Increase Your Yield by **Managing Soybeans** from the **Ground Up**

Research Update

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NCSRP
NORTH CENTRAL SOYBEAN RESEARCH PROGRAM

PLANT HEALTH INITIATIVE
AN NCSRP PROGRAM

By Gregg Fujan
Nebraska soybean grower
& past NCSRP President

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NORTH CENTRAL SOYBEAN
RESEARCH PROGRAM

The North Central Soybean Research Program (NCSRP) is comprised of state soybean checkoff boards in Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota and Wisconsin. Established in 1992 to coordinate soybean production research efforts on a regional level, NCSRP invests soybean checkoff funds in research programs to better understand and manage soybean pests and diseases.

Cover photos courtesy of Duane Daily, Chris DiFonzo - MSU, SCN Coalition and Scott Bauer.

NCSRP: Identifying problems, funding research, finding solutions

Thanks to funding from the North Central Soybean Research Program (NCSRP), United Soybean Board (USB) and state checkoff organizations, there have been huge improvements in soybean transformation over the past decade. In fact, there have been genetic modifications for resistance to certain diseases – such as white mold and *Phytophthora* root rot – that I think we now take for granted.

Another good example of NCSRP-funded research is all the information on soybean aphids, from economic thresholds to proper scouting to treatment recommendations. As a soybean grower, I've had hands-on experience with aphids, and the information provided by the research scientists has been vital.

Asian soybean rust is another NCSRP priority area. We helped develop, fund and expand the Sentinel Plot System, which now includes data on both rust and aphids. And it's very likely we'll continue to invest checkoff dollars in this effective early warning system for growers.

After several years of concentrating mainly on aphids and rust at the NCSRP, we've recently begun to refocus on soybean cyst nematode (SCN), which remains a serious challenge in several North Central states. SCN is adapting to PI88788, the source of resistance used in most SCN-resistant varieties. As a result, the NCSRP will be looking for new answers to the evolving problem of SCN.

Several years ago SCN was one of our top priorities, when all of a sudden aphids appeared and took everyone by storm. So the NCSRP quickly shifted gears to focus on aphids. The same thing happened again when it was clear that Asian rust was heading toward the U.S. southern shores.

That, in a nutshell, is what NCSRP does. We recognize impending problems to soybean production, move quickly to line up top university researchers, and fund their efforts to find solutions. It's all designed to improve the ability of growers to effectively manage soybeans and increase yields.

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For higher yields, manage soybeans from the ground up

By David Wright, Ph.D.
Director of NCSRP's
Plant Health Initiative

The idea for a Research Update geared to help producers "manage soybeans from the ground up" came from a meeting I had with a several nematologists. These researchers are deeply concerned about how soybean cyst nematode (SCN) is adapting to resistant varieties, and robbing producers of millions every year in lost yield.

With Asian soybean rust and soybean aphids getting the lion's share of attention, SCN was pushed to the back burner. But it needs to be front and center in your soybean management plans. Research shows it's still the No. 1 pest in terms of yield reduction. SCN also is spreading, and making some fungal diseases worse.

In fact, checkoff-funded* researchers have recently determined that if you have SCN, and conditions are right for sudden death syndrome (SDS) or brown stem rot, these diseases will appear sooner and symptoms will be more severe. Yield loss also increases.

This is not to say that aphids and rust aren't formidable foes; they are. But thanks to checkoff funds, the country's top research scientists already have learned plenty about both problems, and have armed growers with information on how to effectively manage them.

In addition, at least a few new aphid-resistant varieties likely will be available in three to five years. Rust-resistant varieties also may be on the horizon. Again, all because of checkoff funds invested in soybean research. That's your soybean checkoff. Delivering results.

**Please note that not every research project cited in this Soybean Research Update is funded by the North Central Soybean Research Program. Many are financed by the United Soybean Board and/or various state soybean organizations. However, all this research is funded by you, the soybean grower, through your checkoff investments.*

Six slam dunks for higher yields

1. Choose the best varieties for your fields
2. Plant early
3. Don't use more seed than you need
4. Take advantage of available technology
5. Scout regularly
6. Manage insects and pests when needed

Courtesy of Brian McCornack, U. of Minn.

What you don't see can hurt you. SCN can reduce the yields of susceptible cultivars by 30 percent, without causing obvious symptoms.

Visit *www.planthealth.info* for more information about variety selection, soybean cyst nematode, aphids, Asian rust, soybean viruses – and many other topics of interest to soybean growers. From diagnosing plant and pest symptoms to identifying weed seedlings, *www.planthealth.info* connects you with the information you need and the people who can help. Launched in 1992, *www.planthealth.info* is part of the NCSRP's Plant Health Initiative.

Courtesy of George Rehm, U. of Minn.

Calcareous soils and IDC

High pH calcium carbonate soils – located mainly in north central Iowa, southern Minnesota and eastern South Dakota – often pose a problem for soybean growers. "Soybeans just don't grow well in this soil, because of iron deficiency chlorosis (IDC)," says Antonio Mallarino, Iowa State University agronomist.

Mallarino and George Rehm, University of Minnesota soil scientist, have spent years studying IDC. "We've tried just about everything you can dream of, like coating seeds with iron, applying iron as a foliar treatment, applying iron in a band near the seed at planting, and increasing plant populations," Rehm explains.

"Now we have a theory that excess nitrate nitrogen in the soil exaggerates IDC," Rehm adds. "Higher levels of nitrate nitrogen in the plant tissue interfere with the plant metabolism, and iron taken up by the plant can't be converted to a usable form."

Recently, Rehm has had success using a competition crop. "We planted small grains with or just prior to planting soybeans. The small grain crop absorbs the nitrates and keeps soybeans green early in the season. When the competition crop gets tall enough, we burn it down with Roundup®. It costs maybe $6 an acre, but if I can increase soybean yield by 10 to 12 bushels an acre, it works."

Mallarino has this advice: "Select varieties that are resistant, or at least tolerant to IDC. And if you have precision ag tools, use them, so you can see where IDC is in your field."

Know Your Fields

Fertile ground

Every soybean researcher will tell you it pays to know your fields, but what does that entail?

For starters, it means managing soil fertility levels, and applying fertilizer based on soil tests and yields. "We need to build up and maintain soil test levels to ensure consistent yields over time," says Antonio Mallarino, Iowa State University agronomist. "And we need to avoid applying fertilizer when it's not needed."

Courtesy of Antonio Mallarino, ISU

Higher K recommendations

Mallarino has been studying optimum soil test levels for Iowa soybeans since 1994, and in 2002 he raised the recommendation for potassium. "After years of on-farm strip trials and long-term research at experimental farms, two things became obvious. One, our phosphorus recommendations were fine, in terms of soil test levels and placement methods. And two, it was clear we needed higher potassium levels for soybeans."

Mallarino explains that with slow, but steady increases in soybean yield and higher fertilizer costs, "Some farmers haven't realized yet that they need to increase maintenance P and K rates to maintain soil test values."

He adds that managing field fertility is easier now, thanks to precision ag technology. "The yield monitor in your combine will give you solid data about what's going on in your fields."

Pay attention to pH

"Growers should also keep an eye on soil pH," says Craig Grau, plant pathologist at the University of Wisconsin-Madison. "Our data show that as soil pH rises to and above 7, this favors soybean cyst nematode (SCN). As we go down to and below a soil pH of 6, you may still have an SCN problem, but the risk of associated yield loss declines."

Grau says that as soil pH approaches 7, "We see brown stem rot (BSR) activity decline. There's a BSR intensity area in southern Wisconsin, northern Illinois, eastern Iowa and Minnesota. We think it probably relates to cooler weather conditions," he notes.

Courtesy of X.B. Yang, ISU

Potassium and leaf/stem diseases

Mallarino recently began studying the interaction of K applications and leaf and stem diseases. "There's data from orchards, on fruits and vegetables, showing that better nutrition results in better tolerance to fungal diseases.

"It won't help avoid disease, but we're trying to discover if better potassium nutrition gives soybean plants the ability to better tolerate the presence of pathogens," says Mallarino. "That's what happens with aphids."

The potassium/aphid connection

Courtesy of Antonio Mallarino, ISU

In his research on K applications in no-till and ridge till systems, Antonio Mallarino discovered that potassium applied in a band – 5 to 7 inches deep – was beneficial. "Deep placement of fertilizer is more costly than broadcast. But every two years we need to apply a deep band of K in these systems," says the Iowa State University agronomist.

It started out with Wisconsin soybean growers wondering how there could be such variation of soybean aphid populations within a single field. University of Wisconsin-Madison (UW) entomologists tested fields throughout the state, and followed up with test plot trials.

"What they found was, the lower the K level, the greater the aphid infestation," says Craig Grau, UW plant pathologist. "A field that's low in K might reach the economic threshold for treatment faster. And a field with higher potassium levels might take longer to reach that treatment threshold – or it might not reach it at all."

Grau cautions that potassium cannot be viewed as a silver bullet. "It won't replace insecticides, but it certainly can affect how fast aphids build up."

Aphids and virus-infected soybeans

They thrive on soybean plants stressed by potassium deficiency. So you might also assume that aphids are attracted to plants stressed by viral diseases, right? Wrong.

"We've been looking at whether infected plants are better or worse for aphid growth and reproduction," says Jack Donaldson, UW entomologist. "Our lab assays show that aphid population growth rates are 30 percent lower on plants infected with viruses." A field study showed similar results.

"Typically, pathogens are thought to illicit different defense pathways than insects," Donaldson says, "But that's not always the case. Now we're looking into whether there's some 'cross talk' between the viral pathogens and the insects. If it is cross-talk, maybe we can use that as a tool to control aphids."

Aphids prefer soybean plants stressed by potassium deficiency, because those plants contain a larger amount of amino acids that aphids need for optimal growth and reproduction.

Courtesy of David Ragsdale, U. of Minn.

Variety Selection

Take time to choose varieties wisely

Courtesy of Palle Pedersen, ISU

"Yield pays the bills," says Emerson Nafziger, University of Illinois agronomist. "Every year, farmers face different challenges, depending on temperatures, rainfall, pests and diseases. I think the best route is to find the highest yielding varieties with the best performance record over a range of locations and conditions – and that don't fall apart in the face of stress."

According to Nafziger, matching varieties to fields is a good common sense concept, but harder to carry out in practice. "There are unknown challenges in any given field in any given year," he says. "And most diseases we see in soybeans tend to be pretty sporadic."

He agrees that farmers should factor in obvious field problems, such as poor drainage or light soils that don't hold water. "But one of the problems I have is that for some diseases, we don't have a good set of resistant varieties yet.

"Certainly some varieties have better disease resistance than others," he adds. "And resistance is great, as long as it doesn't yield 10 bushels an acre. In an ideal world, we'd have really good genetic resistance to everything out there."

"Seedsmen often tell me that a grower will spend two hours picking out corn hybrids and 10 minutes on soybean varieties," says Shawn Conley, agronomist at Purdue University. "I think the biggest issue is growers don't take the time to properly select soybean varieties based on environmental conditions and pests."

Conley surveyed Indiana growers in 2006, and discovered that 28 percent plant only one soybean variety, and 25 percent plant two varieties. "That means we're limiting the genetic pool of what we're capable of obtaining, yield-wise. If you start the season with a limited gene pool and varieties that aren't suited for your particular environment, you're starting with a loss."

Check the yield trials

Seth Naeve, University of Minnesota agronomist, says when selecting soybean varieties, growers should first look at university or public tests of varieties across companies. "Use these independent research evaluations to choose among the highest yielders," he says.

Naeve also urges growers to understand the relationships between seed companies, and to buy from several different companies. "If you're not careful, you can wind up with the same variety under different names," he says.

Play tough defense

"Once you've identified several of the top yielding varieties, then you need to look at the disease traits, resistance or tolerance you need, based on the history of problems in your fields," Naeve adds.

For instance, soybean cyst nematode (SCN) and sudden death syndrome (SDS) are common problems in Indiana, Iowa and Illinois, while growers in the non-Corn Belt areas of Wisconsin and Michigan more often struggle with brown stem rot (BSR) and white mold. Growers in North Dakota and northwestern Minnesota wrestle with iron chlorosis. In Ohio and Indiana, *Phytophthora* is a major problem.

Manage your disease risk

The Ohio State University's *Phytophthora* expert, Anne Dorrance, explains it this way: "If it's a field that takes longer to drain and always has *Phytophthora* problems, then get the best resistance package – both genetic and field resistance – to *Phytophthora* and make sure your seed is treated. In contrast, if you always get a good stand and never have *Phytophthora* issues, then leave off the seed treatment and put your highest yielder in that field.

Courtesy of Anne Dorrance, OSU

Courtesy of Anne Dorrance, OSU

"If it's a long-term cyst field, look at your rotation," she continues. "How many years have soybeans been in that field? How many years have you put resistant varieties in there? Have you been rotating to different sources of SCN resistance, such as Peking or CystX?"

Naeve says that for most Minnesota farmers, SCN resistance is probably the second most important factor to consider after yield. "There's a caveat here. Not all SCN-resistant varieties are created equal, so make sure you have a handle on whether those varieties are truly resistant."

SDS and early planting

SDS is another issue, especially for those growers planting early. "There's a strong correlation between early planting and SDS," says Conley. "If you're pushing the planting date, make sure you've got SDS tolerance."

Conley adds that in Indiana, 65 percent of growers are planting earlier than they did a decade ago. "We're doing this to increase yield, and because the weather has changed. May has become one of our wettest months, and growers are more willing to take the risks of planting in April than getting rained out in May."

Spread your maturity risk

Conley and Naeve also encourage growers not to plant all their varieties in the same maturity group. "Choosing varieties from different maturity groups helps manage your risk, and maximize the possibility of getting rainfall during the grainfill period," Conley continues. "That's impossible if a grower only plants one variety."

Naeve says that in Minnesota, farmers can push maturities harder. "I think longer-season varieties are less risky here, because shorter days and cool nights tend to hasten development anyway," he adds.

SCN magnifies other problems

"If you've got soybean cyst nematode (SCN), it can make a lot of other problems even worse," says Greg Tylka, nematologist at Iowa State University. "These include brown stem rot (BSR), and sudden death syndrome (SDS).

"If you have soybeans infected with SCN, and the environmental conditions are right for SDS to develop, the SDS will show up sooner in the season and develop more severe symptoms," says Tylka.

Here's another problem: SDS is spreading quickly, likely because it can infect SCN cysts and eggs, which then become vectors for the SDS pathogen.

Terry Niblack, nematologist at the University of Illinois, has researched the SCN/SDS connection. For Illinois growers, where 84 percent of fields are infested with SCN and 84 percent are infected with SDS, she recommends that if you have SDS, select varieties that are resistant to both.

Courtesy of Greg Tylka, ISU

Much like soybean cyst nematode (SCN) can make sudden death syndrome worse, SCN also makes infection by the fungus that causes brown stem rot occur earlier in the season, and become more severe. Researchers also have plotted the spread of the fungus, and it spreads quicker in plants with SCN.

Planting Practices

Courtesy of Chris DiFonzo, MSU

"In Illinois, our planting date studies suggest there's nothing wrong with planting the last week of April, and that there's not much yield loss expected if you can't plant until mid-May," says Emerson Nafziger, agronomist at the University of Illinois. "I emphasize that it's more important to plant in good conditions. I'm more worried about planting in the mud, and other things that may restrict root growth."

Planting dates: It's not about soil temperature anymore

"Most textbooks still recommend that soybean growers wait until soil temperatures reach 55 to 60 degrees before planting," says Palle Pedersen, agronomist at Iowa State University. "And many Iowa farmers still consider May 15 'early' when planting soybeans.

"But that was the old recommendation," he says. "If we want to increase yield potential, we need to take more risks, and plant earlier to increase yield."

Instead of soil temperature, Pedersen encourages Iowa growers to concentrate on good seed quality, the calendar and seedbed conditions. "Make sure there are no cracked seed coats, and good germination.

"In the southern two-thirds of Iowa, we now recommend planting April 25, but growers need perfect seedbed conditions," he continues. "For the northern third of the state, it's May 1, but again, in ideal conditions."

Earlier is better with a good seedbed

Pedersen says the seedbed is the most important factor, because little is gained from planting early unless conditions are ideal. "Don't plant early if it's too wet," he cautions. "And if there's a history of seedling diseases in your fields, you may consider a fungicide treatment to protect your stand."

In optimal soil conditions, soybean responds favorably to early planting dates. "Soybeans can easily germinate at soil temperatures of 50 degrees at 2 inches. It'll just take longer for emergence.

"The ideal soil temperature for soybean germination is 77 degrees F," Pedersen adds. "But it may be early June before soil at a 2-inch depth in Iowa hits 77 degrees, and we can't afford to wait that long, because it lowers our yield potential."

In Kansas, it depends on topsoil

"In Kansas, I'm trying to talk producers out of planting earlier, unless they have deeper topsoils," says Gary Kilgore, agronomist at Kansas State University. "The deeper your topsoil, the lower your risk of planting early.

"But in the Prairie Region with clay pan soils – where the majority of

Seed treatments

Treating seeds with fungicides may be beneficial under the following conditions:

1. Early planting in cold, wet and poorly drained soils
2. Reduced till and no-till fields
3. Seed with low germination rate (<80%) or low seed vigor

Purdue University research shows the optimal planting depth is .75 to 1.5 inches for soybeans. "But according to our 2006 grower survey, only 46 percent of Indiana farmers plant in that optimal range. Most farmers are still drilling," says Shawn Conley, Purdue agronomist. "So we're planting earlier to increase yields, we're sinking beans deep in cool soil conditions – yet 64 percent of growers say they don't use treated seed. We do get yield increases by planting earlier, but we need to do a better job of managing that early season environment."

Courtesy of Case IH

Courtesy of Palle Pedersen, ISU

Kansas soybeans are produced – there are some areas with only 4 to 5 inches of topsoil," Kilgore adds. "We've found it's best to plant soybeans in the first half of June here, because only about 2 inches of moisture can be stored in the soil."

Kilgore says that when soybean plants are flowering and podding, they require 3/10 of an inch of moisture per day for optimum production. "So we're always 10 days away from a drouth in the shallow clay pan soils."

Seeding rates: There's a new paradigm

After three years and more than 30 experiments on seeding rates and plant populations, Palle Pedersen says, "Planting more seeds as insurance seldom pays off in higher yields. And with seed costs rising, planting 20 to 30 percent more seed than we really need is expensive insurance."

Pedersen is an agronomist at Iowa State University. His research also shows that you don't need to increase your seeding rate if you're using 15-inch row spacing instead of 30-inch spacing.

New seeding recommendations in Iowa

"In 2006, we changed the seeding recommendations in Iowa for growers using planters," Pedersen says. For a planter with a row spacing of 15, 20, 22, 30 or 36 inches, farmers can get by with 125,000 to 140,000 seed per acre.

"However, if a grower is using a drill with a row spacing of 7.5 to 10 inches, you don't have good soil to seed contact," he adds. "So it will take a much higher seed population – 160,000 to 200,000 – to get uniform distribution and a final plant stand of 100,000." (Drills are disappearing in Iowa; USDA figures show only 8 to 9 percent of growers still using them.)

It's similar in Kansas

"When I talk to a producer, I tell them – regardless of soil type on dry land – I want to see them drop between 120,000 and 140,000 seed per acre if they're using a planter," says Kansas State University agronomist Gary Kilgore. "I don't care what the row width is."

On irrigated soils, "I'd be dropping 160,000 to 175,000. There's opportunities for higher yields, so we want more plants," Kilgore adds. "For growers using a grain drill, they should increase the seeding rate by 10 percent, because emergence won't be as good."

Kilgore's pet peeve: "Farmers planting 200,000 seeds per acre. That's way too high, even with irrigation. There's too much competition between plants."

100,000 plants per acre

Pedersen says all the data show it takes a final plant population of 100,000 plants per acre, evenly distributed. "The trick for each grower is getting to that point.

"If the planter is working well and the seedbed's perfect and your seed quality is good, you're in good shape. But if the planter's moving too fast, the meter's not working right or they're mudding in the beans, it's going to take much more seed to hit that 100,000 final plant stand."

Row spacing: Narrower is better

Data from the past 20 years indicate that narrower row spacing improves yield. "I encourage Kansas producers to go to 15-inch rows," says agronomist Gary Kilgore at Kansas State University. "We've got enough data to show that you'll see a 10 percent yield advantage switching from 30- to 15-inch rows."

In Iowa, "Our research is showing 4 to 4.5 bushels more with 15-inch rows compared to 30-inch rows," says Palle Pedersen, Iowa State University agronomist. In Illinois, the increase is 1 to 2 bushels.

"Row spacing of less than 30 inches is preferred, regardless of tillage system, rotation or planting date," Pedersen adds. "And in most cases, there's no difference between 7.5-, 10-, 15-, 20- and 22-inch row spacing."

Kilgore's research also shows there isn't much difference when going lower than 15-inch rows. "If you're going to buy a new planter, I'd sure look at a 15-inch row planter," he says.

Pedersen says the benefits of narrower rows are due to the canopy closing earlier. "When the rows close early, it can significantly impact the crop growth rate – and eventually crop yield," he says. "In addition, the beans can out-compete the weeds. With 30-inch rows, you may have to spray weeds a third time."

Courtesy of Brian McCornack, U. of Minn.

Virus vector

Soybean aphids are a major vector of viruses, according to John Hill, Iowa State University (ISU) plant pathologist. Yet despite the fact that aphids transmit soybean mosaic virus (SMV), soybean dwarf virus (SDV) and alfalfa mosaic virus (AMV), "For SMV, research shows there's no point in spraying insecticides to reduce disease," he says.

"Even if there's insecticide on the plant, as soon as the aphid feeds, viruses can be spread," he adds.

"Now we have an aphid that's widely distributed across the region, capable of moving viruses from one location to another," says David Ragsdale, University of Minnesota entomologist. "There's lots of potential for negative interactions."

Ragsdale adds that because aphids transmit viruses, they've become a major problem in other crops, such as potatoes, snap beans, cucumbers and pumpkins. "All those ugly pumpkins you saw in 2006, that was from AMV," he says.

"We're also seeing more AMV in soybeans, which we never used to see," says Hill. "And we're concerned with SDV, which we've found in Illinois and Wisconsin. The question is, will it move to soybeans in a big way?"

Managing for bean leaf beetle and aphid

In parts of Wisconsin and Iowa, bean leaf beetle (BLB) snuck in the back door during 2006. As a result, "Virtually every Iowa field south of Hwy. 20 was 80 to 100 percent infected with the bean pod mottle virus (BPMV)," says John Hill, Iowa State University (ISU) plant pathologist.

The BLB outbreak has researchers throughout the North Central Region studying seed treatments and early insecticide treatments, how these tactics affect aphids, and whether growers can manage aphid and BLB together. The answer: You can't.

"The only thing that will manage virus diseases is host resistance," says Palle Pedersen, ISU agronomist. "Not insecticides."

Seed treatments: BLB vs. aphids

"Seed treatments have a fit if you're targeting BLB, which appear as soon as soybeans emerge," says David Ragsdale, entomologist at the University of Minnesota. "Especially if you're a seed grower who needs high-quality, disease-free seed.

"But seed treatments for aphid control are a gamble," Ragsdale adds. "We're finding aphids earlier in Minnesota – the first week in June. But that doesn't mean they'll become a risk until mid-July. By that point, seed treatments are of minimal value."

Matt O'Neal agrees. "Seed treatments alone will not protect soybeans from aphids," says the ISU entomologist. "You may need a seed treatment for BLB, but you don't get 2-for-1 control."

Spraying early won't stop BPMV

The news isn't so great here, either. "Our initial recommendations suggested that an early (R1/R2) spray with Warrior® would improve seed quality and reduce yield loss from BPMV," says Hill. "We've since discovered that's not consistently true.

Courtesy of Palle Pedersen, ISU

Courtesy of Palle Pedersen, ISU

"Warrior will reduce beetle populations, but won't control the disease. I think it's because BLB is a very efficient vector, and we can't get the beetle population down far enough," Hill adds. "Warrior does seem to consistently increase seed quality and reduce mottling."

The good news: "We've found field tolerance to BPMV," Hill says. The bad news: "We haven't identified the genes responsible for BPMV tolerance. That will likely require nontraditional molecular approaches."

It's the same story with aphids

Researchers piggybacked on the BLB/BPMV management studies, to see if insecticides applied early would protect against aphids later in the season. "The punchline is, they don't work very well, if at all," says O'Neal.

The problem: In Iowa, aphid populations build up in late July/early August. "By that time, anything you've applied in May and June is gone," O'Neal adds. "And there's some evidence that if you apply a foliar insecticide in June, you might get more aphids than if you apply nothing at all."

He explains that, "Foliar-applied insecticides are like weapons of mass destruction to insects. You kill the beneficial insects that might otherwise help keep aphid numbers in check when they start to arrive 30 days later."

Courtesy of Jack Donaldson, U. of Wis.

Courtesy of Eileen Cullen, U. of Wis.

There's good news on the IPM front. Several species of parasitoids (tiny wasps that specialize in attacking aphids) are currently in quarantine, and researchers are waiting for permission from the USDA to release them. They're hoping to release at least one species of wasp in 2007 – at least on a limited scale. The number of natural enemies in U.S. soybean fields also is increasing.

New aphid resistant varieties

"Thanks to funding from the checkoff, we've found two independent, dominant genes so far – Rag1 and Rag2 – that prevent colonization of aphids," says Glen Hartman, plant pathologist with USDA ARS and the University of Illinois. "And potentially there will be more sources of resistance, as we learn more about the genetic uniqueness of the many lines that have been identified with resistance. Over the next 10 to 20 years, this may help fight off aphid biotypes if they develop."

Hartman thinks at least one company will have seed with the Rag1 source of resistance available in 2008. "There's a lot in the pipeline, so it's just a matter of time."

This may not be the ultimate end of aphid. "But hopefully, resistant varieties will provide enough protection to reduce the number of sprays to one, or even none," he says.

Treating soybean aphids

Current recommendations:

1. Scout regularly
2. Treat when aphids number 250 per plant and the population is increasing; and
3. Plants are in the reproductive stages R1 (beginning bloom) through R4 (full pod) – R1-R3 is best

This assumes a seven-day lead-time to arrange applications and manage weather delays.

Foliar fertilizer generally doesn't pay

"Most of the time, foliar fertilization doesn't pay in Iowa," says Antonio Mallarino, Iowa State University agronomist. "We've found a few situations where it works. Where there's early stress from cold, wet or hail, then a pass of foliar fertilizer can help. But in general, you can't substitute a foliar fertilizer application for soil fertilization."

Mallarino adds that two years ago, when farmers started spraying fungicides, "People were wondering, 'What happens if I apply a foliar fertilizer/fungicide mix?' Once again, our trials show inconsistent results." There's one important result: It never decreased yield. "We're planning more experiments in 2007," he says.

Courtesy of Antonio Mallarino, ISU

Fungicides to improve plant health? It depends on your ZIP code.

Researchers in several North Central states are studying whether applying fungicides to improve plant health makes economic sense. "In Ohio, we can get a one- or two-bushel increase, but it's not consistent," says Anne Dorrance, plant pathologist at The Ohio State University. "Sometimes it's negative. We cannot show that it's an economic advantage."

Studies in Minnesota also show very little benefit. "Occasionally we'll have a trial that shows a yield increase, but it's fairly rare, and the increase often doesn't pay for the application," says Seth Naeve, University of Minnesota (U of M) agronomist. "I don't recommend it."

Dorrance's advice: "Use fungicides to manage diseases."

David Ragsdale agrees. "I'm not a proponent of improving plant health by using fungicides," says the U of M entomologist. "If there's a disease you're targeting and you have a product that will control that disease, then by all means use a fungicide."

Killing beneficial fungi has a downside

Ragsdale's lab is looking at the negative consequences of applying fungicides on aphid populations. "There are beneficial fungi that attack soybean aphids," he explains. "In our plot research, we found that if you apply fungicides more than once, aphids in the treated plots are healthier. They don't get diseased."

Ragsdale says there's a group of fungi – called entomopathogens – that attack only insects. "They're everywhere, and they typically move from crop system to crop system on winged aphids. They get into soybeans and inoculate aphids.

"Where we first noticed the problem was in potato production, where there are fungicide applications every few days. So all of a sudden you have these

Courtesy of Chris DiFonzo, MSU

healthy aphids that are increasing exponentially. Thankfully, we don't see that with one or two applications in soybeans," he notes.

Ragsdale is worried about these healthy aphids, and he has a prediction: "If we get rust in a region and there's widespread fungicide application, I think aphids could be a problem the following year, because of the healthiness of the aphids moving back to buckthorn."

On the other hand …

"We don't have recommendations for foliar fungicides in the absence of rust, but that's not stopping farmers from spraying them," says Jason Bond, plant pathologist at Southern Illinois University. "And based on Illinois

Courtesy of Palle Pedersen, ISU

studies, sometimes we can get double-digit yield increases.

"The 'plant health response' that is often referred to is an increase in plant health in the absence of noticeable disease," Bond adds. "However, in many fields there are a lot of 'minor' pathogens feeding on the plant – controlling them can lead to a three- to six-bushel increase."

For example, frogeye leaf spot is a big problem in southern Illinois. "I'd say 80 percent of the fields here had plants with symptoms in 2006," he says. "The strobilurins gave us the best response last year. We saw from a three-bushel to a 13-bushel increase."

Bond says fields that have longer dew periods, that are shaded for longer periods during the day, areas where you've had higher rainfall – these are situations where you can get tremendous results from spraying fungicides.

Courtesy of Anne Dorrance, OSU

It also depends on variety

In Indiana, studies show some yield response, depending on variety. "If a grower is interested, I suggest targeting varieties that have holes in them," says Shawn Conley, agronomist at Purdue University.

"Not every variety is bulletproof. If you can fill a hole with a fungicide, the odds of it paying off are significantly greater," Conley adds. "But if you have a variety with a strong defensive trait package against diseases like frogeye, the odds of you getting a yield response to pay for the fungicide is less."

"I think there's a latitude effect in all this," says Minnesota's Naeve. Because researchers in different states are getting such varied results, check with an agronomist before using fungicides for plant health.

If there's an upside to aphids and Asian soybean rust, it's this: "These threats have caused all of us to get out and look at the soybean crop at various maturity stages, and we're catching other diseases," says Jason Bond, Southern Illinois University plant pathologist. "That's helpful, because even though rust isn't a major player, it has given us good scouting habits that shouldn't be discarded."

Courtesy of David Ragsdale, U. of Minn.

Courtesy of Jason Bond, SIU

Tillage practices and disease control

What's the relationship between compacted soil and sudden death syndrome (SDS)? In the clay soils of southern Illinois, researchers found that you could reduce SDS disease severity by as much as 50 percent with deep ripping vs. no tillage. "But because of the different soil types in central Illinois, our colleagues there didn't get the same results," says Jason Bond, pathologist at Southern Illinois University.

"We also did follow-up studies at different locations in southern Illinois over several years, where we looked at chisel plowing vs. no-till," Bond says. "With chisel-plowing, we were able to reduce the incidence of SDS disease by 35 to 40 percent over no-till."

Researchers also measured the impact of different tillage practices on soybean cyst nematode (SCN) densities. "In our area, we never saw an impact," Bond notes. "But some states do see an impact on SCN densities with varied tillage practices. Unfortunately results varied widely depending on soil type, so it's hard to use those findings in a recommendation for managing SCN."

Spotlight On SCN

Rotate – Rotate – Rotate

The current soybean cyst nematode management message:

1. Rotate your crops – use non-host crops to reduce SCN population densities
2. Rotate to SCN-resistant varieties
3. Rotate the resistant varieties you use to ones with different sources of resistance if possible

SCN type testing

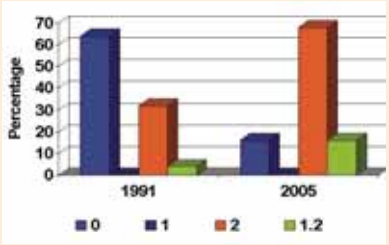
The HG type test is a greenhouse test that provides information on how well an SCN population can reproduce on seven sources of SCN resistance currently available in soybean varieties. "If you're seeing reduced yields using SCN-resistant varieties and don't know why, consider an HG type test," Terry Niblack says. "Or if you're seeing numerous SCN females on the roots of SCN-resistant plants during the growing season."

Dana Pekarchick, USDA-ARS

The University of Illinois nematologist also is working on a molecular test. "But it's a lot more complicated than we'd hoped it would be," she says. "We may have it available in a year or two if we're lucky."

Distribution of SCN types in Illinois

Source of 1991 data: Sibora and Noel, 1991, J. Nematol. :-8.



SCN: It's spreading – and adapting to resistant varieties

With aphids and Asian rust grabbing headlines and causing nightmares, it's easy to forget about soybean cyst nematode (SCN). Don't.

"I'd like to print T-shirts that say, 'Manage what you've got,'" says Greg Tylka, nematologist at Iowa State University. "I don't want to downplay rust and aphids. But if you don't have them, yet are worried about them instead of managing SCN, you're missing the mark."

SCN is the most economically important soybean pathogen in the United States. What's more, it's spreading, and SCN types are shifting. "We don't refer to SCN races anymore," Tylka explains. "We call them HG types." HG stands for *Heterodera glycines*, the scientific name for SCN. (Please see sidebar on SCN type testing.)

Tracking SCN type shifting

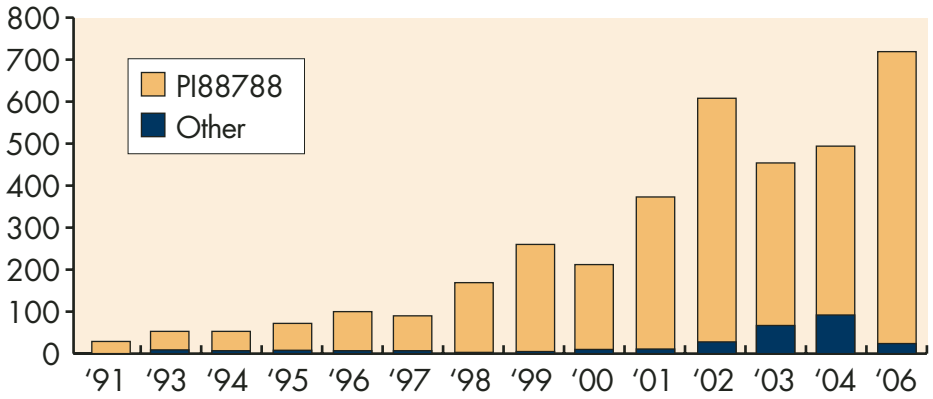
Terry Niblack, nematologist at the University of Illinois, says 84 percent of Illinois fields have SCN, and that there has been a significant type shift. Back in 1990, a survey showed two-thirds of the SCN population in Illinois was Race 3 (now called Type 0).

"In 2005, a follow-up survey with 150 type tests throughout the state showed that not only are SCN populations five times the damage threshold – with an average of 2,700 eggs per 100 cc of soil (a handful) – but two-thirds are now are SCN Type 2, which attacks the PI88788 source of resistance," she says. "SCN types are adapting to and reducing the yields of SCN-resistant varieties."

The problem with PI88788

"That's a concern, because almost all resistant varieties have SCN resistance genes from the soybean breeding line PI88788," Tylka notes. "Yet we're seeing SCN populations develop elevated reproduction on varieties with this resistance source. I've gotten more calls in Iowa in 2006 than ever before saying, 'It's not working.'

"I'm not ready to hit the panic button, but we need to get more sources of resistance in the pipeline," Tylka says. In 2004, 15 percent of the 500-plus cyst-resistant beans were non-PI88788. In 2006 and 2007, it's 3 percent of 700-plus varieties. "That's a troubling trend," he adds. Especially



Number of SCN-resistant soybean varieties available for Iowa growers from 1991 to 2006. No data were available for 1992 or 2005. The gold portion of each bar represents the number of varieties with SCN resistance from PI88788; the blue portion of each bar indicates the number of resistant varieties with SCN resistance other than PI88788.

since some of the existing alternative sources of resistance are susceptible to iron chlorosis and brown stem rot.

Researchers are working on new sources of resistance, as well as alternative tactics to control SCN. Andreas Westphal of Purdue is studying how soils might suppress SCN with the help of certain agronomic inputs; Gregory Noel at the University of Illinois is field-testing a bacterial pathogen (*Pasteuria nishizawae*, an obligate parasite of SCN); and the University of Minnesota's Senyu Chen is investigating biological controls.

Rotate resistant varieties

Until new resistant sources and tools are available, there is an upside: All varieties with the PI88788 source of resistance are not created equal. "Just because a variety comes from PI88788, that doesn't mean it has exactly the same resistance as other varieties derived from PI88788," says Niblack.

So, if a soybean grower can't find a variety with a non-PI88788 source of resistance, "At least pick a different high-yielding, highly-resistant variety the next time you plant soybeans," Niblack suggests. "Don't use the same one twice."

New sources of SCN resistance on the way

Over the past 30 years, soybean breeders have screened nearly 7,000 soybean lines, and identified 118 with some level of resistance to soybean cyst nematode (SCN).

Prakash Arelli took those 118 lines, screened them all for nematode populations, and identified reactions of different nematode types (races) to the different lines. He also has identified unique new sources of SCN resistance, and is now expanding the level of resistance to nematode populations.

"I haven't used field cultures to screen resistant sources," says the USDA soybean breeder. "I've developed homogenous nematode cultures for screening soybeans in a greenhouse. The outcome is that nematode populations have specific reactions to specific lines that are consistent and repeatable."

The end result: "We've identified 18 very unique, resistant soybean lines," he explains. "And we verified them using molecular markers in a genetic diversity study, just to make sure these 18 lines are not closely related to sources of SCN resistance now widely in use, such as PI88788 and Peking."

Courtesy of Lisa Fritz, USDA-ARS

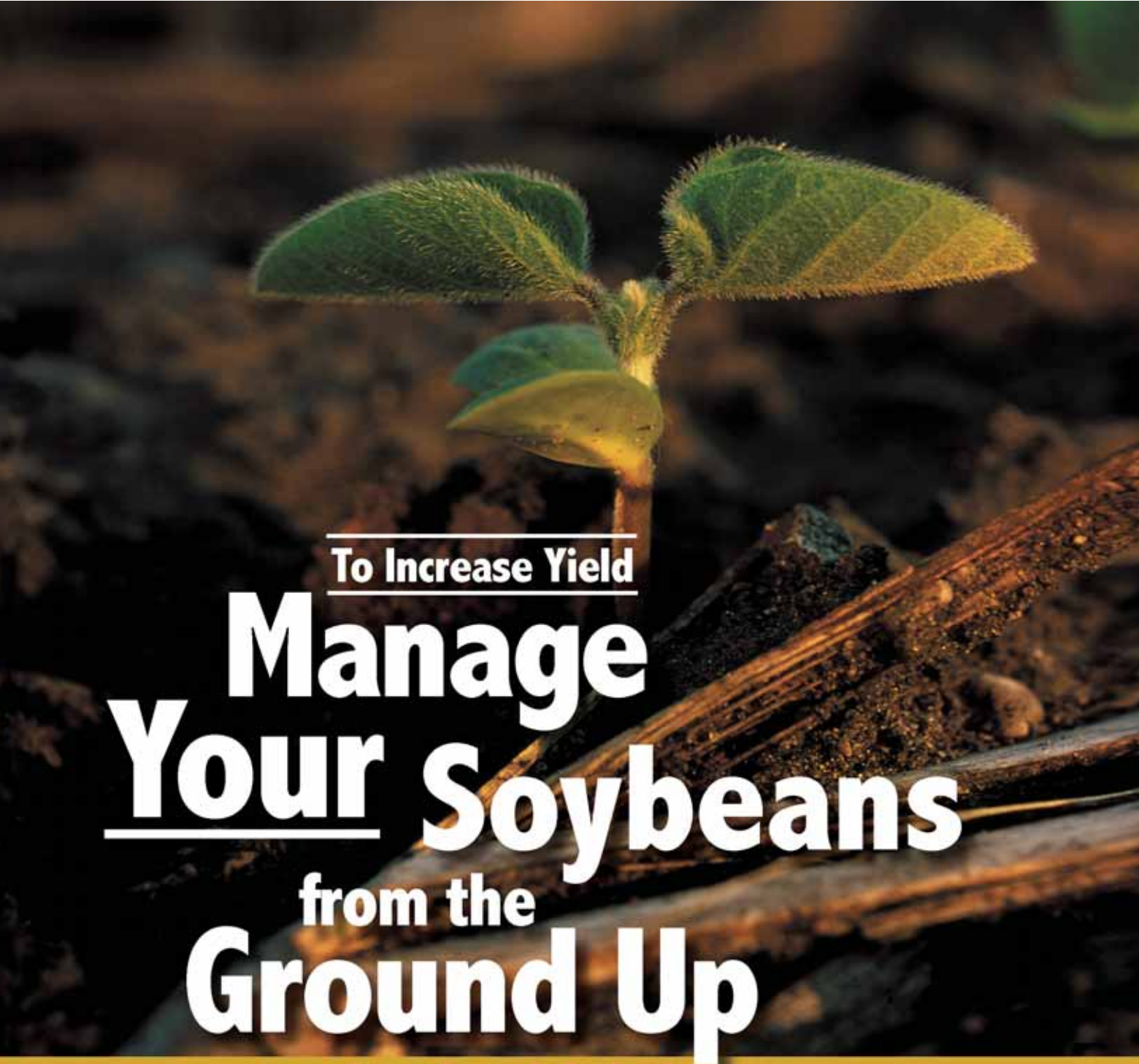
Plant breeders are developing new cultivars that include existing sources of SCN resistance stacked with genes from newly-identified SCN-resistant sources, for broader resistance.

Backcrossing into high-yielders

Currently, breeders are using five of these new sources of SCN resistance – PI89772, PI438489B, PI567516C, PI507354 and PI567286 – and introgressing (backcrossing) the resistance genes into elite cultivars of different maturity groups.

"It's slow going," Arelli cautions, "Because these plant introductions can't be used directly as cultivars. They're poor yielders, black, brown or green-seeded, and viney." All these traits need to be eliminated, backcrossed into the top high-yielding cultivars, and then tested and retested for resistance in Arelli's greenhouse.

Arelli hopes to release cultivars containing new nematode resistance genes within the next three to four years. "Until growers can plant varieties with these new sources of SCN resistance, you should at least rotate to different SCN-resistant varieties. And if possible, switch to varieties with different sources of SCN resistance currently available."



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