Purdue Cooperative Extension Service

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Insects, Mites, And Nematodes

Rootworm Control Options, 2007 Efficacy Results - (*Christian Krupke, John Obermeyer, and Larry Bledsoe*)

- Four delivery methods for rootworm protection, none provide 100% control.
- Product efficacy compared by delivery method.

Listed below, by application method, are the current registered control products and their efficacy in protecting roots in 2007 Indiana and Illinois university rootworm trials. Products are grouped by application technology for ease of comparison. There is no consideration of other insect pests (e.g., wireworms, white grubs, cutworms) in these evaluations – rootworms are the focus of these trials. Before deciding to use any of these options, be sure that you actually need it in your growing area – many areas of the state have little rootworm pressure and can get by simply by continuing to rotate corn with other crops in alternating years. Know your pressure levels and don't buy protection you don't need.

Insecticide Coated Seed Root-Rating Performance[1], 2007

Location	Best[2] Rating	Poncho 1250	Check
Lafayette, IN	0.03	0.11	1.36
Wanatah, IN	0.15	0.29	2.25
Farmland, IN	0.21	0.63	2.20
Dekalb, IL	0.08	1.18	2.18
Monmouth, IL	0.03	0.90	1.14
Urbana, IL	0.13	1.49	2.74

[1]Node Injury Scale 0-3. 0=no damage, 3=severe root pruning, 0.25 or greater = plants likely predisposed to a significant yield loss.
[2]The "Best Rating" is the least amount of rootworm damage for any registered product in the plot.

Liquid Soil Insecticide Root-Rating Performance[1], 2007						
Location	**Best[2] Rating**	**Capture LFR**	**Regent**	**Lorsban 4E**	**Force CS**	**Check**
Lafayette, IN	0.03	0.16	0.22	0.13	0.16	1.36
Wanatah, IN	0.15	1.51	1.53	0.36	0.99	2.25
Farmland, IN	0.21	1.07	1.85	1.25	1.35	2.20
DeKalb, IL	0.08	-	-	0.55	0.45	2.18
Monmouth, IL	0.03	-	-	0.25	0.23	1.14
Urbana, IL	0.13	-	-	0.34	0.36	2.74

[1]Node Injury Scale 0-3. 0 = no damage, 3 = severe root pruning, 0.25 or greater - plants likely predisposed to a significant yield loss.
[2]The "Best Rating" is the least amoutn of rootworm damage for any registered product in the plot.

Granular Soil Insecticide Root-Rating Performance[1,2], 2007								
Location	**Best[3] Rating**	**Aztec 2.1G**	**Aztec 4.67G**	**Force 3G**	**Fortress 2.5G**	**Fortress 5G**	**Lorsban 15G**	**Check**
Lafayette, IN	0.03	0.13	-	0.20	-	0.12	0.16	1.36
Wanatah, IN	0.15	0.46	-	1.06	-	0.32	0.65	2.25
Farmland, IN	0.21	0.37	-	1.37	-	0.21	0.63	2.20
DeKalb, IL	0.08	0.81	0.66	0.74	0.96	-	0.90	2.18
Monmouth, IL	0.03	0.34	0.12	0.22	0.10	-	0.20	1.14
Urbana, IL	0.13	0.31	0.21	0.41	0.15	-	0.40	2.74

[1]Node Injury Scale 0-3. 0 = no damage, 3 = severe root pruning, 0.25 or greater - plants likely predisposed to a significant yield loss.
[2]Aztec 2.1, Force 3, and Lorsban 15 were applied in T-band. Fortress 2.5G was placed in-furrow. Aztec 4.67 and Fortress 5 were applied through SmartBox.
[3]The "Best Rating" is the least amount of rootworm damage for any registered product in the plot.

Bt Corn Rootworm: Side-by-side root rating comparisons of Bt-CRW hybrids with different events (i.e., Agrisure, Herculex, YieldGard) are not possible. Plant genetics that determine a hybrid's root mass, architecture, and rooting depth make direct root rating comparisons between the Bt events virtually impossible – the plants are different in many ways, not just the presence or absence of Bt. The advancement in Bt events has created challenges for university researchers in order to compare rootworm efficacy between not only transgenic hybrids but the chemical controls as well. Imagine having 40 treatments replicated 4 times for one hybrid and then repeating that for each and every hybrid with the rootworm Bt – this is an impossible task. However, what we have listed below are the best comparisons available, taking data from multiple sites and states. Though the locations and planting may have occurred the same day, the plots were and should be compared separately. The take-home message is that overall the YieldGard RW and Herculex RW gave excellent performance when compared to the genetically-similar isoline lacking rootworm protection.

Nodal Injury Scale, 0-3

Transgenic BT-CRW Root-Rating Performance[1], 2007						
Location	YGRW& P250	Isoline & Insecticide & P250	Isoline	Herculex RW & P250	Isoline & Insecticide & P250	Isoline & P250
Lafayette, IN	0.03	0.16	1.36	0.09	0.13	0.23
Wanatah, IN	0.15	0.41	2.25	0.12	-	1.72
Farmland, IN	0.54	0.56	2.20	0.11	1.92	1.98
DeKalb, IL	0.20	0.81	2.18	0.08	-	1.89
Monmouth, IL	0.03	0.34	1.14	0.05	-	0.84
Urbana, IL	0.84	0.31	2.74	0.49	-	2.36

[1]Node Injury Scale 0-3. 0 = no damage, 3 = severe root pruning, 0.25 or greater - plants likely predisposed to a significant yield loss.

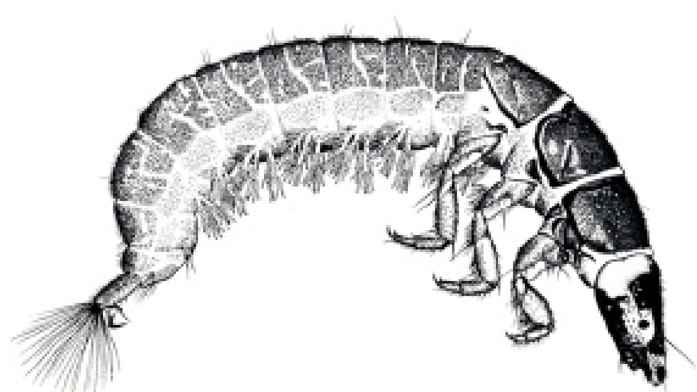
Is Bt Corn Harmful to the Aquatic Environment? – (*Christian Krupke*)

Recently, some of you may have heard a press release about a study showing the toxicity of leaves and pollen of Bt corn to aquatic insects. If not, you can read more about it here: <http://newsinfo.iu.edu/web/page/normal/6570.html?emailID=6570>

Stream surrounded by corn fields
(*Photo credit: Indiana University*)

Aquatic systems are intensively studied in assessing the overall health of our environment. And rightly so – if organisms in the water start dying due to exposure to toxins, it is not good news for land animals higher up the food chain, including livestock, pets and even humans.

Therefore, this study has been generating lots of controversy in the popular press, but how worried should we actually be? Is this the beginning of the end for the Bt corn boom? Actually, this is less of a worry than you might think. The authors of the study are making the point that the Bt corn in the study (this is a corn borer Bt, not the rootworm product) is toxic to caddisfly larvae, which can be described as a kind of "aquatic caterpillar." Caddisflies superficially resemble moths as adults and the fully aquatic caterpillar-like larvae feed on algae and other vegetation under rocks and on the stream bottom. They usually make a cylindrical case out of leaves, sticks or stones that protects them as they eat – many of you have probably seen these cases before. They also serve as food for larger animals such as trout and other game fish.



Filter-feeding caddisfly larva
(*Drawing credit: Arwin Provonsha*)

So what does the study tell us? Nobody disputes that Bt is toxic to some non-target organisms. It is, after all, an insecticide. (As an aside, granular and foliar insecticides historically (and currently) used in field crops are far more toxic to aquatic organisms in general.) So the toxicity, while concerning, is not surprising. However the other important variable in assessing risk – and the one that is not clearly addressed by this study - is exposure. These experiments were done using controlled studies in aquaria to essentially “forcefeed” the caddisflies Bt residue with no choice of other, perhaps more palatable, foods. There are many hurdles to overcome before the events of this study actually happen in nature. First, there would have to be large amounts of Bt (pollen) entering the stream at the same time. This probably does happen. Second, it would have to remain intact and unaffected by breakdown until consumed by caddisflies. This is a big unknown. Third (this is the tough one), caddisflies would have to eat large amounts of it and over a wide space and time to have any measurable effect on the population.

In short, the authors do not present any data showing what the bottom-line exposure rate might be in an actual stream. Without this, it’s similar to the monarch butterfly scare of a few years ago where the actual exposure rates were eventually found to be many times less than that required to kill monarch caterpillars. The caddisfly study is an interesting, and crucial, first step but only half the story. I suspect other researchers will soon begin work to quantify exposure, if they have not begun this work already. These particular Bt products have been around for over 10 years, so there should be many areas in the Midwest where sampling can and will be done to answer this important question. This is a great example that shows that we have to remain vigilant to preserve our pest management tools and the environment around them long after registration is granted.

Nematode Updates-Winter Annuals and Management of Soybean Cyst Nematode – *(Jamal Faghihi, Bill Johnson, Virginia Ferris, and Valerie Mock)*

Once again winter weeds like henbit and purple deadnettle are beginning to show up in fields around Indiana. These two winter weeds are particularly good hosts of soybean cyst nematode. For the most part, we used to think that the active growth period for these weeds does not coincide with SCN activities. However, over the last couple of years we have closely observed winter weed emergence and have noted that henbit and purple deadnettle can emerge in the spring, late summer and fall. Emergence in the spring can occur as early as mid March and generally ceases in late April. Late summer or fall emergence can begin in late-August when we have cool wet weather conditions. So now, we have evidence that the life cycles of winter weeds and SCN do overlap and the potential exists for SCN population increases on winter annual weed hosts, especially in fields with high densities of these weeds.

SCN is not physically active when soil temperature falls below 50°F. The optimum temperature for soybean cyst nematode is 75°F. At 75°F the nematodes require about one month to complete one life cycle, about 750 degree days . Winter weed growth is fairly abundant this year and an earlier than usual harvest might encourage more winter weed growth. Recently, we were able to document and report the completion of at least one generation of SCN in the field. Earl Creech, the former graduate student who worked on this project, was able to follow a life cycle of SCN and extract newly developed cysts on roots of purple deadnettle plants in a field in southern Indiana. In addition we have shown that SCN can complete its lifecycle on purple deadnettle even when its lifecycle is interrupted by a period of up to 20 days of 32°F soil temperatures. Thus, it could conceivably complete its lifecycle by combing both fall and spring development periods on a host which is not killed by freezing temperatures.

The winter annuals in Indiana typically germinate in late fall and mature in early spring. During this time period, under normal conditions, the Indiana soil temperature seldom reaches and stays at the required temperature for SCN development. With warm September weather conditions we have had this year, completion of an SCN life cycle on winter weeds is a definite possibility. Growers might have an extra incentive to spray for winter weeds this fall as part of their overall farm management and SCN population control if they have fields with both purple deadnettle and SCN and herbicide applications can be made very soon after crop harvest. With funding from the Indiana Soybean Board and USDA CSREES we are continuing to pursue the correlation between winter weeds and soybean cyst nematode. We hope at some point that we might be able to predict the activities of SCN on winter weeds based on the number of degree days required for SCN to complete the life cycle (750 DD). The accumulation of DD in southern and northern Indiana will be different in different years. We will continue to monitor SCN and winter annuals activities and correlate them with soil temperatures to be able to make better recommendations in the future. Valerie Mock, a graduate student in Weed Science is conducting research to determine whether or not early fall removal timing will have an influence on SCN reproduction on purple deadnettle – stay tuned for more details in the next year

Nematode Update: Soybean Producers, Harvest is Over, Do You Know Where Your Nematodes Are? - (*Jamal Faghihi, Christian Krupke and Virginia Ferris*)

Another soybean season has come and gone. Hopefully, you had a successful harvest. For those of you who are wondering why your yield was low, the old but forgotten Soybean Cyst Nematode (SCN) may be the problem.

If you thought just planting SCN resistant varieties solved your problem, we have bad news. Soybean cyst nematodes might be changing. Early indications are that

SCN might be changing their behavior towards the old source of SCN resistance (PI 88788) in Indiana and the rest of North Central Region. Most growers have planted PI 88788 soybean resistant varieties for many years. With funding from the North Central Soybean Research Program (NCSRP), we have started a collaborative research program to determine the possibility of behavioral changes toward PI 88788. We are still in the process of collecting and analyzing data, but we are finding more and more populations of SCN that are capable of reproducing on PI 88788. We have had complaints from growers and seed producers this year about possible reductions of yield due to this problem.

We have had a gradual increase in the number of requests for race determination since 2004. We had four times as many requests in 2007 as compared with 2004. Other colleagues from the North Central Region have made similar observations. This anecdotal evidence and our preliminary data indicate gradual changes in the behavior of SCN toward the PI 88788 source of resistance.

We continue to recommend resistant varieties in a rotational program as the most effective tool in managing SCN. However, we need to look to the future and incorporate other sources of resistance into the resistant varieties. Varieties with Peking and CystX sources of resistance continue to be very effective and we have not observed any SCN changes toward these sources of resistance. Management of SCN is best achieved by using rotation with non-host crops like corn, alfalfa, canola, etc. and use of resistant soybean varieties with various sources of resistance. In any case, we should continue to be diligent regarding this elusive and serious pest of soybeans.

They only way we can determine if the SCN populations are changing is by continued sampling. If you haven't sampled your fields in the last four years, you need to sample now, regardless of the type of soybean variety used. If you have not done a race test in the last ten years it might be prudent to do so to determine possible changes toward the common source of resistance, PI 88788. We use PI 88788, Peking, and CystX while determining the race type. While you can sample anytime of the year for SCN, after harvest is the best time to do so. Sampling for SCN is done to a depth of four to six inches with a soil probe or trowel. We require one quart of soil to determine the population levels. However, the more intensively you probe the field, the more accurate the counts will be. Detailed sampling information can be found at <http://www.entm.purdue.edu/nematology/samples.html>. If you choose to determine the race of a population we need at least one gallon of soil. More details for the race test can be found at <http://www.entm.purdue.edu/nematology/services.html>.

If you have any questions about these or any other kinds of nematodes, you can call 765-494-5901, send an email to jamal@purdue.edu or visit our website <http://www.entm.purdue.edu/nematology/index.html>. Soil samples for nematode analysis can be sent to: Nematology Laboratory, Purdue University, Department of Entomology, Smith Hall, 901 W. State Street, West Lafayette, IN 47907-2089.

Have a safe and Happy Holiday!

From all of us to all of you!

Agronomy Tips

Mitigate the Downside Risks of Corn Following Corn – (*Bob Nielsen, Agronomy; Bill Johnson, Botany & Plant Pathology; Christian Krupke, Entomology; and Greg Shaner, Botany & Plant Pathology*)

Indiana corn growers planted an additional 1.1 million acres of corn in 2007 compared to the previous season, for a total of 6.6 million acres (USDA-NASS, 2007). Essentially all of the additional corn acres came at the expense of a decrease in soybean acres. Consequently, the number of acres planted to 2nd-year corn and/or continuous corn increased markedly. Farmers' planting intentions for 2008 are yet unknown, but the amount of aggressive tillage being conducted in corn stubble fields this fall would suggest that many farmers plan to continue planting corn following corn.

From an agronomic perspective, a continuous corn cropping system is fraught with hazards (Butzen, 2006; Lauer, et. al., 1997; Pedersen & Lauer, 2003; Vyn, 2004) and typically yields less than corn in a crop rotation system. Most growers understand this. However, some are equally concerned that soybean rust (*Phakopsora pachyrhizi*), soybean aphid (*Aphis glycines Matsumura*), or other major soybean stresses in coming years may result in unacceptably low soybean yields and/or high production costs.

Consequently, some growers are willing to accept the known risks associated with growing corn following corn in order to avoid the uncertain risks associated with soybean production. While most agronomists certainly do not encourage monoculture of any kind, they can at least offer suggestions for mitigating the downside risks of corn following corn for those growers who feel pressured to do so. More detailed information can be found in the references listed at the end of this article.

Nitrogen Fertility Issues

Most agronomists agree that optimum nitrogen (N) fertilizer rates for corn following corn are higher than for corn following legumes (including soybean), with estimates ranging from 30 to 50 additional lbs of N required per acre (Butzen, 2006; Vitosh, et. al., 1995; Vyn, 2004). Coupled with the oft-cited 7 to 10% lower yield potential of continuous versus rotation corn, the higher required optimum N rates for continuous corn "adds insult to injury". Preliminary analyses of Purdue's 2007 Nitrogen Trials from five locations agree with previously published data in that 2nd-year corn required, on average, 35 lbs/ac more nitrogen than corn following soybean even though 2nd-year corn yields ranged from 7 to 22% less (data not yet published).

Nitrogen fertilizer prices continue their upward trend in response to high domestic natural gas prices, reduced domestic N fertilizer production, and a greater volume of imported N fertilizer (personal communication with Mike Hancock, Fertilizer Administrator, Office of Indiana State Chemist). Corn growers must remember to factor in higher N fertilizer requirements for corn following corn and possibly high N fertilizer prices when developing comparative budgets for alternative crop rotations.

Another consideration for growers who routinely sidedress most or all of their N fertilizer is the fact that obviously more days will be required for this operation if more corn acres are planted. However, sidedressing must be completed within a certain time period. Plant height limitations imposed by traditional ground-driven sidedress applicator tools add to the logistical headaches of covering more corn acres in a timely fashion. High-clearance applicators (e.g., Hagie™, Spra-Coupe™) that can either dribble liquid N between the rows or inject liquid N via coulters offer an option for lengthening the sidedress "window".

P & K Fertility Issues

Corn removes more soil phosphorus and less soil potassium per acre than soybean (Vitosh, et. al., 1995). Per bushel of grain, corn removes 0.37 and 0.27 lbs of P_2O_5 and K_2O while soybean removes 0.80 and 1.40 lbs of P_2O_5 and K_2O. A 180-bushel corn crop therefore removes 67 lbs per acre of P_2O_5 and 49 lbs of K_2O while a 60-bushel soybean crop removes a total of 48 and 84 lbs of P_2O_5 and K_2O.

A one-time move to second-year corn will have negligible effects on P & K soil fertility levels. Over a number of years of corn following corn, however, growers should monitor soil phosphorus and potassium levels and adjust P & K fertilizer application rates accordingly.

Stand Establishment Issues

Higher levels of corn residue associated with continuous corn cropping systems on poorly drained soils in Indiana can create difficult stand establishment conditions due to slowed warming and drying of the soil. High levels of surface residue (including old "rootballs") often also physically interfere with the furrow opening and closing functions of the corn planter's row units (Nielsen, 2003).

Not only can germination and emergence be delayed or uneven, but so can initial seedling development. Delayed stand establishment thus lengthens the potential period of seedling exposure to seedling blights or insect pests and increases the risk of lower than desired populations and/or higher numbers of weakened plants that are less able to tolerate later-occurring stresses.

Mitigate the risk of poor stand establishment by selecting hybrids with superior seedling vigor ratings. If you will be switching only part of your soybean acres to second-year corn, target better-drained fields in your farming operation. Where practical, consider burying the stalk residues with tillage to better facilitate seedbed preparation and planting. Consider adopting strip tillage practices (Vyn, 2004). In no-till corn with heavy surface trash conditions, consider the use of row-cleaning attachments for the corn planter. Avoid planting excessively early in order to minimize the risk of sub-optimal soil temperatures during germination and early seedling establishment. Consider using starter fertilizer, especially nitrogen, in a traditional 2 x 2 placement at rates no less than 20 lbs/ac of actual nitrogen. Consider the use of either soil-applied insecticide or insecticide-treated seed if the risk for secondary insect pests (wireworm, seedcorn maggot, etc.) is high (Obermeyer, et. al., 2005a).

Disease Management Issues

The risk of some corn diseases is greater when corn follows corn, especially when some form of reduced tillage is practiced that leaves greater amounts of non-decomposed, inoculum-bearing residue on the soil surface. Two such diseases that can devastate susceptible hybrids are gray leaf spot (*Cercospora zeae-maydis*) and, as some experienced in 2004 and 2005, northern corn leaf blight (*Exserohilum turcicum*). Other diseases that may become more prevalent in corn following corn are stalk and ear rots, including those caused by *Colletotrichum graminicola* (anthracnose), *Fusarium verticillioides*, *Gibberella zeae*, and *Diplodia maydis*.

Over the past 2 years there has been a lot of talk about substantial yield increases in field corn sprayed with strobilurin fungicides. Experimental data from repeated, replicated university trials suggest that economically beneficial responses to fungicide applications in commercial hybrid corn may occur approximately 60% of the time, but are linked closely with the actual occurrence of significant levels of disease. Economic yield responses to fungicides in the absence of disease are not well documented. On-farm tests in which single strips of untreated corn are used to evaluate the efficacy of treatment on most of the field can be misleading.

The decision to use a foliar fungicide should be based on known susceptibility of the hybrid to gray leaf spot or northern corn leaf blight and the likelihood that disease will develop. Disease risk depends, in addition to the abundance of corn residue in the field and the hybrid's susceptibility, on weather during the summer. Frequent, well-spaced rain (not necessarily heavy), high relative humidity, and dew that persists into the morning favor leaf blights. In the absence of good data to support the economic return of fungicides, it is a good idea to leave some check strips—preferably more than one, and assigned to random strips across the field (i.e., don't use portions of a field that have historically yielded less as your untreated check strips).

In the absence of research-based disease severity thresholds for fungicide application timing, many growers have opted to treat fields at or just before tassel emergence (VT). Stage VT typically occurs about 3 days before silks emerge (R1). If disease will become a problem in a field, treatment at this time will protect leaves during early grain fill and may reduce secondary inoculum that can cause more disease later. Therefore, it is a good idea to scout fields as they near the VT stage of growth. If there is little or no leaf disease evident at this time, application of a fungicide at this time may not be economically justified. Some fungicides can be applied after silking. Check labels for preharvest intervals for each product.

Mitigate the disease risk in second-year corn by careful hybrid selection with emphasis on resistance to specific diseases as well as on overall good plant health characteristics (Thomison, et. al., 2004; Vincelli, 2004b; Vincelli, 2005). Where practical, consider burying the stalk residues with tillage to reduce the abundance of disease inoculum for next year. The use of fungicides is often not considered economical for disease control in commercial feed grain corn production (Vincelli, 2004c), although the experience of some farmers suggests otherwise. For more information on fungicide use in corn, see Nielsen (2007).

Insect Management Issues

The major insect threat to corn following corn in Indiana is the Western corn rootworm (*Diabrotica virgifera virgifera*). The yield and production cost consequences for corn following corn is particularly meaningful for growers in areas of the state where crop rotation remains a viable control option for this insect pest (i.e., areas where the variant rootworm has not yet appeared, primarily the southern and eastern parts of Indiana [Obermeyer, et. al., 2005b]).

There are other notable belowground pests of corn, however, particularly early in the growing season. As indicated earlier, greater levels of surface corn residues in corn following corn can delay corn emergence and growth. This results in a lengthier exposure of corn seedlings to secondary soil pests (e.g., wireworms, seedcorn maggots, white grubs and slugs) that in turn may result in weakened plants and/or stand reductions. A combination of surface corn residues and live winter annual weeds in the spring can attract cutworm and armyworm moths for egg laying, leading to corn seedling damage/death from subsequent larval feeding on plant tissue. Given all of these factors, pressure levels from these pests could potentially increase in corn following corn.

On the other hand, second-year corn should not experience greater populations or damage from European corn borer (*Ostrinia nubilalis*) or Southwestern corn borer (*Diatraea grandiosella Dyar*). In both cases, adult female moths find and fly into cornfields each year to lay eggs. The use of a continuous corn cropping system over a wide area over several years may increase the risk of elevated corn borer pressure and potential yield/harvest losses, simply because of the increase in potential food sources and associated increased pest populations.

> Mitigate the insect risk in second-year corn by the judicious use of soil-applied insecticides, insecticide seed treatments (high rate formulations), or transgenic resistance (Bt-rootworm) for rootworm (Obermeyer, et.al., 2006). Scout fields during seedling emergence for cutworm and armyworm damage to leaves and stems to determine the possible need for rescue treatments of foliar insecticides. Consider using hybrids with Bt-corn borer traits where appropriate.

Hybrid Selection Issues

Good hybrids for rotation corn tend to be good hybrids for continuous corn. Therefore, growers should first seek out hybrids that demonstrate consistent high yield performance across multiple environments (years and/or locations). Consistent performance across multiple sites is important because multiple sites represent possible weather patterns your farm may experience in the future. Consult closely with your seed sales representative and check out the latest corn hybrid performance results from non-biased sources such as Purdue's Crop Performance Program Web site.

Once you have identified otherwise good yielding hybrids, then further filter among that group for hybrid characteristics important for a continuous corn cropping system. Such characteristics include hybrid traits for disease resistance, stalk strength, stalk and root health, seedling vigor, and overall stress tolerance. While always important, these traits take on extra meaning when adopting continuous corn strategies because of the increased risk of diseases and often-greater risk of early season stress during the stand establishment period.

Weed Management Issues

Growing continuous corn limits growers to fewer herbicide options than growing corn in rotation with soybeans or another crop. In addition, corn grown continuously can lead to increased crop residue levels which can decrease the efficacy of many soil-applied herbicides and favor certain weed species that thrive in an environment of higher residue and greater soil surface moisture. Consequently, certain annual grasses, johnsongrass (*Sorghum holepense* (L.) Pers.), and certain small-seeded broadleaf weeds can be more problematic in continuous corn.

If using soil-applied herbicides, use full rates to compensate for the effects of greater residue to best manage weeds in continuous corn. If plans include greater reliance on post-emerge herbicide applications, ensure that weeds are not taller than 6 inches before making applications. In the long run, a combination of pre emergence and postemergence weed control strategies will usually result in the most effective weed control.

Weed management concerns in second-year corn will be influenced by the performance of the previous year's weed management program. In 2004, for example, early planting and subsequent wet conditions diluted soil-applied herbicides, resulting in widespread instances of giant ragweed (*Ambrosia trifida* L.), burcucumber (*Sicyos angulatus* L.), and giant foxtail (*Setaria faberi* Herrm.) breaking through the soil-applied treatments. In 2005 and 2007, lack of rainfall to activate soil applied herbicides resulted in widespread instances of poor control giant foxtail, lambsquarter (*Chenopodium album* L.), and giant ragweed.

In 2006 and 2007, many growers waited until weeds were excessively large before making postemergence herbicide applications and weed control failures were obvious. The fields with moderate to high densities of weeds that emerged with corn and were not controlled until the V3 corn stage or when weeds were in excess of 4-6 inches tall likely suffered significant yield losses and allowed weeds to produce seed. In addition, many growers apparently reduced their use of residual herbicides in corn production. Consequently, late-season of grass weeds such as crabgrass (*Digitaria sanguinalis* (L.) Scop.), barnyardgrass (*Echinochloa crusgalli* (L.) Beauv.) plus broadleaf weeds such as waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer.) and redroot/ smooth pigweed (*Amoranthus retroflexus* L., *Amaranthus hybridus* L.) were very evident.

Fields with such weed escapes leave behind a good supply of new weed seed in the soil seed bank. Furthermore, giant ragweed, burcucumber, waterhemp, and crabgrass have relatively long emergence periods in Indiana and two pass weed control programs are always more successful on these weeds.

> Mitigate the risk of poor giant ragweed and burcucumber control by adjusting weed management plans to include the use of postemergence herbicides that provide residual activity on these weeds. Shifting atrazine use from preplant to postemergence application will extend the residual window of activity and reduce late season weed emergence. Callisto™, Hornet™, and Peak™ (Spirit™) containing products also provide foliar and residual activity on these weeds, unless the giant ragweed is ALS resistant and would be well suited to use as postemergence treatments.

> For better control of late-emerging grass weeds and some small seeded broadleaf weeds, consider adding a reduced rate of an amide (metolachlor (Dual™ and other formulations), acetochlor (Degree™ or Surpass™ and other formulations), dimethenamid (Outlook™), or flufenacet (Define™) to the postemergence herbicide treatment. Amide herbicides will not control emerged grass weeds. If grass weeds have emerged, a postemergence grass

herbicide will be required to control them. All of the chloroacetamide products listed above are labeled for application to emerged corn.

Mitigate the risk of yield loss due to late postemergence herbicide treatments by using residual herbicides at planting and making postemergence treatments before the V3 stage of corn growth. Use the WeedSOFT® Yield Loss Calculator (Univ. of Nebraska, 2006) to assist in your understanding of the impact of early-season weed competition on corn yield.

Glyphosate-Resistant Weeds. Glyphosate-resistant marestail (aka horseweed, Conyza canadensis) is widespread in southeast Indiana and southwest Ohio and effective postemergence control of marestail with glyphosate alone in this region is unlikely (Loux, et. al., 2006). In addition, glyphosate-resistant marestail has now been documented in 15 states in the U.S. In 2006 and 2007, we observed frequent giant ragweed and lambsquarter control problems with glyphosate in soybean and corn. Lambsquarter biotypes with elevated tolerance to glyphosate have been reported in Indiana and Ohio. Purdue and Ohio State weed scientists have conducted extensive field and greenhouse experiments on giant ragweed biotypes with elevated tolerance to glyphosate and have documented populations that show a low level of resistance to glyphosate.

Mitigate the risk of glyphosate resistant weeds by including a variety of herbicide modes of action, especially on weeds that are most problematic to control with glyphosate alone. If glyphosate-resistant corn was grown in a particular field in the previous year, one should also strongly consider using herbicides that rely on other modes of action on the most problematic weeds to reduce selection pressure for glyphosate-resistant weeds. This is particularly important in fields where the grower has noticed increased difficulty in controlling giant ragweed and common lambsquarter. Marestail, lambsquarter and giant ragweed are effectively controlled by many postemergence herbicides in corn. The most effective control of these weeds are usually provided by dicamba, 2,4-D, Hornet™, or Callisto™-based products containing atrazine, provided the applications are made before weeds are 6 inches tall.

Lambsquarter is easily controlled with tillage and many soil-applied herbicides, so effective management is not difficult if one doesn't rely solely on postemergence herbicides. If you will be relying on glyphosate in Roundup Ready® (RR) corn and the field has lambsquarter and giant ragweed, the labels for RR corn limit the glyphosate rate to 0.75 lb ae/A.

We have shown that it is critical to use a rate and tankmix partner which is most likely to be effective with the first postemergence treatment, rather than trying to control escapes with higher rates in a second postemergence treatment. You can use state weed control guides such as the Weed Control Guide for Ohio and Indiana – Bulletin 789 (Loux, et. al., 2007) to determine the most appropriate tankmix partner with glyphosate to provide effective control of emerged lambsquarter and giant ragweed.

For more information on glyphosate-resistant weeds and specific recommendations on tough to control weeds in RR cropping systems, weed scientists in the North Central region began producing publications on this topic and launched a website to distribute this information. The "Glyphosate, Weeds, and Crops Group Web Site" can be found at <http://www.glyphosateweedscrops.org> (URL accessed 11/1/07).

Harvest Season Issues

Obviously, planting more corn acres will effectively lengthen the corn harvest season because of time and capacity demands on harvest machinery, drying facilities, transport, and storage. Some portion of the corn crop will likely remain in the field longer into the fall. Deterioration of mature stalk tissue, especially if already stressed with stalk rots, greatly increases the risk of stalk breakage and mechanical harvest loss if fields suffer severe wind damage prior to harvest. The greater risk of leaf diseases in corn following corn also indirectly increases the risk of stalk rot development if photosynthetic output is severely compromised during grain fill. Excessively dry grain may lead to greater than normal mechanical harvest loss at the header.

Mitigate the risk of stalk breakage by selecting hybrids with superior overall plant health and stalk strength characteristics. If you will be switching only part of your soybean acres to second-year corn, target better-drained fields in your farming operation. Scout fields for the occurrence of stalk rots prior to harvest and prioritize their harvest schedule if necessary to harvest "weak-kneed" fields early. Consider beginning harvest earlier than usual to avoid finishing in late fall when rain and snow prospects typically increase.

Bottom Line

The decision to switch significant soybean acres to second-year corn acres should be made cautiously with careful attention to both the economics and agronomics of such a choice. While short-term economics may favor second-year corn over soybean production (Schnitkey & Lattz, 2005), long-term economics are very much dependent on the economic assumptions made when calculating comparative crop budgets. Growers should recognize that second-year corn yields will range from 7 to 10% less than corn following soybean. Consideration of the risks outlined in this article will help minimize the downside dollar potential of second-year or continuous corn relative to corn following soybean.

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Bits & Pieces

2007 Post Harvest Training and Recertification Workshop – (*Linda Mason*)

The 2007 Post Harvest Training and Recertification Workshop is the last chance for CCH's for 2007!!! This will be held on December 19, 2007 at the Beck Agricultural Center, Purdue Agronomy Center for Research and Education, 4540 U.S. 52 W., West Lafayette, IN. CCH's approved are: Category 1 – (1 CCH); Category 7A – (6 CCH); Category 7D – (6 CCH); Category RT – (4 CCH). Session contents are:

Session 1: Aflatoxin Prevention & Mycotoxin Management
Session 2: Aeration and Quality Grain Management
Session 3: Pests ID – Who & Why Do You Fumigate?
Session 4: Individualizing the Fumigation Management Plan – Precision Fumigation
Session 5: Pesticide Transportation and Storage

For more information please go to <http://www.entm.purdue.edu/Entomology/ext/postharvest.pdf> or call Sally Shewmaker, Agribusiness Council of Indiana, 317-684-5450, email: sshwmaker@bosetreacy.com.

2008 Crop Management Workshops – (*John Obermeyer*)

The 2008 Crop Management Workshop meeting locations and dates are:

January 28 – Shipshewana, Farmstead Inn and Conference Center
January 29 – West Lafayette, Beck Agricultural Center, Agronomy Center for Research and Education
January 30 – Danville, Hendricks County Fairgrounds
January 31 – Jasper, Jasper Inn and Convention Center
February 1 – Shelbyville, Indiana Downs

We will have the same format as last year having both the General Session and the Optional Cropping Session. To register online: <http://www.conf.purdue.edu/crop>. Click on the Crop Management Workshop you want to attend. If you need more information, please call John Obermeyer at 765-494-4563. Hope you see you all there!

Weather Update