Root Rating Results from University of Illinois Corn Rootworm Trials

Root rating results for the 2012 season are detailed in Table 1. Each year our research team evaluates root protection products (soil insecticides and Bt hybrids) targeted at corn rootworms. We establish our experiments in fields that were devoted to trap crops (late-planted corn, interplanted with pumpkins) the previous season to increase the likelihood of sufficient pressure in our control plots to adequately challenge the treatments. Our studies are conducted at the University of Illinois Research and Education Centers near DeKalb, Monmouth, Perry, and Urbana.

The results from only three locations are shown in the table because the overall level of injury in our check plots at Monmouth was very low, and the root rating results are not useful in separating product efficacy. Four different check hybrids were used at each location. Overall, root injury in the control plots was greatest in Urbana, with about two nodes of roots pruned on each check treatment. Root injury ratings in the check plots at DeKalb ranged from about one-half to over two nodes destroyed. Injury at the Perry location was least severe; however, one of the check treatments averaged well over one node of roots destroyed. This is the greatest level of root injury at Perry we have observed in our corn rootworm experiments conducted there.
A review of the results indicates that several of the Bt treatments at Urbana had root injury greater that producers would like to see. The YGVT3 and the Agrisure 3000GT treatments had nodal injury scores of 1.38 and 1.57, respectively. Although these ratings are statistically better than the check plots, this level of protection is not satisfactory. The HxXTRA treatment at Urbana had nearly one node (0.89) of roots destroyed—again, greater injury than should be expected for this product.

The other Bt hybrids in Urbana (SmartStax, Agrisure 3122) performed significantly better than the other Bt treatments. Adding a soil insecticide with a Bt hybrid generally improved the level of root protection, but it was still common for nodal injury scores to be about 0.5 for YGVT3 and Agrisure 3000GT. Nearly one complete node (0.98) of roots was destroyed in Urbana for the Agrisure GT treatment despite the addition of Force 2.1 CS. Soil conditions at our locations were exceptionally dry this season and undoubtedly negatively affected the performance of soil insecticides. The use of a soil insecticide with some of the other Bt hybrid treatments (SmartStax, Agrisure 3122, HxXTRA) did keep root injury to nearly negligible levels (minor scarring of root tissue).

Overall, the level of root injury in DeKalb was lower than in Urbana, but injury to one of the Bt treatments (Agrisure 3000GT) was nearly equivalent to two nodes of roots destroyed (1.78) and not statistically different from two of the checks for this location. When Force 2.1CS was used with Agrisure GT at DeKalb, the nodal injury score remained near one node of roots pruned (0.81). Because of the overall low pressure at Perry, the rootworm products could not be separated statistically, but all of the products had significantly less injury than one of the control treatments (1.4). We encourage producers to review reports of University of Illinois root

### Table 1. Node-injury ratings for corn rootworm control products in 2012 University of Illinois research trials near DeKalb, Perry, and Urbana.

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate</th>
<th>Placement</th>
<th>DeKalb</th>
<th>Perry</th>
<th>Urbana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aztec 4.67GR (DKC 64-82)</td>
<td>3 oz/1,000 row ft</td>
<td>SB furrow</td>
<td>0.14 e-h</td>
<td>0.02 c</td>
<td>0.77 def</td>
</tr>
<tr>
<td>Rootworm Bt Corn Hybrids</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>YGVT3 (DKC64-83)</td>
<td>—</td>
<td>—</td>
<td>0.66 cd</td>
<td>0.01 c</td>
<td>1.38 c</td>
</tr>
<tr>
<td>SmartStax RIB (Stone 6128 RIB)</td>
<td>—</td>
<td>—</td>
<td>0.17 e-h</td>
<td>0.0 c</td>
<td>0.29 c</td>
</tr>
<tr>
<td>Agrisure 3000GT (Garst 84U58)</td>
<td>—</td>
<td>—</td>
<td>1.78 ab</td>
<td>0.1 bc</td>
<td>1.57 bc</td>
</tr>
<tr>
<td>Agrisure 3122 Garst 84U58</td>
<td>—</td>
<td>—</td>
<td>0.31 d-h</td>
<td>0.0 c</td>
<td>0.41 g</td>
</tr>
<tr>
<td>HxXTRA (Mycogen 2K592)</td>
<td>—</td>
<td>—</td>
<td>0.43 c-g</td>
<td>0.05 bc</td>
<td>0.89 de</td>
</tr>
<tr>
<td>SmartStax (Mycogen 2K594)</td>
<td>—</td>
<td>—</td>
<td>0.33 d-h</td>
<td>—</td>
<td>0.33 gh</td>
</tr>
</tbody>
</table>

### Soil insecticides + rootworm Bt corn hybrids

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate</th>
<th>Placement</th>
<th>DeKalb</th>
<th>Perry</th>
<th>Urbana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aztec 2.1GR + YGVT3 (DKC64-83)</td>
<td>6.7 oz/1,000 row ft</td>
<td>SB furrow</td>
<td>0.1 fgh</td>
<td>—</td>
<td>0.5 f g</td>
</tr>
<tr>
<td>Aztec 2.1GR + Agrisure 3000GT (Garst 84U58)</td>
<td>6.7 oz/1,000 row ft</td>
<td>SB furrow</td>
<td>0.08 fgh</td>
<td>—</td>
<td>0.56 efg</td>
</tr>
<tr>
<td>Counter 20GR + SmartStax (Mycogen 2K594)</td>
<td>6.0 oz/1,000 row ft</td>
<td>SB furrow</td>
<td>0.23 e-h</td>
<td>—</td>
<td>0.03 l</td>
</tr>
<tr>
<td>Counter 20GR + YGVT3 (DKC64-83)</td>
<td>6.0 oz/1,000 row ft</td>
<td>SB furrow</td>
<td>—</td>
<td>0 c</td>
<td>—</td>
</tr>
<tr>
<td>Force 2.1CS + YGVT3 (DKC64-83)</td>
<td>0.46 fl oz/1,000 row ft</td>
<td>Band</td>
<td>0.17 e-h</td>
<td>0.02 c</td>
<td>0.4 g</td>
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<tr>
<td>Force 2.1CS + SmartStax (Mycogen 2K594)</td>
<td>0.46 fl oz/1,000 row ft</td>
<td>Band</td>
<td>0.13 e-h</td>
<td>0.0 c</td>
<td>0.04 hi</td>
</tr>
<tr>
<td>Force 2.1CS + Agrisure 3000GT (Garst 84U58)</td>
<td>0.46 fl oz/1,000 row ft</td>
<td>Band</td>
<td>0.46 f-f</td>
<td>0.04 bc</td>
<td>0.42 g</td>
</tr>
<tr>
<td>Force 2.1CS + Agrisure 3122 (Garst 84U58)</td>
<td>0.46 fl oz/1,000 row ft</td>
<td>Band</td>
<td>0.03 h</td>
<td>0.0 c</td>
<td>0.04 hi</td>
</tr>
<tr>
<td>Force 2.1CS + Agrisure GT (Garst 84U58)</td>
<td>0.46 fl oz/1,000 row ft</td>
<td>Band</td>
<td>0.81 cd</td>
<td>0.28 bc</td>
<td>0.98 d</td>
</tr>
<tr>
<td>Force 2.1CS + HxXTRA (Mycogen 2K592)</td>
<td>0.46 fl oz/1,000 row ft</td>
<td>Band</td>
<td>0.35 d-h</td>
<td>0.01 c</td>
<td>0.02 i</td>
</tr>
<tr>
<td>SmartChoice GR + HxXTRA (Mycogen 2K592)</td>
<td>5 oz/1,000 row ft</td>
<td>SB furrow</td>
<td>0.05 gh</td>
<td>0.01 c</td>
<td>0.04 hi</td>
</tr>
</tbody>
</table>

### Untreated checks

<table>
<thead>
<tr>
<th>Product</th>
<th>Rate</th>
<th>Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDKC64-82 RR2</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Stone 6N52 RR2</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Garst 84U58 GT</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Mycogen 2K591 RR2</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

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Notes:

1. Root-injury ratings are based on the 0-to-3 root-rating scale developed by Oleson et al. (2005): 0.00—no feeding damage; 1.0—one node (circle of roots), or the equivalent of an entire node, pruned back to within approximately 1.5 inches of the stalk (or soil line if roots originate above ground nodes); 2.0—to two complete nodes pruned; 3.0—three or more complete nodes pruned (greatest rating that can be given).

2. Means followed by the same letter within a column do not differ significantly (P = 0.05, Duncan’s New Multiple Range Test).

3. Band: insecticide applied in a 5-inch band over the planted row; SB furrow: insecticide applied through a SmartBox insecticide delivery system and directed into the seed furrow.

DeKalb: Planted on April 23 into an area planted to a trap crop in 2011 (late-planted corn interplanted with pumpkins). Roots were evaluated on July 16.

Perry: Planted on April 19 into an area planted to a trap crop in 2011 (late-planted corn interplanted with pumpkins). Roots were evaluated on July 10.

Urbana: Planted on April 18 into an area planted to a trap crop in 2011 (late-planted corn interplanted with pumpkins). Roots were evaluated on July 9.

Seed treated with Poncho 250, 0.25 mg a.i. per seed.

Seed treated with Cruiser 250, 0.25 mg a.i. per seed.

Seed treated with Poncho 500, 0.5 mg a.i. per seed.

Roots were planted into an area planted to a trap crop in 2011 (late-planted corn interplanted with pumpkins). Roots were evaluated on July 16.
Continuing Evolution
Confirmed of Field
Resistance to Cry3Bb1
in Some Illinois Fields by
Western Corn Rootworm

Last year I reported on severe cases of rootworm damage to Bt hybrids expressing the Cry3Bb1 protein in some producers’ fields in northwestern and north-central Illinois (Bulletin issues 20 and 22 in 2011). The fields with severe root pruning and lodging had been in continuous corn production systems for many years. In addition, the producers had relied consistently on the use of a single trait (Cry3Bb1). These problem fields fit a pattern similar to one described by Dr. Aaron Gassmann, Iowa State University, for Iowa fields in which resistance to the Cry3Bb1 protein was confirmed in 2011 (www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0022629).

As I indicated in the 2011 Bulletin articles, the presence of severe root pruning (1 to 2 nodes destroyed), lodging, and confirmation of the expression of the Cry3Bb1 protein from injured roots does not prove resistance. Bioassays are required to understand the mechanism behind these Bt failures in producers’ fields. We collected adults from the Illinois problem fields and sent them to Dr. Gassmann. Bioassays were conducted on the offspring (larvae) from these problem fields. Control western corn rootworm larvae (never exposed to Bt proteins) also were used in the bioassays.

The results from Dr. Gassmann’s laboratory were provided to me in early August, and I recently shared them with audiences at the 2012 Agronomy Day on campus. The findings from Illinois mirror those published by Dr. Gassmann last year concerning problem fields in Iowa. Survivorship of the Illinois larvae on Cry3Bb1 root tissue was not different from the isolate tissue (no Cry3Bb1 expression). The larvae for the Illinois bioassays were offspring reared from adult western corn rootworms collected in Henry and Whiteside counties last year (2011). Larvae collected from these problem Illinois fields remained more susceptible to the Cry3/35Ab1 protein. The control larvae (never exposed to Bt proteins) remained susceptible to both Cry3Bb1 and Cry3/35Ab1 proteins.

In light of these results, growers who have experienced less-than-satisfactory performance with a Bt hybrid should consider the following recommendations. In addition, growers who want to avoid a future problem with a Bt hybrid and, more importantly, to prolong the usefulness of this technology should think through these recommendations as well.

- Consider rotation to soybeans or another non-host crop.
- Consider using a corn rootworm soil insecticide at planting along with a non-Bt hybrid.
- Consider using a Bt hybrid that expresses a different corn rootworm Cry protein than one that may have performed poorly in your fields in 2012 or has been in use for several consecutive years.
- Consider using a pyramided Bt hybrid that expresses multiple Cry proteins targeted against corn rootworms.
- Most importantly, consider a long-term integrated approach to corn rootworm management that includes multiple tactics.

I am particularly concerned about the escalation of soil insecticide usage with Bt hybrids for corn rootworm protection. This practice is seemingly becoming very common in many Corn Belt states. Many will recall that a primary benefit touted when rootworm Bt hybrids entered the marketplace (2003) was the reduction or potential elimination of soil insecticides. Even though commodity prices have increased, so have seed costs, and now many producers are adding yet another input cost—a soil insecticide.

Another very strong concern that I and many of my entomology colleagues hold is the increased selection pressure being placed on the Cry3/35Ab1 protein in areas of the Corn Belt where resistance to the Cry3Bb1 protein has been confirmed. Pyramided hybrids that are being used in these areas continue to work reasonably well; however, in effect, one protein (Cry3/35Ab1) is providing the primary control. And the required refuge for these pyramided Bt hybrids has been reduced from 20% to a 5% seed blend. Even though a seed blend (refuge-in-a-bag) is a preferred resistance management strategy for corn rootworms, the reduction in refuge is a lingering concern for me.

The western corn rootworm remains a versatile insect foe. It has adapted to many classes of insecticides, to crop rotation, and to this relatively new transgenic technology. Producers will need to employ a well-conceived integrated pest management approach to stay one step ahead of this insect.—Mike Gray

Weeds

From Pollination to Seed
Maturation in Waterhemp

This time of year provides an opportunity to assess the success of waterhemp in thwarting our attempts to control it with various herbicides. In many fields across the state, soybean fields in particular, infestations of waterhemp towering above the crop canopy reflect how challenging successful management can be. The amount of seed produced by female waterhemp plants can vary greatly; published research has demonstrated that individual female waterhemp plants
Growing in noncompetitive conditions are capable of producing in excess of one million seeds per plant, although the actual amount of seeds produced when waterhemp is growing under competitive conditions is less. Regardless, the capacity to produce large amounts of seed helps facilitate the rapid spread of waterhemp infestations, especially when the seeds are scattered by harvesting and tillage equipment.

We are often asked if applying a herbicide to large waterhemp plants would reduce the amount of seed they produce. We do not recommend this practice, for myriad reasons. One in particular is that the interval between when female waterhemp flowers are pollinated and the seeds become mature is shorter than some might realize.

Research conducted at the University of Illinois by Michael Bell, a weed science graduate student under the direction of Dr. Pat Tranel, examined how long it took female waterhemp plants to produce viable seed after flowers were pollinated. Female waterhemp plants were pollinated for 24 hours, then separated from the male plants. Two branches were harvested from female plants at various intervals after pollination; these branches were placed under either warm (86 °F or 30 °C) or cold (–4 °F or –20 °C) conditions for 48 hours, then stored at room temperature until all harvests were complete. Germination tests were then conducted to determine how soon after pollination the seeds became viable.

Seeds that were stored for 48 hours under the warm conditions became viable just 7 to 9 days after pollination, compared with 11 days for the cold-stored seeds. The color of the seed coat changed from white to black in about 12 days.

These results illustrate how quickly female waterhemp plants can produce viable seed after pollination. It’s unlikely that all female plants in a field are pollinated at an identical time, so total seed production in any particular field likely occurs over several weeks during late summer, even though maturation of individual seeds can occur relatively quickly. So if you have a field with only a few scattered mature waterhemp plants and you decide to physically remove them, you might want to take along a plastic garbage bag to carry out any female plants with seed, as the seed might already be mature.—Aaron Hager

More Charcoal Rot Observed

In the last issue of the Bulletin (no. 19), Suzanne Bissonnette described charcoal rot in soybean and reported its prevalence in central Illinois. In my travels in the past week, I have observed charcoal rot in several fields in southern Illinois in both soybean and corn. The vascular tissue of corn stalks affected by charcoal rot will be shredded. Microsclerotia (small, dark survival structures of the charcoal rot fungus) also will be inside the vascular tissue of affected corn and soybean plants. The strength of affected corn stalks will be compromised, and lodging will occur readily. Cornfields affected by charcoal rot may need to be harvested before severe lodging occurs.—Carl A. Bradley

A New Virus to Notice in Soybeans

Change is always the name of the game when it comes to diseases that affect our field crops. Efforts to observe, detect, diagnose, and manage pests need to be as flexible as the pathogens are—which is a long way of saying, “There is a new disease you may have noticed in your soybean fields.” If you’ve been monitoring soybean fields for late-season pests, you may have noticed very odd symptoms on some leaves.

Have you seen large, brown, blotchy lesions that run in the direction of the leaf veins and look a bit like the leaf was scratched with something abrasive and then tried to scab over the scratch? That symptom is characteristic of a new disease of soybean called soybean vein necrosis virus, or SVNV.

We have seen this symptomology in soybean leaf samples at the plant clinic for the past several years, and now we know its cause. A 2010 survey of soybean fields conducted by USDA-ARS virologist Les Domier of the University of Illinois Department of Crop Sciences showed that the disease is found...
throughout Illinois and is the second-most prevalent virus found in Illinois soybean fields, right after bean pod mottle virus. That is an amazing feat for a pathogen that not only causes a new disease but is itself a newly described virus.

The virus is transmitted to soybean by the insect thrips. Domier notes that SVNV is in the tospovirus family of viruses, unusual in that they replicate not only in an infected plant but also in their thrips vectors. So thrips that are carrying SVNV can transmit it for a long time.

Symptoms of SVNV in Illinois typically start showing up in August, which is certainly the case this year. Infected leaves may just have a single necrotic scabby lesion or may have many large lesions. Symptoms may be restricted to a scabby necrosis along the veins or may spread widely from the veins.

Leaf symptoms of several virus diseases in Illinois. The leaflets at upper left and lower right show typical symptoms of soybean vein necrosis virus (SVNV)—brownish (necrotic) lesions running along the veins. (Photo courtesy of the University of Illinois Plant Clinic.)

Initial studies and observations in Arkansas note that symptoms do vary with the cultivar, as we seem to be seeing here. Let’s hope that this variation in symptomology points to a source of genetic resistance, as has been the case for other pathogens. Changing disease and pest populations keep us all on our toes and remind us to remain flexible and vigilant in our scouting expeditions.—Suzanne Bissonnette

Crop Development


First published as an Alert on August 13, 2012

One of the questions frequently heard since drought began to take shape earlier in the 2012 season was how yields might be affected in comparison with yields in 1988, when the last widespread drought hit Illinois. Interest centers on whether the development of genetically modified hybrids and the general improvement in hybrid yield potential and stress tolerance have made the corn crop more “drought-proof” now than it was in 1988.

The projected 2012 Illinois corn yield, released by NASS on August 10, is 116 bushels per acre. That may not hold up as the final yield, but for now it’s the estimate we’ll use. Projected yields range from 143 bushels in the Northwest crop reporting district to 80 bushels in the East Southeast district.

In 1988, the average Illinois corn yield was 73 bushels per acre, with a range from 87 bushels in the Southeast (actually higher than the estimate of 86 for this year in that district) to only 63 bushels in the Northwest. So the patterns of dryness were very different in the two years, with southern Illinois relatively better than northern Illinois in 1988. In 2012, dryness has been more evenly distributed, creating closer correlation between soil water-holding capacity and yield.

To look at how much yield was lost to drought in 1988 and 2012, I projected trend-line yields for each drought year based on yields over the 30 previous years. The expected (trend-line) yield for 1988 was 129 bushels per acre; the actual yield was 73, so the loss was 56 bushels per acre. In 2012, the expected yield was 173 bushels per acre and the estimated yield is 116, so the projected loss is 57. Measured in terms of bushels per acre less than expected, the two years are almost identical.

The 1988 yield represents a loss of 44% of expected yield, while in 2012, with higher yield expected, the percentage loss was only 33%. So in relative terms, the 2012 crop lost less yield than the 1988 crop, but in absolute terms, losses were almost identical between the two years.

It’s not clear whether percentage loss or bushel loss is the better measure of drought effects, but what is clear is that serious drought continues to cause serious yield loss, even with today’s faster-growing, higher-yielding hybrids. We don’t yet know if hybrids improved specifically for drought tolerance will be less affected by drought this year, but it’s unlikely that any hybrid will produce high yields in areas and soils where most well-managed fields yield little or nothing.

As we look at plot and field yields this year, we will want to note any hybrids
that do relatively—and consistently—better than other hybrids under dry conditions. But since we don’t know what next year will bring, we also need to include in our comparisons relative hybrid performance under better conditions, even if those come from last year or from 50 or 100 miles away.

In other words, use data from low-yielding comparisons done under drought conditions only if you expect those conditions in 2013. Otherwise, expect better conditions next year and, accordingly, use mostly data from better-yielding trials to choose hybrids.—Emerson Nafziger

Managing After Drought

The corn crop rating in Illinois stays in the low single digits, and all indications are that, apart from ongoing concerns about standability and grain quality, we more or less have the crop we’re going to harvest at this point. Early yield reports are coming in about as expected, though some have reported more in-field variability than expected and yields lower than anticipated.

As the season winds down on what will go down as one of the most drought-reduced corn crops in Illinois history, a number of factors are at play that will affect how we approach management of crops in the coming year.

Some parts of Illinois have gotten rain in recent weeks, but others have received little or no rainfall; parts of the state remain stuck at seasonal rainfall totals 8 to 10 inches below normal. Where the crop is poor, it has used less than the 20 to 22 inches or so of water it would normally have used, but with the low rainfall, soil in many areas will need to take in at least 6 to 8 inches of water to recharge to field capacity.

Average precipitation between September 1 and March 31 ranges from about 15 inches in northwestern Illinois to about 30 inches in the southernmost part of the state. Some feel that we need a snowy winter to get moisture levels back. Because snow melts slowly, most of the water moves into the soil, but it is not always distributed evenly across the landscape, and relatively little of our precipitation comes in the form of snow. There seems to be some debate about whether the drought pattern still persists, but recharging soil water will need only about half the amount of precipitation we normally get during the off-season. Chances of getting that much would appear to be high. It will be better to come in smaller events so that more of it gets into the soil instead of running off.

In areas where harvest is underway, some tillage is already being done. While we often expect that tillage of dry soils after extended periods of dry weather will bring up large, hard clods, initial reports indicate that the soil is quite friable, breaking apart better than expected. This makes sense; tillage last fall and field operations this year all took place when soils were relatively dry, so there has been little of the compaction that normally results from heavy equipment on moist soils.

While rainfall does not really cause much compaction—it simply can’t produce the high weight loads needed—it does cause surface soils to run together to form a hard surface that often means more water running off slopes. So expect soils to be mellower than normal during fall tillage, and match the tillage operation, if any is needed, to this condition.

The 2012 winter wheat crop was a good one in Illinois, and the loss of income from poor corn crops along with early harvest or destruction of corn will have some producers in dry areas thinking about wheat as a possible follow crop for corn. In some cases, wheat (or rye) might also be considered as a cover crop, used to take up some of the nitrogen (N) left in the soil. While having some of the leftover soil N stay in a (grass) cover crop for a following corn crop may seem like a good way to recycle N, actively growing cereal rye or wheat cover crops in the spring can be challenging to manage for establishment of a corn crop, especially if corn is to be planted in early April.

It will often be easier to manage a grass cover crop to establish soybeans rather than corn next spring, though wet soils and heavy cover crop residue can present challenges for any crop that follows a cover crop. Soybeans will use the N released by breakdown of the cover crop but will likely fix less, so there won’t be much economic gain from keeping N for the soybean crop. It will, though, keep some N in the field so that less reaches surface water.

While we can’t guess how much of the leftover N will be left for next year’s crop, other factors associated with a drought-damaged corn crop make such fields a better place for corn next year than they would normally be. Corn that stops growing in midseason does not produce much lignin, so its residue is softer and it breaks down faster. Lower quantities of softer residue will also present less physical challenge to the planting operation.

This is not a suggestion to plant more corn and fewer soybean acres next year. Corn following corn is showing more stress effects again this year, in some areas for a third year in a row. So even though a field with a short corn crop this year may be more corn-friendly than normal next year, it is still unlikely that corn following a corn crop—even a low-yielding one—will yield more than corn following soybean.—Emerson Nafziger

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