North Central Ohio
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Erie Basin Extension Education & Research Area

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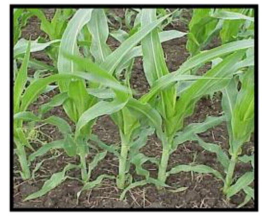

Dear Agricultural Producer:

Welcome to the 2011 edition of the Agronomic Newsletter. This year may prove to be one of the highest crop profit opportunities of our careers. With record level prices and the demand extremely strong, returns to good management and good weather may be at levels most of us never imagined.

It appears we will have a wet start to early spring; fortunately for many a great deal of field work was completed in the fall and early winter.

We will try to provide newsletters as timely as possible. However, we may not be able to provide them as frequently as we have in the past. Best wishes as you begin to finalize plans for the busy spring season.

Best regards,

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NORTH CENTRAL OHIO AGRONOMY REPORT

Wheat

Howard Siegrist, Extension Educator, Licking County
Ohio State University Extension

Wheat Yield Components

Optimum yields usually occur at a point close to 550-600 heads/yards^2. Below this range there is a direct relationship between yield and head numbers (a 50% reduction in head number will result in a 50% yield reduction). Head numbers above 600 do not result in dramatic yield loss unless severe lodging occurs; however, double crop soybean yields and combine efficiency will both suffer. It is important to target a specific set of yield components to achieve 100 bu/A yields. **Table 1** depicts values that are ideal for wheat fields in Illinois, Indiana and Ohio.

Table 1.

plants/sq yard	200
tillers/plant*	4
heads/plant	2.75
Heads/sq yard	550
spikelets/head	16
grains/head	32
seeds/lb	12500

*tillers with more than 3-4 leaves in early February

Nitrogen Timing

Spring nitrogen applications are timed to occur at two important wheat growth stages. These periods of growth are defined in **Table 2**. GS 3 N applications are used to manipulate the number of tillers surviving and to provide sufficient nitrogen for the early stages of head development. Two main factors affect tiller survival: nitrogen content and tiller size. We cannot affect tiller size after emergence, as this is temperature dependent, but we can affect available nitrogen in early spring.

Table 2.

GROWTH STAGE	SIGNIFICANCE	ROLE OF NITROGEN
GS 3: end of tillering	Start of tiller abortion & double ridge stage	Increases tiller number
GS 5-6" pseudo stem erect-first node detectable	Main vegetative growth & terminal spikelet stage	Plant growth & increases head, spikelet and grain numbers
node detectable	spikelet stage	spikelet and grain numbers

GS 5-6 signifies the onset of a period of maximum nitrogen uptake and includes a period of key embryonic growth called the terminal spikelet stage which occurs 5-7 days prior to the 1st node. During this growth phase, we are attempting to ensure optimum N availability to the 550 heads/yard^2 which should result in a large head size and a higher number of grains/head.

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Timing of Foliar Fungicide Applications in Wheat

Pierce Paul, Extension Specialist, Corn & Small Grain Diseases
Katelyn Willyerd, Postdoctoral Researcher, Department of Plant Pathology
Dennis Mills, Program Specialist, Plant Pathology
Ohio State University Extension

Over the last few years we have observed several new trends in the timing of foliar fungicide applications in wheat, and in 2010, we conducted several field trials at multiple locations to evaluate the efficacy and benefit, if any, of these new fungicide programs. Our current recommendations are to apply a foliar fungicide at flag leaf emergence or heading to control foliar diseases, if a susceptible variety is planted and weather conditions are favorable for disease development. For head scab management, we recommend applying a triazole (see attached table) at flowering, along with planting the most resistant variety and rotating wheat with soybean. These recommendations are based on years of research that consistently show that they are the most effective and economical fungicide programs for disease management in wheat. However, recently, some growers have expressed interest in, and other have already been using, one or more of several new foliar fungicide application programs, including applications at green-up, split applications, and applications at flowering.

Quite often, the primary purpose of these new programs is to “preserve” or “protect” yield and not necessarily to manage diseases. Before presenting results from our 2010 trials, let us first recap how the yield is made in wheat in an effort to better understand the rationale behind current management recommendations. Growth and development of the wheat plant can be divided into four distinct phases, tillering, jointing or stem extension, heading, and ripening. The main yield components of the crop are head-bearing tillers per acre, spikelets per head, kernels per head, and kernel size. These components are determined at different stages in the development of the plant, therefore the crop needs to be managed during each of the four stages to achieve the best yield and minimize yield and quality losses.

Seeding rate, planting depth, fertilizer application, planting date, and weed and seedling disease control are all important for determining the number of tillers per acre, and as such, are commonly managed at planting or during the tillering stage of crop development. The head begins to develop and the number of potential spikelets per head and head size are determined during the late tillering and early jointing growth stages (Feekes 5 and 6). Nitrogen application is important at this stage of crop development since it can affect the number of kernels per head. Stresses such as severe drought at Feekes 5/6 may also reduce the potential number of kernels per head. However, the number kernels that ultimately develop per head and size of these kernels depend on pollination and grain fill. The flag leaf (the uppermost leaf of the plant) contributes about 75% of the compounds needed for grain fill. As a result, it is very important to protect the flag leaf from damage caused by foliar diseases and insects, since these may substantially reduce grain yield and quality if the damage occurs before grain fill is complete.

Before the 2009-2010 growing season, most of the early (before flag leaf emergence) and late (after heading) foliar fungicide application programs had not been tested in Ohio with currently available fungicides. However, results from previous studies showed that the greatest benefits from foliar fungicide applications were obtained when applications were made between Feekes 8 and 10. This is largely because most of our major foliar diseases, with the exception of powdery mildew, usually develop and reach the flag leaf after Feekes 8-9. In 2010, we evaluated the effects of single, split, and double applications of several triazole (Prosaro, Caramba and Folicur), strobilurin (Headline), and combination (Twinline, Quilt, and Stratego) fungicides on powdery mildew, Stagonospora, head scab, and grain yield. Applications were made at green-up, flag leaf emergence, boot, and flowering. Among the single application programs, applications made at flag leaf emergence or boot did better than green-up applications in terms of foliar disease control and yield. A single application of a triazole at flowering provided the best control of head scab. Among the programs with double or split applications, we observed the best results with those treatments that included an application at full rate at Feekes 8-9. A single full-rate application at this growth stage did just as well or better than the grean-up+flag leaf or the flag leaf+flowering applications. Comparing a single application at flag leaf emergence with a single application at flowering, all of the tested fungicides resulted in better control of powdery mildew when applied at flag leaf emergence than when applied at flowering, and comparable levels of Stagonospora control were achieved with the two programs. This is largely because powdery develops early and as such applications made at flowering are generally too late to provide the best control of this disease. Stagonospora, on the other hand, usually develops later in the season, and in a wet growing season like 2010, foliar fungicides may still provide very good control when applied at flowering. In fact, because of the high levels of powdery mildew, Stagonospora, and head scab we had in 2010, the fungicide programs that provided the best overall control of all three diseases and resulted in the highest yield gain were those with a triazole applied at flag leaf emergence followed by a second application at flowering.

However, it is rarely ever beneficial to make two foliar fungicide applications in wheat in Ohio. The yield gain is generally not sufficient to offset the cost of two applications. If foliar diseases are a concern, then one well-timed application between Feekes 8 and 10 should be sufficient to control powdery mildew, Stagonospora, Septoria, and leaf rust. If head scab is of concern, a well-timed application at flowering will provide the best control of scab, while at same time provide protection against the late development of Stagonospora and rust. In general, conditions favorable for scab development are also favorable for Stagonospora.

In summary, here is what we observed in our trials and what we recommend:

1. For foliar disease control, fungicides provided the best results when applied between Feekes 8 (flag leaf emergence) and Feekes 10 (boot).

2. Applications made at Feekes 8 or 10 did better than applications made at Green-up or split applications in terms of disease control or yield response.

3. If the variety is susceptible and weather conditions are highly favorable throughout the growing season, an application at full rate at Feekes 8 or 9 followed by a second at flowering may be beneficial, if the value of the crop is high.

4. Fungicides are generally not beneficial when resistant varieties are planted.

5. For adequate head scab control, fungicides should always be applied at flowers or as close as possible to this growth state.

Fungicides with strobilurin chemistry are not recommended for scab control since they have been associated with increased levels of vomitoxin in the grain.

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Glyphosate's Impact on Field Crop Production and Disease Development

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"Produced and prepared by Purdue University Extension Weed Science"

The U.S. Department of Agriculture's recent decision to approve Roundup Ready alfalfa renewed a debate about the safety of genetically modified crops and the use of glyphosate in the environment.

This is not a new controversy, but many statements released in recent weeks by groups opposed to the use of genetically modified (GM) crops have claimed that glyphosate use and Roundup Ready® technology will be disastrous and that glyphosate has damaged crop production by decreasing nutrient availability to plants, reducing nutrient content of food and livestock feed, and increasing plant susceptibility to disease (Zerbe, 2011). There also are claims that glyphosate is contributing to an increase in more than 40 plant diseases that may also affect human and animal health (Smith, 2011; Zerbe, 2011). However, evidence to support these claims has neither been presented to nor evaluated by the scientific community.

As scientists, we are equally concerned about the health of the environment and the sustainability of agricultural production. We have previously addressed questions on the impact of glyphosate and manganese (Mn) interactions on soybean (see http://www.btny.purdue.edu/weedscience/2010/GlyphosateMn.pdf). In this article, we discussed the limited research available on the impact of glyphosate and glyphosate-resistant crops on Mn nutrition of soybeans, and encouraged producers to avoid "insurance" applications of Mn for the sole purpose of counteracting perceived plant health damage due to glyphosate use. However, the most recent press releases around this issue are focused on the impact of glyphosate on plant and human disease development. This article is intended to clarify the relationship between glyphosate and plant disease development.

The claim that herbicides, such as glyphosate, can make plants more susceptible to disease is not entirely without merit. Research has indicated that plants sprayed with glyphosate or other herbicides are more susceptible to many biological and physiological disorders (Babiker et al., 2011; Descalzo et al., 1996; Johal and Rahe, 1984; Larson et al., 2006; Means and Kremer, 2007; Sanogo et al., 2000; Smiley et al., 1992). Our research with glyphosate-susceptible weeds has shown that some weeds die more rapidly after they have been sprayed with glyphosate when grown in soil that contains certain soil-borne fungi. This suggests that some soil fungi are more effective in infecting a weed after it has been weakened by glyphosate. Herbicides with other modes of action, such as ALS inhibitors and dinitroanilines, can influence fungal growth and disease severity of some soybean pathogens (Bradley et al., 2002; Harikrishnan and Yang, 2001; Sanogo et al., 2000). Based on observations from our research, we speculate that this happens when weeds are exposed to ACCase inhibitors as well.

Despite the potential for herbicides to increase disease levels in certain plants, plant pathologists have NOT observed a widespread increase in susceptibility to plant diseases in glyphosate-resistant corn and soybean. There is limited research data available to suggest that disease is of greater concern in GM or Roundup Ready® soybean and corn, compared with non-GM soybean and corn. In fact, research indicates that glyphosate-tolerant soybean and wheat are no more susceptible to soil-borne fungal diseases than conventional glyphosate-sensitive varieties, regardless of whether or not glyphosate is applied (Baley et al., 2009; Njiti et al., 2003). The target of glyphosate is an enzyme (5-enol-pyruvul shikimate 3-phosphate synthase or EPSPS) that aids in the synthesis of aromatic amino acids. This enzyme is present in plants, fungi, and bacteria, but not in humans or animals (Kishore, 1998). Therefore, glyphosate may inhibit fungal development as well as the growth of weeds. Research on glyphosate-resistant wheat and soybean indicates that applications of glyphosate have the potential to control or suppress stripe and leaf rust of wheat, and soybean rust (Anderson and Kolmer, 2005; Feng et al., 2005). This research is limited, and therefore we do not advocate applications of glyphosate for disease control. The research simply demonstrates that glyphosate may also have the ability to inhibit growth of certain fungi, and indicates that additional research is necessary to fully understand the interactions between glyphosate, fungal diseases and plants.

Although some research indicates there is an increase in disease severity on plants in the presence of glyphosate, it does NOT necessarily mean that there is an impact on yield. The most important point to make about the majority of research available on glyphosate-disease interactions is that the research does not always quantify the effect of glyphosate-influenced disease development on yield. Despite claims linking glyphosate use to increases in yield-limiting diseases such as Goss's wilt of corn, or sudden death syndrome (SDS) of soybean, we are not aware of published research that fully examines the impact of glyphosate on disease development and yield under disease pressure. Previous research examining the effect of herbicides, including glyphosate, on disease development in soybean has been conducted in greenhouse or limited field trials, and has not examined the effect of these interactions on yield (Bradley et al., 2002; Sanogo et al., 2000). All plant diseases do not have an equal impact on yield. Plants have natural defense systems that are able to limit infection and prevent yield loss in some cases. Disease-causing organisms exist naturally in the environment, but only cause infection when a susceptible host and a favorable environment are present. Even when infection occurs, the disease must reach a level in the host where the plant is weakened enough to cause yield loss.

The claim that plant disease has "skyrocketed" due to glyphosate usage is also unfounded. Many factors influence the level and type of disease present in any given year. For instance, reduced tillage or no-till operations have become more common across the Midwest. Many fungi and bacteria that cause plant disease survive from year to year on crop residue or in the soil. An increase in residue and a reduction in soil disturbance can favor disease development in certain diseases (Cotton and Munkvold, 1998; Flett et al., 1998; Workneh et al., 1998). In the past, disease management recommendations focused on using hybrids and varieties with strong disease resistance packages. The current push for high-yielding varieties and quick variety turnover in the market means that some varieties may not have resistance to all major diseases, and disease resistance is not always a high priority when producers are selecting hybrids or varieties. These practices increase the likelihood that disease could develop in a given year.

It is also important to note that crop yields have been protected from yield-robbing weeds by many different herbicides for more than 50 years. Use of herbicides has not been linked to yield-limiting disease outbreaks during that time. In fact, glyphosate has been used extensively for more than 30 years and no yield-limiting disease outbreaks have been attributed to glyphosate use prior to these recent reports.

The articles and websites state that fungi in the genus Fusarium cause not only plant diseases but also disease outbreaks in humans and animals. In fact, very few pathogens infect both plants and animals. Some fungi can produce toxic compounds called mycotoxins that can be harmful to animals and humans (Desjardins and Proctor, 2007). However, only certain species within the genus Fusarium have been shown to produce mycotoxins. The majority of Fusarium fungi that produce mycotoxins are pathogens of corn and wheat. Wheat and food-grade corn are non-GMO crops, meaning that mycotoxin development in these crops would not be directly linked to glyphosate usage or interactions. Plants and grain affected by the fungus that causes SDS, Fusarium virguliforme, have not been shown to be toxic to humans or livestock. Additionally, the United States Food and Drug Administration has set levels for the amount of mycotoxins that can be in animal feed, and in food for human consumption, and these markets are closely regulated to prevent introduction of mycotoxin-contaminated grain into the market.

Overall, the claims that glyphosate is having a widespread effect on plant health are largely unsubstantiated. To date, there is limited scientific research data that suggest that plant diseases have increased in GM crops due to the use of glyphosate. Most importantly, the impact of these interactions on yield has not been demonstrated. Therefore, we maintain our recommendations of judicious glyphosate use for weed control. We encourage crop producers, agribusiness personnel, and the general public to speak with University Extension personnel before making changes in crop production practices that are based on sensationalist claims instead of facts.

References available at: http://www.btny.purdue.edu/weedscience/2011/GlyphosatesImpact11.pdf

Study Determining Best Practices to Manage Burcucumber in Corn

Mark Loux, Weed Scientist, Ohio Agricultural Research and Development Center (OARDC)
Ohio State University Extension

Burcucumber can be one of the most difficult weeds to manage in corn. It can emerge well into the growing season and its vines can spread up to 25 feet and twine around corn plants.

It can drag down the corn and make it difficult to harvest, impacting yields.

Mark Loux is in the middle of a two-year study to determine the most effective way to manage burcucumber in corn.

While we previously had an idea of the relative effectiveness of various pre- and post-emergent herbicides, we weren't sure what would be the most effective combinations of herbicides and application timings to provide the most consistently effective late-season control, said Loux, who is also a weed science specialist for Ohio State University Extension. Late-season emergence varies from year to year based on rainfall patterns and other factors, but when burcucumber emerges in big numbers after post-emergent herbicides have been applied, it can create a mess.

Loux's research compares the effectiveness of various residual pre- and post-emergent herbicides and the timing of their application. In 2010, the first year of the study, researchers applied herbicides Lexar, Corvus+atrazine and Harness Xtra at planting (pre-emergent) and early post-emergent, when corn was at the V2 (second-leaf) stage. These treatments were followed with various residual and non-residual post-emergent herbicides, including Callisto, Spirit and bromoxynil. Researchers tested different timings for the post-emergent herbicides and single and multiple applications.

One of the research sites in 2010 was non-GMO corn; several more are planned in 2011, including at least one with glyphosate-resistant corn, Loux said.

The study's 2010 findings included these observations:

- The Lexar and Corvus+atrazine were much more effective than the Harness Xtra for control of burcucumber between planting and the post-emergent application. Not only were there fewer burcucumber plants with the Lexar and Corvus+atrazine, but the weeds were small and had not started to vine at the time of the post application. Plants in the Harness Xtra treatments were much larger, and some had already extended tendrils to the corn plants by the time the post-emergent herbicides were applied.

- There appeared to be more effective control when the residual herbicides were applied at the early post-emergent stage instead of at planting, but this was much less important than the choice of residual herbicide. These results indicate that delaying the residual herbicide application until corn is at about the V2 stage could provide more effective control in mid-season and allow a more flexible application window for later treatment.

- Choice of post-emergent herbicide was even more important than the choice of pre-emergent herbicide. Applying of Callisto at either 20- or 37-inch corn resulted in half the number of burcucumber plants at the end of the season compared with bromoxynil. More importantly, the Callisto resulted in a biomass (total above-ground growth) and burcucumber seed production that was about 97 percent lower than where bromoxynil was applied. "So, the potential for the burcucumber to twine around corn plants and create a mess was much lower with Callisto, as was the seed production," Loux said.

- Spirit provided control generally similar to Callisto. The end-of-season burcucumber population was higher with Spirit compared with Callisto, but the biomass and seed production were similar, so the Spirit prevented plants from producing substantial above-ground growth. The researchers saw similar levels of control when they applied bromoxynil twice at the post-emergent phase. However, they saw no improved control when they followed Callisto and Spirit applications with a late post-emergent (50-inch corn) application of bromoxynil.

- The researchers monitored burcucumber emergence throughout the season in several untreated areas. The majority of the weeds emerged in mid-June, but emergence started in early May and extended into early July. "In 2010, we did not observe the substantial emergence that can apparently occur in mid-summer, based on grower comments, so these results may overestimate the end-of-season effectiveness of the herbicide treatments we studied."

Although there's another year to the research project, Loux said a few things are already clear to him. First, effective burcucumber management in corn requires a combination of pre-emergent and post-emergent herbicide applications. Starting with a pre-emergent herbicide reduces the number and also the size of the weeds at the time of the post-emergent herbicide application. Herbicides capable of doing so include Lexar, Lumax, Corvus+atrazine and Balance+atrazine. Any of these should be much more effective for early-season control in comparison to atrazine premix products.

More importantly, it appears that the use of a post-emergent herbicide treatment with both foliar and residual activity on burcucumber may be the most vital component of a management program. Callisto or Spirit, both of which have residual activity on burcucumber, provided more effective end-of-season control than bromoxynil, unless the bromoxynil was applied twice.
We expect that results with glyphosate will be similar to bromoxynil, since both herbicides lack residual activity.

It didn't seem to make a difference if Callisto was applied on 20-inch or 37-inch corn, but it's possible that the later application could be more effective in a year when burcucumber emerges in great numbers in late June or July.

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Sampling Your Soil For Better Soil Test Results

Emily Sneller, Field Crops Educator
Michigan State University Extension

Soil sampling is not rocket science, but taking certain steps can result in more useful and accurate soil test results.

Sampling your soils to determine soil pH and soil nutrient levels is an excellent management tool that aids in determining not only liming requirements, but also your fertilizer needs.

Soil sampling may be conducted any time of the year with a few exceptions. First, sampling should be done prior to lime or fertilizer applications as these nutrient inputs will directly affect the accuracy of your testing results. If either lime or fertilizer has been applied, wait a period of time to allow for the nutrient applications to equilibrate in the soil before sampling and testing.

The frequency in which you should sample your soils also varies depending on factors such as the crops grown, crop rotations, nutrient inputs and removals, soil texture and a pre-existing soil test history. A general rule of thumb when it comes to soil sampling frequency is to follow your crop rotation frequency. For example, if you have a three-year crop rotation, sample your soils every three years. If you have a four-year crop rotation, sample every four years. Remember, the more consistent you are in following your crop rotation frequency and taking samples during the same time each year, the more comparable the soil test results will be.

When it comes to taking your soil sample, the key is to obtain a sample that is representative of the area. For traditional soil sampling, a single sample should represent no more than 20 acres. Each soil sample should comprise of at least 15 to 20 soil cores to a depth of 8 inches which have been collected from the field in a random zig-zag fashion. If you have a large field, you will need to take multiple soil samples that represent a portion of the field. Splitting your field according to good versus bad production areas, old use patterns, soil types, and other influential factors will yield more representative soil test samples.

Additionally, there are other soil sampling strategies that are more intensive than traditional sampling, such as using GPS technology. For additional information on these sampling strategies or soil sampling and testing, see MSU Extension Bulletin E-498, Sampling Soils for Fertilizer and Lime Recommendations (http://bookstore.msue.msu.edu/Bulletin/PDF/E0498.pdf), and Extension Bulletin E-498S, Sampling Soils for Fertilizer and Lime Recommendations: Frequency of Soil Sampling (http://bookstore.msue.msu.edu/Bulletin/PDF/E0498S.pdf).

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Roundup Ready Alfalfa is Approved

Doo-Hong Min, Extension Forage Specialist, UP Research Center
Michigan State University Extension

Planting Roundup Ready alfalfa can be one of the tools in controlling heavy weed invasion in pure stands of alfalfa and farmers can plant it this spring.

Alfalfa is the major legume forage crop in the Midwest United States and is produced for on-farm dairy and livestock feed and as a cash crop. There are 1.2 million acres of alfalfa fields in the state of Michigan.

Roundup Ready alfalfa varieties offer a new option for weed removal during stand establishment and in established stands. Weed management systems that use glyphosate as the main method of weed control could have potential benefits not previously observed with traditional practices. It took almost four years to get the final approval for planting Roundup Ready alfalfa (RRA) by the U.S Department of Agriculture in late January, after several rounds of regulation, deregulation, and re-regulation without conditions. Over the past several years, lots of debates took place regarding concerns of potential gene flow into conventional alfalfa fields and adverse effects on plants and animals including threatened or endangered species. With the USDA's approval and announcement, farmers can plant RRA starting this spring.

Planting RRA can be one of the tools for controlling heavy weed invasions that happen in typical alfalfa fields by using less herbicide, possibly resulting in less environmental impact. RRA can kill grass if planted with grass in binary mixtures so RRA should be planted as pure stands rather than alfalfa-grass mixtures.

Electronic copy of the Environmental Impact Statement (EIS) on Roundup Ready Alfalfa has been published and can be found at www.aphis.usda.gov/biotechnology/downloads/alfalfa/gt_alfalfa%20_feis.pdf

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Maximizing Returns on Soybean Seed Investments

Bob Battel, Extension Field Crops Educator
Michigan State University Extension

With soybean seed sold at a per unit cost rather than by weight, farmers may be curious how low soybean populations may be dropped, while still maintaining a profitable yield.

MSU Extension educators in the Thumb and Saginaw Valley studied optimal soybean seed populations in multiple on-farm population studies in 2009 and 2010. Planted populations ranged from 80,000 to 240,000 seeds per acre with incremental increases of 40,000 seeds. Harvested populations were generally similar to planted populations. The soybeans were planted in 30-inch rows, and the variety Pioneer 92Y30 was used both years. These results represent 15 study replications over the two years. It should be noted that these studies were established on high yielding, well-tiled loams and clay loams throughout the tri-county Thumb region.

Gross per acre returns for each population were calculated using a soybean price of $12.90 per bushel and a cost of $45 for a 140,000 seed unit. Thus, each incremental increase of 40,000 seeds increases costs $12.86 per acre, and an additional 1 bushel per acre yield would be necessary to cover the increased seed cost. See the following table for results.

Soybean Population Per Acre Returns Seed at $45/Bag and Soys at $12.90/Bu.				
Pop X 1,000	2009 Yield (bu./A)	2010 Yield (bu./A)	2 Year Ave Yield (bu./A)	Return/A
80	36.80	43.99	40.40	$ 495.38
120	43.20	44.52	43.86	$ 527.22
160	43.90	45.84	44.87	$ 527.39
200	44.80	44.79	44.80	$ 513.57
240	48.80	44.95	46.88	$ 527.54

Results between 2009 and 2010 were substantially different. In 2009, the 200,000 and 240,000 populations were significantly greater than lesser populations at the 0.05 level. In 2010, each population between 120,000 and 240,000 were statistically similar, and significantly greater than the 80,000 population. When averaged together, and with the seed costs factored in, it is clear that more profitable yields are realized at populations greater than 80,000 seeds per acre by about $30 per acre. But within the 120,000 to 240,000 seed range, the results are not different enough to recommend one population over another at this point. This study will be repeated in 2011 to help clarify differences in yield between soybean populations.

The Michigan Soybean Promotion Committee provided funding to make this study possible.

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Maximizing Returns on Seed Corn Investments

Bob Battel, Extension Field Crops Educator
Michigan State University Extension

With rising seed corn costs and continuing genetic improvements allowing for better yields at thicker planting populations, growers may question which population yields the best per acre return.

MSU Extension educators in the Thumb and Saginaw Valley studied optimal corn seed populations in multiple on-farm population studies in 2008, 2009 and 2010. Planted populations ranged from 24,000 to 38,000 seeds per acre with incremental increases of 2,000 seeds. Harvested populations were generally similar to planted populations. The corn was planted in 30-inch rows, and the hybrid Great Lakes 4689GVT3 was used each of the three years. These results represent 54 study replications over three years. It should be noted that these studies were established on high yielding, well-tiled loams and clay loams throughout the Thumb and Saginaw Valley.

Gross per acre returns for each population were calculated using a corn price of $5.60 per bushel and a per bag seed cost of $275. Thus, each incremental increase of 2,000 seeds increases costs $6.88 per acre, and an additional 1.3 bushel per acre yield would be necessary to cover the increased seed cost. See the following table for results.

According to the statistics, when populations were between 30,000 and 38,000, yields were significantly higher than the 24,000 and 26,000 populations at the 0.05 level each of the three years the study was conducted. Corn yields leveled off at populations of 32,000 seeds and greater. There was only a small increase of 0.7 bu./A between the 32,000 and 38,000 populations, which is not statistically significant. At an average yield of 194.0 bu./A, the 32,000 seed per acre treatment returned the most revenue per acre.

Corn Population Per Acre Returns
Seed at $275/bag and corn at $5.60/Bu.

Pop X 1,000	2008 (bu./A)	2009 (bu./A)	2010 (bu./A)	3 Yr Ave Yield (bu./A)	Per Acre Seed Cost	Return/A
24	191.0	179.7	157.0	175.9	$82.50	$902.47
26	196.5	183.5	156.7	178.7	$89.38	$911.53
28	201.9	196.2	158.8	185.7	$96.25	$943.48
30	207.1	196.1	169.0	190.7	$103.13	$964.85
32	207.3	201.5	173.6	194.0	$110.00	$976.51
34	209.2	200.3	171.0	193.4	$116.88	$966.31
36	209.4	203.2	169.2	193.8	$123.75	$961.46
38	210.0	198.8	175.3	194.7	$130.63	$959.77

The Corn Marketing Program of Michigan provided funding to make this study possible.

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What's New for Agronomic Weed Control: 2011

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CORN: Corvus 2.63SC (Bayer CropScience) is a newer corn herbicide premix that includes a novel corn safener to reduce the potential of crop injury. Corvus contains two active ingredients: isoxaflutole (HPPD-inhibitor in Balance Flexx) and thiencarbazone (ALS-inhibitor) plus the corn safener. This safener called cyprosulfamide safens corn both pre and post and is reported by Bayer to increase corn metabolism of isoxaflutole. Corvus is a pre or early post herbicide that has a broader weed control spectrum than Balance Flexx since it also contains thiencarbazone which controls several grass and broadleaf weeds. Corvus can be applied either pre or early post (up to the V2 growth stage) at the typical rate of 5.6 fl oz/A. It will likely not provide adequate control of severe problem annual grasses (foxtails and panicum, etc.), so it is recommended that these herbicides be used in a planned pre followed by post program that include additional grass control. The addition of atrazine will also improve the weed control spectrum. Corvus can also be used to help with no-till burndown and provide some residual control of weeds including triazineresistant species. Penn State research has looked at Corvus over the past few years and noted limited crop injury and good weed control. Corvus contains herbicides in WSSA groups 2 and 27 (see discussion below about WSSA herbicide groups).

Prequel 45WG (DuPont) contains two herbicide modes of action, isoxaflutole (Balance, HPPD-inhibitor) plus rimsulfuron (Resolve, ALS-inhibitor). This is a similar product to Corvus, but Prequel does not contain a safener and must be applied before corn emergence. It provides some burndown and residual control of common broadleaves and some grasses when applied at the labeled rate of 1.66 to 2.5 oz/A. At labeled rates, it will either need to be mixed with other herbicides to provide better grass control or requires a post herbicide program to control escaped weeds. It is primarily designed for use in two-pass programs in GMO corn. Prequel contains herbicides in WSSA groups 2 and 27.

TripleFlex 4.25L (Monsanto) is a premix identical to SureStart (Dow AgroSciences) for control of annual weeds and contains acetochlor (TopNotch), flumetsulam (Python), clopyralid (Stinger), and a corn safener. It can be applied from pre to the early post stage (11-inch tall corn) and is intended to be used with Roundup Ready or Liberty Link field or silage corn hybrids. When applied pre, it is designed to provide early season control of common annual grasses and broadleaf weeds to allow better timing of the in-crop application of glyphosate or glufosinate. The use rate on medium-texture soils ranges from 1.5 – 1.75 pints/A. TripleFlex does not contain atrazine, so it provides a nonatrazine alternative for atrazine-sensitive areas. However, atrazine, glyphosate, 2,4-D, and other herbicides can be tank-mixed with TripleFlex to broaden the weed control spectrum. Make sure to plant corn 1 ½ inches deep and be cautious of interactions with certain OP insecticides that may cause crop injury. Wheat may be planted 4 months after application; alfalfa, soybeans, barley, oats, and rye can be planted the following spring; sorghum after 12 months. TripleFlex contains herbicides in WSSA groups 2, 4, and 15.

CORN and SOYBEAN: Kixor (BASF) is a new active ingredient called, saflufenacil, a PPO-inhibitor herbicide similar to Valor and Authority herbicides. Much of the interest in Kixor in our region has been focused on the potential burndown activity of saflufenacil for glyphosate resistant horseweed or marestail in no-till soybean and the opportunity to use a new mode of action (PPO) preemergence in corn. Relative to summer annual weeds, Kixor-powered products will provide burndown and residual activity on several broadleaf weeds including pigweed, lambsquarters, and nightshade. Kixor will not control grasses and the current labeled rates target small seeded broadleaves and shorter residual control.

Additional herbicides may need to be tank-mixed with saflufenacil or applied post to control escaped weeds or to increase the control spectrum. BASF has developed prepackaged herbicide mixtures to supplement this need. These products will primarily be used as pre, "setup" herbicides since they typically will be used in a planned pre followed by post herbicide program. Although Kixor is a BASF trademark, saflufenacil products will include:

- **Sharpen** (saflufenacil alone) can be used in field corn, soybeans or small grains. The use rate in corn is 2 to 3 fl oz/A and in soybean it is 1 fl oz/A. Sharpen is a WSSA group 14 herbicide.

- **Verdict** (formerly Integrity) [saflufenacil + dimethenamid-P (Outlook)] can be used in corn and soybeans as a burndown/pre and this premix provides some annual broadleaf and grass residual activity but at the labeled rate, post herbicides will likely be necessary to control escapes. The typical medium-soil use rate is 13 fl oz/A for corn and 5 fl oz/A for soybean. The lower use rate in soybeans results in less residual activity. Verdict contains herbicides in WSSA groups 14 and 15.

- **Optill** [saflufenacil + imazethapyr (Pursuit)] is designed as a "setup" herbicide for use in soybeans but it will likely need to be followed by glyphosate or other post herbicides. The targeted use rate is 2 oz/A. Optill contains herbicides in WSSA groups 2 and 14.

Warrant 3CS (Monsanto) contains encapsulated acetochlor and is designed to be used post emergence in soybeans and corn to provide residual control of later-emerging annual weeds. It provides residual control of foxtails, panicum, crabgrass, lambsquarters, pigweed, smartweed, and black nightshade. Warrant does NOT control emerged weeds so it must be tank-mixed with glyphosate (RR soybeans or corn) or Ignite (LL soybeans or corn) to control existing weeds. The typical use rate is 1.5 qt/A. Warrant is a WSSA group 15 herbicide.

SOYBEAN: Authority XL 70WG (FMC) is a premix of sulfentrazone (Authority, PPO inhibitor) and chlorimuron (Classic, ALSinhibitor) and is similar to the old Canopy XL. Authority XL contains a higher rate of sulfentrazone than Canopy XL, so it should provide improved residual control of horseweed and eastern black nightshade while also controlling lambsquarters, pigweed, mustards, velvetleaf, and ragweed. In a two-pass system, apply 3.2 oz/A (typical medium soil rate) followed by glyphosate (RR soybeans) or Ignite (LL soybeans) as an in-crop application. The typical medium soil rate for full season control is 6.5 oz/A. Authority XL can be applied in the fall or at soybean planting time as a preplant or preemergence treatment. Be cautious of crop rotation restrictions: in general, wheat- 4 months, field corn- 10 months, and alfalfa-12 months. Higher soil pH greatly increases recropping intervals. Authority XL contains herbicides in WSSA groups 2 and 14.

Ignite 280 2.34SL (Bayer CropScience), formerly known as Liberty, is a newer higher-load formulation of glufosinate. Ignite is a post, broad-spectrum herbicide that controls many annual broadleaf and grassy weeds and provides some suppression to biennials and perennials. The typical use rate for Ignite is 22 to 29 fl oz/A; include ammonium sulfate (AMS) at 3 lb/A to the spray solution (use only 1.5 lb/A if temperatures are expected to exceed 85°F). Do not apply more than 44 fl oz total/A/season.

Keys to success with the LibertyLink soybean program include:

- Start clean. In no-till settings, a burndown program that kills all weeds before planting is essential. A pre application or a post application with a residual product may be required for broader spectrum and extended control in problematic fields. The use of soil residual herbicides before crop emergence can reduce the number of post applications required or provide a larger window for later season control.

- Include residual herbicides. Include an effective residual herbicide with the burndown followed by a timely post application of Ignite about 4 weeks after planting. Ignite can be slightly less effective on grasses than glyphosate such as yellow foxtail, shattercane, and barnyardgrass, but is more effective on some of the broadleaf weeds such as annual morningglory, eastern black nightshade, and smartweed. In the program, is best to include residual herbicides such as, Authority MTZ, Boundary, Valor, Sonic, Prefix, Pursuit, Envive, Prowl, Outlook, Optill, Intrro, among others. Dual Magnum, Reflex, and Warrant can be tank-mixed with Ignite and applied post emergence.

- Use in glufosinate resistant soybeans. Ignite can be used on all LibertyLink soybean varieties from emergence up to bloom stage and has some limited utility for burndown situations (i.e. horseweed). If Ignite is used in the burndown program, no in-crop application of Ignite is allowed.

- Size matters. Although weed size is important with glyphosate, is it more critical with Ignite and spray applications should be made when weeds are no more than 4 to 6 inches tall.

- Uniform coverage necessary. Since it is a contact herbicide, it is weaker than glyphosate on perennials and requires uniform spray coverage to achieve consistent weed control. Use a minimum spray volume of 15 gallons/A and nozzles that provide a uniform distribution of medium sized spray droplets.

- Weather and timing impact effectiveness. Warm temperatures, high humidity, and bright sunlight improve the performance of Ignite. Do not apply when heavy dew or mist/rain are evident. For more consistent lambsquarters and velvetleaf control apply between dawn and 2 hours before sunset (9 am to 6 pm is best).

- No extended control. Ignite does not have residual activity and will not control weeds not yet emerged.

In studies at Penn State and other universities, some occasional temporary crop injury was observed to soybean, however no yield reductions were observed. Currently, there are no soybean varieties that have stacked gene traits of glyphosate and Ignite. This will likely be a benefit when it does occur. Ignite and the LL system are marketed as an alternative to a Roundup Ready (glyphosate resistant) system. It allows rotating herbicide modes of action to reduce the potential of developing glyphosate resistance biotypes of weeds. Unfortunately for Bayer and glyphosate resistance management, current low cost glyphosate will likely limit the utility of Ignite and Liberty Link crops. Ignite is a WSSA group 10 herbicide.

SMALL GRAINS: Huskie 29.6L (Bayer CropScience) contains pyrasulfotole (an HPPD-inhibitor) plus bromoxynil (Buctril) and controls broadleaf weeds in wheat, barley, and triticale. Huskie controls common chickweed, wild buckwheat, mustards, prickly lettuce, lambsquarters, pigweed, smartweed, ragweed, and velvetleaf. Apply 11 oz/A (plus AMS or UAN) to the small grains between 1 leaf and up to flag leaf emergence and to actively growing weed that have 1-4 leaves. Do not apply to crops under sown with legumes. Huskie can be tank-mixed with certain herbicides, insecticides and fungicides. In wheat, liquid nitrogen may be used as the carrier. Soybeans can be planted 4 months after application; alfalfa, corn, and potatoes after 9 months. Penn State researchers plan to test this product in wheat next spring. Huskie contains herbicides in WSSA groups 6 and 27.

PowerFlex 7.5WDG (Dow AgroSciences) is a new ALSinhibitor herbicide that contains pyroxsulam. It controls annual ryegrass, downy brome and cheat plus a few annual broadleaves such as chickweed (non-ALS resistant), mustards, henbit, wild buckwheat, and hairy vetch. When targeting grassy weeds, fall applications seem to provide the best control. Apply 3.5 oz/A once wheat reaches the 3-leaf stage. PowerFlex has a favorable crop rotation timeframe. Soybeans can be planted after 3 months while other crops can be planted after 9 months. Penn State researchers have limited experience with this herbicide on weed control and crop injury potential in wheat. PowerFlex is a WSSA group 2 herbicide.

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GRASS FORAGE: Paramount 75WG (BASF) contains quinclorac and can be applied in cool-season grass pastures or hay. Paramount is currently the only herbicide labeled that controls some annual grasses in grass forages. According to the label it has activity on foxtails, large crabgrass, and barnyardgrass as well as broadleaves such as lambsquarters, ragweed, velvetleaf, annual morningglory, dandelion, and field/hedge bindweed. Paramount can be applied in bromegrass, tall fescue, Kentucky bluegrass, orchardgrass, and ryegrass. It is also labeled for use on several warm-season grasses. The typical use rate is 3 to 8 oz/A plus necessary adjuvants. A waiting period of 7 days is required before cutting. Paramount will severely injure or kill clovers, alfalfa, and other legumes. Be cautious of crop rotation restrictions. Paramount is a WSSA group 4 herbicide.

PENDING PRODUCTS: Pyroxasulfone is an experimental herbicide (formerly coded as KIH-485) that is expected to be labeled in corn (all types), soybeans and wheat. It has annual grass activity similar to metolachlor (Dual) and acetochlor (Harness) but also provides good control of several annual broadleaves. The use rates are up to 8 times lower than Dual or Harness with comparable weed control. BASF will sell pyroxasulfone as **Zidua 85WG**, but will likely premix it with other active ingredients. Valent and FMC will also have some premixes. **Fierce 76WG** (Valent) contains pyroxasulfone plus flumioxazin (Valor SX) and will initially be labeled for burndown/residual use in field corn and soybeans. Anticipate EPA approval by early to mid 2011 with full scale marketing of products by 2012. Penn State has evaluated pyroxasulfone for the past several years in corn and has noted very good weed control performance and crop safety.

Realm Q (DuPont) contains rimsulfuron (Resolve, ALSinhibitor), mesotrione (Callisto, HPPD-inhibitor) and the corn safener (isoxadifen). DuPont claims this safener allows more flexibility to apply the herbicides across a diversity of application conditions. The safener does not totally eliminate potential crop injury, just lessens the impact. Realm Q will likely be applied at 4 oz/A and can be tankmixed and applied post with glyphosate, Ignite, or included in other post herbicide programs to improve weed control spectrum. Realm Q contains herbicides in WSSA groups 2 and 27.

GENERICS: More and more generic products are being sold due to patent expiration and licensing agreements. Some of the more commonly used generic products are those that strive to mimic Bicep and Harness products, Prowl, Cimarron, and Harmony. In most cases, generic herbicides cost less than name-brands. When looking to purchase generic alternatives, ask or search for the herbicide by its chemical name or active ingredient, for example, glyphosate, metolachlor, dicamba. Not all generics are equal to the original. Always read the label and be cautious of how it is formulated since it may not have equivalent amounts of active ingredients and therefore the quality and application rates may be different. Relative to quality, generic products may or may not be as sound as the original and there could be problems with mixing and compatibility with other pesticides. Some of the generics are not labeled for use on the same crops or allowed to be applied in certain situations. Watch out for offers that sound too good to be true or promise too much. In addition, most generics herbicides will not include product service or guarantees if weeds are not controlled or crop injury occurs. It is best to consider all factors such as product quality, rebates, warranties and not just price before purchasing a generic herbicide.

Other News – Incoming Herbicide Resistant Crops: DHT is the acronym for Dow AgroSciences Herbicide Tolerance traits that will provide overall tolerance in corn and soybeans to 2,4-D and some of the post-grass herbicides like Assure and Fusilade. These traits also will be stacked with glyphosate tolerant traits. Dow AgroSciences estimates launch timing for this technology at 2013 for corn and 2015 for soybeans.

Dicamba resistant soybeans are being developed by Monsanto and BASF to allow pre or post applications of dicamba (active ingredient in Clarity, Banvel, etc.) on soybeans. These varieties will likely be stacked with the Roundup Ready trait. Marketing of these soybean varieties is not expected until 2014 or later.

In general, there are some benefits and risks associated with DHT and dicamba-resistant technologies. Overall, we can expect to see better annual and perennial broadleaf weed control in soybeans. Also these traits will offer some protection from drift and spray tank contamination. However, off-site movement of 2,4-D and dicamba to sensitive non-target plants is of great concern.

In a diverse landscape like Pennsylvania, this will be more of a concern then perhaps for our neighbors to the west. Over the next few years, we will see how these companies and universities devise ways to handle these issues.

Optimum GAT corn and soybean debut has been delayed. Optimum GAT confers resistance to glyphosate and ALSinhibitor herbicides. DuPont and Pioneer have been working on this technology for the past several years, but no revised release date has been set.

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Soil Fertility

Fact or Fiction: Anhydrous Ammonia Application Should Not Exceed 10 LB N Per Unit Soil CEC

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There are two aspects to this supposed rule of thumb. One, what is the maximum rate of anhydrous ammonia that a soil can “hold” at application? Two, should this be used as a N rate recommendation?

Just what is soil CEC?

CEC is the abbreviation for cation exchange capacity. Cations are positively charged ions, examples being K^+, Ca^{++}, Mg^{++}, $NH4^+$. Since the soil has a net negative charge, cations are attracted to the negatively charged soil sites (called exchange sites) by electrostatic attraction (like a magnet). The CEC is determined by clay and organic matter – the source of negative charges in soil. CEC is an important soil property related to supply of certain plant essential nutrients, those taken up in a cation form (like K+, Ca++, Mg++, NH4+), and liming soils for pH correction. CEC is reported in a unit of charge equivalent; for routine soil test reports as meq/100 g soil (meq is the abbreviation for milliequivalent, a charge equivalent concentration rather than weight basis). The CEC for low organic matter, low clay content, and coarse textured sandy soils will be less than 5 meq/100 g, while high organic matter, high clay content, and fine textured soils will greater than 20 meq/100 g.

What happens when ammonia is injected into soil?

Anhydrous ammonia (NH_3) reacts rapidly with soil water (immediately since ammonia is highly soluble in water), ammonium (NH_4^+) is formed, and can be held on the soil CEC. Remember that the word “anhydrous” is important, that is, there is no water in a tank of anhydrous ammonia. Therefore, when injected into the soil an initial reaction will be ammonia dissolution in water. This is why ammonia injury to skin can be severe, the reaction with water in cells, and why having plenty of clean water immediately available in case of an accident is vital to help limit injury.

$$NH_3 + H_2O \ = \ NH_4^+ + OH^-$$

This reaction with water (consumes H^+ ions) results in an initial alkaline pH in the ammonia retention zone (pH can temporarily rise above 9 at the point of highest concentration). It is free ammonia and not ammonium that moves and can be lost from soil if it reaches the surface. As pH increases above 7.3, the equilibrium between ammonium and ammonia results in increased free ammonia (the fraction as ammonia would be much less than 1% at pH below 7, 1% at pH 7.3, 10% at pH 8.3, and 50% at pH 9.3). The pH in the retention zone will remain high until nitrification results in a lowering of pH (produces H^+ ions).

$$2NH_4^+ + 3O_2 \Rightarrow 2NO_2^- + 2H_2O + 4H^+$$
$$2NO_2^- + O_2 \Rightarrow 2\,NO_3^-$$

When anhydrous ammonia is injected into soil, several physical and chemical reactions take place: dissolution in water, reaction with soil organic matter and clay, and attraction of the resulting ammonium ions with the cation exchange complex. These reactions all tend to limit the movement and potential loss of ammonia. The ammonia retention zone has the highest concentration of ammonium near the point of injection (depending on rate can be greater than 2,000 ppm N), with a tapering of the concentration toward the outer edges. The greatest ammonium concentration is within the first inch or two of the injection point, and with many soils the overall retention zone is less than approximately four inches in radius (six inches in sandy soils). The size of this zone, and shape, vary greatly depending upon the rate of application and knife spacing, soil texture, and soil conditions at injection (moisture status and soil structure).

Ammonia moves farther at injection in coarse-textured soils and soils low in moisture. Also, if the injection knife causes sidewall smearing, then ammonia may preferentially move back up the knife slot. A similar movement occurs if the soil breaks into clods at application and there are large air voids left in the soil. Both of these conditions can result in greater ammonia concentration toward the soil surface, and greater potential losses at or after application (the same if the injection point is near the soil surface).

Bottom line, when ammonia is injected into soil, the initial reaction at the point of release is violent. The ammonia reacts and binds with soil constituents such as organic matter and clays. It dissolves in water to form NH4 +. These reactions help retain ammonia at the injection point, not simply soil CEC. Using an acre furrow slice of soil (6 2/3 inch depth), the meq per lb applied N, as NH_4^+ equivalent, is only 0.0035. With the high affinity for water, soil moisture is important for limiting the movement of ammonia, but does not ultimately determine retention in soil. After conversion to ammonium, which is a positively charged ion, it is held on the soil exchange complex and does not move with water. Only after conversion to nitrate (NO_3^-), via the nitrification process, can it be lost from soil by leaching or denitrification.

Ammonia application rates?

The rate of anhydrous ammonia that can be held in soil is not a direct relationship with CEC. Soil properties affect the size of the injection zone, but ultimately several other factors are more important, such as moisture content, depth of injection, and soil coverage, especially with dry soil or coarse textured soil. Wing sealers immediately above the outlet port on the knife can help close the knife track and reduce vertical movement of ammonia. Within agronomic rates of application, there is no real limit or maximum application rate (rates well above agronomic need can typically be injected). Anhydrous ammonia has been successfully injected into sandy soils at rates over 200 lb N/acre. In research conducted with alternate row injection (example 60 inch spacing in 30 inch row corn), more than 200 lb N/acre has been successfully applied – which is an equivalent of more than 400 lb N/acre per injection knife. It's injection depth and multiple soil conditions that determine potential volatile loss, not simply CEC.

Nitrogen rate determination?

Across much of the Corn Belt the current approach to N rate recommendations for corn is the Maximum Return To N (MRTN). This approach uses yield response to N application from many response trials and economics (corn and N prices) to determine application rates. Information on the MRTN approach can be found in the Extension publication *Regional Nitrogen Rate Guidelines for Corn* (www.extension.iastate.edu/Publications/2015.pdf) and is used in the online Corn Nitrogen Rate Calculator (http://extension.agron.iastate.edu/soilfertility/nrate.aspx).

Research has shown that soil properties such as clay and organic matter (components of CEC), or corn yield, are not directly related to economic optimal N rates. In fact, in many areas soils with low CEC and coarse texture (sandy) have higher N fertilization requirements that soils with higher CEC (for example, southern Illinois soils compared to central and northern Illinois; in Wisconsin, sands compared to medium and low yield potential fine textured soils). Therefore, if one simply used a "rule of thumb" such as 10 lb N per unit CEC (or some other multiplication factor) many fields would not be properly fertilized.

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