Research Link

Cuphea does wonders for wheat and corn in rotations

Growing the oilseed plant called cuphea the year before growing wheat results in better wheat seedling survival and grain that is 8% higher in protein, according to an Agricultural Research Service (ARS) study. ARS plant physiologist Russ Gesch and colleagues discovered this in a four-year experiment in which they rotated cuphea with corn, soybean and wheat on fields in Morris, Minn. Gesch is at the ARS North Central Soil Conservation Research Lab at Morris.

Based on these results, Gesch recommends the following rotation order: soybean, cuphea, then wheat or corn. This planting regimen increases the profitability of both wheat and corn. The research was recently published in the *Agronomy Journal*.

Crop rotations are known to be good for soil and reduce the need for pesticides and fertilizers. Insect, disease and weed pests adapt well to surviving in fields where little to no crop rotation is practiced. Perhaps the best example of this is the emergence of the highly adaptable corn rootworm, which accounts for more pesticide use on U.S. row crops than any other insect.

Cuphea is a new oilseed crop Gesch and other ARS scientists are developing for farmers in the northern Corn Belt. It can be used for a variety of industrial products, including jet fuel and other biofuels. It is a domestic alternative to palm kernel and coconut oils that supply the fatty acids needed to make thousands of products, from soap to motor oil.

Some 260 undomesticated species of cuphea are native to Central America, South America and North America.

Gesch wanted to know how cuphea might interact when rotated with corn, soybean and wheat. He found only beneficial effects. Cuphea did not harm yields of the other crops, nor did those crops harm cuphea yields.

— ARS

Switchgrass pelletized for biomass as part of UK research project

Round switchgrass pellets, resembling small pieces of wood, rolled off machines at Midwestern Biofuels in Wurtland as the crop from a biomass research project at the University of Kentucky (UK) College of Agriculture was pelletized for the first time.

Officials with East Kentucky Power Cooperative, a partner in UK's study, suggested this year's crop be pelletized for easier handling during the energy-making process. In 2008, the power company mixed switchgrass, ground into small pieces, with coal at its Maysville plant for the first time. The ground switchgrass proved to be cumbersome for the company to work with as it was used to handling coal, said Tom Keene, UK hay marketing specialist.

"Putting it in this form (pellets) allows them to use current operational procedures to incorporate this biomass into their system without any significant changes or major financial output," Keene said.

Like the ground switchgrass, the pellets will be mixed with coal to produce energy.

"Currently, we've tested up to an 8% blend with coal, and it's gone to another utility with no problems," said Jeff Lowe, president of Midwestern Biofuels. "It's handled well. It went through their mills and crushed down and went right to the furnace to make power."

In addition to being easier to handle, pelletized switchgrass is a much denser product than rolls or bales, which means more material can fit into a truck, rail car or onto a barge.

"A truckload with just plain biomass is around 11 tons. Our condensed product holds upwards of 27 tons on the same truck," Lowe said.

Tom Malone from Bracken County was one of several participating northeastern Kentucky farmers who viewed the pelletizing process. He continues to be encouraged about the future of this crop.

"As we stand here today, we find ourselves on a verge of having a lot further interest and further development. I'm really excited and intrigued," he said.

2009 was the third year of the four-year research project, and Keene said UK researchers, cooperating farmers and their county Cooperative Extension Service agents continue to learn more about the crop's viability for northeastern Kentucky farmers. The two drought years of 2007 and 2008 followed by an exceptionally wet 2009 have allowed the group to learn about the crop's ability to tolerate hot, dry weather and wet, cool conditions.

"If we have a drought, that's not the end of the world," Keene said. "We still get production in a dry year, so that's very good to know."

They've also learned the crop can stand some weed pressure, and it doesn't need a perfect stand like other crops, such as corn and soybeans, to produce a quality product. In addition, soil tests have shown that the crop requires few inputs.

The group also tested different sizes and types of packages of switchgrass to determine the most efficient in getting the product from the farm to the power plant or pelletizing plant.

"Mid-size square bales are the package of choice because they transport and store easier than round bales," Keene said. "However, those balers are not cheap. Farmers would have to go in together to purchase one, and then some of our slopes in northeastern Kentucky won't accommodate the baler. So we'll have to have a round bale component to any future program."

With all 20 plots harvested in 2009 for the first time, the amount of switchgrass burned will increase dramatically from 2008. In 2008, the six plots harvested produced 70 tons of switchgrass. In 2009, the plots produced 265 tons. Keene hopes production in 2010 increases to more than 400 tons.

— by Katie Pratt, UK College of Agriculture

PHOTO COURTESY OF ARS

National Animal Germplasm Program coordinator Harvey Blackburn and technician Ginny Schmit place germplasm samples into a liquid nitrogen tank for long-term storage.

ARS gene collections vital to animal research efforts

When the National Animal Germplasm Program (NAGP) opened its doors a decade ago, it started out with genetic material from 40 lines of chickens. Today, the center operated by the ARS in Fort Collins, Colo., has grown into one of the largest repositories of its kind in the world, housing more than half a million genetic samples from 12,000 animals.

This collection of germplasm assures genetic diversity of agriculturally significant animals such as dairy and beef cattle, chicken, sheep and swine, in addition to bison, elk and fish, according to Harvey Blackburn, animal geneticist and NAGP coordinator. Among the animal germplasm Blackburn has added to the ARS collections is that from Shorthorn cattle.

Providing vital genetic material for scientific research has become a primary function for Blackburn and other NAGP specialists, who distribute animal samples to university researchers, private laboratories and others who work to improve the genetic makeup of animals.

The collection has been useful in many ways. For example, ARS researchers have used frozen bull semen to genotype prominent bulls that have sired dairy cattle. This information, combined with milk production data gathered from those cows, has been used to improve dairy cattle breeding programs.

Genetic material also has been used to restore breeds of cattle and other animals that had died out. Researchers insist that maintaining diversity by preserving germplasm — even if the material comes from breeds that aren't currently being studied — acts as an insurance policy against future diseases or other threats.

In other related work, scientists at the ARS National Sedimentation Laboratory (NLS) in Oxford, Miss., have been cataloging 124 species of fish, amphibians, reptiles and mammals to build a baseline sampling of animal diversity, including about 11,000 samples since 1986. During those efforts, scientists documented the presence of one rare species, the Yazoo darter, a fish found only in fresh water and ponds near Oxford.

In Michigan, researchers worked with DNA-based technology to develop 40 distinct lines of chickens at the Avian Disease and Oncology Laboratory (ADOL) in East Lansing. Those studies have revealed tools and techniques to find sources of genetic resistance to diseases such as virus-induced tumors.

Read more about the research in the January 2010 issue of *Agricultural Research* magazine, available online at *www.ars.usda.gov/is/AR/archive/jan10/animal0110.htm*.

— by Chris Guy, ARS, USDA

Honeybees offer tips on disease spread

The study of honeybees and their social structure can give scientists a greater understanding of how infectious disease spreads among animals and humans, says a Colorado State University (CSU) professor who has embarked on a five-year study of honeybee behavior, funded by a National Science Foundation CAREER award.

Dhruba Naug, an assistant professor of biology in the College of Natural Sciences, is using the $650,000 grant to investigate how the social organization of bees has evolved in response to the threat of the parasites that infect the colony. At the same time, parasites can also be expected to adapt rapidly to these changes, making it a continuous arms race between the two parties. The grant includes some funds from the American Recovery and Reinvestment Act and also comprises an educational component to get children at the elementary school level more interested in biology and science.

"We are investigating whether we can use the honeybee colony as a model system to understand how diseases spread in a social group," Naug said. "If you're talking about the spread of disease in a human community, there is a social context to it. Who infects who is based on various things — what you do, how often you come in contact with other people, how you behave. Bees have a fairly sophisticated social structure, they get a lot of diseases, and they can be subjected to a variety of experimental paradigms — a golden combination for research."

"What is it about the social structure that allows bees to be tolerant of diseases and what do parasites do to adapt to them?"

His research on diseased bees has produced some interesting results, including:

- Bees that carry a disease experience starvation since the pathogens infecting them steal nutrition, leading to changes in their behavior. They are, for example, less willing to share food with other bees and more willing to leave the colony to find food, which may affect the contact structure and even affect honey production.
- Hunger in infected bees also means that they have problems maintaining their temperature; they get colder because they don't have enough food to burn. As a result, they are likely to move toward the center of the colony for warmth, which is likely to infect more bees.
- The social structure of bees is such that the young individuals and the queen are segregated toward the center of the colony, providing them some amount of immunity from pathogens entering the colony.

"We're not studying specific diseases as much as we are the transmission of diseases," Naug said. "Anytime you're looking at dense populations — such as livestock — you are talking about similar principles of how things spread." Focusing on general principles that apply to most infectious diseases rather than any specific pathogen is more illuminating in many ways.

Naug, who joined CSU in 2005, teaches undergraduate biology and a graduate course in behavioral ecology. He plans to teach an undergraduate course this fall that will explore how to apply the principles of evolutionary biology to medical science. Understanding more about host-parasite interactions can help doctors tackle such issues as antibiotic resistance.

"When we get a fever, we take a bunch of medicines to lower our temperature. But what if the body is ramping up the temperature to fight the pathogen? Maybe we need to understand the symptoms a little better rather than trying to come up with a chemical to fight every symptom of a disease."

— by Emily Narvaes Wilmsen, CSU

(Continued on page 132)

Research Link *(from page 131)*

Farmers can take steps to decrease manure pathogens in runoff

By following a few simple recommendations, farmers who apply manure as a fertilizer to their no-till field can decrease the chance that pathogens end up in runoff and pose environmental and health hazards.

Ohio State University (OSU) scientists with the Ohio Agricultural Research and Development Center (OARDC) studied the transport of *Cryptosporidium* (a parasite present in animal waste) through no-till and tilled fields. They found that a greater number of the parasite moved along with excess water through no-till fields and into tile drains than in tilled fields, especially during a rain event.

Cryptosporidiosis, caused by *Cryptosporidium*, is a waterborne disease causing intestinal illness in humans.

Warren Dick, an OARDC soil microbiologist, said *Cryptosporidium* moves more readily through no-till fields because of the presence of macropores created by either earthworms or plant roots.

"We found that the macropores extend from the soil surface right down to the tile drains, so the parasite has a conduit from the manure directly to a water source," Dick said. He and his colleagues took the study one step further to look for ways to keep *Cryptosporidium* in the soil and found that some tillage seems to do the trick.

Researchers treated six undisturbed no-till and six no-till blocks that were tilled on the surface with liquid manure containing *Cryptosporidium* oocysts to test the effect of tillage and rainfall on parasite transport.

"Even before any artificial rain was applied, almost 30% of the liquid manure moved through the no-till soil, but none moved through the tilled blocks," Dick said. "During the rain event, a greater number of *Cryptosporidium* moved through the no-till blocks compared to the tilled blocks." However, the number of oocysts recovered from the tilled blocks was greater than from the no-till blocks, researchers found.

"If no-till growers can do just a little light tillage right over the drain tiles, it can have a tremendous impact on the movement of pathogens and nutrients from the soil surface to the field drain tiles, with potential decreases in the transport of oocysts up to 80%," Dick said. "Tilling disturbs the macropores and disrupts the direct linkage from the soil surface to the drain tiles."

In addition to tillage, other factors affecting the transport of *Cryptosporidium* include rainfall timing and rainfall intensity. To lessen the impact, researchers recommend farmers apply manure at least 48 hours prior to an anticipated rainfall event.

"This study is in no way advocating that no-till is a bad management practice. As a whole, no-till has a multitude of environmental and crop production benefits," Dick said. "But any production practice can be improved upon, and this study demonstrates that there are ways of making no-till better, for people and for the environment."

The study, "Effect of Tillage and Rainfall on Transport of Manure-Applied *Cryptosporidium parvum* Oocysts Through Soil," was recently published in the *Journal of Environmental Quality*. It is one of the few studies available demonstrating the transport of manure pathogens through no-till soils. Fertilizer chemicals and nutrients are also readily transported through no-till soils via macropores from the surface to drain tiles. The results from this study suggest that tilling directly over the drain tile lines could produce similar results in reducing movement of these materials from the field.

Dick and his colleagues are also studying the transport of *E. coli* and *Campylobacter* through no-till soils. Both cause foodborne illnesses.

— by Candace Pollock, OSU