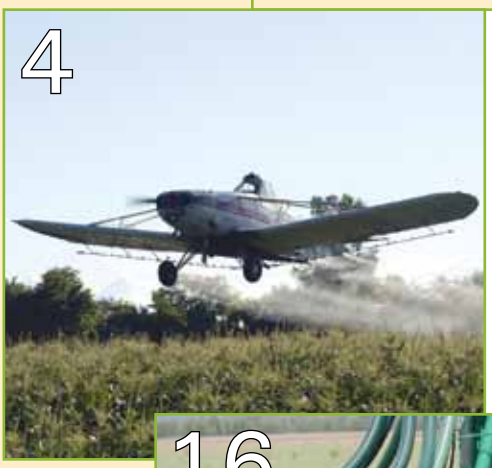
Crops & Soils

agronomy for practicing professionals

Volume 43 ■ Issue 5
September–October 2010



An American Society of Agronomy Publication

How can we squeeze more food from a RAINDROP?

Farming feeds the world, but it depends on vital natural resources. Just consider this: irrigation for agriculture consumes 2/3 of the world's fresh water withdrawals.

Experts have concluded that agricultural output will need to double by 2050 to feed a growing world. We'll need to get more from each drop of irrigated water.

We'll also need to do more with the solution nature already provides: rain.

The challenge for farmers is squeezing the most out of unpredictable rainfall. That requires putting the latest science-based tools in farmers' hands, including advanced hybrid and biotech seeds. Our goal is to develop seeds that significantly increase crop yields and can help farmers use 1/3 less water per unit produced.

Producing more. Conserving more. Improving farmers' lives. That's sustainable agriculture. And that's what Monsanto is all about.

Non-irrigated agriculture produces 60% of the world's food. It will need to do more.

Learn more at: **www.ProduceMoreConserveMore.com**

MONSANTO imagine®

PRODUCING MORE | CONSERVING MORE | IMPROVING FARMERS' LIVES

Crops & Soils

agronomy for practicing professionals

Volume 43 ▪ Issue 5 ▪ September–October 2010

Crops & Soils, the magazine for practicing professionals in agronomy, is published bimonthly (January–February, March–April, May–June, July–August, September–October, and November–December) by the American Society of Agronomy. Visit us online at www.agronomy.org/publications/crops-and-soils.

Contributions/correspondence

Crops & Soils welcomes letters, comments, and contributions, published on a space-available basis and subject to editing. The deadlines are February 15 (March–April issue), April 15 (May–June issue), June 15 (July–August issue), August 15 (September–October issue), October 15 (November–December issue), and December 15 (January–February issue). Call 608-268-4968 or email cropsandsoils@sciencesocieties.org. *For general inquiries not related to Crops & Soils, please email certification@sciencesocieties.org or call 866-359-9161.*

Advertising

Contact Alexander Barton (abarton@sciencesocieties.org or 847-698-5069) or visit www.agronomy.org/advertising.

Postage/subscriptions

Crops & Soils (ISSN 0162-5098) is published bimonthly by the American Society of Agronomy. Send address changes to *Crops & Soils*, 5585 Guilford Rd., Madison, WI 53711-5801 (for the U.S.) and IBC Mail Plus, 7686 Kimble St., Units 21 & 22, Mississauga, Ontario L5S1E9 Canada (for Canada). Subscriptions are $20/year (U.S.) and $45/year (international). To subscribe, visit www.agronomy.org/publications/subscriptions, call 608-268-4961, or email lnavis@sciencesocieties.org.

foliar fungi

on corn and soybeans: current trends and debates

By Laura Lipps, *Crops & Soils* magazine contributing writer;
sciencewriter@sciencesocieties.org

Foliar fungicides like Headline are becoming a popular pest management strategy for corn and soybean growers.

"In recent years, we've seen an evolution of practices with fungicides on corn, and also on soybeans," says Kevin Black, a CCA for GROWMARK, Inc. "We've gotten some new fungicides, particularly the strobilurin class." Black says they're "highly active and very good fungicides" for dealing with many common foliar diseases such as gray leaf spot, northern corn leaf blight, and eyespot.

Traditionally, growers have not used foliar fungicides on either crop. In corn, low prices in the past meant that foliar fungicides were not economically feasible. But with more favorable corn prices in recent years, growers have gone the extra mile to protect yields, including increased spraying of fungicides.

In soybeans, foliar fungal diseases have historically not been thought to be very significant yield stealers, so growers did not feel the need to spray. But in the last decade, fears of soybean rust spurred the development of two new classes of fungicides—the strobilurins and the triazoles—for use on soybeans to respond to this potential threat. Now these products are routinely being used, Black says, and soybean growers are seeing an average 3 bu/ac yield increase in some areas of the Midwest.

Another reason for the recent surge in use is the controversial claim that strobilurins in particular can have positive effects on corn and soybean physiology, aside from reducing disease pressure. Companies such as BASF, which makes the Headline fungicide, and some scientists say that data show enhancement of plant photosynthesis, stress tolerance, and other positive physiological benefits, leading BASF to market Headline as a "plant health" booster. Other scientists remain unconvinced that any effects on corn and soybean yield are independent from the fungicides' primary disease-reducing benefits.

Nonetheless, growers are hoping to take advantage of any potential benefits. "Basically we started to see some yield improvements where it could not totally be attributed to disease presence," Black explains. That brought about a tremendous increase in the use of fungicides on corn and soybeans over the last several years, even in some cases where growers did not see evidence of disease.

To spray or not to spray?

The decision about if and when to apply foliar fungicides is often not clear-cut, due to their highly variable effect on yield and the cost of the fungicides to the grower.

"When we have high disease pressure, that's when we get the most benefit from spraying a fungicide," says Dr. Alison Robertson, an extension field crops pathologist at Iowa State University. "Under disease pressure, we do get a benefit from a fungicide. That benefit is increased yield, although it's not really increased yield—we've just protected that yield potential from the fungi." BASF has reported a 12–16 bu/acre yield increase with Headline in corn and a 4–8 bu/acre in soybeans, while university trials have shown somewhat smaller yield benefits. Robertson stresses that the greater the disease pressure in the field, the higher the yield response to strobilurins is likely to be and the greater the likelihood that growers will make back their money.

When considering whether to use foliar fungicides, Robertson says her top three recommendations are:

1. Know the history of the fields in question. "Do you have a field where you often have a lot of disease pressure? Is there a history of disease?"

2. Know your hybrid or variety type. Some are more susceptible to disease than others. Check to see if your hybrids are vulnerable to diseases you know are present in your area. Check with other growers who might be growing a similar variety: Have they seen a lot of disease? "If you hear rumors that a certain corn hybrid, or even a soybean variety, appears to be having issues, then contact your seed dealer and speak with them," Robertson advises. "If it looks like a particular hybrid is having problems, it may pay to use a foliar fungicide."

3. Stop the truck and get out and scout. "Walk into the field and see what's going on inside," she says. Cornfields should be scouted near or at tasseling. Sometimes there are too many acres to scout them all, she says. "But if you know which fields have a ▶

history of disease, or where you had planted susceptible hybrids, you could target those fields." In the case of corn, look down in the lower part of the canopy and see if you have disease developing on the lower leaves. "With most of these diseases, they'll start off pretty slowly and then they'll build up exponentially" over the season, she adds.

In the case of scouting soybean fields, it is a bit more complex. "For soybeans, the different diseases are developing at different layers in the canopy. So you would have to look through the whole canopy," Robertson says. She recommends that soybean growers become familiar with potential disease symptoms ahead of time and come up with an assessment strategy for determining at what level of symptom severity they might decide to use a fungicide. Noting the incidence and severity of diseases at given points during each season can also help to develop a field history record for use in future years.

Black follows a similar approach in his recommendations to clients: "We look at the field history, how often disease has been a problem in that field. We look at cropping practices, like no-till. No-till is a practice that will increase the inoculum level, the presence of the disease, simply because that disease then exists off-season on the crop residue." This is especially common in corn-on-corn situations, which have increased in recent years.

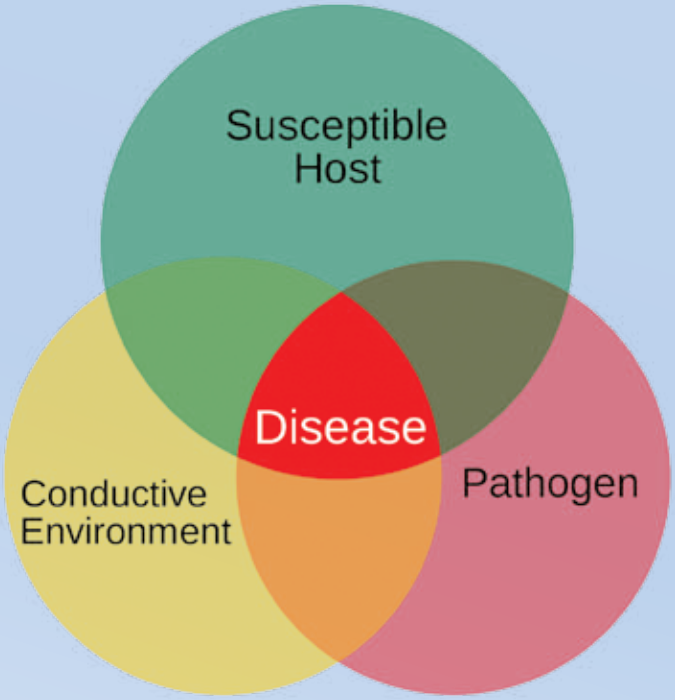
Black also recommends taking note of the general environment to predict where a foliar fungicide might be warranted. "Diseases tend to repeat in certain fields," he says. "If you have a bottomland field surrounded by trees, the microclimate there may be highly conducive for some of these pathogens, whereas a field that is exposed to a lot of air movement probably won't have as much trouble."

Black takes all these factors into account for making recommendations to his clients. He says if a grower has a susceptible hybrid, a history of disease, a no-till continuous cropping operation, and thinks the environment is currently conducive for the diseases, then it makes sense to apply a foliar fungicide. Knowledge of all these factors is rolled into a "prescription approach" to advise clients about foliar fungicides, he says.

Even with knowledge of these factors, determining whether foliar fungicides would benefit a crop can be difficult. This uncertainty is due to the "disease triangle," a fundamental concept in plant pathology. "To get a disease, you have to have the host plant, the pathogen, and the environmental conditions all interacting," Robertson explains.

For example, Robertson notes that the recommended timing for applying the fungicides, the tasseling–silking stage, is still pretty early in the season, making it difficult to

Leaf blight in corn. Center photo by Keith Weller (USDA-ARS). Left and right inset photos courtesy of the Division of Plant Industry Archive, Florida Department of Agriculture and Consumer Services, Bugwood.org.



Disease triangle. Image courtesy of Wikipedia.

predict whether disease will actually develop. Environmental conditions that favor or disfavor a disease could still change. Growers must use their best judgment and take the risk to apply or not to apply a foliar fungicide.

"That makes it really tough to recommend a fungicide because we can't say to a grower, 'If you have 1% disease severity on the ear leaf at tasseling, then you will need to apply a fungicide.' "

She notes that research is ongoing to develop disease "thresholds" like a percentage of disease cover or a severity measure that would allow growers to better assess whether disease is enough of a threat to merit a fungicide.

Potential for resistance

It is well known that strobilurins such as Headline have a high potential for fungal resistance to develop. Black explains that is because these fungicides work on a single site of action within the fungus, the mitochondria within fungal cells, and by a single mode of action within that site. They are part of a class of fungicides known as the QoIs (quinone outside inhibitors) that all have the same site of action. Because of this narrow targeting, chemicals in this class have a high likelihood of developing resistance in the target fungi.

"Chemicals that have narrow modes of action tend to be more subject to resistance because the fungi only have to overcome one particular mode of action, and all of a sudden these products no longer work," Black says. "So there's a great concern that resistance could quickly develop to the strobilurin class and a great fear that once resistance develops to a particular product, there will be cross-resistance to all of the products within the class."

"Resistance could turn out to be a real problem," Robertson says. She says more than 30 pathogens have been reported to be resistant to the strobilurins and the triazoles, and new fungi are being added to that list as time goes by. "Some of those pathogens are very closely related to the pathogens that we have in corn and soybeans," a fact that adds to suspicion that more will become resistant. For example, the fungus that causes anthracnose on turfgrass has developed strobilurin resistance, and it is very similar to the species that cause anthracnose on corn and soybeans.

As a comparison, Robertson cites the rate of development of weed resistance to the herbicide glyphosate. "With glyphosate, weeds developed resistance in 10 years, and plants evolve much slower than fungi evolve. So I think the potential is there for us to develop resistance to these fungicides in pathogens of corn and soybeans within the next 10 years."

To test whether resistance is developing, researchers across the Corn Belt are busy collecting gray leaf spot and northern corn leaf blight lesions and testing them to see whether and when they develop resistance to the fungicide.

Resistance management

For growers who decide to use foliar fungicides, the potential for resistance makes it important to properly apply resistance management strategies to preserve the effectiveness of the foliar fungicides. Black's top recommendations are:

1. Don't use it where you don't need it, and follow the label's recommended rates and application timing; and

2. Don't use reduced rates of a product since this might encourage partially resistant strains to survive and erupt into worse problems later.

Black notes that if you look at one of the labels for a particular product up near the top, in many cases you'll see a code. This is the FRAC code, named for the Fungicide Resistance Action

Committee, a group of disease management professionals who aim to watch out for and monitor development of resistance. The code number identifies the particular class, or mode of action, of the fungicide. To stave off fungal resistance, it is important not to tank mix or alternate fungicides with the same FRAC number in a spray program. Some fungicides are labeled "M," which means that they act upon multiple sites and resistance risk is low.

Knowing the fungicide's FRAC code can help growers implement the fundamental rule of resistance management: Rotate classes of products, or use combinations of classes, to prevent resistance from developing. "You might use a combination of a strobilurin and a triazole," Black says. "Or use the strobilurin once, and then if you need to come back with another product, come back with a triazole.

"If you start to see what you think is development of resistance, stop using the product. Go to a different class. Don't keep pushing with higher and higher rates of that product."

Plant health benefit?

Experts agree that the higher the disease pressure in the field, the more likely growers are to break even on their investment in a foliar fungicide. But what about cases without noticeable disease symptoms? Do fungicides have positive effects on corn and soybean health in the absence of disease?

BASF's strobilurin, Headline, now carries a USEPA-approved "plant health" label as well as a label for disease control. The label claims several physiological benefits of Headline to the plant, including improved nitrogen use efficiency and general stress tolerance. This has worried some plant pathologists, and in 2009, 26 university scientists sent a joint letter to the USEPA objecting to the "plant health" label (see www.epa.gov/pesticides/regulating/headline-letter.pdf). They argued that there is not enough scientific data to support the broad plant health claims and that growers may be misled by the label.

"I don't argue with the fact that strobilurins can change the physiology of a crop plant," says Robertson, one of the letter's signatories. "But what we're really struggling with is that we can't predict when the strobilurins will affect the physiology in such a way that we will see a yield response in the absence of disease."

***Bottom photo*: Foliar application. *Left inset:* Soybean leaves infected with soybean rust. *Right inset:* Pod and stem blight in soybean.** Bottom photo originally submitted with the *Agronomy Journal* paper, "Fungicide Application Timing and Row Spacing Effect on Soybean Canopy Penetration and Grain Yield," by S.O. Hanna, S.P. Conley, G.E. Shaner, and J.B. Santini (Agron. J. 100:1488–1492). Left inset photo by Christine Stone (USDA-ARS). Right inset photo courtesy of Clemson University–USDA Cooperative Extension Slide Series, Bugwood.org.

She notes that most of the studies that have shown an extra physiological benefit to plants have been done on other crops such as wheat and tobacco, but not on corn or soybeans. She says, "There's all this little anecdotal research scattered around all over the place" on the physiological effects of strobilurin fungicides, "but we don't have a really clear understanding of how and why they happen and if they even happen on corn and soybeans. So it's really hard for me to justify to a grower to go ahead and spray a fungicide for a plant health benefit when I can't guarantee that he's going to get his money back for that application.... In fact, there's a one in three chance that he might lose money by spraying that fungicide."

Robertson notes that more research is needed on when plant health benefits occur and how to predict them so that a grower could take advantage of them. "There is still so much learn…. Right now we're trying to write an essay without knowing our ABCs."

Timing of applications

Another uncertainty is the question of how many applications of foliar fungicides are most beneficial and when they should be applied. Typically, application in corn has been at the tasseling (VT) or silking (R1) stage. But BASF and other companies are now promoting early applications, at V5 or V6 (when five- or six-leaf collars have developed), instead or in addition to applications at tasseling/silking.

Black recommends that interested crop advisers and growers conduct tests of early or double applications. "We at GROWMARK are encouraging a number of our crop specialists to put out trials in which they compare the application timing—no application (a control treatment or check), a V5 application, an R1 application, and a combination of the V5 + R1 application. Alternatively, if a grower chooses to spray most of a field, he could leave multiple strips of untreated crop as a check. The goal is to try to find out: Are we getting disease control that looks better than what we've had before. Are we getting yield improvement?

"We recommend to growers that wherever possible, repeat the trial. In other words, replicate it in the field, so that they have more than one look at it. Or we recommend that they work with their neighbors or work within the community and see if they can't get several trials applied on several different fields" that are near each other and similar to each other in structure.

Robertson agrees that more testing needs to be done. "There's limited data available on early application. The data that we do have suggests that an application at V4–V7, those early growth stages, is not going to lead to any increase in yield." She notes that BASF, the maker of Headline, conducted field trials across several states that seemed to show a yield effect under two scenarios: (i) one application of Headline at VT and (ii) two applications—one at V6 and one at VT (V6 + VT). She says that the V6 + VT application did not result in greater yields, indicating that the V6 application was not necessary and adds that further research is needed on this practice. She says other companies are recommending two applications of their products with very little data at all to support their recommendations, a marketing strategy she finds "disheartening."

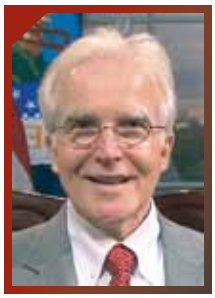
> *"It's really hard for me to justify to a grower to go ahead and spray a fungicide for a plant health benefit when I can't guarantee that he's going to get his money back for that application.... In fact, there's a one in three chance that he might lose money by spraying that fungicide."*
>
> —Alison Robertson, Iowa State University

Managing the risk

With the advent of strobilurin and triazole foliar fungicides, growers have more opportunities but also more tough decisions each year. Black notes, "One of the things that is always a thorny issue for a person in my position is that we see the yield benefits out there. We know that in these cases where these products are working extremely well, we're seeing remarkable yield improvements. But we also know that that's not the kind of return we get in every case…. It is not uniform."

Robertson adds that research into predicting disease outbreaks and developing decision-making tools is ongoing. Until we have a better understanding, she says, deciding whether to spray will remain a gamble. "It's just another risk to take into account." ■

Measuring conservation progress in the Upper Mississippi River Basin



By Douglas Lawrence, Ph.D., Deputy Chief for Soil Survey and Resource Assessment, USDA-NRCS, Washington, DC

In mid-June, Agriculture Secretary Tom Vilsack released a landmark study from the USDA Natural Resources Conservation Service (NRCS) quantifying the effects of cropland conservation practices on environmental quality. This study of the Upper Mississippi River Basin is the first in a series that will cover all of the major river basins and water resource regions in the lower 48 states. The studies are being conducted as part of the Conservation Effects Assessment Project (CEAP).

The study tells us that voluntary, incentive-based conservation works. This validates what we have seen in the field and have known anecdotally for many years, but had not previously quantified on a national scale. This is particularly true with respect to nutrient and pesticide loadings.

The report also underscores the need for the agency's traditional whole-farm, multidisciplinary approach to conservation planning.

Modelers used a comprehensive, four-year survey of farming practices in the region linked to sample points from the NRCS National Resources Inventory to obtain the statistical basis for the study. They then used physical process models to estimate losses of sediment, nutrients, and pesticides from cropland, both at the edge of the field and in the tributaries to the Mississippi River and in its main stem.

They employed two scenarios. The first was a "baseline" or current conservation condition scenario with existing conservation practices in place; the second was a "no-practice scenario," simulating conditions that would exist if no conservation practices had been applied.

Alternating strips of alfalfa with corn on the contour protects this crop field in northeast Iowa from soil erosion.
Photo by Tim McCabe (USDA-NRCS).

Lessons from the study

Here are some key lessons gleaned from the study:

1. Conservation practices work.

In the Basin, most acres have either structural or management practices—or both—in place to control erosion. Nearly half the cropland acres are protected by one or more structural practices, such as terraces. Reduced tillage is used in some form on 95% of the cropland.

Adoption of erosion-control practices has reduced edge-of-field sediment loss by 69% and in-stream sediment loads by 37%, evidenced at the outlet of the Upper Mississippi River Basin (near Grafton, IL, just above the confluence of the Missouri River).

This is a major success story for agriculture in one of the most intensively farmed regions of the United States. But there remains substantial room for improvement.

2. Comprehensive planning is needed because suites of conservation practices work better than single practices.

A *suite* of practices that includes both soil erosion control and consistent nutrient management is required to simultaneously address soil erosion *and* loss of nitrogen through leaching—the most critical conservation issue in the region.

For instance, the application of conservation practices has reduced surface nitrogen losses by 46%, but subsurface losses have been reduced by only 5%. Why is this? It's because without nutrient management, erosion control can increase subsurface nitrogen losses. For about one-fifth of the acres, re-routing surface runoff to subsurface flow path-

ways results in a net increase in total nitrogen loss from the field—when coupled with nutrient management that lacks consistent rate, timing, form, and method of application.

3. Targeting critical acres significantly improves the effectiveness of conservation practice implementation.

This is common sense. Targeting the most critical acres can have three-to-five times the impact of treating acres with less serious problems, although we need to be vigilant about maintaining the gains we have already made.

Conservation practices have the greatest effect on the more vulnerable acres, such as highly erodible land and soils prone to leaching. Thus, identifying and concentrating resources on those vulnerable lands is the most efficient strategy for reducing sediment, nutrients, and pesticide loading.

4. The most critical conservation issue in the Upper Mississippi region is reducing the loss of nitrogen by leaching.

Total losses of phosphorus and nitrogen have been reduced by 49 and 18%, respectively. Yet complete and consistent nutrient management (proper rate, form, timing, *and* method of application) is generally lacking throughout the region.

Nutrient loss is controlled by management of rate, form, timing, and method of nutrient application that maximizes the availability of nutrients for crop growth while minimizing environmental losses.

Sixty-two percent of the cultivated cropland acres require additional management to reduce the loss of nitrogen or phosphorus from fields. About 51% of cropped acres require additional nutrient management to address excessive levels of nitrogen loss in subsurface flow pathways, including tile drainage systems.

The cropland work is not the only CEAP study to produce exciting results. The CEAP Wildlife, Wetlands, and Grazing Lands national assessment components continue to explore the effects of conservation practices on environmental quality and to inform technology and program development within the agency. This is in addition to more than 40 watershed studies.

We continue to learn from the Upper Mississippi River Basin study, and that learning reinforces the scientific basis for our conservation practices and policies, today and in the future. This will ensure that we can continue to help people help the land—by targeting resources where they will do the most good and by returning dividends on the nation's investment in conservation on working lands. ■

Canada East

Ontario CCA conference

By Tina Hanley, program administrator, Ontario CCA program, Elmira, ON, Canada; tina.tfio@sympatico.ca

With summer drawing to a close so quickly, the Ontario CCA office has been in high gear getting ready for its 8th CCA Conference and Annual Meeting. Every January, between 200 and 250 CCAs come out of hibernation to gain some knowledge, network with industry associates, and share valuable insights, experiences, and stories.

This year will be no different. On January 12 and 13, 2011, the Ontario CCA program will host its Conference and Annual Meeting at the Best Western Lamplighter Inn in London, ON.

We have a great array of speakers lined up for this annual event. We are fortunate enough this year to have Dennis Snow of Snow and Associates. Dennis has a passion for service excellence and has consulted with organizations around the world on the subject. He spent more than 20 years developing his customer service skills with The Walt Disney World Company. In his last year with Walt Disney World, his leadership performance was ranked in the top 3% of the company's leadership team. Dennis, now a full-time speaker, trainer, and consultant, is dedicated to helping organizations achieve their goals in the areas of customer service, employee development, and leadership. He is the author of the book *Lessons from the Mouse: A Guide for Applying Disney World's Secrets of Success to Your Organization, Your Career, and Your Life*.

Along with Dennis, we will also hear from David Foot, professor of economics at the University of Toronto and co-author of the best-selling books *Boom, Bust & Echo: How to Profit from the Coming Demographic Shift* and *Boom, Bust & Echo: Profiting from the Demographic Shift in the 21st Century*. These books reflect his research on the relationships between economics and demographics and on the resulting implications for both private and public policies. In addition to academic writings and contributions to professional journals and popular media, David's work in the area of public policy has included research and submissions to many government commissions and numerous consulting and conference assignments for both private and public organizations. He is a recipient of a national 3M award for teaching excellence and is a two-time winner of an undergraduate teaching award from the University of Toronto.

The Ontario Conference and Annual Meeting is also a perfect time to pay homage to those CCAs who have gone above and beyond their duties with the CCA Award of Excellence. The award recognizes crop advisers who deliver exceptional customer service, are highly innovative, have shown that they are leaders in their field, and have contributed substantially to the exchange of ideas and the transfer of agronomic knowledge within the agricultural industry. A candidate may be nominated by a customer, employer, peer, or other associate. For their hard work and dedication, the winner receives a cash award of $1,000 and will have another $1,000 donated on their behalf to an agriculture-related charity of their choice. Nomination forms can be obtained online at www.canadiancca.com, and nominations are due October 31.

Mark your calendars now—you don't want to miss out on this exciting event! We invite all CCAs, whether you live in Ontario or not, to join us for this event. A copy of the agenda and registration form can also be found at www.canadiancca.com under the News and Information tab or by contacting the Ontario CCA office at 519-669-3350. ■

North Central

Illinois aglime booklet now online

Agronomy, crops, and soils experts know that aglime builds and maintains long-term soil productivity, making modern agriculture sustainable. As a cost-saving measure, the Illinois Department of Agriculture will no longer print the *Illinois Voluntary Limestone Program Producer Information* booklet detailing the latest testing results for aglime available from various sources in Illinois and surrounding states. Beginning with the 2010 issue, these test results will only be available online at: www.agr.state.il.us/news/pub/Limestonebooklet.html. ■

Southern

Soil scientist licensure in Tennessee

On June 11, 2010, Tennessee Gov. Phil Bredesen signed into law a bill that will license professional soil scientists in Tennessee. The bill takes effect July 1, 2011. This landmark legislation provides enhanced protection to the citizens of Tennessee while strengthening the profession of soil science by requiring an education and experience base, standardized testing, continuing education, and ongoing professional development. The new law also removes the state-required bond for soil scientists.

The bill allows for grandfathering soil scientists that are: (i) CPSS or CPSC certified, (ii) on the current Tennessee Department of Environment and Conservation approved list, (iii) members of the SSAT certified soil scientist list, or (iv) federal employees in the GS-470 series.

The deadline for grandfathering is January 1, 2011. ■

Louisiana CCAs receive continuing education awards

Eddie Eskew, with G&H Seed Co. in Crowley, LA, and Johnny Dukes, with Agriliance in Hazen, AR, received the CCA Continuing Education Achievement Award for the 2008–2009 CEU year. This award is presented to Louisiana CCAs who have obtained continuing education hours "over and above" the necessary requirements set by the American Society of Agronomy.

CCAs are required to obtain 40 CEU hours in a two-year cycle, which must include at least five hours each in Nutrient Management, Crop Management, Integrated Pest Management, Soil and Water Management, and Professional Development. Both Eskew and Dukes have demonstrated their dedication to improving their knowledge of all aspects of agriculture by going above and beyond the necessary educational requirements. For the 2008–2009 CEU cycle, Eskew obtained 182 CEU hours and Dukes obtained 159 CEU hours.

Left: **Johnny Dukes (right), Agriliance CCA, receives a plaque from Greg Sadler, regional manager for Agriliance, for winning the Louisiana CCA Continuing Education Achievement Award for the 2008–2009 CEU year.** ***Right:*** **Eddie Eskew (center holding plaque), with G&H Seed Co., also received the award. Pictured l to r are John Fontane, Louisiana CCA board; Wayne Hensgens, G & H Seed Co.; Eskew; Ray Hensgens, G&H Seed Co.; and Rustin Gilder, Louisiana CCA board.**

Both of these CCAs have shown their desire to not only keep up on the newest aspects of agriculture but also to reinforce their knowledge on the everyday challenges facing crop consultants. Farmers and others seeking ag consulting advice from Eskew and Dukes can be assured that they are dealing with professionals who have the farmers' best interests at heart. ■

Tales from the pits: An introduction to a new column

By Dawn R. Ferris, Ph.D., PSS, and CPSS and Soil Science Program Coordinator for the Soil Science Society of America; 608-819-3900 or dferris@sciencesocieties.org

Editor's note: Dawn Ferris, a member of the American Society of Agronomy and the Soil Science Society of America (SSSA) and licensed and certified professional soil scientist, joined the headquarters staff in July as SSSA's Soil Science Program Coordinator. She is a soil scientist with experiences in both the public sector (academia and county government) and the private sector (consulting for an environmental firm). For the past three years, she worked as the exam development consultant for the Council of Soil Science Examiners (CSSE) and before that served on the CSSE as a member and chair.

Yes, I know, it's a bit hokey to suggest a takeoff on *Tales from the Crypt* as the name of this new column in *Crops & Soils* magazine, but I think maybe this might work. We all have our weird little stories or tales to tell from time spent in the field. My vision for this column is to share our experiences as soil scientists by highlighting those tales—good or bad. We are, after all and much to people's surprise, a very creative and outgoing bunch that has a great time doing field work. OK, so I have been called a geek from time to time, and my mother believes that I make mud pies for a living, but I still love soils.

This light-hearted column is meant to illustrate the work we do, the successes we have, and the mistakes we make. We need to be able to laugh at ourselves sometimes and realize when we have learned valuable professional lessons. So, those of you with lots of experience, send me your tales! And hopefully those who are still gaining experience will find some gems of wisdom—and if you have a tale you would like to share too, please do so. The only ground rule is that you are respectful of others—feel free to make light of yourself, but don't land anyone else in an embarrassing spot unless you have their permission. You can choose to be anonymous in your story or put your byline on it.

I suppose it is only fair that since this was my idea I go first. I have a lot to choose from; some not so stellar. But I always say if you learn from your mistakes, then you have done well. First let me give you a little background on myself so that there is some context of where my experience comes from. I have spent the majority of my career as an environmental consultant, but also have a fair amount of experience working with government and academia.

So where do I start with one of my tales? Perhaps the best start is with one of my not-so-stellar moments to break the ice. I was mortified at the time, but I learned a very valuable lesson.

Tales from the pits: Chapter 1

As a consultant, you get to do a lot of different jobs, and not necessarily in areas that you went to school for or have a lot of experience in. Such was the case with me during the first few years on the job. These experiences served me well, however, as I rose to the rank of manager and director in the consulting world and also in my government and academic careers. So a tip for those who are new to the workplace—get as much experience in as many different areas as possible, as this experience will always pay off. But I digress.

I was sent on a job with a crew to use a Geoprobe to sample and map contaminated groundwater around a hotel adjacent to Lake Superior. The hotel was part of a large chain and thus the client was important in terms of additional work. (As an aside, the Geoprobe is a direct-push tool, not a drill, used to sample soil, water, or vapor.) We traveled to the work site the afternoon before we started sampling, constructed a site map of the hotel and surrounding grounds, and stayed the night at the client's hotel. While we were not a group that expected a five-star hotel, even by our "stay in the cheap hotel" consulting standard, this hotel was not good. It was not clean, there were a lot of noises in the walls, the chlorine smell from the pool permeated everything, and the restaurant left a lot to be desired. Most notable in the morning was the sludge of orange juice concentrate in the bottom of the juice glass with the water on top. Well, the crew had fun with this.

While we were enjoying our "fresh squeezed" orange juice at breakfast, reviewing the site map and planning our strategy for the day, the crew was also busy amending the site map with little comments about the hotel like "Restaurant Elegante," "Eau de Chlorine," "Wall of the Rats," and

"Hotel de la Pit." We all had a great laugh at the artwork. Then the time came to do the sampling.

As we were deciding where we could and couldn't use the Geoprobe in the rocky terrain, we found an additional spot to sample where we were going to disturb some flower beds and needed to move some landscaping rocks in order to get the probe where we needed it. As the lead scientist, I was elected to go in and speak to the hotel manager to make sure that he understood what we were doing and where we were going to sample from. Guess who had the site map on the top of her clipboard? Yeah, me, which wouldn't have been so awful if the manager hadn't grabbed the clipboard out of my hands to look at the site map while we were talking. OUCH! And yes, he caught the comments on the site plan and was none too pleased. Talk about wanting to be anywhere else at that moment! I did perhaps the fastest talking of my life up to that point in the next few minutes trying desperately to save the job and the overall client.

I did eventually get the manager to overlook the "jokes" on the site map. But it wasn't over because I still had to call our project/client manager back in Minneapolis and explain what just happened. So for the second time within a half hour I was talking as fast as I could to work everything out with a minimum of damage. I also had to protect the crew that was with me. Being the lead on the field crew, I took the blame for the fiasco because if I had more sense, I would have never let the site map get written on. Our project/client manager was not happy with me, but overall the fallout wasn't too bad. I did well enough with the hotel manager that it never got back to the overall client. I just had to endure what seemed like endless ribbing from the office. Oh, and I never made that mistake again!

Lessons learned

I learned some valuable lessons:

1. Never ever write anything on field notes that you don't want the client to see.
2. Always be an advocate for the crew you are working with if you are in charge. In other words, don't ever throw anyone under the bus—take your lumps and move on.

So there you have it, a very uncomfortable day early in my career and a few lessons learned. Now it is your turn. Please send me your tales. They don't have to be the uncomfortable side of the job as mine was. I understand there are many of you that cannot talk about specifics, especially with consulting jobs, but as with my story, much of the detail, time frame, and location can be removed to render it pretty general. I also encourage you to share the good experiences and the "aha" moments with us because those are equally as interesting and educational.

If you have questions or would like to submit a tale for this column, please contact me at dferris@sciencesocieties.org. Together we can make this a successful, useful, and much-read column. I look forward to working with you. ■

Managing manure in reduced-tillage systems

Application of manure to forage soils and those under reduced tillage represents a particular concern, as the manure is typically surface-applied and not followed by tillage incorporation. This can lead to environmental losses through runoff and ammonia (NH_3) volatilization. Surface-applied manure is also a major source of nuisance odors.

Repeated surface application of manure to no-till soils may result in severe stratification of soil properties, requiring periodic tillage to mix the soil. However, this increased tillage is not compatible with forage maintenance and can reverse the soil quality and environmental benefits of reduced tillage. Thus, the challenge is to find methods of manure incorporation that reduce environmental impacts but leave crop residue and forage on the surface to protect soil from erosion.

An array of technologies now exist to facilitate the incorporation of liquid manures into soil with restricted or minor soil disturbance, some of which are new: shallow disk injection, chisel injection, aeration infiltration, and pressure injection. In a new article scheduled for an upcoming issue in the *Journal of Environmental Quality*, a group of researchers from various universities and the USDA report on the different methods of manure application in reduced-till systems.

There are various methods to work manure into the soil with minimal tillage. Disc injectors cut a slit in the ground, inject the manure, and then close the injection slit causing a minimum of soil disturbance. Chisel injectors cause slightly more soil disturbance, dragging a vertical chisel through the soil and injecting manure behind it. Often there is a sweep at the base of the chisel that helps spread the manure horizontally in the soil. Aerators punch holes into the ground and are meant to help increase manure liquid and rainfall infiltration. However, by changing the angle of the arms on some aerators, they can be used to till instead of simply aerating. As the researchers relate, there is not an easy answer as to which implements are compatible with no-till, although some consider an implement that disturbs the soil in less than one-third of the implement width to be a good guide.

Although there is a range of aeration equipment available, the researchers found that there are not enough studies that have been conducted to evaluate when aeration may work and when there will be no benefit. Soil aeration is intended to hasten manure infiltration, but its benefits are not consistent and may be related to factors such as soil drainage characteristics.

The researchers found that, depending on conditions, more than 85% of total NH_4–N can be lost as NH_3 from surface-applied manure

▶ **Examples of novel manure application technologies currently available, including (*clockwise*) a disk injector system that is capable of injecting liquid manure to a depth of 15 cm; a chisel injector with sweeps, which includes a disk to cut surface residue; and an aerator set up to band liquid manure over the injection slots.**

within 24 hours. So, tillage has to occur immediately after manure application to effectively capture N. They found that soil aeration followed by manure application does not consistently decrease NH_3 volatilization or nutrient losses in runoff.

In addition, they found that surface banding of manure in forages decreases NH_3 emissions relative to surface broadcasting, as the plant canopy can decrease wind speed over the manure, but greater reductions can be achieved with manure injection.

Surface banding of manures may reduce NH_3 volatilization where there is a standing crop, such as application to forages, especially where the ground is too stony for manure injection. From their review of the studies available, the researchers found that manure injection seems to be the most promising in terms of reducing NH_3 volatilization in no-till and forages, and this can increase yield where N is limiting and decrease odors and nutrient and sediment losses in runoff.

More soil disturbance may be acceptable for preplant manure injection for row crops than for manure injection into established forages, which may be damaged. Although it is now possible to use these technologies to improve N recovery and decrease nutrient losses in runoff and odor problems, surface broadcasting remains the predominant method used for liquid manures, as it is quick and cheap. However, according to the researchers, there are great opportunities to improve manure management in no-till and forages if the economic hurdle can be overcome. ■

Adapted from the Journal of Environmental Quality *article, "Manure Application Technology in Reduced Tillage and Forage Systems: A Review," by R.O. Maguire, P.J.A. Kleinman, C.J. Dell, D.B. Beegle, R.C. Brandt, J.M. McGrath, and Q.M. Ketterings. J. Environ. Qual. 39. See www.soils.org/publications/jeq/new-articles*

Preventing nitrogen losses from green manure crops

Agriculture is the largest source of nitrogen (N) inputs to waterways in the United States, flowing into streams and rivers via erosion from farmlands or through leaching of nitrate into groundwater. Once in aquatic systems, excess N degrades the ecosystem, producing anoxic conditions that contribute to fish kills. When leached into drinking water supplies, nitrates can be a human health concern.

Legume cover crops, such as hairy vetch, have been considered as an alternative or supplement to synthetic N fertilizers that may improve the sustainability of agricultural systems. Such cover crops can contribute substantial amounts of N to subsequent crops, as well as protect soils from erosion and promote overall soil quality. Legume-derived N tends to be released more slowly than synthetic fertilizers, possibly being more synchronous with crop demand. It has been shown, however, that legume-derived N sources can still be lost from the system. One way to possibly minimize these losses may be to add more carbon to N-rich residues, such as those of cereal grain crops, during cover crop phase of the cropping systems.

In the May–June 2010 issue of *Agronomy Journal*, researchers report on a study in which they evaluated the potential for legume-derived N to be immobilized by the retention of small-grain residues prior to the legume cover crop establishment. In this study, three different quantities of small-grain residue were spread on research plots that were later planted to hairy vetch. A corn grain crop was later no-till planted into the vetch/small-grain residues.

The study revealed that treatments with added small-grain residues tended to have lower soil inorganic N than treatments with strictly vetch residues. On average, across sampling dates, soil inorganic N was 7.3% lower in the treatments with small-grain residues retained. The type of residue present affected not only the magnitude of the peak of N in soil but also the timing of this peak, which is important when considering the synchrony of N availability to corn N demand. However, the reduced availability of N in the soil also negatively impacted corn grain yields, which in one year of the study fell 16% below the county average.

▶ **Hairy vetch establishing through small grain crop residues.** Photo by Robert Gallagher.

The authors conclude that partial retention of small-grain residues prior to a hairy vetch cover crop can reduce legume N losses, but may result in reduced crop yields in some years. Further research is needed to help better predict legume N availability and how to best integrate legume cover crops with synthetic fertility management systems. ■

Adapted from the Agronomy Journal *article, "Management of small grain residues to retain legume-derived nitrogen in corn cropping systems," by A. Starovoytov, R.S. Gallagher, K.L. Jacobsen, J.P. Kaye, and B. Bradley. Agron. J. 102:895–903. See www.agronomy.org/publications/aj/tocs/102/3*

Have you met your CEU requirements?

Is your two-year CEU cycle ending in December? Do you have at least 40 total CEUs reported? You can check your CEUs online 24/7 at www.certifiedcropadviser.org, www.agronomy.org/certifications, or www.soils.org/certifications. You'll need to log in with your certification number.

You can check your CEUs online 24/7 at www.certifiedcropadviser.org, www.agronomy.org/certifications, or www.soils.org/certifications

For those of you who still need to earn CEUs before the end of the year, we will send you a statement in the fall. If you've already met your requirements, we will send you a confirmation email rather than mailing you out a statement. This will help us keep costs down as we move towards a paperless program.

As you know, you have until December 31 to earn enough CEUs. If you still need some and are looking for opportunities, you can search the calendar at www.agronomy.org/meetings/calendar or visit our self-study CEU page at www.certifiedcropadviser.org/certifications/self-study.

CCAs also have the option of self-reporting CEUs at educational events that have not been reviewed by a local CCA board. The reporting must be done online using the "CEU Self Reporting Form." ■

The value of certification

By Luther Smith, Director of Certification Programs; lsmith@sciencesocieties.org or 608-268-4977

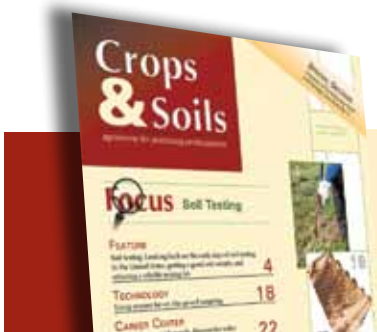
I had the opportunity earlier this year to sit down with a group of farmers and CCAs to discuss the CCA program and how it worked in the United States. The reason for this meeting was to help our India CCA team learn more about the program and what farmers thought about it. Although the focus was on CCAs, the responses we received are applicable to certification in general.

Farmers are the clients and customers of CCAs and represent the end user of the certification programs. A goal of the program has always been to be a value to the farmer and in return make the CCA designation more valuable to the CCA. It was very interesting what the farmers thought about the program. Every one of them stated that "continuing education" was the most important piece. Here are some of the comments we received from the farmers and CCAs:

- "The important part for farmers is finding unbiased information. A salesman sells products, so you have a natural skepticism. Is he trying to sell a product or make a recommendation? An important part of the CCA program is that it adds creditability to your salesperson/agronomist." *(Farmer)*
- "Best part of the CCA program experience is having to continually learn—helps keep you up to date, interact with researchers, and learn new technology." *(Farmer/CCA)*
- "Continuing education is a very important part of the CCA program; it gives a reason to keep up. Everyone gets busy and [continuing education] is the last thing you have to do, so continuing education requirements keep people who advise us up to speed on what is going on." *(Farmer)*
- "I have over 34 CEUs in Soil and Water Management since becoming certified. Without the program, I would never have had that education. [The CCA program] keeps me well rounded and of greater benefit to my customers." *(CCA)*

Each one was unsolicited and gave different reasons for the value of certification, but all point to continuing education as a major value point to being certified. It's true that you don't have to be certified to participate in continuing education; however, the certification requires it and formalizes the process. There are consequences for not meeting the requirements, and it can be motivating when you just don't feel like going to another session.

The short answer to the value question is "yes," being certified is a value to you as the holder of the certification and to your clients and customers. But if you don't believe and express that, don't expect anyone else to. I'll continue this discussion in a series of articles in future issues of *Crops & Soils* magazine, looking at the issue from different perspectives. ■



Want to contribute an article to *Crops & Soils* magazine? Email

cropsandsoils@sciencesocieties.org

Earn CEUs at the Long Beach Annual Meetings

Join your peers this fall, October 31–November 3 in Long Beach, CA, for the 2010 International Annual Meetings of the American Society of Agronomy (ASA), Crop Science Society of America (CSSA), and Soil Science Society of America (SSSA). There will be plenty of opportunities to earn CEUs with nearly 2,500 papers being presented in three-and-half days. View the program, search the schedule, and browse by day and division of interest at: www.acsmeetings.org/program.

Certified professionals working in agronomy, crop, soil, and related sciences can learn about the latest advances in production agriculture, network with colleagues, view products and services in the exhibit hall, and attend professional development programs.

Earning CEUs

Nearly 2,500 poster and oral papers will be presented in sessions throughout the week, covering such topics as nutrient management, soil and water management, integrated pest management, crop management, and professional development. Certified professionals can attend the paper sessions and self-report their CEUs following the meeting. CCAs may only receive CEUs for structured oral presentations; open poster sessions do not qualify for CCA CEUs. Self-reporting forms are available online at: www.certifiedcropadviser.org, www.agronomy.org/certifications, and www.soils.org/certifications.

Career opportunities

If you are looking to hire, or looking for a job, tap into the services of the Annual Meetings Career Center. Open Sunday through Wednesday in the exhibit hall, the center assists employers and employees with job opportunities and facilitates interviews. For information, visit: www.careerplacement.org or contact Leann Malison at 608-268-4949 or lmalison@sciencesocieties.org.

Soils exam prep workshop

SSSA is sponsoring a Soils Exam Prep Workshop on November 1 during the Annual Meetings. The workshop will review the Soils Fundamentals Exam performance objectives in relationship to soil science concepts and is designed to help prepare someone to take the exam. Sign up for the workshop when you register for the meetings. *Note the workshop fee increases after September 23*. For information, visit: www.acsmeetings.org/tours-workshops#Soils.

Long Beach Convention and Visitors Bureau.

Meeting registration

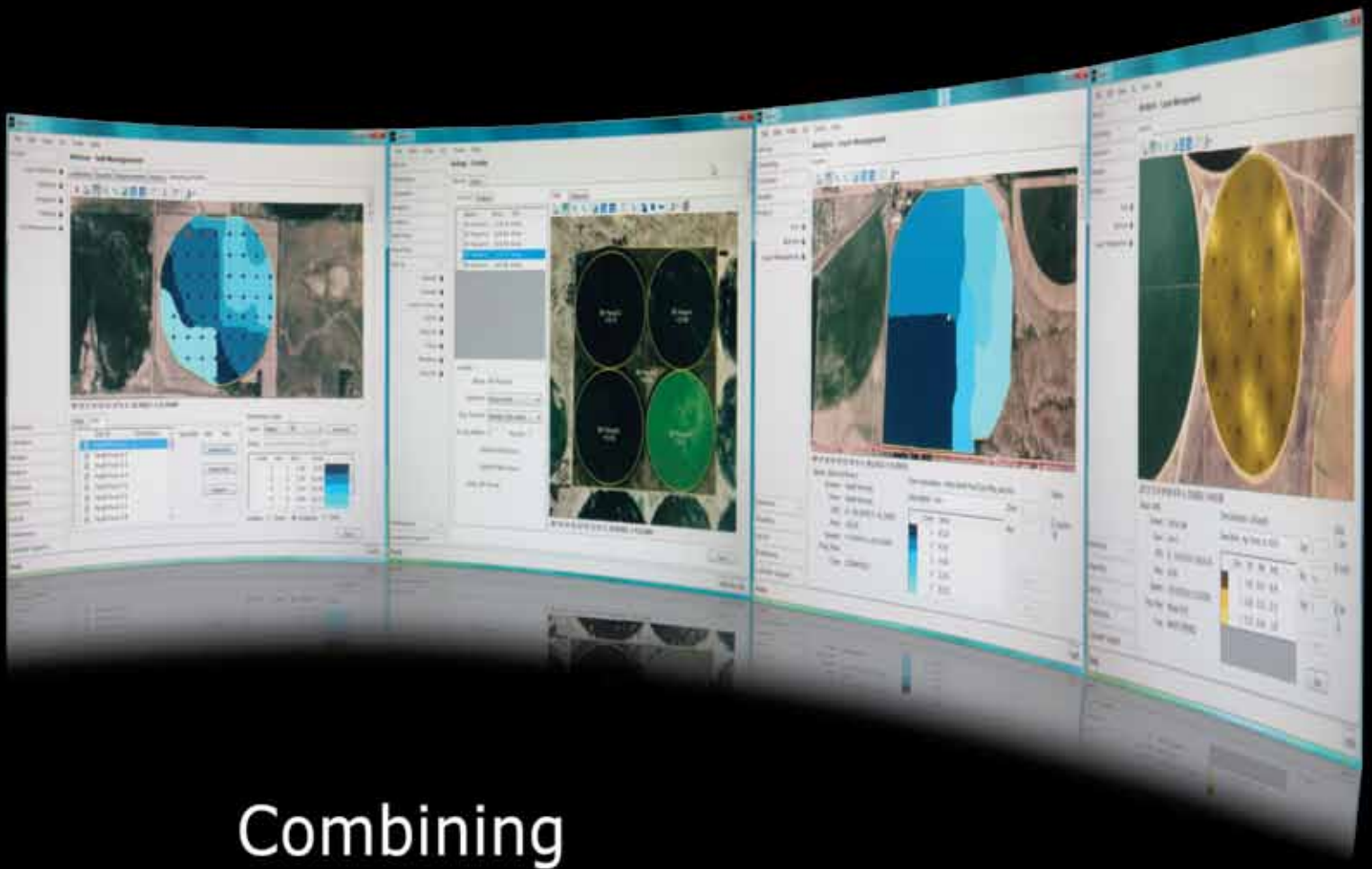
Registration for the Annual Meetings is available online or by fax or mail. Register by September 23 to receive the early registration discount or by October 8 to receive the pre-registration discount. Early pre-registration by September 23 is $435 for ASA, CSSA, and SSSA members and $635 for non-members. After October 8, the registration fee increases to $565 for members and $765 for non-members. Both one- and two-day rates are available. Members receive substantial registration discounts. In most cases, it costs less to join or renew and register for the Annual Meetings than it does to attend at the nonmember fee. For more information, visit: www.acsmeetings.org/registration. ■

ADVISOR | CDMS Applied® Intelligence

The Next Generation Agronomy Management System

ADVISOR IS A COMPREHENSIVE WEB-BASED AGRONOMY MANAGEMENT SYSTEM providing decision support for agronomic best practices, GIS based field activity, and connectivity between all participants in the food production continuum.

With its comprehensive approach to crop production, ADVISOR can be applied to virtually any input requirement for optimizing crop production.



Combining Agronomy & Technology

- Web-based for Mobility and Flexibility
- Full GIS/Mapping Features
- Sampling, Scouting, and Trap Monitoring
- Crop Protection, Soil Performance, and Crop Production
- Precision Ag and VRA Support

CDMS | Data Logic Knowledge

800.237.2367 | sales@cdms.net | www.cdmsadvisor.com

Self-Study Course

Earn 1 CEU in **Crop Management** by reading this article and completing the quiz at the end. CCAs may earn 20 CEUs per two-year cycle as board-approved self-study articles. Fill out the attached questionnaire and mail it with a $20 check (or provide credit card information) to the American Society of Agronomy. Or, you can complete the quiz online at www.certifiedcropadviser.org ($15 charge).

Selecting green manure crops to enhance potato production

As potatoes become a more important crop, managing the crop rotations that are commonly a feature of potato production is increasingly essential. Intensification of potato production in recent decades has resulted in generally shorter potato rotations, with decreased use of legume and nonlegume rotational forage crops, leading to depletion of soil organic matter. To ameliorate the depletion, in some areas both legume and nonlegume crops are employed between potato planting, and depending on the soil types and other climatic variations, selecting a good rotational crop is essential to keeping the organic matter needed in the soil. Systems that reduce the return of residue to soil can rob it of both C and N quickly, so use of cropping systems that increase organic residues from green manure crops or from organic amendments can increase the sustainability of intensive potato production. Green manure crops are usually used as soil amendments and nutrient sources to the next crop. This also aids in controlling weeds and plant diseases.

Traditional potato production includes barley, frequently used in two-year rotations to increase the amount of organic matter added back to soils. Another popular crop is red clover used in three-year rotations, although root lesions and bacteria-feeding nematodes may reduce potato yields, according to some reports. Of recent interest is the increased use of Italian ryegrass as a green manure in potato production in Atlantic Canada as a replacement for barley and/or red clover. Italian ryegrass is commonly grown at low N fertility for the whole growing season, and the forage is mowed and returned to the field midseason and plowed in the fall prior to spring planting of potatoes. The effect of management of an Italian ryegrass crop on N availability to the potato crop is unclear.

Forage plants are usually quite efficient in taking up soil N, and addition of recommended rates of fertilizer N does not usually result in accumulation of N in autumn, although high soil nitrate accumulation or increased nitrate leaching can occur where N fertility is very high. In Atlantic Canada, soil nitrate is lost from the root zone over the fall and winter period through leaching and denitrification, and soil N supply is controlled primarily by soil N mineralization. That being the case, the effects of an Italian ryegrass green manure crop on N supply to a subsequent potato crop are expected to occur primarily through the processes of mineralization and immobilization during decomposition of the crop residues.

After forage grasses are incorporated, the quantity of N mineralized into the soil increases with the age of the sward because more organic N over time is absorbed. A higher rate of N fertilizer application to the sward can also increase the quantity of N mineralized following incorporation of a forage grass due to lower C/N ratios of the plant residues. Incorporation of low C/N ratio residues generally results in net N mineralization while high C/N ratio residues result in net immobilization. Using laboratory tests, researchers calculated the break point between net mineralization and immobilization to be at a C/N ratio of 40, although a C/N ratio of 20 to 30 is more common under field conditions. However, the amount of N mineralized from a crop residue varies not only with the C/N ratio but also with the composition of the residue.

How residues are incorporated can influence N mineralization. The N mineralization from legumes, specifically a white clover or pea crop, was greater when the residue was incorporated by plowing than when it was surface mulched, whereas the reverse was true for non-leguminous ryegrass and wheat crops due to net immobilization following plowing. Early-fall plow down of a preceding red clover crop reduced soil nitrate content in the following spring compared with late-fall or spring plow down. This finding was attributed to increased fall mineralization and subsequent nitrate leaching during the winter period with early-fall plow down.

Methods

To determine the effect of different fertilizer N managements and plow-down dates for a preceding Italian ryegrass green manure crop on soil N supply to a subsequent potato crop, two field experiments were conducted at the Harrington Research Farm, Prince Edward Island, Canada. The experiment used a nested arrangement of treatments using a randomized complete block design with four blocks. Main plots were two plow-down dates for the Italian ryegrass crop (early September vs. early November), subplots were three fertilizer N managements on the Italian ryegrass crop, and sub-subplots were two fertilizer N rates (0 or the recommended rate of 179 lb N/ac) on the succeeding potato crop. Sub-subplots were 28 by 12 ft (four potato rows) in size. The Italian ryegrass fertilizer N managements (Table 1) were chosen to represent a control (N_1), current grower practice for Italian ryegrass as a green manure rotation crop for potato (N_2), or a high level of fertility comparable to that used for Italian ryegrass grown to produce a harvested forage crop for animal feed (N_3).

Soil samples were taken from each sample before ryegrass seeding from each N management subplot before ryegrass plow down, from each N management subplot before potato planting in the subsequent spring, and from all potato plots that did not receive fertilizer N application after tuber harvest. Composite soil samples were collected for 0- to 6-inch and 6- to 12-inch depths. Samples were frozen until analyzed. Soil samples were sieved to pass a 0.2-inch sieve. A 20-g subsample of moist soil was oven-dried at 221°F to determine gravimetric water content. A 20-g subsample of moist soil was extracted with 1.7 *M* KCl using a 1:5 soil/extractant ratio and 30-minute shaking time. The concentrations of NO_3–N and NH_4–N in the extract were determined.

Apparent recovery of applied fertilizer N was estimated in the harvested forage, the forage stubble tissue, and the potato plant at vine desiccation for the subsequent unfertilized potato crop. In each case, apparent recovery was calculated using treatment means as N accumulation in the appropriate tissue for the N_2 or N_3 management, less N accumulation in the N_1 management that had no fertilizer N applied, divided by the fertilizer N applied, and expressed as a percentage.

▶ Table 1. Fertilizer N treatments applied to the Italian ryegrass green manure crop.

N treatment	Spring	Tillering	After first harvest	After second harvest	Total applied
	lb N/acre				
N_1	0	0	0	0	0
N_2	50	0	0	0	50
N_3 (early plow down)	50	34	50	0	134
N_3 (late plow down)	50	34	50	34	168

Results

Forage dry matter yield for the first harvest did not differ between years. Forage dry matter yield was higher for the ▶

second harvest in 2002 than in 2003 and was lower for the third harvest (late plow-down treatment only) in 2002 than in 2003. Increasing the rate of N application increased forage yield within each harvest.

There was a significant year × fertilizer N management interaction on forage C/N ratio for harvests 1 and 2. For harvest 1, forage C/N ratio decreased with increasing N rate in 2002, whereas in 2003, forage C/N ratio was lowest for the N_3 management and highest for the N_2 management. For harvest 2, forage C/N ratio increased with increasing N rate in 2002, whereas in 2003, forage C/N ratio was lower for the N_1 and N_3 managements than for the N_2 management. For harvest 3, forage C/N ratio was slightly higher for the N_2 management than for the N_1 and N_3 managements.

Increased fertilizer N rate increased dry matter yield in the harvested above-ground Italian ryegrass crop. Crop growth was limited during the period between second and third crop harvests, presumably because of drier soil conditions and cooler temperatures at that time, and the delayed plow down did not significantly increase growing season forage dry matter yield. Increased fertilizer N rate increased dry matter production of stubble tissue. In contrast to above-ground plant tissue, delayed plow down resulted in large increases in dry matter production as stubble tissue. Stubble tissue represented a large (40–90%, average of 73%) proportion of dry matter production compared with perennial forages in eastern Canada, which indicated that approximately 25 and 50% of biomass was partitioned to roots in legume and grass species, respectively.

Increased fertilizer N rate increased N uptake in harvested forage and in stubble tissue. Similar to the result for dry matter production, delayed plow down increased N uptake in stubble tissue but not in harvested forage. Due to commonly lower N concentrations, stubble tissue accounted for a lower proportion of N uptake than of dry matter production. On average, 56% of N uptake occurred in stubble tissue, with values ranging from 24 to 82% among individual treatments and years.

Apparent recovery of applied fertilizer N in the Italian ryegrass averaged 67%. Apparent recovery of applied N is expected to be overestimated because the harvested forage was returned to the field as a green manure, so that N in the harvested forage can subsequently be taken up again by the ryegrass crop. Despite the high N uptake by stubble tissue, apparent recovery of applied N was much lower in stubble tissue (average of 12%) compared with harvested forage (average of 55%). Roots comprise a significant proportion of plant total biomass in forage grasses, and their loss during washing may have resulted in underestimation of apparent recovery of applied N by the ryegrass crop. Soil mineral N contents measured at plow down of the Italian ryegrass were low and independent of ryegrass N fertilizer and plow-down management treatments. As a result, apparent recovery of applied N as residual soil mineral N was negligible. This is consistent with previous studies that reported limited accumulations of soil mineral N under forage grasses fertilized at or below recommended N rates.

While heavier N application increased N uptake in the above-ground tissue, it did not necessarily increase N concentration in the tissue, and reduce the C/N ratio, as might have been expected. Similar to above-ground tissue, increased N accumulation associated with higher N application did not necessarily increase the N concentration, or reduce the C/N ratio, of stubble tissue. This may reflect reduced dry matter production under conditions where N supply is quite limited. This may also reflect differences in forage maturity at the time of harvest.

Increased N application on the Italian ryegrass crop resulted in increased N uptake in the subsequent unfertilized potato crop. Potato plant N uptake measured at vine desiccation where no fertilizer N is applied can be used as a measure of soil N supply. The magnitude of the increase in plant N uptake was small. Apparent N recovery in potato plants from N applied to the Italian ryegrass was low and averaged 10%. Increased N application on the ryegrass crop resulted in small increases in tuber yield, mean tuber weight, and plant dry matter accumulation. These responses are consistent with an increased soil N supply for high N fertility in the preceding ryegrass crop. Increased N application on the preceding ryegrass crop increased petiole nitrate concentration on some sampling dates, particularly for the late plow-down treatment. Petiole nitrate concentration is a sensitive indicator of potato N status.

Soil mineral N contents measured in spring before potato planting were low and independent of ryegrass management treatments. Therefore, in this study, there were no accumulations of residual mineral N that could influence soil N supply to the subsequent potato crop. This may reflect limited net mineralization on incorporation of the ryegrass residues by plowing and/or loss of mineralized N by nitrate leaching over the fall and winter period. The quantity of organic N accumulated in crop residues, the quality of the crop residues, and the soil properties and environmental conditions will be expected to be the primary factors controlling any effects of the Italian ryegrass green manure crop on soil N supply to the subsequent potato crop.

Conclusions

This study did not demonstrate a significant effect of Italian ryegrass management on potato N accumulation or tuber yield when N was applied to the potato crop. This is consistent with the potato crop response measured in potato plots being primarily the result of the effect of N and plow-down management of the Italian ryegrass crop on soil N supply and not to other nutrient or non-nutrient effects of the preceding ryegrass crop.

Despite this, an Italian ryegrass green manure crop in potato rotations in Atlantic Canada has been shown to increase soil organic matter inputs. Increased fertilizer N rate increased both above-ground and stubble biomass, whereas delayed plow down primarily increased stubble

biomass. Current grower N management (i.e., a modest N rate in spring only) in combination with delayed plow down would therefore be a cost-effective option for growers to manage soil organic matter inputs.

Over the range of ryegrass N management and plow-down options likely to be used by growers, it is not likely that the effect on soil N supply is sufficiently large to justify a change in the rate of N applied to the subsequent potato crop. This reflects in part the high C/N ratio and relatively low decomposability of the stubble tissue. The phase of net N immobilization following incorporation of nonlegume green manure crops can occur over several months, and monitoring the effects of the Italian ryegrass green manure crop over one growing season in this study may not have been sufficient to fully characterize the effects on soil N availability. ■

Adapted from the November–December 2009 Agronomy Journal *article, "Italian Ryegrass Management Effects on Nitrogen Supply to a Subsequent Potato Crop," by B.J. Zebarth, W.J. Arsenault, S. Moorehead, H.T. Kunelius, and M. Sharifi. Agron. J. 101:1573–1580.*

September–October 2010 Self-Study Quiz

Selecting green manure crops to enhance potato production (no. SS 04077)

This quiz is worth 1 CEU in Crop Management. A score of 70% or higher will earn CEU credit. The International CCA program has approved self-study CEUs for 20 of the 40 CEUs required in the two-year cycle. An electronic version of this test is also available at www.certifiedcropadviser.org. Click on "Self-Study CEUs."

DIRECTIONS

1. **After carefully reading the article, answer each question by clearly marking an "X" in the box next to the best answer.**
2. **Complete the self-study quiz registration form and evaluation form on the back of this page.**
3. **Clip out this page, place in an envelope with a $20 check made payable to the American Society of Agronomy (or provide your credit card information on the form), and mail to: ASA c/o CCA Self-Study Quiz, 5585 Guilford Road, Madison, WI 53711. Or you can complete the quiz online (www.certifiedcropadviser.org) and save $5.**

DETACH HERE

1. Green manure crops are usually used as soil amendments and nutrient sources to the next crop. This also aids in

- ❑ a. increasing soil N.
- ❑ b. controlling weeds.
- ❑ c. controlling moisture.
- ❑ d. controlling erosion.

2. Traditional potato production includes

- ❑ a. red clover, which is frequently used in two-year rotations.
- ❑ b. barley, which is frequently used in two-year rotations.
- ❑ c. kura clover, which is frequently used in three-year rotations.
- ❑ d. field pea, which is frequently used in four-year rotations.

3. Current grower N management (i.e., a modest N rate in spring only) in combination with delayed plow down would

- ❑ a. not be a cost-effective option for growers to manage soil organic matter inputs.
- ❑ b. be a cost-effective option for growers to manage soil organic matter inputs.
- ❑ c. be cost neutral for growers to manage soil organic matter inputs.
- ❑ d. be a very expensive way for growers to manage soil organic matter inputs.

4. In this study, crop growth was limited during the period between second and third crop harvests, presumably because of

- ❑ a. drier soil conditions and cooler temperatures.
- ❑ b. delayed plow down.
- ❑ c. lower-than-average rainfall.
- ❑ d. warmer-than-average temperatures.

5. On average, 56% of N uptake from ryegrass crop growth occurred in stubble tissue, with values ranging

- ❑ a. from 24 to 82% among individual treatments and years.
- ❑ b. from 10 to 30% in average years.
- ❑ c. from 20 to 60% among individual treatment and years.
- ❑ d. between 5 and 15% among different treatments during the same year.

6. How residues are incorporated can influence N mineralization. The N mineralization from legumes, specifically a white clover or pea crop, was greater when

- ❑ a. the residue was incorporated by plowing than when it was surface mulched.
- ❑ b. non-leguminous ryegrass and wheat crops were used as cover.
- ❑ c. the residue was surface mulched than when it was incorporated by plowing.
- ❑ d. the residue was incorporated by burning.

Quiz continues next page

7. Soil mineral N contents measured in spring before potato planting were

- ❑ a. dependent on ryegrass management treatments.
- ❑ b. high when ryegrass management was optimal.
- ❑ c. high but independent of ryegrass management.
- ❑ d. low and independent of ryegrass management treatments.

8. Over the range of ryegrass N management and plow-down options likely to be used by growers, it is

- ❑ a. not likely that the effect on soil N supply is sufficiently large to justify a change in the rate of N applied to the subsequent potato crop.
- ❑ b. likely that the effect on soil N supply is sufficiently large to justify cutting back on the rate of N applied to the subsequent potato crop.
- ❑ c. probable that the effect on soil N supply is sufficiently large to justify increasing the rate of N applied to the subsequent potato crop.
- ❑ d. not possible for soil N supply to be large enough to be a reasonable choice for producers.

9. Italian ryegrass is commonly mowed and returned to the field midseason and

- ❑ a. plowed in the fall prior to spring planting of potatoes.
- ❑ b. left fallow for a year.
- ❑ c. incorporated into the soil before spring planting.
- ❑ d. incorporated into the soil immediately.

10. Which of the following is NOT listed in the article as a primary factor controlling the effects of the Italian ryegrass green manure crop on soil N supply to the subsequent potato crop?

- ❑ a. The quality of the crop residues.
- ❑ b. The soil properties and environmental conditions.
- ❑ c. The timing of planting and harvest.
- ❑ d. The quantity of organic N accumulated in crop residues.

SELF-STUDY QUIZ REGISTRATION FORM

Name: _____

Address: _____ City: _____

State/province: _____ Zip: _____ CCA certification no.: _____

❑ $20 check payable to the American Society of Agronomy enclosed. ❑ Please charge my credit card (see below)

Credit card no.: _____ Name on card: _____

Type of card: ❑ Mastercard ❑ Visa ❑ Discover ❑ Am. Express Expiration date: _____

Signature as it appears on the Code of Ethics: _____

I certify that I alone completed this CEU quiz and recognize that an ethics violation may revoke my CCA status.

This quiz issued September 2010 expires September 2013

SELF-STUDY QUIZ EVALUATION FORM

Rating Scale: 1 = Poor 5 = Excellent

Information presented will be useful in my daily crop-advising activities: 1 2 3 4 5

Information was organized and logical: 1 2 3 4 5

Graphics/tables (if applicable) were appropriate and enhanced my learning: 1 2 3 4 5

I was stimulated to think how to use and apply the information presented: 1 2 3 4 5

This article addressed the stated competency area and performance objective(s): 1 2 3 4 5

Briefly explain any "1" ratings: _____

Topics you would like to see addressed in future self-study materials: _____

DETACH HERE

Water balance and nitrate leaching under corn in kura clover living mulch

Self-Study Course

Earn 1 CEU in **Soil & Water Management** by reading this article and completing the quiz at the end. CCAs may earn 20 CEUs per two-year cycle as board-approved self-study articles. Fill out the attached questionnaire and mail it with a $20 check (or provide credit card information) to the American Society of Agronomy. Or, you can complete the quiz online at www.certifiedcropadviser.org ($15 charge).

In the midwestern United States, corn production is a dominant land use. In 2008, approximately 37 million acres of corn were planted in Illinois, Iowa, Minnesota, and Wisconsin, accounting for 46% of all cropland in those states. Corn yields in the region are high and increasing due to good soils and climate, improved hybrids, and expert management. These yields also support large industries such as livestock production and, increasingly, ethanol production. Corn-based cropping systems make this one of the most verdant agricultural regions in the world, for a few months each year.

For the remainder of the year, however, fields are dormant, solar radiation is not captured for photosynthesis, soil organic carbon is lost to respiration, the soil surface is relatively unprotected, and nutrient-rich soil water is prone to leach out of the root zone. These problems are exacerbated when corn is harvested for silage or if stover is harvested for biofuel production or livestock feed. The resulting negative off-site impacts on groundwater, surface water, and atmospheric greenhouse gas concentrations are major environmental concerns. The agricultural systems of the region, to meet global resource needs and to be sustainable, must undergo a process of biological intensification.

Biological intensification is the process of intentionally increasing the number of complementary species in an agricultural system. It is pursued to: (i) increase agricultural productivity per unit of land area, (ii) conserve and improve the soil, and (iii) create positive off-site impacts on water quality and greenhouse gas concentrations.

Living mulches may provide one path to effective biological intensification of agriculture. A living mulch is a cover crop grown with a main crop and maintained as a living ground cover throughout the growing season. Living mulches can reduce soil erosion and pesticide transport, improve soil quality, and promote biological control ▶

▶ Corn grown in kura clover living mulch.

of weeds and insect pests. Leguminous living mulches can also supply a portion of the N needs of a cereal crop through biological N fixation. Studies further suggest that living mulches can reduce nitrate leaching significantly under cereal crops, but no data are available to quantify the effects of leguminous living mulches on nitrate leaching.

Kura clover is a perennial, rhizomatous legume that is well suited as a living mulch for corn production in the midwestern United States. Some studies in the region have found that kura clover can provide year-round soil protection with little or no reduction in corn yield. Kura clover is also compatible with other annual grass species for forage production. Binary mixtures of kura clover with winter wheat and winter rye, for example, have produced similar yields to monocultures of the grasses while producing forage of higher nutritive value.

One of the primary challenges with living mulch cropping systems is competition for water between the main crop and the living mulch. Research in Illinois and Minnesota has documented yield reductions from living mulches of 20 to 29%, on average, for nonirrigated corn, with smaller or no yield reductions for irrigated corn. Despite these indications of water limitations, little is known about soil water balance under living mulches.

The general objective of a recent study in the *Agronomy Journal* was to learn whether corn grown in kura clover living mulch is a viable option for biological intensification of agriculture in the midwestern United States. The specific objective of this research was to determine the impact of a kura clover living mulch on the water balance and nitrate leaching under corn near Arlington, WI.

Field conditions

Field studies were conducted from April 2006 through November 2008 at a research station near Arlington, WI. Kura clover (experimental line KTA202) was established in the plot area in spring 2004 and mechanically harvested three times per season in the two years before this experiment was initiated. The experiment was a randomized complete block design with four replications. The control was corn following a perennial legume (i.e., kura clover) and is comparable to corn following alfalfa, a common cropping system supporting dairy and beef production in the midwestern United States. The control was managed for no-till corn production with a nonlimiting N supply. Living mulch treatments were corn grown in herbicide-suppressed (glyphosate and dicamba) kura clover with five fertilizer N rates ranging from 0 to 80 lb/ac. The 0 and 80 lb/ac N rates were selected for soil water and N measurements because resources were limited, and these rates were likely to produce the lowest and highest levels, respectively, of N leaching under the living mulch in this study.

The experiment was marked by above-average precipitation in general. In fact, the period from December 2007 through May 2008 was the second wettest on record for the upper Mississippi River basin. However, April through July was dry in 2007 with cumulative precipitation 28% below the 30-year average. Also, July through September was dry in 2008 with cumulative precipitation 30% below average.

Corn yields

Whole-plant corn (as for silage) was hand-harvested at about 50% kernel milk-line, typically in mid-September. Grain yields were determined by hand harvest in October each year. Corn grain yield was adjusted to 15.5% moisture content. After grain harvest, all remaining corn was cut at about a 6-inch stubble height, and the cut plants were removed from the field, simulating silage harvest or stover harvest.

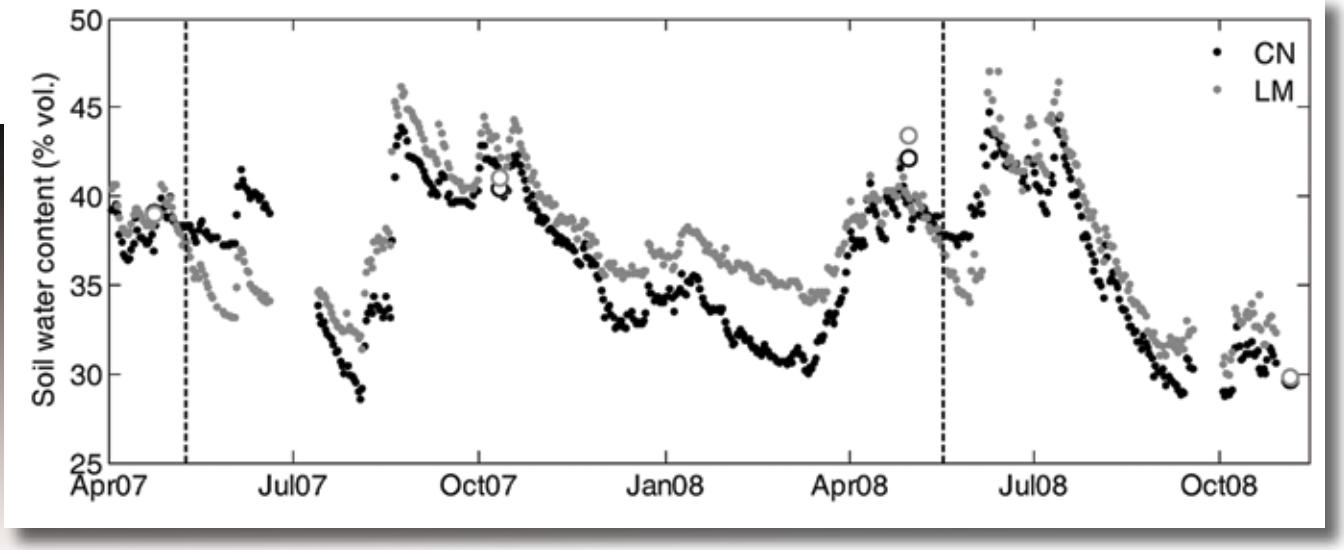


Fig. 1. Average time domain reflectometry (TDR) measured liquid soil water content to 3-ft depth under control (CN) and living mulch (LM). Open circles represent direct measurements of soil water content from soil sampling. Dashed vertical lines at May 9, 2007 and May 17, 2008 mark the beginning of spring soil water depletion by the living mulch.

The control produced high yields of both whole-plant dry matter (8.0 to 9.8 tons/ac) and grain (6.2 to 6.8 tons/ac). Yields were generally lower in the living mulch treatments than in the control. Specifically, for the living mulch receiving 80 lb/ac N annually, yields were reduced 14% on average relative to the control. Whole-plant and grain yields in this treatment were lowest in 2007; water stress resulting from the April through July dry period is a likely explanation. For the living mulch with no added N, the average yield reduction relative to the control was 30%.

Soil water content

Soil water storage to 3 ft in depth was monitored daily by time domain reflectometry (TDR) sensors in one replication of the control and the living mulch receiving 80 lb/ac N. The TDR waveforms were then processed and used to estimate soil water content during the course of the experiment (Fig. 1). In addition, one tensiometer was installed in each plot to 3 ft in depth to provide supplemental data about soil moisture status. Tensiometer readings were recorded every two weeks when the soil was not frozen.

Averaged across all three years, the soil water content to 3 ft in depth was 40% by volume at the beginning of the growing season for both the control and the living mulch. Thus, both the control and the living mulch treatments entered the growing seasons at "field capacity" with no soil water deficit carried over from the prior year.

In 2007, greater early growing season transpiration led to lower soil water contents in the living mulch relative to the control beginning on May 9 (Fig. 1). The largest measured deficit was 2 inches on June 19. In May 2008, the living mulch also depleted soil water content beginning about May 17, reaching a maximum soil water deficit of 1.5 inches less than the control on May 30. Unlike in 2007, however, these effects were soon negated by heavy rain in June. Overall, the TDR and tensiometer data suggest that the living mulch increases the probability of corn experiencing water stress, especially when the late spring is drier than average. The magnitude of the increased risk remains to be quantified and will likely be site specific.

Later in the growing season, at the time of maximum soil water depletion, soil water content was lower under the control. This was evident in both 2007 (1.4-inch difference on August 3) and 2008 (1.1-inch difference on September 12). At these times, the corn canopies were dense, and transpiration by the corn likely accounted for most of the water depletion. Thus, the researchers hypothesized that the living mulch reduced or delayed the development of the corn root system to some extent, thereby reducing the corn's ability to deplete soil water stores. Reduced belowground corn biomass would be consistent with the ▶

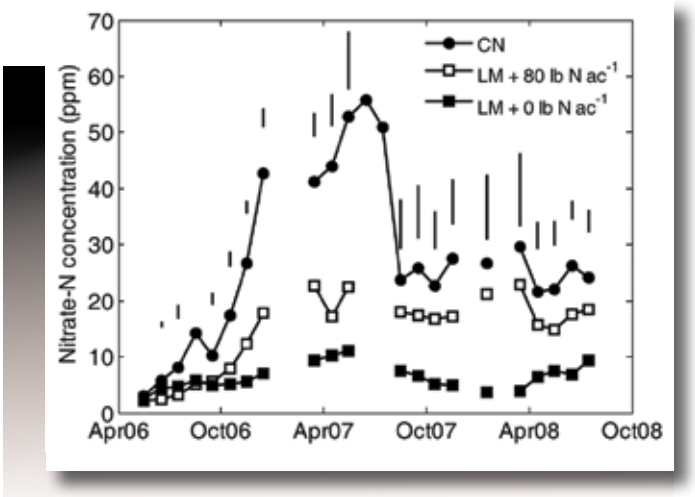


Fig. 2. Monthly mean nitrate-N concentration in soil solution samples at 3-ft depth for the control (CN) and two living mulch (LM) treatments. Vertical bars above the data series indicate the least significant difference (p = 0.10). Absence of vertical bars indicates no significant differences occurred.

reduced corn yields under the living mulch treatments, assuming similar root/shoot ratios for corn in each treatment.

Nitrate leaching

The nitrate-N concentration in the soil solution at 3 ft in depth was monitored using ceramic suction cup samplers (Model 1920F1, Soilmoisture Equipment Corp.) in all replications of the control and the living mulch with 0 and 80 lb/ac N. Soil water samples were collected every two weeks when the soil was not frozen and the soil water content was sufficient to permit water collection. Nitrate-N concentrations in the samples were measured by flow injection analysis (Model QC8500, Lachat Instruments) using the colorimetric Cd reduction method.

At 3 ft in depth, nitrate-N concentrations in the soil solution were significantly reduced in both living mulch treatments relative to the control (Fig. 2). Mean monthly nitrate-N concentration in the control increased steadily from background concentrations at the beginning of the experiment to a peak of 56 ppm in June 2007. This trend was likely the result of mineralization of the killed kura clover combined with the addition of N fertilizer. The effects of mineralization would likely be less in rotations that do not include a killed perennial legume.

Following the peak in June 2007, nitrate-N beneath the control at 3 ft in depth declined sharply and stabilized between 22 and 30 ppm, a comparable range to that observed in previous studies with continuous corn. In April through July 2008, long after the effects of mineralization had dissipated, nitrate-N concentrations under the control were still significantly higher than under the living mulch with 80 lb/ac N. For most of the experiment, nitrate concentrations under the control exceeded 10 ppm, the maximum contaminant level (MCL) for drinking water set by the USEPA.

The living mulch with no added N maintained nitrate concentrations below 10 ppm for most of the experiment (Fig. 2). These data show that corn may be grown for three consecutive years in kura clover living mulch with no added N while maintaining low nitrate levels in water draining beneath the root zone.

The living mulch with 80 lb/ac N exhibited nitrate-N concentrations intermediate to the control and the living mulch with no added N. Nitrate-N concentrations in the soil solution at 3 ft in depth increased through the first year of the experiment before stabilizing around 20 ppm (Fig. 2); thus this level of N addition is too large to meet the MCL target at this site. Prior studies have found 40 lb/ac N to be adequate for the living mulch system. Whether or not the MCL target is achieved for corn in kura clover living mulch receiving 40 lb/ac N is a question for future research.

Below 3 ft in depth over the course of the experiment, the total nitrate-N leaching under the living mulch with no added N was reduced 74% relative to the control, and the total nitrate-N leaching under the living mulch with 80 lb/ac N was reduced 31% relative to the control. Since drainage amounts were similar across treatments, these large reductions are due primarily to lower nitrate-N concentrations beneath the living mulch. The observed leaching total for the control corresponds to an annual nitrate-N leaching loss of 54 lb/ac N. This is similar to the results of other studies in this region, which have found annual nitrate-N leaching under no-till continuous corn ranging from 37 to 50 lb/ac.

Conclusions

The impacts of kura clover on the soil water balance under corn were generally small, but temporary soil water depletion occurred under the living mulch during the spring and contributed to subsequent water stress in the corn. The living mulch treatments resulted in important water quality benefits, reducing nitrate-N leaching 31 to 74% relative to the control. The living mulch also provided valuable soil cover in this corn production system where both the grain and stover were harvested. Thus, the living mulch system has potential to improve the sustainability of whole-plant corn harvest, whether for livestock feed or for bioenergy. Corn yields were reduced in the living mulch systems, and thus only two of the three objectives of biological intensification (i.e., conserve and improve the soil and create positive off-site impacts on water quality and greenhouse gas concentrations) were achieved.

Harvesting or grazing the kura clover or accounting for the value of the biological N fixation might improve the agricultural and economic productivity. Future work should consider these possibilities. More research is also needed on other aspects of the kura clover living mulch system including soil carbon effects, greenhouse gas emissions, and suitable crop rotations. In this living mulch experiment,

biological intensification produced important environmental benefits, but the potential economic losses due to yield reductions cannot be ignored. ■

Adapted from the July–August 2010 Agronomy Journal *article "Water Balance and Nitrate Leaching under Corn in Kura Clover Living Mulch," by Tyson E. Ochsner, Kenneth A. Albrecht, Todd W. Schumacher, John M. Baker, and Robert J. Berkevich (Agron. J. 102:1169–1178)*

September–October 2010 Self-Study Quiz

Water balance and nitrate leaching under corn in kura clover living mulch (no. SS 04078)

This quiz is worth 1 CEU in Soil & Water Management. A score of 70% or higher will earn CEU credit. The International CCA program has approved self-study CEUs for 20 of the 40 CEUs required in the two-year cycle. An electronic version of this test is also available at www.certifiedcropadviser.org. Click on "Self-Study Quizzes to Earn CEUs."

DIRECTIONS

1. **After carefully reading the article, answer each question by clearly marking an "X" in the box next to the best answer.**
2. **Complete the self-study quiz registration form and evaluation form on the back of this page.**
3. **Clip out this page, place in envelope with a $20 check made payable to the American Society of Agronomy (or provide your credit card information on the form), and mail to: ASA c/o CCA Self-Study Quiz, 5585 Guilford Road, Madison, WI 53711. Or you can complete the quiz online (www.certifiedcropadviser.org) and save $5.**

1. Intentionally increasing the number of complementary species in an agricultural system is referred to as
- ❑ a. agricultural diversification.
- ❑ b. biological intensification.
- ❑ c. agricultural intensification.
- ❑ d. crop system diversification.

2. Living mulches are
- ❑ a. cover crops planted in the fall after harvest.
- ❑ b. organic residues grown with a main crop.
- ❑ c. cover crops grown with a main crop.
- ❑ d. perennial crops grown in place of the main crop.

3. One of the primary challenges with living mulch cropping systems is
- ❑ a. competition for water between the main crop and the living mulch.
- ❑ b. allelopathic effects between the main crop and the living mulch.
- ❑ c. emergence of the main crop.
- ❑ d. increased weed and insect pressure.

4. The time domain reflectometry and tensiometer data in this study suggest that the living mulch increases the probability of corn experiencing water stress, especially
- ❑ a. when the living mulch is maintained throughout the growing season.
- ❑ b. with a leguminous perennial living mulch such as kura clover.
- ❑ c. when temperatures are warmer than average.
- ❑ d. when the late spring is drier than average.

5. In this study, the researchers hypothesized that the living mulch reduced or delayed
- ❑ a. development of the corn root system.
- ❑ b. emergence of the corn.
- ❑ c. anthesis of the corn.
- ❑ d. transpiration in the corn.

6. In this study, the living mulch with 80 lb/ac N exhibited nitrate N concentrations
- ❑ a. that were below the maximum contaminant level for drinking water set by the USEPA.
- ❑ b. comparable to those of living mulch with no added N.
- ❑ c. comparable to those of the control.
- ❑ d. that were greater than maximum contaminant level for drinking water set by the USEPA.

7. In this study, temporary soil water depletion occurred
- ❑ a. under kura clover during the summer.
- ❑ b. under the continuous corn treatment.
- ❑ c. under the living mulch during the spring.
- ❑ d. in the second year of the experiment.

Quiz continues next page

DETACH HERE

8. The living mulch treatments reduced nitrate-N leaching

- ❑ a. compared with the perennial cover crop treatments.
- ❑ b. compared with the control only when N was not added.
- ❑ c. 22 to 43% relative to the control.
- ❑ d. 31 to 74% relative to the control.

9. Which of the following is NOT one of the three objectives of biological intensification listed in this article?

- ❑ a. Conserve and improve the soil.
- ❑ b. Reduce labor and fuel costs.
- ❑ c. Increase agricultural productivity per unit of land area.
- ❑ d. Create positive off-site impacts on water quality.

10. In the living mulch systems, corn yields

- ❑ a. were reduced 14 to 30%.
- ❑ b. were similar to corn without living mulch.
- ❑ c. decreased with increased mulch.
- ❑ d. were reduced 5 to 10%.

SELF-STUDY QUIZ REGISTRATION FORM

Name: _____

Address: _____ City: _____

State/province: _____ Zip: _____ CCA certification no.: _____

❑ $20 check payable to the American Society of Agronomy enclosed. ❑ Please charge my credit card (see below)

Credit card no.: _____ Name on card: _____

Type of card: ❑ Mastercard ❑ Visa ❑ Discover ❑ Am. Express Expiration date: _____

Signature as it appears on the Code of Ethics: _____

I certify that I alone completed this CEU quiz and recognize that an ethics violation may revoke my CCA status.

This quiz issued September 2010 expires July 2013

DETACH HERE

SELF-STUDY QUIZ EVALUATION FORM

Rating Scale: 1 = Poor 5 = Excellent

Information presented will be useful in my daily crop-advising activities: 1 2 3 4 5

Information was organized and logical: 1 2 3 4 5

Graphics/tables (if applicable) were appropriate and enhanced my learning: 1 2 3 4 5

I was stimulated to think how to use and apply the information presented: 1 2 3 4 5

This article addressed the stated competency area and performance objective(s): 1 2 3 4 5

Briefly explain any "1" ratings: _____

Topics you would like to see addressed in future self-study materials: _____

Career opportunities in Long Beach

This year's International Annual Meetings of the American Society of Agronomy (ASA), Crop Science Society of America (CSSA), and Soil Science Society of America (SSSA) in Long Beach, CA on October 31–November 3 offer plenty of opportunities to develop your professional skills and advance your career. Following is some of the career-related programming on tap. For more information, visit www.acsmeetings.org.

Professional development programs

The ASA, CSSA, and SSSA Early Career Members Committee invites you to take a break from the paper sessions, symposia, exhibits, and business meetings and attend its unique slate of professional development programs in Long Beach. These programs will enhance your meetings experience, focusing on topics that will help you navigate through your career. For more information, visit: http://a-c-s.confex.com/crops/2010am/webprogram/Z04.html. Here's the lineup:

Grant Writing Navigation

Monday, November 1, 8:15–9:45 am
Presenter: Ronald Turco, Purdue University
The session will cover successful approaches to obtaining competitive grant funding. Participants will be taken through the grant-writing process and learn how grants can support their work.

So You Got the Interview, Now What? Interview and Negotiating Skills

Monday, November 1, 1:30–2:30 pm
Presenter: Brianna Blaser, Science Careers/AAAS, Washington, DC

The session will cover the interview process from initial phone interviews, preparing for the big day, post interview follow-up, and negotiating offers. Attendees will learn about what employers want to see from job applicants and what job applicants should ask about during the interview.

Balancing Career and Home

Monday, November 1, 2:45–3:45 pm
Presenter: Brianna Blaser, Science Careers/AAAS, Washington, DC

Learn about what work/life balance means in today's world while succeeding in your career. Topics covered include assessing your time management needs and making the most of your time at work and home.

Writing Manuscripts for Publication

Tuesday, November 2, 9:00–11:00 am
Presenter: Ruth Yanai, SUNY, Syracuse, NY

Learn about how to write papers with minimal effort and maximum impact, and get advice on organizing your writing. Included will be examples on how to prepare each section of your paper. To participate, complete the "Getting Started Exercise" found at www.esf.edu/for/yanai/publishing/GSE.htm before attending.

How to Publish a Manuscript in ASA, CSSA, and SSSA Journals

Tuesday, November 2, 11:15 am–1:00 pm
Presenters: Panel with various ASA, CSSA, and SSSA editors

This program is a continuation of the Writing ▶

[continued on page 38]

Sensitive-crop registries: An emerging tool to minimize drift damage

By Madeline Fisher, *Crops & Soils* magazine contributing writer; sciencewriter@sciencesocieties.org

Earlier in her career, Leighanne Hahn investigated complaints for the Office of Indiana State Chemist, including instances where a pesticide being sprayed on one farmer's fields had drifted off target and harmed crops in someone else's. Charged with regulating pesticides and other agricultural matters for Indiana, the office would send Hahn to the field, where she would pull on her boots and scout for damage along the rows. Details such as where the pesticide had come from and whether the applicator had sprayed according to label directions were carefully noted in her report. The applicator might then be cited for violating regulations, while the farmer might choose to seek damages in court.

The process, though necessary, was time consuming and expensive. It also seemed to Hahn to be too little, too late.

"I've been walking fields, looking at drift incidents for years," says Hahn, who is now a water quality and endangered species specialist for the State Chemist's Office. "We needed a better approach."

The new approach now being pursued by Indiana and many other states is a preventative one that exploits the power of the internet. Known as sensitive-crop registries, these websites give farmers a place to record the locations of pesticide-sensitive crops, pesticide applicators a place to find them, and both parties the chance to cooperate to keep drift damage from occurring.

In other words, the effort rests on the idea that drift incidents will drop once people possess the information they need to prevent them. The internet, therefore, is the perfect medium, and new web applications, like Google Maps, are making the display of spatial information easier than ever before. Emerging technology is truly the key, according to Hahn. "We couldn't have done this five years ago."

Specialty crops on the rise

The new capability is especially timely given today's rapidly diversifying agricultural industry, adds Craig Romary, an environmental programs specialist with the Nebraska Department of Agriculture, who oversees Nebraska's sensitive-crops locater. While much of the farm landscape in Nebraska was once a solid blanket of corn, soybeans, wheat and a few other crops, today it resembles a patchwork quilt. Vineyards, organic farms, bee keepers, nurseries, and other specialty producers are on the rise, and many of the crops they grow are exceedingly sensitive to conventional pesticides such as glyphosate (Roundup), dicamba, and 2,4-D.

Thus, a major aim of Nebraska's sensitive-crops locater, which went online in November 2009, is to "create a better awareness of what's out there in terms of these types of crops," Romary says. "And hopefully that creates more dialogue and communication."

The same trend is happening in other states, as well. In Indiana, acres of specialty crops have increased by 75% over the last five years, while their value has risen to nearly $500 million annually, Hahn says. Wisconsin's organic farm sector is reportedly growing by 20% a year. And in Iowa, officials put the annual economic value of the state's honeybees (especially as crop pollinators) at more than $90 million. In short, the worth of these crops in the United States now totals in the billions.

At the same time, the specialty-crop sector is still dwarfed by production agriculture, which is partly why the situation is so challenging for applicators. Specialty-crop farms tend to be much smaller than their conventional counterparts, so applicators may simply fail to learn of them before it's too late. Specialty opera-

tions aren't typically concentrated in any particular area either; instead they tend to be dotted randomly across the landscape in places applicators may not be expecting them.

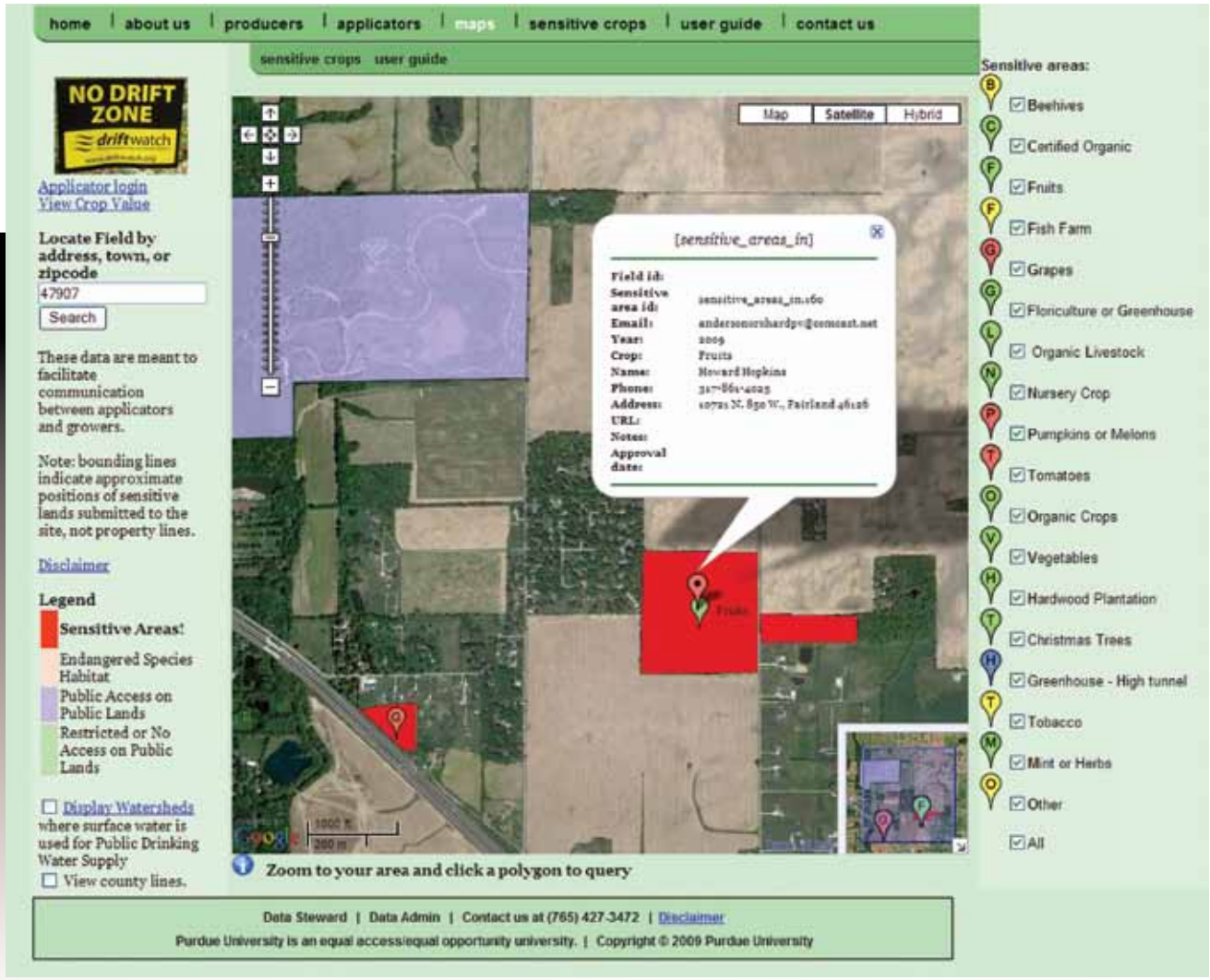
Advances in technology are yet another complication. For example, Red Gold, a major processor of tomatoes in Indiana, never had many problems with pesticide drift back when farmers mainly used pre-plant herbicides, says Steve Smith, CCA and director of agriculture for the company. The reason was simple: Tomatoes weren't in the ground by the time most of these herbicides were being sprayed.

But when Roundup Ready crops were introduced a few years ago, the situation changed. "Once we went to Roundup technology, most of [the herbicide] got applied in June after we already had a lot of tomatoes around," Smith says. "And people weren't used to that."

To help growers and applicators navigate this complex and shifting landscape, a number of states, including Iowa, Kansas, Missouri, Oklahoma, and Wisconsin (along with Indiana and Nebraska), have sensitive-crop registries today. In addition, Michigan and Illinois now use tools from Indiana's site, known as Driftwatch, and these states plus Minnesota, Ohio, and Wisconsin will be included in a regional Driftwatch registry soon, Hahn says.

She has also received inquiries from North Dakota and North Carolina, and as the word spreads, she expects other states will follow. Since no federal rules or regulations mandate the registries, individual states have been developing them on their own, often after talking with neighbors. Both Romary and Hahn, for example, began creating their registries after hearing about Oklahoma's a few years ago.

Although the technical details vary by state, all sensitive-crop registries offer a way, first of all, for producers to record the locations of their fields and other data, including the kinds of crops grown, number of acres farmed, and how they themselves can be ▶



▶ **Driftwatch is the sensitive-crops registry used in Indiana, Illinois, and Michigan, with Minnesota, Ohio, and Wisconsin sites coming soon. The program layers the locations of sensitive crops submitted by producers onto maps publicly available through Google.**
Image courtesy of Driftwatch/Purdue University (www.driftwatch.org).

reached. By searching a database or simply downloading a list, pesticide applicators can then retrieve this information, with the option to filter by county or crop type in some cases.

Some registries also allow pesticide applicators to view farm locations on a map. Nebraska, for example, creates its maps with a web-based GIS program housed at the University of Nebraska's Center for Advanced Land Management and Information Technology. Because the Indiana State Chemist's Office is part of Purdue University, Hahn, for her part, collaborated with Purdue's Department of Agricultural and Biological Engineering to implement Driftwatch in Google Maps. In simple terms, Driftwatch layers the locations submitted by producers onto maps publicly available through Google, making the system—after the initial programming is done—very straightforward to use.

In most states, pesticide applicators must visit the registry periodically to see if any new farms have cropped up in their spray areas. Through her own expertise and her relationship with Purdue's ag engineers, though, Hahn has added an extra function to Driftwatch. The idea came from applicators. "They asked if we could produce a pesticide applicator registry also," Hahn says, in which an area of interest, such as a specific location, set of counties, or the entire state, could be selected. Now, when a new field is registered within the boundaries of an applicator's designated area, the applicator gets an automated email notifying him/her of the change.

Using multiple tools

At the same time, simple "no spray" signs, available for purchase in states like Iowa, Kansas, Missouri, and Indiana, also work well as notification tools. Smith at Red Gold, in fact, credits the combination of these types of field signs and the Driftwatch website with the "precipitous" drop in drift claims his company has seen over the past two years—from a peak of nine claims totaling more than $750,000 in 2008 to three claims for very small amounts this year. "And when it's all said and done," Smith says, "we may not have any economic loss [this year]."

What makes the combined approach so successful, he thinks, is that the website and signs primarily reach different groups. The website is probably most useful to commercial applicators, who travel to "a field here and a field there and may not know what's around it," Smith says. He suspects that local farmers who spray pesticides, on the other hand, mostly key in on the field signs. Early on, in fact, Red Gold's signs created something of a stir: Smith got several phone calls from people wondering if the company was accusing them of spraying its fields.

"So, my answer always was, 'No, we're not accusing you [specifically]. We just want everyone in the neighborhood to be aware of spray drift considerations,' " Smith says. "And it has really raised awareness in the communities about the situation."

Red Gold actually mandates that its contract tomato growers register with the Driftwatch site, and the state of Iowa has a similar requirement. According to the Iowa "Pesticide/Bee Rule," all beekeepers must register with the state's sensitive-crops directory. The rule further bans commercial pesticide applicators from spraying blooming crops within a 1-mile radius of any registered apiary between 8 am and 6 pm—the hours that honeybees are out visiting flowers.

But in most or all other cases, use of the registries is voluntary, not regulatory. So, how do states make producers and applicators aware of the service and get them to use it?

Sensitive-crop registries

Here are some of the sensitive-crop registries in the U.S.

Driftwatch: Illinois, Indiana, and Michigan (with Minnesota, Ohio, and Wisconsin sites coming soon)
www.driftwatch.org

Iowa
www.agriculture.state.ia.us/Horticulture_and_FarmersMarkets/sensitiveCropDirectory.asp

Kansas
www.ksda.gov/pesticides_fertilizer/content/177

Missouri
http://mda.mo.gov/plants/ipm/sensitivecrops

Nebraska
www.agr.state.ne.us/division/bpi/pes/psci.htm

Oklahoma
www.ok.gov/~okag/cps-pslv.htm

Wisconsin
http://datcp.state.wi.us/mktg/orgFarmReg/index.jsp

Getting the word out

In Nebraska, Romary has sent emails and direct mailings to producer groups, commercial applicators, extension agents, and various other agencies, all of which disseminate the information, in turn, through their own channels. He has attended meetings of grape growers and other farmers in the state, as well as regional meetings of vegetable growers. Most importantly, Romary and his colleagues have worked closely with the pesticide education office at University of Nebraska Extension to incorporate information about Nebraska's locater tool into training materials for those seeking certification as pesticide applicators.

"The applicators have to re-certify every three years," he says. "So, hopefully in a couple of years, we will have reached all of the [current] folks, as well as the new people coming in, and at least made them aware of this."

People do seem to be getting the message. Nebraska's database of growers has doubled in size since the website launched last November, Romary reports. Participation by applicators is somewhat harder to assess, since they don't register on the Nebraska site. To get at this in the future, Romary plans to work with University of Nebraska Extension to survey applicators on what they know about the site and how they use it.

"I know it's being promoted by growers and applicators out there and that they are communicating amongst themselves," he says, pointing out that his office has received calls from farmers who have heard about the website from applicators. "And I'm sure the reverse is happening: Growers are telling applicators that this is available."

To promote Driftwatch, Hahn has relied on many of the same strategies as Romary, as well as the aid of Purdue's Department of Agricultural Communication, which has captured press attention for Driftwatch and helped invent the catchy name. As a result of these efforts, more than 100 commercial pesticide applicators have signed on since their registry became available this spring—enticed, in part, by the hour of continuing education credit they receive for doing so, Hahn says. She adds that more than 500 farm fields were registered within six months of the site's launch in 2009, including virtually all of Indiana's vineyards and "huge participation" by Red Gold. Red Gold has in fact been a partner from the start, helping to plan how the site would work and providing funds for its development.

Yet another collaboration with the Indiana Department of Natural Resources has added even more information to Indiana's database: The locations of 2,000 sensitive habitat areas and 42 watersheds that supply drinking water to 92 Indiana communities. As a result, watershed coordinators and others can now use Driftwatch to educate commercial applicators and farmers about the risk of pesticides drifting into surface drinking water supplies or harming protected habitats, Hahn says.

Funding the sites

In the future, Romary's priority is to find a stable source of funding for the Nebraska tool. Money from the USEPA, the Nebraska Grape and Winery Board, and others helped launch the website, and funding exists to keep it running for another year. But going forward, Romary hopes to follow a different approach. "If [the registry] is successful, which I think it will be, then hopefully the stakeholders—the applicators and growers—will come together to keep it going," he says. This is exactly the model that Hahn has followed. From the beginning, companies and groups such as Red Gold, Syngenta, the Indiana Wine Grape Council, and the Indiana Vegetable Growers' Association have paid for the programming to build and maintain Driftwatch.

Romary and his colleagues, as well as Hahn and hers, have also redoubled their efforts to teach people general strategies for preventing spray drift. Hahn now wants to take this a step further. With the help of Purdue Extension specialists, Driftwatch will soon include a set of fact sheets explaining how applicators can prevent damage to specific sensitive crops listed in the registry. Similar to Iowa's bee rule, for example, applicators will be advised not to spray near apiaries during the daytime hours when bees are foraging. "What I love about this," she says, "is that it delivers a very targeted message at a teachable moment."

> *"If [the registry] is successful, which I think it will be, then hopefully the stakeholders—the applicators and growers—will come together to keep it going."*
>
> —Craig Romary, Nebraska Department of Agriculture

But Hahn isn't content simply reaching applicators and growers in Indiana. "By the end of last year, I had several contacts from producers in other states who asked, 'How do we sign up?' " Hahn says, so now she's working to bring Driftwatch to other states. Her first target is Midwestern states in USEPA Region 5 who have agreed to fund a website expansion. Michigan and Illinois are the most recent additions, and Hahn encourages any other interested states to get in touch.

It ultimately means more work, but to her the outcomes are well worth the effort and time.

"About once a week, I will hear a story from either an applicator or a sensitive-crop producer about how [Driftwatch] worked for them, and that's so rewarding," she says. "It really gives you a lot of incentive to keep working and improving what you're doing." ■

Career programming in Long Beach | FROM PAGE 33

Manuscripts for Publication workshop and takes the process one step further by covering topics specifically related to publishing in the Societies' journals such as style and manuscript submission.

Undergraduate student activities

SASES program

The SASES (Students of Agronomy, Crops, Soils, and Environmental Sciences) Annual Meeting is scheduled for October 30–November 1. Highlights include professional development programs; daylong tours; national competitions for speech, research symposia, and club poster presentations; the ever-popular Quiz Bowl; President's Trophy Competition; and election of new officers. Professional development sessions cover topics such as graduate school, leadership, and professionalism. Here's the lineup:

- **Graduate School Workshop**, Sunday, October 31, 1:30–3:00 pm
- **Leadership: Foundation for Your Future Career**, Monday, November 1, 8:30–9:45 am
- **Professionalism On and In Demand** (*sponsored by AgCareers.com),* Monday, November 1, 10:00–11:00 am
- **Leadership Program** (*sponsored by Monsanto*), Monday, November 1, 1:00–5:00 pm

For more information about the SASES program go to http://a-c-s.confex.com/crops/2010am/webprogram/Z00.html.

Career Placement Center

Employers—post jobs, conduct interviews

If you are looking to hire and want to gain exposure to agronomy, crop, and soil science job candidates, then the Career Placement Center is the place to be. As an employer, you can post your job announcements and sign up to conduct job interviews on-site. The Career Placement Center will be open for business on Sunday, October 31 (7:00–9:00 pm); Monday and Tuesday, November 1–2 (9:00 am–6:00 pm); and Wednesday, November 3 (9:00 am–4:30 pm).

At the Career Placement Center, you'll be able to: search resumes, post job and internship announcements, schedule interviews and reserve interview tables, and meet qualified candidates from around the world

Staff will be available to help you with any questions. To schedule interviews, go to www.careerplacement.org and click on "View Instructions for Interviewing at the Annual Meetings."

Job seekers—post resumes, register for meetings

Looking for a job or graduate school opportunities? Submit a resume through the Career Placement Center at www.careerplacement.org. The resumes are kept in our database for six months, and the service is free for members and only $30 for nonmembers. The edit feature allows you to change information at any time, so your resume is always up to date and accurate. You can post a resume even if you are not attending the meetings. All resumes can be viewed online before and during the meetings.

Job seekers attending the Annual Meetings can register and submit their interview schedule beforehand. Go to www.careerplacement.org and access the "View Instructions for Interviewing at the Annual Meetings" link to post your schedule and indicate what times you will be available to interview.

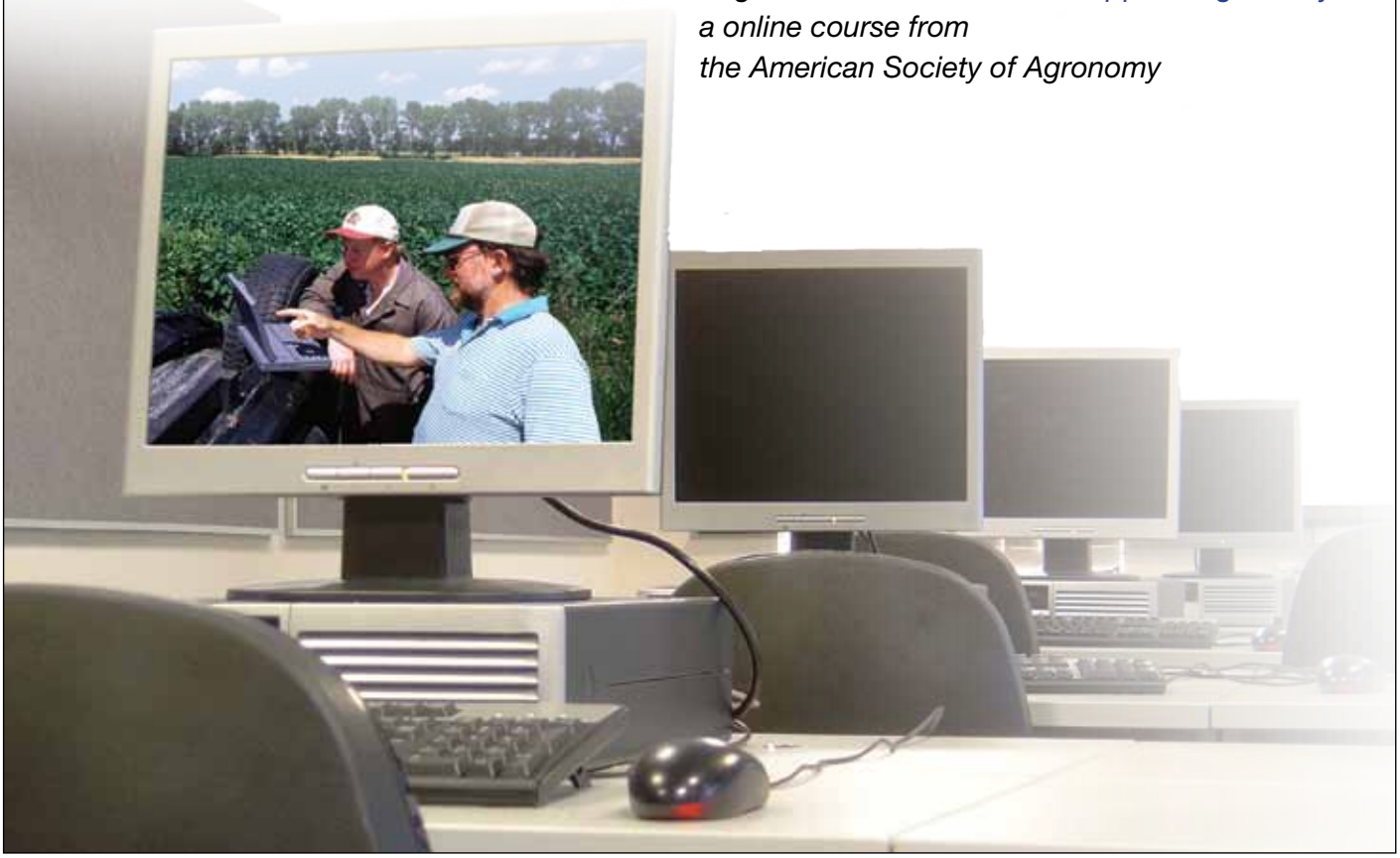
Graduate School Forum

Students considering graduate school can meet face to face with university representatives from top graduate schools around the country in a relaxed, informal setting. The Graduate School Forum is designed for university representatives to interview students for M.S. and Ph.D. programs, provide information on their schools and departments, and discuss assistantships and fellowships with students. The Forum will be located next to the Career Placement Center in the exhibit hall.

University departments must reserve booths for the Graduate School Forum by October 7. A fee will be required to make a reservation and includes a 4- by 8-ft poster board, one 6-ft table, and a 7- by 44-inch sign with the name of your university that will be mounted on the poster board. The Forum is open from Monday through Wednesday, November 1–3, and you can reserve a booth for one, two, or three days. Go to www.careerplacement.org/meetings/graduate-forum and review the layout of the Forum, select a booth number, and then reserve the booth on the Booth Reservation Form. Payment can be made by credit card or by check. ■

Do you have the skills to be an effective Certified Professional?

Register for Fundamentals in Applied Agronomy
a online course from
the American Society of Agronomy



Fundamentals in Applied Agronomy is a preparatory course for those who want to become a Certified Crop Adviser (CCA) or Certified Professional Agronomist (CPAg). This course will follow the 2010 ICCA Exam Performance Objectives, transforming book knowledge into real management skills.

Already Certified?

Recommend this course to someone who needs to become certified or is seeking to update their skills in applied agronomy.

Advance Your Career

Advance your career without travel and time away from work. Attend one live two-hour online session each week on Tuesdays from September 28 to December 14 from 7:00 to 9:15 p.m. Eastern/ 6:00 to 8:15 p.m. Central/5:00 to 7:15 Mountain/4:00 to 6:15 p.m. Pacific. The price is $475.00 plus the cost of resources. ***Registration deadline: Monday, September 20.***

For details or to register online go to www.agronomy.org/fundamentals-in-applied-agronomy or contact Michele Lovejoy at mlovejoy@sciencesocieties.org.

American Society of Agronomy

Scholars + Mentors = Golden Opportunity

"One's mind, once stretched by a new idea never regains its original dimension."— Oliver Wendall Holmes

Extraordinary Opportunity

The Golden Opportunity Scholars Institute, a program of the American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, matches undergraduates with scientist-mentors during the ASA–CSSA–SSSA International Annual Meetings. The program encourages talented students to enter the agronomy, crop, and soil sciences, cultivate networks, and succeed in their careers.

Extraordinary Support

You can help support young scientists with a monetary gift to the Golden Opportunity Scholars Institute. In 2010, the program will become global with our first International scholar/mentor tandem being invited to Long Beach, CA.

To contribute, please contact:

Alexander Barton
608-273-8095
abarton@sciencesocieties.org

GOLDEN OPPORTUNITY SCHOLARS

www.goldenopportunityscholars.org