iowa, the Des Moines Water Works reported that nitrate concentrations in the Raccoon River set a new record at 24 ppm, while the Des Moines River reached 14 ppm this spring. The U.S. Geological Survey (USGS) recently installed several real-time nitrate sampling stations, and nitrate data will now be available instantaneously. Data from Indian Creek near Fairbury, Illinois, are shown in Figure 20. More information is available at waterdata.usgs.gov/il/nwis/rt.

The Illinois EPA is developing a strategy to prioritize watersheds.

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[Figure 18. In an on-farm trial in 2012, incidence levels of the foliar disease Septoria brown spot were significantly lower in the rye treatment plots than the fallow treatment plots.](#)

[Figure 20. Discharge and nitrate plus nitrite concentrations from the USGS website.](#)
statewide for nitrogen and phosphorus load reductions. The first step is to assess current conditions and nutrient loads from point and non-point sources. Since drainage and water resources vary considerably across the state, it makes sense to do this analysis on a more local scale. The USGS developed a system of maps showing hydrologic boundaries to describe drainage areas that range from large regions to small subwatersheds. They created the hydrologic unit code (HUC), which reflects the relative size of the area. Figure 21 shows the 8-digit HUCs that will be used to identify priority areas.

The next step is to evaluate practices that minimize nutrient loss, such as best management practices (BMPs), stewardship programs, edge-of-field treatment, cover crops, and land use changes, along with the estimated cost for adopting these changes. A range of scenarios will then be developed to meet nutrient reduction targets. Scenarios will be based on major land resource areas (MLRAs) that the Natural Resources Conservation Service has established to help with statewide agricultural planning.

In most cases, a combination of practices will be needed to achieve water quality goals, and they will likely vary depending on soils, topography, and individual farm operation. Unfortunately, there is no quick and easy solution for addressing water quality impacts of agriculture. Changes in production techniques and installation of conservation practices targeted at improving water quality in both tile-drained and non-drained regions will be needed across millions of acres to make significant reductions in nutrient losses across the state.
Will corn and soybean costs come down?

Non-land costs reached record high levels in 2012. A central question is whether costs will decline when commodity prices decline.

Data from Illinois Farm Business Farm Management indicate that non-land costs for corn in central Illinois on high-productivity farmland averaged $581 per acre in 2012, up $78 per acre from 2011 (Figure 22). In 2005, non-land costs averaged $287 per acre, then increased to $302 in 2006, $341 in 2007, $428 in 2008, and $534 in 2009. High costs in 2009 occurred because of high fertilizer prices and high drying costs resulting from a wet crop. Costs then declined to $452 per acre in 2010. After the decrease in 2010, non-land costs again rose to $503 per acre in 2011 and $581 in 2012.

The trend for soybeans is similar (Figure 22). Non-land costs increased each year from 2005 to 2009: $187 per acre in 2005, $190 in 2006, $207 in 2007, $253 in 2008, and $290 in 2009. Costs then decreased in 2010 to $273 per acre. Costs again increased in 2011 to $303 per acre and in 2012 to $353 per acre.

Implications for break-even corn prices

Higher non-land costs mean higher break-even prices for corn and soybean. Break-even prices are estimated for cash-rent farmland with a rent of $300 per acre. Higher cash rents will result in higher break-even prices and vice versa.

At a 195-bushel yield for corn, the break-even price to cover all costs is $4.52 per bushel ([$581 non-land costs + $300 cash rent] / 195 bushel corn yield). There are significant possibilities that cash prices will be below that break-even level.

At a 57-bushel yield for soybeans, the break-even price to cover all costs is $11.46 per bushel ([$353 non-land costs + $300 cash rent] / 57 bushel corn yield). Similar to corn, there are significant possibilities that future cash prices will be below that break-even level.

Cost-decrease possibilities

It is possible that non-land costs could decrease if prices decrease in the future. Insights into this potential can be gained by examining cost components. Three components accounted for 75% of the increase in corn costs from 2005 to 2012:

- Fertilizer costs increased from $78 per acre in 2005 to $200 in 2012, an increase of $122. There are some reasons to believe that fertilizer costs could decrease. Nitrogen fertilizer capacity is being built, which could lead to lower nitrogen fertilizer prices. From 2011 to 2012, fertilizer costs remained relatively stable. This may indicate that farmers built up phosphorus and potash soil levels, which could be drawn down in future years.
- Seed costs increased from $43 in 2005 to $108 per acre in 2012, an increase of $65. Decreasing seed prices would cause technology companies’ profits to decline, so reductions in seed costs are unlikely.
- Machinery depreciation increased from $20 per acre in 2005 to $55 in 2012, an increase of $35. Higher machinery purchases lead to increases in depreciation costs. A period of lower incomes could lead to lower machinery purchases, which would then lead to slowly declining depreciation.

Summary

Both non-land costs and cash rents have increased in recent years. Because higher prices are required to cover costs, these higher costs place farms at risk when commodity prices decrease. There is potential for some costs to decrease when commodity prices decrease. Cash rents likely will have to decrease as well to cover any future price declines.
Vegetable soybean: Overcoming hurdles to domestic production

Vegetable soybeans, also known as edamame, are special cultivars of soybean that are harvested near the R6 (“full seed”) stage, and the plump, immature seeds are consumed as a vegetable. Like grain-type soybean, edamame seeds are high in protein and low in fat. However, edamame requires almost no processing and is easy to prepare, nutritious, and delicious. Currently, we import most of the edamame consumed in the U.S., but that is changing.

Growing U.S. demand could be filled domestically

China, believed to be the largest supplier of edamame to the U.S., is the world’s largest producer, consumer, and exporter of edamame. U.S. consumption of frozen edamame increased from 20 million pounds in 2000 to some 80 million pounds by 2008, and it continues to grow rapidly. The United Soybean Board forecasts edamame to grow larger than other soy products by 2020. A number of major vegetable processors are investigating the prospect of feeding the growing U.S. demand with domestic product. From 2011 to 2012, several of these companies increased their edamame acreage by 100 percent or more, and they appear poised to continue expanding over the next few years.

However, a number of challenges to production exist, including lack of improved varieties adapted to various U.S. growing regions and crop losses due to pests, particularly weeds.

Research to improve weed management is underway

Because weeds are a major threat to U.S. edamame production, we are researching ways to improve weed management. In the last three years we have evaluated more than 120 entries of commercial or public edamame germplasm for response to herbicides being considered for use on the crop and agronomic traits important to commercial production. Additional field studies are being used to quantify effectiveness of different integrated weed management systems.

Soybean pesticides can’t necessarily be used on edamame

Pesticides registered for use on soybean are not necessarily registered for use on edamame. The time from pesticide application to harvest can be much shorter for edamame, and the U.S. Environmental Protection Agency considers edamame a different crop. Edamame is in crop subgroup 6A (edible-podded legume vegetables), along with snap beans and snow peas. Currently only four herbicide active ingredients have a federal label for use on edamame: clethodim, linuron, s-metolachlor, and trifluralin. A federal label for use of fomesafen on edamame is expected for the 2014 growing season. A list of registered herbicides is maintained at martywilliamslab.com.

Figure 23. In the last 20 years, Chinese edamame breeders have released some 50 cultivars. Here, a scientist with the Zhejiang Academy of Agricultural Sciences shows off one of the latest edamame cultivars. Photo courtesy of Marty Williams.

Figure 24. A traditional method of preparing edamame: lightly steamed, then chilled and served. Photo courtesy of Marty Williams.

Figure 25. You’ve never tasted edamame? Drop by this talk for a sample, served up fresh by the World’s Greatest Assistants, who will tell you “Eat the seeds, not the pod!” Photo courtesy of Becky Williams.

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Soybean cyst nematode virulence: An emerging threat to soybean production

The soybean cyst nematode (SCN) is the most damaging pathogen of soybean in Illinois. Soybean yield loss due to SCN is currently managed with crop rotations using “SCN-resistant” soybean varieties. As in many plant pathogen systems, host-plant resistance, when available, is a cost-effective and environmentally sound method of nematode control. SCN-resistant soybean varieties are a valuable natural resource, and protecting their effectiveness is important for sustainable soybean production.

SCN virulence (the ability of a nematode to grow on a resistant plant) was noted soon after SCN was discovered in the United States. That is, some SCN populations could reproduce on resistant soybean, rendering them less effective at suppressing nematode populations. SCN populations in the field are diverse, and they can eventually adapt and grow on any SCN-resistant soybean variety.

Currently, a single source of SCN resistance, derived from PI88788, is used in about 96% of soybeans labeled SCN-resistant. This overuse of one source of resistance means that virulent SCN that grows on soybeans with PI88788-type resistance is increasingly common. This means that SCN virulence is not just scientifically interesting but that, in fact, the understanding of virulence at the field and molecular genetic levels is critical for managing SCN.

It is important to measure the virulence type for any population of SCN, since this will determine which source of SCN resistance is effective at managing the nematode. SCN populations are classified based on their ability or inability to reproduce on different sources of SCN resistance. Currently, virulent SCN are tested for the ability to grow on a set of seven SCN-resistant soybean indicator plants (the Hg-type test). If an SCN population cannot grow on a particular source of SCN resistance, then soybean producers can use this type of resistance to control their populations.

In essence, controlling SCN using resistant soybean is all about matching the field population to the most effective source of resistance. Failure to match SCN virulence with appropriate soybean resistance can cost soybean growers $50 to $100 an acre. SCN virulence is currently assessed by growing a population of SCN taken from a field on the seven SCN resistance indicator lines in a temperature-controlled greenhouse. The Hg-type test, while effective, requires numerous SCN eggs and one to two months to conduct. If the test could be conducted faster and cheaper, then personalized matching of field SCN to the most effective source of SCN resistance could reap the maximum benefits from the SCN-resistant soybean. The SCN virulence trait is controlled by a small number of genes; if they could be identified, a rapid (two-hour), low-cost molecular Hg-type test should be possible.

Recent research in the Department of Crop Sciences has identified regions in the SCN genome that contain virulence genes, so the exact genes will probably be identified very soon, which in turn will allow virulent SCN to be rapidly identified.

In summary, SCN could be sustainably managed if one could quickly and cost-effectively monitor SCN populations for the buildup of highly virulent nematodes; this would allow rotation strategies to be devised that would limit the accumulation of these virulent nematodes. This type of SCN management will protect valuable nematode-resistant soybean varieties and would provide a sustainable, environmentally friendly method of SCN management.
Join us for an exciting global discussion about the future of our food supply.

Learn how University of Illinois College of ACES researchers are engaging in studies to provide solutions to these food security challenges.

**SPEAKERS**

*Finding the best corn plant density*
  Emerson D. Nafziger, Professor of Crop Sciences and Agronomist

*Working with cover crops in Illinois*
  Maria Villamil, Assistant Professor, Sustainable Cropping Systems

*The economics of soybeans: Macro and micro perspectives*
  Peter Goldsmith, Associate Professor and Director, Food and Agribusiness Program

*Herbicide-resistant weeds*
  Patrick Tranel, Professor of Molecular Weed Science

*Managing insect pests of corn in a transgenic landscape*
  Michael Gray, Professor and Assistant Dean, ANR Extension

*The use of exotic germplasm to increase soybean yield*
  Randall Nelson, USDA-ARS Research Leader and Professor of Plant Genetics

Advance registration and payment are required – deadline is Monday, August 19.
Register online at [internationalagronomyday.org](http://internationalagronomyday.org)
Plant density tolerance: Old premise, new research

The world population reached 7 billion people in 2011. By 2100, it is projected that the global population will top 10 billion. In addition, meat consumption is increasing in developing countries with a rapidly growing middle class, like India and China, further raising demand for corn grain as a major source for livestock feed. Despite this growing demand for corn grain, possibilities for developing new agricultural land are limited. Increasing grain demand combined with limited land availability suggests that yield increases will need to be achieved by producing more grain on the same land area. This can be accomplished by increasing the number of plants grown in a given space (plant density) while maintaining "per plant" yield. There is much variability in maize, and not all genotypes can tolerate high plant densities, so the need exists to develop germplasm with such tolerance.

Increasing yields by improving plant density tolerance has historically proven to be successful. While old hybrids and new hybrids yield similarly at low density, new hybrids have a distinct yield advantage at high plant densities. This suggests that higher plant-density tolerance rather than greater yield potential is the main source of yield increase.

High plant density increases the competition for light, water, and nutrients. As plants are increasingly crowded, shading in the canopy occurs, and plant root systems are in closer proximity, so roots from multiple plants compete for water and nutrients. The ability to tolerate abiotic stresses is evidenced as the plant progresses from vegetative to reproductive stages. Characteristics such as ear shoot development, synchronous silking, ear size and structure (Figures 26 and 27), and standability are vital to the goal of maintaining per-plant yield at high planting densities.

Due to the complex nature of yield and considering the importance of the various traits likely to impact yield under the stress of high plant density (barrenness [Figure 28], rows per ear, tassel branch number, etc.), we have taken a top-down approach to explore this complex trait, as there are many possible interactions between traits underpinning grain yield. These various traits that contribute to yield under stress will be simultaneously studied to determine relationships between the traits and the overall impact on plant productivity. An initial plant density survey performed at six densities found six inbreds that were top-yielding at high density in hybrid combination. This initial survey also identified 16 traits that were directly associated with yield at increasing plant densities. Based on this information, we derived a connected mapping population from the six top-yielding parents.
for the purpose of locating regions in the maize genome associated with plant density tolerance. The connected population structure allows us to observe alleles within multiple backgrounds, which will be valuable in a quantitative genetics context to determine genetic regions of interest.

Test-cross hybrids from the connected population were evaluated for a comprehensive set of traits in two locations in the summer season of 2012 (Figure 29). Three more locations are being evaluated this year: two in Urbana, one of which is irrigated, and a third in Monmouth. The agronomic information obtained from the field experiments will be associated with genetic data to map genetic regions involved in the inheritance of high plant density tolerance. This will be the first step to identify genes that are vital to maintaining high yield at high plant density.

Figure 27. These ears are from a hybrid with poor plant density tolerance. The integrity of the ear structure was not maintained, resulting in the “zipper effect” seen on the ear. The ears also suffer from fewer rows per ear and kernels per row, resulting in decreased yield. Photo courtesy of Sarah Potts.

Figure 28. This picture shows a plant that did not produce an ear. High plant density causes inter-plant competition for light, water, and nutrients. As a result, plants can suffer from decreased yield from multiple causes, such as barrenness, decreased ear width, or reduced kernels per row. Photo courtesy of Sarah Potts.

Figure 29. (LEFT) A total of 320 testcross hybrids were planted at two locations in 2012 to evaluate 20 traits associated with plant density tolerance. An additional three locations are being evaluated during the 2013 growing season.
Several species of the genus *Amaranthus* are competitive weeds in various cropping systems of the Midwest (Figure 30A). These weedy pigweeds are often categorized into two groups based on whether male and female flowers occur on the same plant. The monoecious species (with male and female flowers on the same plant)—smooth, redroot, spiny, tumble, prostrate, and Powell—historically have occupied more acres in Illinois than the dioecious species (male and female flowers on separate plants), waterhemp and Palmer amaranth. However, these frequencies essentially have reversed over about the past 15 years. Spiny amaranth is frequently found in pastures and old feedlots, while tumble pigweed and prostrate pigweed are more common in low-growing crops (such as some vegetable cropping systems).

In the early 1990s, smooth pigweed was the *Amaranthus* species most widely distributed across the southern two-thirds of Illinois; redroot and Powell were most common in the northern third. In this same period, waterhemp began to migrate north and east from its historic distribution area, which extended roughly south of Interstate 70 and along the western border of Illinois about as far north as the Quad Cities. Currently, waterhemp is the *Amaranthus* species most widely distributed in Illinois agronomic cropping systems. Anecdotal observations in the past 10 years suggest that it has effectively displaced the other pigweed species from most fields in Illinois.

Several characteristics of waterhemp have contributed to its becoming our most common pigweed species (Figure 30B). Female plants can produce an abundance of very small seeds that are easily distributed within and between fields in myriad ways. These small seeds do not germinate when buried more than about ½ inch deep in the soil, which helps explain why waterhemp thrives in reduced tillage production systems. Germination and emergence can begin as early as late March and persist well into summer, making control very difficult with herbicides that lack soil persistence. Resistance to herbicides from various site-of-action families has become the norm rather than the exception in Illinois waterhemp populations, and this has greatly reduced the number of herbicides that remain viable for control. It’s difficult to imagine another weed species that could adapt to contemporary agronomic productions so effectively, but Palmer amaranth, which shares many of the characteristics that have made waterhemp so common in Illinois, might be it.
Palmer amaranth evolved as a desert-dwelling species in the southwestern United States, including areas of the Sonoran Desert. However, genotypic and phenotypic adaptability have allowed it to expand its distribution and colonize the vastly different agricultural landscapes across much of the eastern half of the country. The presence of Palmer amaranth there is perceived by some as a recent phenomenon, but Dr. Jonathan Sauer, noted expert of *Amaranthus* taxonomy, noted in 1957 that “it looks as if there has been recent and substantial north-eastward expansion of *A. palmeri* resulting in its present wide area of cohabitation with interior species” (Sauer 1957). Will Palmer amaranth populations, likely introduced by seeds moved into Illinois from areas where Palmer amaranth has become the dominant pigweed species, be able to adapt to the growing conditions of Illinois? Perhaps a more important question is to define the damage niche of Palmer amaranth populations in Illinois agronomic cropping systems.

Recent research conducted by Dr. Adam Davis, USDA-ARS plant ecologist at the University of Illinois, has examined these important questions (Figure 31, adapted from McDonald et al. 2009). Results have demonstrated that there are few landscape-level barriers to the establishment of Palmer amaranth populations in Illinois, and that these populations, once established, are competitive with soybean.

References


Phosphorus and potassium placement for no-till and strip-till corn and soybean

Phosphorus (P) and potassium (K) applications represent a substantial cost to corn and soybean producers. Because P and K have low mobility in the soil, placement of these nutrients is often discussed as a management strategy to improve availability to the crops. However, recent studies have shown that tillage method and not placement of P and K is most important for corn and soybean production.

A corn–soybean rotation study (2007–present) with both crops present every year consists of various annual rates of P and K in no-till as broadcast (NTBC), in no-till banded 6 inches below the surface at the crop-row position using a thin low-disturbance knife (NTDB), and in strip-till banded 6 inches below the surface in the strip (STDB). A significant interaction shows that in the no-till treatments (NTBC and NTDB), application method for various rates of P (Figure 32) and K (Figure 33) makes no yield difference, but there is a tillage effect with strip-till that enhances yield at different fertilizer rates relative to the no-till treatments. Similar results were observed for soybean.

It is often hypothesized that subsurface banding is more efficient than broadcasting because nutrients are placed where presumably there is greater water availability as the soil surface dries out. However, our research showed that soil-water content is similar between the surface and the subsurface (Figure 34). While it is true that the surface layer dries out more during prolonged periods without precipitation, often intermittent precipitation events are sufficient to replenish water levels in the surface but not always in the subsurface.

Another reason some promote subsurface banding is because less contact of the fertilizer with the soil means less P and K fixation in the soil. While this can be true, fixation tends to be a problem only with very low fertility levels. Comparison of grain yields for NTBC and NTDB at different P and K fertilization levels shows no evidence of increased yield efficiency when banding the fertilizer (Figures 32 and 33). Yet others argue that subsurface banding increases fertilizer use efficiency because roots proliferate in response to localized fertility. Again, this is true when the entire soil profile is depleted of nutrients except for the fertilizer band. This is very unlikely in production fields. Even under low fertility levels we have not seen root proliferation in response to fertilizer bands. If roots proliferated in response to fertilizer bands, we would expect to see root proliferation where the fertilizer was banded in STDB, but we did not (Figure 35). Instead, we observed that for NTBC and STDB, root proliferation occurred in the soil surface layer and declined with increasing soil depth. We also observed that the NTBC treatment had overall greater root density than the STDB treatment. In stressful environments, it is common for crops to compensate by forming larger root systems to access nutrients and water. Larger root systems and lower grain yields in NTBC are likely a reflection of more stressful growth conditions than for STDB. In fact, apparent nutrient uptake rates show that corn in STDB is more efficient than in NTBC because with a smaller root system the crop is capable of greater nutrient uptake (Figure 36). Ongoing investigations are revealing that relative to NTBC, greater yields with STDB result from improved overall soil conditions (water infiltration rate, bulk density, root penetration resistance, etc.).

Overall, adequate water availability and greater root density in the soil surface layer resulted in greater apparent nutrient uptake in that layer than in deeper layers regardless of placement or fertilizer rate. We also observed that...
broadcasting fertilizer results in vertical stratification with greater P in the surface layer and banding creates an increase in P at the point of application. We determined in a related study that to properly quantify the fertility of a field with fertilizer bands, for each soil core taken at the location of the band, two to three samples should be taken outside of the band and be composited into a sample.

We express gratitude to the Illinois Nutrient Research and Education Council for providing funds for this project and to Kristin Greer, Chris Rudisill, and the entire Soil Fertility group for their assistance with field and laboratory procedures.

Figure 34. Volumetric soil-water content for various soil depth increments averaged across treatments and precipitation for 2009.

Figure 35. (LEFT) Three-year mean corn root length density at R1 development stage as impacted by soil depth and tillage/fertilizer placement treatment (no-till/broadcast [NTBC] and strip-till/deep band [STDB]) at different crop-row positions. The same lowercase letters indicate no significant difference (P > 0.1) between tillage/fertilizer placement treatments for a given depth. The same uppercase letters indicate no significant difference (P > 0.1) between soil depths averaged over tillage/fertilizer placement treatment.

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<tr>
<th>Crop row</th>
<th>Soil depth (in.)</th>
<th>Root length density (cm cm⁻³)</th>
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<td>C</td>
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</table>

Figure 36. Three-year mean root surface area density (RSD) in the top 16 inches of soil at R1 development stage and apparent uptake rate per unit of root surface area as affected by tillage/fertilizer placement (no-till/broadcast [NTBC] and strip-till/deep-band [STDB]).

<table>
<thead>
<tr>
<th>Tillage/fertilizer placement</th>
<th>RSD (cm²/cm³)</th>
<th>Apparent uptake rate (mg/m²/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTBC</td>
<td>0.47 a†</td>
<td>3.02 b</td>
</tr>
<tr>
<td>STDB</td>
<td>0.40 b</td>
<td>3.74 a</td>
</tr>
</tbody>
</table>

† Means within column followed by the same lowercase letter are not significantly different (P > 0.1).
How far can we sustainably push corn yields?

We’ve heard a lot about “sustainability” lately. In fact, it seems “sustainable” can be put in front of just about any other word — agriculture, economy, design, philosophy, etc. — and suddenly the topic seems much more altruistic. Before we discuss sustainable [fill-in-the-blank], perhaps we should answer two questions: How is sustainability defined for this topic? How is it measured?

For our research, we use a modification of the definition of agricultural sustainability taken from the 1990 U.S. Farm Bill:

A system of crop and animal production that, over the long term,
- Satisfies human food, fiber, forage, and fuel needs
- Sustains the economic vitality of farm operations
- Maintains or improves soil organic matter, soil structure, and water quality

In practice, we propose to achieve agricultural sustainability for corn production through agricultural intensification: assembling interactive and complementary biological, technical, cultural, and genetic resources to support higher plant populations. Our objective is to produce more corn per unit area with greater efficiency of inputs and reduced negative soil impacts relative to conventional practices (Figure 37).

In this study, five “technology” treatments (corn population, nitrogen fertilizer, P-S-Zn fertilizer, hybrid trait, and fungicide) were applied at two levels (high technology and traditional) to test for effects of each technology factor alone and factors in combination. Additionally, three “sustainability” treatments (crop rotation, stover management, and tillage) were applied at two levels (9th-year continuous corn vs. corn–soybean rotation; stover retained vs. 50% stover removal; and conventional tillage vs. strip tillage) to assess their individual and combined effects on technology treatments and corn yields. This ongoing study was initiated in 2011 at the University of Illinois research farm in Champaign.

Figure 37. Increasing crop yields in a sustainable way can be accomplished by supporting higher plant populations with complementary combinations of crop rotation, reduced tillage, stover management, and crop inputs. Photo courtesy of David Riecks, ACES ITCS.
Results

Crop rotation displayed strong effects on crop yield in both years of the study. Averaged across other factors, there was a yield penalty of 13 bu/acre for continuous corn (CC) in 2011 and an incredible penalty of 55 bu/acre in 2012, a year of severe drought.

Stover removal increased corn yield in the CC system by 19 bu/acre with high populations and advanced inputs (high tech). For all other treatment combinations, stover removal had minimal effects.

Strip tillage (ST) performed very well in the corn–soybean (CS) rotation, providing yields statistically equivalent to those of the conventionally tilled (CT) system. In 2011, both tillage systems averaged 167 bu/acre; in 2012, CT averaged 151 and ST averaged 146. In the CC system, ST yielded 9 bu/acre less than CT treatments, on average.

Plant population was a significant factor affecting crop yield and the success of the sustainability treatments tested in this study. The CS rotation was able to support the higher plant population (45,000 plants/acre), but the CC system could not; this partially explains the higher corn yields for the CS rotation. In the CC system, the greatest yield was obtained by reducing the plant population to 32,000 plants/acre while maintaining other inputs at the advanced level (represented as –POP in Figure 38).

The Bt hybrid trait was the most beneficial technology treatment in 2012; use of the triple-stack Bt hybrid consistently improved yields for every system tested (relative to the near-isoline refuge hybrid). Omitting the Bt trait from the high tech package, replacing it with the refuge hybrid (–HYBRID), resulted in yield reductions ranging from 11% to 28%. The effect of adding the Bt-traited hybrid to the traditional system was even more impressive; yield gains ranged from 15% to 57%. The CC system benefited more from the Bt trait than CS rotation.

Conclusions

These results suggest that the CS rotation has greater potential for supporting higher plant populations and, consequently, achieving increased corn yields in a sustainable manner compared to CC. Strip tillage can be implemented into many agronomic systems with no significant yield reduction when paired with complementary practices, such as crop rotation. In continuous corn systems, increasing plant populations may reduce grain yield, particularly in strip-tilled systems. The Bt hybrid benefited both rotations tested here. In the CS rotation, which can support higher plant populations, Bt can increase yields by reducing lodging issues. In CC systems, Bt increases crop yields by reducing crop damage associated with increased corn rootworm pressure in long-term corn production.

![Corn Yield (bu acre⁻¹) for System and Tillage Treatments](https://example.com/corn_yield_table.png)

Figure 38. Corn grain yields (bu/acre) for rotation, stover management, tillage, and technology, data averaged over 2011 and 2012 growing seasons. Technology consists of 5 factors applied at 2 levels each, traditional and advanced. Fertility (FERT) = P, S, and Zn fertilizer application, either not applied or applied as 250 lb/acre of Mosaic Microessentials SZ (12-40-0-10-1). Nitrogen (N) = N fertilizer application, applied as either 180 lb N/acre preplant or 180 lb N/acre + 60 lb N/acre side-dress. Bt hybrid trait (HYBRID) applied as either near-isoline refuge hybrid or triple-stack Bt hybrid. Plant Population (POP) applied as 32,000 or 45,000 plants/acre. Fungicide either not applied or applied as strobilurin-containing fungicide applied at VT. High technology (HIGH TECH) treatment = all factors applied at the advanced level. Traditional treatment = all treatments applied at the lower, “traditional” level. Omission treatments (–TREATMENT) established by maintaining all other factors at the high tech level while the named treatment is replaced with the traditional level. Addition treatments (+TREATMENT) established by maintaining all other factors at the traditional level while the named treatment is replaced with the advanced level.
Optimizing nutrient management in a corn–soybean rotation: Understanding crop nutritional needs

Fertility needs for high-yielding corn and soybean production systems routinely are based on outdated recommendations and information sources. In fact, no comprehensive studies that document patterns of nutrient accumulation and utilization have been conducted more recently than 25 years ago. The nutritional requirements of modern corn hybrids and soybean varieties may be greater than originally thought, especially in higher-yielding environments. A series of multi-location research trials from 2010 to 2012 were designed to address key questions regarding fertility management in Illinois corn and soybean production: what are the quantities of macro- and micronutrients required by corn and soybean crops, how are nutrients used by the plant, and when should they be supplied?

What nutrients are needed?
To precisely determine needed nutrition for corn and soybean production, plants were sampled incrementally throughout the growing season and total nutrient accumulation was determined. Results indicated the quantities of nutrients required to grow 230 bushels of corn and 62 bushels of soybeans per acre (Figure 39). Soil organic matter and fertilizer sources that supply nutrients at these quantities would be expected to meet the nutritional needs at these yield levels. Previous studies have documented that the nutritional needs of modern crop production have nearly doubled across a variety of crop management strategies during the last 60 years (Sayre, 1948; Hanway, 1962). A common misconception among growers is that adequate nutrition is less important in soybean production than corn. In reality, however, our research found that soybean requires similar quantities of key nutrients like N, K, S, and Zn (see “Required to Produce” in Figure 39).

How are they used?
Mineral nutrients are essential in supporting plant life, because they are involved in numerous biochemical and physiological growth processes (Figure 40). The ultimate sink for these nutrients, however, involves storage in corn and soybean grain. For example, P is first partitioned to growing leaf and stem tissues of corn and soybean plants (Figure 41). During the seed development process, these nutrients are remobilized (transported) to the grain. Nutrient harvest index (HI) values were calculated, quantifying the percentage of total nutrient uptake that is partitioned to the grain. Nearly 80% of total P uptake is stored in corn and soybean grain at maturity and consequently removed annually. Nutrients with high total requirements for production (N, P, K, S in corn and soybean) and with high HI values (N, P, S in corn; N, P, S in soybean) therefore require intricate management to maximize a crop’s inherent yield potential (Figure 39).

When are they needed?
For optimal corn production, a 10-day period (V10–V14) resulted in maximum daily accumulation rates for key nutrients such as N (7.8 lb N/acre), P (2.1 lb P2O5/acre), and K (5.4 lb K2O/acre). While the timing of acquisition varied considerably among nutrients, some required season-long availability. For example, more than half of total uptake occurred during grain-fill for P (Figure 41), S, and Zn. Micronutrients also demonstrated narrower periods of

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Required to Produce (lb ac⁻¹)</th>
<th>Removed with Grain (lb ac⁻¹)</th>
<th>Harvest Index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>256 271</td>
<td>148 194</td>
<td>58 72</td>
</tr>
<tr>
<td>P2O5</td>
<td>101 50</td>
<td>80 39</td>
<td>79 78</td>
</tr>
<tr>
<td>K2O</td>
<td>180 180</td>
<td>59 75</td>
<td>32 42</td>
</tr>
<tr>
<td>S</td>
<td>23 19</td>
<td>13 11</td>
<td>57 58</td>
</tr>
<tr>
<td>Zn (oz)</td>
<td>7.1 7.9</td>
<td>4.4 2.1</td>
<td>62 27</td>
</tr>
</tbody>
</table>

Figure 39. Mineral nutrition required to produce a 230-bu/acre corn crop (adapted from Bender et al., 2013) and a 62-bu/acre soybean crop. Soybean nutritional requirements were obtained from a nutrient uptake and partitioning study during 2012 in DeKalb, Illinois, which was designed to document the timing, quantity, and remobilization of nutrients in modern soybean production systems. Required to Produce (total nutrient uptake), Removed with Grain (nutrient content of grain), and Harvest Index (portion of total nutrient uptake represented in grain tissue) are three key measures used to estimate nutritional needs in a cropping system.
rapid uptake than macronutrients, especially Zn and boron, with more than two-thirds of uptake occurring during less than one-third of the growing season.

In contrast to nutrient uptake in corn, where maximum rates of accumulation occur during late vegetative growth, a more stable and season-long pattern of nutrient uptake occurred for soybean growth. An approximate 50-day period from V5 to R5 accounted for as much as 75% of total dry weight production and N, P, K, and S acquisition. Although the timing of acquisition was more defined for micronutrients than for macronutrients, maximum rates of micronutrient accumulation were observed during early reproductive development (e.g., R2–R5).

Summary
The future of efficient nutrient management will require applications made using the right source and rate at the right time and place. Despite the many complexities of managing soil and plant nutrients, improved fertilizer use can be achieved by understanding patterns of nutrient uptake, partitioning, and utilization.

References


The six secrets of soybean success

A common perception among Illinois soybean growers is that soybean yields have reached a plateau, particularly if yield growth is compared with corn. Increased productivity of soybean is needed to meet domestic and global demands as well as to maintain the competitiveness of soybean as a rotational crop with corn. Some sources have suggested that average soybean yields will need to double in the next 20 to 25 years to meet the needs of a growing world population, yet at the current rate of gain of approximately 0.39 bu/acre/year, nearly 85 years will pass before the current average Illinois yield of 47 bu/acre reaches 80. While soybean genetics have improved over time, one possible explanation for slow growth of yields may be related to management practices. We believe that understanding the main effects and interactions of six categorical yield factors may help us improve management for increased soybean yield. These factors are weather, fertility, variety, foliar crop protection (fungicides and insecticides), seed treatments, and row spacing—the so-called “Six Secrets of Soybean Success.”

With the support of the Illinois Soybean Association and industry partners, we evaluated the Six Secrets concept at four locations (two trials each) across Illinois in 2012. A “standard” management practice (a variety of typical maturities for the region with either untreated seed or a basic seed treatment) was compared to a “high tech” management practice in which a full-season variety for the region was grown with additional N, P, S, and Zn fertility (MicroEssentials SZ), foliar protection from insects and fungal pathogens, and an advanced seed treatment package consisting of a fungicide, insecticide, and nematicide. All treatments were compared in 20-inch and 30-inch rows (Figure 42). Significant yield responses to the high tech package were detected in six of eight trials. Inappropriate variety placement resulted in no response to intensive management in two trials, highlighting the importance of selecting high-yielding germplasm as a component of intensive soybean management.

Averaged across six trials, the high tech package increased yield by 9.9 bu/acre ($P \leq 0.05$). Narrow row spacing increased yield at Champaign, DeKalb, and Rushville (3.0, 6.5, and 1.6 bu/acre, respectively). At the management-responsive sites, banded fertility (N, P, S, and Zn) and full foliar protection (fungicide + insecticide) had the greatest individual effects on yield, with respective contributions of 4.3 and 3.6 bu/acre when averaged across the traditional and high tech systems (Figure 43). Switching from a variety of “normal” maturity to a fuller season variety had a 3.2 bu/acre effect on yield, and use of a seed treatment including a fungicide, insecticide, and nematicide contributed an additional 2.6 bu/acre. The results of the 2012 study highlight the importance of choosing a high-yielding, locally adapted soybean variety and managing it with improved fertility and a full suite of crop protection products.
Agricultural Safety and Health and AgrAbility Unlimited
Providing farmers practical techniques to reduce risks and hazards on the farm

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Chip Petrea, Department of Agricultural Engineering principal research specialist, ag safety and health, repetrea@illinois.edu, 217-333-5035

University of Illinois Extension safety specialists offer the most recent data and circumstances involved in Illinois farm-related fatalities and injuries. Important practical techniques are provided to help farmers reduce the hazards on their farms and the risks that they, their families, and their farm visitors encounter from daily work situations in production agriculture. Through AgrAbility Unlimited, farmers and their families and agricultural workers will continue to enjoy their way of life. The program seeks ways to overcome disabilities through various activities, including a toll-free information and referral hotline, networking with local agricultural and rehabilitation professionals, coordinating community resources, and providing information on modifying equipment.

Center for Advanced BioEnergy Research (CABER)
One-stop shop for Illinois bioenergy information

Hans Blaschek, director
Greg Knott, associate director
Vijay Singh, associate director for engineering
Natalie Bosecker, coordinator for communications and external relations bioenergy@illinois.edu, 217-244-9270, bioenergy.illinois.edu

The Center for Advanced BioEnergy Research (CABER) of the College of ACES provides a framework for bioenergy-related research and scholarship. CABER helps facilitate cross-disciplinary research, education, and outreach programs that promote the use of biorenewable resources, and it provides science-based information to consumers and to external stakeholders in the bioenergy industry. The CABER bioenergy research blog provides a daily review of news and research throughout the world at bioenergyuiuc.blogspot.com.

At the CABER Bioprocessing Laboratory, researchers and commercial partners can test scale-up and commercialization steps for new feedstocks, biofuels production, and biochemical production. Progress in this lab will create opportunities and new crops for farmers and help produce sustainable renewable energy sources.

CABER’s educational activities include coordinating the professional science master’s degree in bioenergy, a 16-month program combining science classes, business classes, and an internship. Its seminar series in advanced bioenergy topics is held during the spring semester and is open to the general public. An online class in bioenergy also is offered in the spring semester.

CABER is a founding member of the Illinois Biomass Working Group, which discusses opportunities for farmers, industry, academics, and the financial industry to work together on biomass issues, including logistics, market creation, research, and small- to large-scale heat and electricity projects. For more information, visit www.illinoisbiomass.org.
Field and Furrow Club

An agricultural club for students

**Patricia Stoller**, club advisor, pstoller@illinois.edu, 217-244-5953

The Field and Furrow Club exposes its members to every aspect of agriculture and equips them with the leadership skills needed for success. The club strives to incorporate students of many majors to become a well-rounded and diversified agricultural club. After celebrating Field and Furrow Club’s 75th anniversary in 2010, the group has become more active than ever. In 2010 and 2012 it was named the outstanding club in the College of ACES. In addition to having served breakfast to Agronomy Day attenders for more than 30 years, the club sponsors fundraising events throughout the year and participates in various social and philanthropic activities. Funds raised are used for monthly meetings and to attend regional and national conferences in conjunction with the American Society of Agronomy.

Illinois Farm Business Farm Management (FBFM) Association

Helping farmers manage successful businesses

**Dwight D. Raab**, FBFM program coordinator, dwight.raab@fbfm.org, 217-333-5511, www.fbfm.org

The FBFM program in Illinois is a cooperative educational-service, record-keeping, and business analysis program for operating farmers. There are 9 local associations in the state, with 5,775 cooperators. The Pioneer FBFM Association is the oldest, in existence since 1924. The Shawnee FBFM Association is the most recent, starting in the early 1960s.

The participating farmers (or cooperators) are the members of the association. They elect representatives to serve on a board of directors to provide for the services and establish policy. The local board employs field staff to deliver the services, each working with about 100 cooperators or members. Field staff have an opportunity to work closely in financial management, accounting, and tax with commercial farmers.

The 60 professional staff all have at least a bachelor’s degree in agricultural economics or a closely related field. They meet with their clients four or five times per year to discuss the business analysis for the farm, income tax planning, agronomic analysis, estate planning, and other topics related to operating and managing the farm business.

**Ryan Batts**, Department of Agricultural and Consumer Economics, batts@illinois.edu, 217-333-1817

Farmdoc—**www.farmdoc.illinois.edu**—is a website maintained by ACES’ Department of Agricultural and Consumer Economics to improve farmers’ decision-making under risk through education and research. The site provides Illinois farmers with comprehensive and integrated risk management information and analysis, including publications, decision tools, and databases related to a variety of risk management issues. Subject matter is divided among finance, marketing and outlook, management, law and taxation, and policy. Specialty sections are devoted to the AgMAS (Agricultural Market Advisory Services) Project, crop insurance, farmland owners, prices and weather, and agricultural web resources.

**TENT DISPLAYS**

**AGRONOMY DAY 2013**
Illinois Soybean Association

Increasing opportunities for soybean producers

Linda Kull, director of strategic research, lkull@ilsoy.org, 309-808-3614, www.ilsoy.org

The Illinois Soybean Association (ISA) invests checkoff dollars not only in programs that help soybean farmers increase yield potential, but also in activities that help increase demand for Illinois soybeans at home and abroad. ISA's mission is to ensure that Illinois soy is the highest quality and most dependable, sustainable, and competitive in the global marketplace.

ISA's priority target areas for investment are animal agriculture, transportation, soybean yield and composition, and freedom to operate. The association also funds programs tied to organizational excellence and leadership development. ISA partners with livestock and poultry producers to increase soybean use in feed rations; seeks solutions to the transportation challenges that threaten Illinois competitiveness; works to enhance yields and soybean quality to meet all buyer needs; and coordinates with industry stakeholders to keep market pathways open for the future.

Mary Hosier, project manager, SARE Professional Development Program, mhosier@illinois.edu, 217-333-7512

SARE, the Illinois Sustainable Agriculture Research and Education program, advances profitable and environmentally sound farming systems that are good for communities through a nationwide program of research and education grants. Illinois offers 5 competitive grant programs:

1. Farmer Rancher: For farmers and ranchers who want to explore sustainable solutions to problems through on-farm research, demonstration, and education.
2. Research and Education: With a strong outreach component and significant farmer/rancher or other end user involvement from inception of the idea through implementation of the project.
3. Professional Development Program: Supports state professional development programs and competitive grants for training agricultural educators in extension, the Natural Resources Conservation Service, and private and not-for-profit sectors, using farmers as educators and addressing emerging issues in the farm community.
4. Graduate Student: Funds graduate student projects that address sustainable agriculture issues.
5. Youth Educator: Supports educators to provide programming on sustainable agriculture for youth.

For more information, visit illinoissare.org, or “like” SARE on Facebook at www.facebook.com/ILSARE.

Preparing a new generation of Illinois fruit and vegetable farmers

Mary Hosier, project manager, SARE Professional Development Program, mhosier@illinois.edu, 217-333-7512

This project is supported by the Beginning Farmer and Rancher Development Program of the National Institute of Food and Agriculture, USDA, Grant # 2012-49400-19565. The project has these goals:

1. Increase the number of new farmers producing fruits and vegetables throughout Illinois and enhance the viability, profitability, and sustainability of new and beginning enterprises to meet increasing demand for local produce and contribute to local economies.
2. Assist a specific target audience—seasonal Hispanic farm workers—in beginning viable, profitable, and sustainable small produce farms.
3. Increase the expertise of university extension educators, high school and community college teachers, and educators in community organizations so they can better aid new farmers.

In year one of a 3-year grant, over 100 students are enrolled at three locations: St. Charles Horticulture Research Center (northern Illinois), Urbana Research and Education Center (central Illinois), and Dixon Springs Agricultural Center (southern Illinois). Applications for year two are currently being accepted through October 15, 2013, at www.newillinoisfarmers.org/new_generation_app.php.
The National Soybean Research Laboratory (NSRL) at the University of Illinois promotes strategic research, outreach, and education related to soybean production, nutrition, and international development. NSRL is a leader in processing techniques and works with nutritionists, producers, processors, animal scientists, food companies, and humanitarian organizations to connect the high protein value of soy and its important amino acids for food, feed, and industrial applications.

Soy research focuses on enhancing quality, increasing yield, and meeting the nutritional needs of the livestock, poultry, and aquaculture industries. Soybean research spans the gamut from diseases, pests, and weeds to hybridization, genetics, and nanotechnology. NSRL also finds sustainable soy solutions around the world for those who face the extreme challenges of malnutrition. NSRL educates on the advantages of a soy-enriched diet, promotes the health benefits of eating soy, and aims to incorporate soy into local cuisines by providing nutritional support for the world’s growing protein requirements. NSRL works with global partners to increase the use of soy everywhere. For more information, see www.nsrl.illinois.edu.

The sights and sounds of construction are coming to Turner Hall (home to Crop Sciences)! It has been 50 years since the building was constructed in 1963, and renovations are needed throughout. As a top priority for both the campus and the College of ACES, a $10-million initiative to renovate Turner Hall classrooms and teaching laboratories received $5 million in campus funding. A volunteer committee co-chaired by alums Bill Kirk and Jerry Brookhart seeks to raise an additional $5 million to complete the project and provide light, bright, modern learning spaces in key areas of the building. Thanks to lead gifts from individuals and corporations, the project is nearing the halfway mark, with almost $2 million raised so far. Stop by the booth to learn more about the planned improvements to Turner Hall, and visit the website to make a gift: advancement.aces.illinois.edu/turner.

Be sure to visit the PubsPlus sales table in the main tent. Among the titles featured this year is the new Identifying Weeds in Midwestern Turf and Landscapes. Other publications on hand for immediate purchase include Field Crop Scouting, Manual, Growth Stages of Agronomic Crops, Field Guide to Corn Diseases, and Pest Management in the Home Landscape. We’d also like to hear what future publications or mobile apps would be helpful to you, so be sure to stop by for a chat. And, once Agronomy Day is over, you can visit us online at any time at www.pubsplus.illinois.edu. PubsPlus is your source for books, CDs, and other educational materials prepared by experts at the University of Illinois and elsewhere. Home gardening, commercial agriculture, educational kits for K-12 — whatever your interests, you’ll find information you need at attractive prices.
How does root complexity determine the response of maize (Zea mays L.) to abiotic stresses?

Elizabeth Blissett, Department of Crop Sciences graduate research fellow, blisset1@illinois.edu

Martin O. Bohn, Department of Crop Sciences associate professor of maize breeding and genetics, mbohn@illinois.edu, 217-244-2536

Maize cultivars exhibit significant genetic variation for root system complexity. However, little is known about how root characteristics determine plant response to abiotic stresses, specifically drought stress and low nitrogen fertility. This study aims to identify the relationship between maize root complexity and overall performance when plants are subjected to inadequate water and nitrogen levels. Six elite hybrids with differing root complexity phenotypes were evaluated in both field and greenhouse experiments using four treatments: well-watered, adequate nitrogen, water-limited, and low nitrogen. Relevant traits were observed at biologically significant developmental stages spanning vegetative and reproductive growth. A control trial was conducted in the greenhouse to establish a point of reference prior to execution of the stress trials. Fractal geometry was used to phenotype the root structures of the six hybrids prior to selection for use in the study. These findings will be critical in understanding the relationship between root complexity and key abiotic stresses and to guide breeding efforts to develop maize cultivars with improved stress tolerance.
Even though the U.S. is a major producer of corn grain, limits have been established for corn grain use for biofuels. However, the “food vs. fuel” debate and existing policy have not adequately considered future expectations for corn and ethanol production and how these factors will interact with animal food supply. U.S. ethanol production from corn grain is expected to increase to 15 billion gallons, which is the limit established by the Energy Independence and Security Act of 2007. Based on typical ethanol yields and an average corn yield of 164.7 bu/acre, 32.9 million acres would have been required to produce 15 billion gallons of ethanol. Ethanol production also coproduces DDGS, corn gluten feed, and corn gluten meal, which replace corn and soybean meal in livestock diets. Currently, DDGS replaces corn and soybean meal that require about 12.1 million acres of corn and soybeans. Objectives of this work were to estimate net acreage required for ethanol production from corn grain, considering DDGS use in livestock diets, based on current and historical production; and to project future land use for corn ethanol production under scenarios that include expected improvements in crop production, ethanol yields, and animal feeding technologies.
In the past three years, three diseases that previously were nonsignificant have occurred in most Illinois pumpkin and winter squash fields and caused significant yield losses. These emerging diseases are anthracnose (caused by *Colletotrichum orbiculare*), bacterial spot (*Xanthomonas cucurbitae*), and Sclerotinia rot (*Sclerotinia sclerotiorum*).

**Anthracnose.** Anthracnose is a common disease in Illinois cucumber and watermelon fields, but it was not observed in pumpkin and squash fields until recently. *C. orbiculare* caused fruit infection of both pumpkin and squash (Figure 1). Symptoms developed when fruit approached maturity. One or more lesions developed on each fruit. Initially, the lesions were small, circular, sunken orange spots. Gradually, the lesions enlarged and turned black. Concentric rings of reproductive bodies (acervuli) of the causal fungus developed on infected areas.

**Bacterial spot.** Bacterial spot was more widespread than anthracnose and Sclerotinia rot. *X. cucurbitae* infected leaves and fruit, causing small lesions (Figure 2). On leaves, the lesions were small (2 to 4 mm in diameter), angular, and yellow to beige. The lesions coalesced and caused yellowing of the leaves. The appearance and size of fruit lesions varied, depending on rind maturity and presence of moisture. Initial lesions were slightly sunken and circular (1 to 3 mm in diameter), with a beige center and a dark brown halo. Penetration of bacteria into the flesh, or invasion of infected fruit by the opportunistic organisms, such as *Fusarium* or *Erwinia* species, resulted in fruit rot.

**Sclerotinia rot.** *S. sclerotiorum* caused fruit rot and vine blight (Figure 3). The main symptom on the fruit was water-soaked lesions with nestlike cottony white mycelia and sclerotia, which develop on the stem end of the fruit or where fruit contacted the soil. Sclerotia were black and varied from a few millimeters to more than a centimeter in diameter. Internal symptoms of fruit appeared as a soft or wet rot with sclerotia in the seed cavity.
Enhance your credentials and advance your career with ACES online courses and programs. The Department of Crop Sciences offers an online master’s degree program, two professional development certificates, and a variety of courses through U of I Online & Continuing Education (OCE). The online courses are equivalent to their face-to-face campus counterparts in terms of academic rigor and quality, and most courses are taught by the same faculty. The primary difference is that the online programs are designed for professionals who want to complete a master’s degree or certificate on a part-time basis and/or improve or update their present competencies. Courses meet in “virtual classrooms” during evening hours to give students flexibility.

Noncredit courses for professional development are also available, enabling interested parties to sign up for courses purely for professional enrichment or to network with colleagues in their professions.

Other ACES departments offering online programs and courses through OCE include Natural Resources and Environmental Sciences, Food Science and Human Nutrition, Agricultural Education, and Animal Sciences.
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We encourage you to stop by any time to view ongoing research projects.
And please plan to join us again next year on August 14, 2014!

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