AGRONOMY SCIENCES RESEARCH SUMMARY

Canadian Edition

Introduction

Intense heat and severe drought characterized the growing season for most producers in 2012. As a result, corn yields were reduced by about 20% in the U.S. as a whole but by as much as 33% to 50% in the hard-hit states of Indiana, Illinois and Kentucky. Soybean yields fared much better, losing only about 5% compared to recent U.S. trends.

Weather events and their effects on crop production are the most serious risks faced by growers each year. Of all weather-related issues, insufficient summer rainfall is the primary limitation on crop yields throughout North America. To help reduce this exposure, DuPont Pioneer researchers are developing hybrids and varieties that perform better under drought stress than historical seed products. Pioneer® brand Optimum® AQUAmax™ hybrids are prime examples of this effort.

Incremental gains in yield potential, as well as yield stability in the face of environmental uncertainty, are routinely achieved in other crops as well, including soybeans and canola. Growers can be assured that Pioneer researchers are working each year to help them reduce their risks from not only weather events but also from insects, diseases and other pests.

In addition, Pioneer Agronomy Sciences researchers conduct and report on extensive crop management studies conducted on farmers' fields and research sites across North America. These studies can help growers make better management decisions based on sound, scientific data gathered across multiple years and growing environments. We hope this research summary provides management insights to help increase your yields and profits in 2013!

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Corn – after – Corn Production

The economic advantages of growing corn have prompted many growers to increase the proportion of corn acres in their operations. These growers may benefit from a review of issues and challenges likely to be encountered when growing corn crops back to back.

Yield losses when corn follows corn vs. soybeans are usually greatest when yield potential is low (Table 1).

Table 1. Yield decrease in corn following corn vs. corn following soybeans at different yield levels*.

Corn-after-corn yield	Corn yield decrease when following corn vs. soybeans	
110 bu/acre	32 bu/acre	29%
140 bu/acre	24 bu/acre	17%
165 bu/acre	12 bu/acre	7%
200 bu/acre	5 bu/acre	3%

*N supplied at 200 lb/acre. Adapted from four-year study at the University of Minnesota research center at Waseca.

These results indicate that rotated corn is generally better able to tolerate yield-limiting stresses than continuous corn, implicating the root system as the most likely source of the problem. When corn roots are limited due to corn rootworm feeding or compaction in this system, drought conditions take a larger toll on yield, especially if drought occurs in July and August, during pollination and early grain-fill stages.

To minimize losses in corn-after-corn production systems, growers should select appropriate hybrids; manage corn residue; and adjust soil fertility, weed management, and tillage practices to accommodate the change in cropping patterns.

Hybrid Selection

To assist in selecting hybrids for corn-on-corn fields, DuPont Pioneer provides hybrid ratings for stress emergence, high residue suitability, disease resistance and stalk and root strength. DuPont Pioneer sales professionals can also recommend products with appropriate insect resistance traits and refuge options, as well as the best seed treatment choices for growers' fields. Corn rootworm is the major corn insect pest associated with corn-on-corn production. Pioneer technology offerings against rootworm include single-bag options that do not require a separate refuge. DuPont Pioneer customers can also choose Poncho® 1250 + VOTiVO® seed treatment on selected Pioneer® brand hybrids where nematode or enhanced insect protection is needed.

Hybrid Selection for Corn after Corn

- Select hybrids with proven performance under the diverse environments and stresses your field may encounter.
- Select hybrids with above average drought tolerance.
- Select appropriate hybrid maturities, accounting for cooler soils and slower emergence under high residue.
- Choose highest-performing genetics with defensive traits such as standability and disease and insect resistance.

Managing Residue

A corn crop produces more than twice the residue of a soybean crop. This has advantages in reducing soil erosion but also presents some challenges. Managing corn residue effectively can reduce its negative impact in corn-on-corn production.

Effects of Corn Residue on Stand Establishment

Residue directly over the row lowers temperatures in the seed zone, delays germination and early growth, and may reduce stands and yields. Studies have shown that soil temperatures in no-till may be 5°F lower under corn residue than soybean residue.

Effects of Corn Residue on Corn Diseases

Corn disease issues generally increase in corn-after-corn production systems, as pathogens survive in corn residue and disease inoculum builds up over time. Leaf diseases such as gray leaf spot, northern corn leaf blight, anthracnose, and eyespot are all known to increase in long-term, high-residue crop production systems. Stalk rot and ear rot fungi such as Fusarium, Gibberella, Diplodia and Aspergillus also survive in crop residue and increase in high-residue systems.

Tips for Managing Corn Residue

Managing corn residue effectively at harvest, with tillage implements and at planting, can contribute to successful corn-after-corn production.

- At harvest, knife rolls can replace normal stalk rolls to more aggressively shred stalks at the corn head. Even residue distribution behind the combine is equally important.
- In areas with cellulosic ethanol plants or feedlots, stover harvest is another option to reduce excess residue, often improving stand establishment and yield.
- Burying corn residue using various tillage operations is another way to manage the additional residue in corn-following-corn production.
- Strip or "zone" tillage is a residue management option that allows growers to retain the benefits of no-till between the rows while gaining the advantages of clean till over the rows.
- Row cleaners, coulters or other residue-management devices can move residue off the row area to create a suitable environment in the seed zone for more rapid germination and emergence of corn.

Foliar Fungicide Application

Foliar fungicides can help reduce leaf diseases and their detrimental effects on corn yields. In 475 DuPont Pioneer on-farm trials, foliar fungicides increased yields by an average of 7.0 bu/acre. However, yield increases were greater in high-residue fields resulting from reduced tillage or corn on corn (Figure 1).

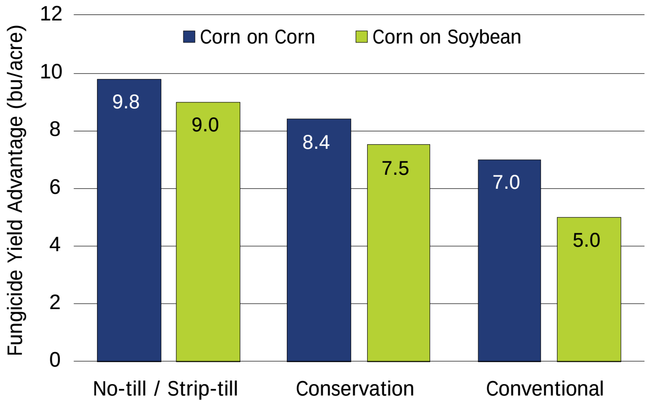


Figure 1. Average yield response to foliar fungicide application as influenced by tillage and previous crop in Pioneer on-farm trials (289 trials, 2007 to 2011).

Soil Fertility

Soil fertility in corn-after-corn production should be based on thorough soil testing and local extension recommendations. Soil tests are needed to determine soil pH and existing levels of phosphorous (P) and potassium (K). The soil pH should be at 6.2 or above for growing corn. Banding P and K can improve nutrient uptake efficiencies particularly on soils with pH above 7.2. Starter fertilizers are most beneficial on soils with low fertility and may provide more uniform seedling growth during extended cold periods in the spring.

Determining nitrogen (N) rates for corn after corn involves compensating factors. Yields are likely to be lower, so overall N use by the crop will be reduced. However, because N is immobilized by corn residue, additional N must be added. Nitrogen rate recommendations vary from state; growers are encouraged to follow their local extension recommendations.

Nitrogen rate has been a component of numerous rotation studies over many years. These studies generally show that increased N alone does not compensate for the reduction in corn yield when following corn vs. soybeans (Table 2).

Table 2. Effect of crop rotation and nitrogen rate on average corn yields (Mallarino and Pecinovsky, 1999*).

Rotation	Crop	Nitrogen lbs/acre (spring-applied)			
		0	80	160	240
		- - - - Corn grain yield (bu/acre) - - - -			
C-C	Corn	55	106	128	135
C-S	Corn	100	141	148	151
C-C-S	Corn1	101	137	148	150
	Corn2	56	106	129	135
C-C-C-S	Corn1	100	135	147	147
	Corn2	58	108	131	136
	Corn3	57	103	127	134

Corn1, Corn2 and Corn3 = 1st, 2nd and 3rd year of corn after soybeans, respectively. *20-year study at Iowa State University.

In this study, corn following corn yields never equaled those of corn following soybeans, regardless of the nitrogen rate applied. However, a recent study showed that additional N may, in some cases, overcome much of the yield reduction associated with corn after corn (Mallarino and Rueber, 2011).

Weed Management

When changing from corn following soybeans to corn on corn, certain weeds may be more problematic. Monitor fields for any increase in specific weed pressure and manage appropriately. Volunteer corn is much harder to manage in corn than in soybeans, so growers should strive to prevent volunteer corn by minimizing stalk breakage, ear droppage and harvest losses. Scout fields in the fall, and harvest fields early that are at risk of lodging or dropping ears. Adjusting and maintaining the combine helps to minimize kernel loss during harvesting.

When rotating corn with soybeans, an obvious opportunity exists to rotate herbicides as well. Rotating herbicide modes of action helps ensure long-term weed management success by preventing weed shifts and/or weed resistance. In corn-on-corn production, growers should also alternate herbicide modes of action and use mixtures or sequential applications of herbicides with different modes of action.

Tillage Systems

In studies conducted at Purdue University, the tillage system affected the penalty for growing corn after corn rather than in rotation with soybean (Vyn, 2010). No-till systems suffered the greatest penalty followed by conservation till and then moldboard plowing.

However, in some high-yield environments, the penalty under no-till systems was no different than that of the other tillage systems. Effective residue management under no-till systems may help to minimize any yield reductions. Strip or "zone" tillage or row cleaners can be used to remove crop residue from over the row while retaining residue between the rows. Some tillage and seedbed tips are listed below:

Tillage and Seedbed Tips

- Plan for fall tillage (where possible) that builds a good seedbed for next year. Spring tillage is often delayed due to cooler and wetter conditions in continuous corn.
- Check for soil hard pans, and use appropriate tillage to break up compacted soil layers.
- Full-width tillage systems should focus on sizing and incorporating residue to speed decomposition.
- In northern areas and on poorly drained soils, strip or zone tillage systems can create a warmer seedbed versus no-till while requiring less fuel than full tillage systems.
- Equip planters with row cleaners to move residue off the row and achieve more consistent soil warm-up and seedling emergence in the spring.
- Closely monitor the wear on planter double disc openers to ensure they cut clean and form a good seed furrow.

Does *Bt* Corn Require Different Tillage and Residue Management? 2012

Objective

- Determine if *Bt* and non-*Bt* hybrids differ with respect to the need for post harvest residue management and if selected post-harvest residue management practices affect emergence, early growth, stand, and yield in continuous corn production.

Study Description

Location: Arlington, WI

Plot Layout: Randomized complete block, split-split-split-plot design

Replicates: 4

Factors:

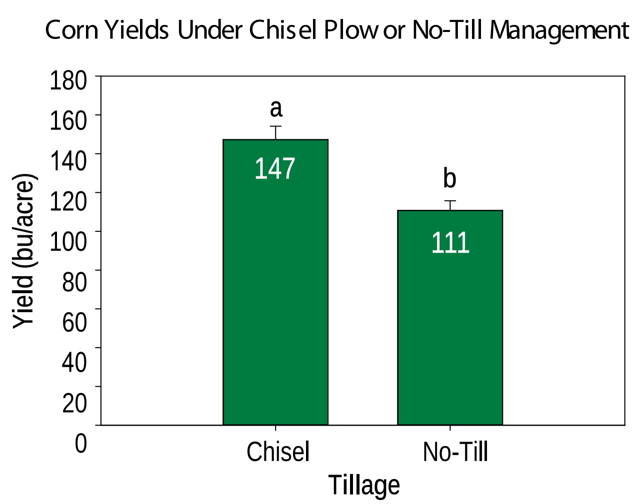
- Whole plot factor – Tillage (no-till vs. fall chisel)
- 1st split plot factor – Corn hybrid (*Bt* vs. non-*Bt*)
- 2nd split plot factor – Residue management (chopped vs. not chopped)
- 3rd split plot factor – Fall nitrogen fertilization (30 lb-N/acre as urea vs. none)

No till corn (left) and chisel plot corn (right). Photo taken on June 29, 2012.

- The site has been in continuous corn and tillage treatments have been in place since 2009.
- The research site experienced severe drought stress in 2012. Results from the 2012 growing season can be interpreted as representative of treatment effects during drought conditions.

Results

- Corn yields were significantly ($P \le 0.05$) greater with fall chisel plowing than with no-till.
- There was no significant yield difference ($P \le 0.24$) between non-*Bt* corn and *Bt* corn.
- There was no significant yield difference ($P \le 0.94$) between non-chopped and chopped residue.
- There was no significant yield difference ($P \le 0.22$) between fall N fertilization and no fall N fertilization.
- Interaction effects were not significant.
- These results are similar to results from previous and concurrent studies that indicate there is a yield drag with no-till continuous corn (relative to tilled continuous corn) and that fall nitrogen has no effect on improving yields through stimulation of residue decomposition.
- Results do not indicate a need to manage crop residue differently in *Bt* corn vs. non-*Bt* corn.



*Different letters indicate a significant difference at the α=0.5 level. Error bars are standard error (SE).

Research conducted by Matt Ruark, University of Wisconsin-Madison as a part of the DuPont Pioneer Crop Management Research Awards (CMRA) Program. This program provides funds for agronomic and precision farming studies by university and USDA cooperators throughout North America. The awards extend for up to four years and address crop management information needs of DuPont Pioneer agronomists, Pioneer sales professionals and customers.

Partial Stover Harvest Increases No-Till Continuous Corn Yield

Much of the yield difference between continuous corn and corn rotated with soybean is related to interference from previous years' stover. Tillage can reduce yield depression of corn following corn, but it is an added cost and may deplete organic matter and cause erosion.

No-till systems avoid tillage costs and improve soil quality but may lead to poor stand establishment and reduced yield, particularly in areas with heavy, wet soils that warm slowly in the spring. Alternative residue management options are needed to improve no-till continuous corn production in these areas.

Study Description

A four-year study[1] was conducted to help identify cost-effective management practices for reducing the negative effects of stover on stand density and yield of no-till continuous corn.

The location of the study was the Bradford Research and Extension Center near Columbia, Missouri. The predominant soil type was a Mexico silt loam. The experiment evaluated five residue management treatments: spraying 40 lb/acre liquid N on the residue in the fall ***(Fall N)***, fine chopping of stalks in the fall ***(Fall Stalk Chop),*** removing stover by baling in the fall ***(Bale and Remove),*** using row cleaners when planting in spring ***(Row Cleaners)***, and no residue management ***(None).***

Diminished emergence and early growth due to corn residue.

A four-row Kinze® planter was used to plant two hybrids in mid-April. In three of four years, plots had to be replanted in late May due to cool, wet conditions and stands of less than 10,000 plants/acre. Plots were 10 feet x 60 feet (four rows on 30-inch spacings). Planting rates were 30,000 seeds/acre in 2008 and 32,000 the other three years. Nitrogen fertilizer was uniformly broadcast across all treatments as ammonium nitrate at a rate of at least 200 lb N/acre soon after planting. Because residue management treatments and hybrids were applied to the same plots each year, results allow for conclusions regarding longer-term management trends.

Stand density was measured by counting the number of emerged plants in two 20-foot row sections in the center of the plots. The center two rows in each plot were harvested to determine grain yield, which was adjusted to 15.5% moisture.

Results

1. Did residue management treatments reduce stover amounts?

Yes. Averaged over the four years of the study, corn stover amounts were reduced by 9, 16, and 53%, respectively, by the ***Fall N***, ***Fall Stalk Chop***, and ***Bale and Remove*** treatments. Stover amounts were not measured for the Row Cleaners treatment because in these plots, stover was not removed from the field but rather moved from within the row area. ***Fall N*** had only a small effect on residue levels. ***Fall Stalk Chop*** likely reduced stover levels by decreasing particle size and increasing decomposition rates. The ***Bale and Remove*** treatment involved mowing, raking, baling and removing approximately half of the stover in the field. This level of removal is the effective maximum harvest rate for current rake and bale machinery.

2. Did residue management treatments affect corn stands?

Yes, but only for two of the treatments (Figure 1).

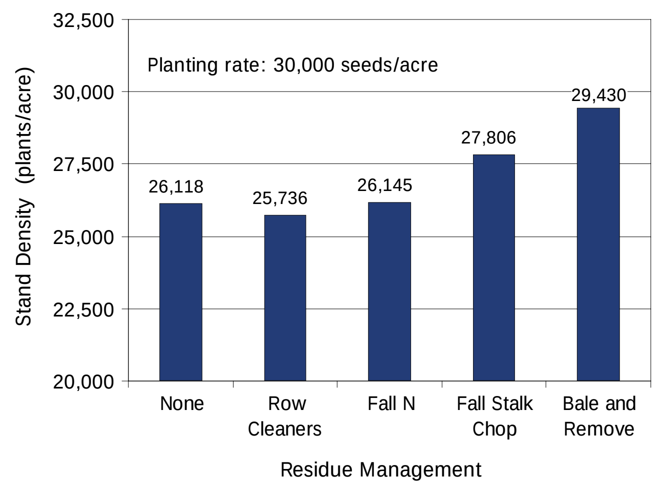


Figure 1. Effects of residue management treatments on stand density for no-till continuous corn. Results are averages of a four-year field study in central Missouri.

Averaged over the four-year study period, rank-order stand densities (plants/acre) were: ***Row Cleaners*** (25,700); ***None*** (26,100); ***Fall N*** (26,100); ***Fall Stalk Chop*** (27,800); and ***Bale and Remove*** (29,400). For ***Fall Stalk Chop*** and ***Bale and Remove***, the only two treatments that resulted in significantly greater stands than the control, four-year average plant counts were only 6 and 12% greater than no residue management.

In three of the four years, plots required replanting to obtain acceptable stand densities. Replanting occurred after soils had warmed and dried, so stand differences among residue management treatments were probably reduced in 2009, 2010 and 2011. In 2008, plots were not replanted, and the treatment that removed the most residue ***(Bale and Remove)*** increased stand density by 44% compared to no residue management. These results indicate that residue management is likely much more important when planting corn into cool and wet soils.

3. Did residue management treatments affect corn yields?

Yes, but only the ***Bale and Remove*** treatment significantly increased yields above no residue management (Figure 2).

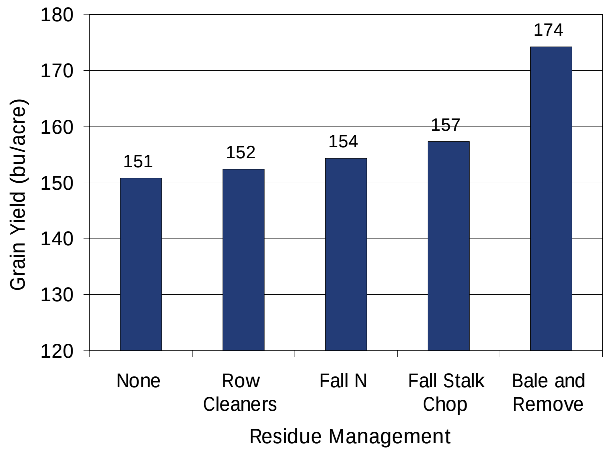


Figure 2. Effects of residue management treatment on grain yield for no-till continuous corn. Results are averages of a four-year field study in central Missouri.

Averaged over the four years of the study, grain yields were 151, 152, 154, 157, and 174 bu/acre for the ***None, Row Cleaners, Fall N, Fall Stalk Chop***, and ***Mow and Bale*** treatments. The only effective treatment, ***Bale and Remove***, increased yield by 16% compared to the no residue management control. The ***Bale and Remove*** treatment yielded more than the no residue management in each of the four study years, even in years when the two treatments produced similar stand densities (Figure 3).

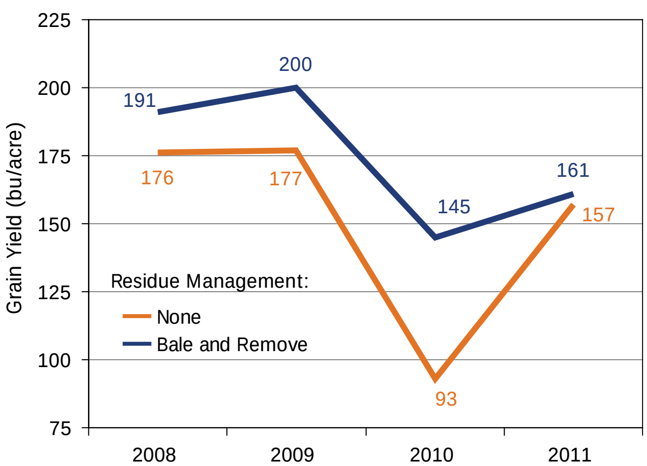


Figure 3. Grain yield over four years for no-till continuous corn with and without partial stover harvest.

Several studies have shown that as much as half of the corn stover in a field can be removed without negatively impacting soil quality and productivity. No-till continuous corn systems are well suited for stover removal due to high annual organic matter inputs in conjunction with a lack of tillage, which makes it possible to sustainably harvest greater quantities of stover from these cropping systems compared to systems that include conventional tillage or soybean rotation.

No interaction was detected between hybrids and residue management treatments, indicating that the two hybrids responded similarly to varying residue levels induced by different residue management practices.

Emergence and crop growth in the spring with heavy (left) and light (right) corn stover on seedbed.

Conclusions

The results of this study highlight the importance of effective residue management for achieving optimum stand density and high grain yield in no-till continuous corn production. However, study results also demonstrated that several commonly used residue management practices including ***Fall N*** and ***Row Cleaners*** were largely ineffective in improving either stand density or grain yield. Of the management practices evaluated, only ***Fall Stalk Chop*** and partial stover harvest (***Bale and Remove***) resulted in improved stand density compared to no residue management, and only ***Bale and Remove*** led to improved stand density and yield.

No-till continuous corn producers who have livestock or access to stover markets should consider partial stover harvest as a method for effectively managing corn residues.

Pioneer research plot following corn stover harvest in the fall.

[1]This article was adapted from the final report submitted by Dr. Bill Wiebold, University of Missouri, Division of Plant Sciences, for his CMRA project entitled, "Mitigation of Stover Effects on Yield in Continuous Corn Planted without Tillage."

Stress Emergence in Corn

The early season seedbed can be an inhospitable environment for corn seeds and seedlings. As planting dates have moved earlier, the potential for cold, wet conditions after planting has increased. When unfavorable weather persists in the spring, planted corn may be exposed to cold, saturated soil conditions for three weeks or longer before emerging.

Two recent trends, early planting and reduced tillage, have introduced early season cold stress into areas not usually affected by this problem. Even in southern and western regions of the US, corn grown in these production systems can experience similar stress levels to those of colder northern regions. Although there are many advantages to reduced tillage, the level of early season stress has increased along with its adoption. This is due primarily to lower soil temperatures, water retained in crop residue, and slower seedbed drying. Corn grown under irrigation can also experience significant stress if the irrigation water is sufficiently cold.

Although corn, with its tropical origins, displays a general sensitivity to early season stress, research has shown that hybrids differ in their ability to emerge in stress environments. This genetic variation is reflected in the DuPont Pioneer stress emergence rating, which is applied to all Pioneer® brand hybrids to help customers select appropriate products for cold-stress fields. This article discusses key factors that impact early season performance and stress emergence ratings.

Impact of Cold Stress on Stand Establishment

The optimal temperature for corn emergence is in the range of 80 to 90ºF. Emergence is greatly reduced at lower temperatures and is effectively halted around 50 to 55ºF or below. Since soil temperatures in the early season are almost never optimal, emerging seeds will experience a degree of stress almost everywhere in North America. The degree of stress and potential damage from stress is determined, to a large extent, by soil and water temperatures during imbibition and seedling emergence.

For successful emergence to occur, all parts of the shoot (roots, mesocotyl, coleoptile and leaf within) must work in a coordinated way to push the coleoptile above the soil surface and allow the first leaf to unfurl. Damage to any one of these structures will likely result in loss of the seedling and its yield potential. The section below describes some of the common causal events.

The Critical First Hours: When the dry seed imbibes cold water (typically 50ºF or below), imbibitional chilling injury may result. The degree of damage ranges from seed death to abnormalities such as corkscrews or fused coleoptiles (Figures 1 and 2). The potential for cold-water damage generally decreases as the seedlings emerge. It also decreases if the initial imbibition takes place at temperatures above 50ºF. This may help explain observations where early planted corn that was followed by favorable weather emerged better than corn planted later and followed by a cold spell or snow cover.

Damage to the emerging root usually has less severe consequences on seedling survival. This is because the primary root, which is the first structure to emerge, plays a relatively minor role in seedling establishment compared to the lateral and nodal roots. Seedling establishment can usually progress normally if the lateral and nodal roots are intact. Any damage to the roots, however, will likely reduce vigor and increase the potential for disease and insect injury (see sections on disease and insect effects). It is important to note that cold damage to emergence is generally irreversible. It is also difficult to diagnose since it usually occurs below the soil surface, long before the crop emerges. Above-ground symptoms of damage may take weeks to become apparent.

Figure 1. Abnormal mesocotyl and coleoptile development due to prolonged cold stress in an early planted Illinois field.

Figure 2. Common symptoms of cold damage during imbibition and seedling emergence.

Stress Emergence Ratings

Pioneer's stress emergence rating helps categorize hybrids for their genetic potential to emerge under stressful environmental conditions (including cold, wet soils or short periods of severe low temperatures) relative to other Pioneer hybrids. Stress emergence ratings are assigned on a 1 to 9 scale. Ratings of 6 to 9 indicate above-average potential to establish normal stands under such conditions; a rating of 5 indicates average potential to establish normal stands under stress conditions; and ratings of 1 to 4 indicate below-average potential to establish normal stands under stress. These definitions are intended as a general guideline; growers should take into consideration specific field conditions in making hybrid decisions.

Stress emergence is an agronomic rating and is not a rating for seedling disease susceptibility. Also, stress emergence should not be confused with early growth ratings, which refer to seedling vigor after emergence. It should be noted that the level of early season stress tolerance is limited in corn. Thus, even hybrids with strong stress emergence will experience some level of injury and stand loss if the conditions are sufficiently severe.

Stress Emergence Testing at DuPont Pioneer

To generate stress emergence ratings, DuPont Pioneer tests hybrids over multiple years and environments beginning several years before commercialization. The goal is to test under many different types of early season stress before assigning ratings. Hybrids are tested in several early planted field sites across North America including no-till, corn-on-corn locations. Testing sites in the US are located in MN, WI, IA, NE, SD, ND, MI, IN, IL and other states. Testing sites in Canada are located in Quebec and Manitoba.

Testing sites are chosen to reflect the various seedbed and environmental conditions likely to be experienced by growers. These testing sites, with their diverse and unique conditions, provide a more thorough understanding of hybrid responses to early season stress. A typical testing site is characterized by large amounts of residue, cold soil (below 50ºF) at planting followed by cold rain or snow, and emergence usually requiring three to four weeks.

Hybrids are also tested in DuPont Pioneer lab assays that simulate stressful field conditions. These tests, validated by multi-year field trials, provide consistent and reproducible test conditions coupled with the flexibility of year-round testing. These lab assays are used to support hybrid advancement decisions and also to support breeding efforts to improve early season stress tolerance through maker-assisted selection.

Seedling Disease and Stress Emergence

Stress emergence is an agronomic trait intended to reflect genetic variability for tolerance to **abiotic stress** in the early season. It is not a rating for disease resistance. Early season stress can promote seedling disease if certain conditions are met, including inoculum presence and prolonged cool, wet conditions. Injury to emerging seedlings will also promote seedling disease. Injury can be caused by chilling, such as imbibitional damage, or by feeding of insects such as seedcorn maggots, white grubs and wireworms.

In environments with heavy inoculum pressure, disease progression is often in a race with seedling growth. Conditions that promote rapid soil warming will generally favor seedling growth and reduce disease incidence. On the other hand, extended cool, wet conditions will generally favor disease progression (Figure 3). Many soil pathogens, including some Pythium species, are most active at temperatures in the 40s and 50s (ºF). Low temperatures such as these can injure emerging seedlings and facilitate infection. Low temperatures also retard stand establishment and increase the window of vulnerability to infection. Seed treatment fungicides generally provide good efficacy against target organisms for 10 to 14 days after planting. However, protection will be diminished if emergence and stand establishment are delayed beyond this period.

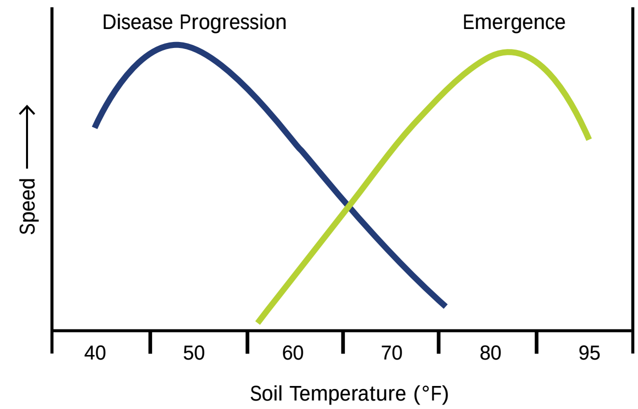


Figure 3. Theoretical responses of disease progression and seedling emergence to soil temperature.

Seed Treatments and Stress Emergence

Seed treatments can help protect stands from both disease and insect pests in stressful environments.

Pioneer Premium Seed Treatment: PPST 250 is the standard treatment package for all Pioneer® brand corn products for the 2013 planting season. It consists of a fungicide and insecticide. The fungicide component of PPST 250 includes a four-way fungicide formulation that, according to the manufacturer, provides a new standard for broad-spectrum protection against seed and seedling diseases, including Fusarium and Pythium. The insecticide component offers proven insect protection to enhance early season plant health.

Poncho® 1250 + VOTiVO® Seed Treatment: Growers can also choose Poncho® 1250 + VOTiVO® seed treatment on selected Pioneer hybrids where nematode or enhanced insect protection is needed. According to Bayer, growers get increased protection from wireworm, black cutworm, white grub and other early-season pests and protection from corn rootworm and billbug with the 1250 rate of Poncho. In addition, this treatment provides a biological mode of action to protect corn seedlings and roots against nematodes.

Conclusion: Choosing hybrids with strong stress emergence helps reduce genetic vulnerability to stress, and planting seeds with a premium seed treatment helps provide critical protection in stressful environments where seeds are vulnerable to attack, as demonstrated below.

Figure 4. Corn seedlings emerging in a high-residue, early-planted field.

Soil Temperature and Corn Emergence

Successful corn emergence is a combination of three key factors – environment, genetics and seed quality:

- Environment: Temperature, residue, compaction and water.
- Genetics: Stress tolerance and vigor.
- Seed Quality: Harvest moisture, drying and conditioning.

Hybrid genetics provide the basis for tolerance to cold stress. High seed quality helps ensure that the seed will perform up to its genetic ability. DuPont Pioneer concentrates on selecting the best genetics for consistent performance across a wide range of environments and producing highest quality seed. Still, environmental factors may dictate stand establishment. For this reason, Pioneer provides research-based advice to help growers better manage field operations to maximize stands.

Soil temperatures at planting are a key environmental component of stand establishment. It is generally recommended to plant corn when soil temperatures are at or above 50°F. However, conditions after planting are also critical – low soil temperatures after planting greatly reduced stands at a stress emergence site near Eau Claire, WI, in 2011 (above).

This article will discuss how the level and timing of cold stress affects seed germination and emergence and how to mitigate these stresses in challenging environments.

Optimal Temperature for Early Corn Growth

Corn is a warm season crop and does best under warm conditions. In North America, early-season planting typically puts stress on the corn seedlings. To help understand optimal corn growth, three hybrids of early, mid and late maturities were germinated in temperatures ranging from 59 to 95°F (15 to 35°C). Growth rates of both roots and shoots were measured. All three hybrids were averaged to determine the optimal temperature for corn growth. Both shoots and roots exhibited the fastest growth rate at 86°F (30°C), and continued to grow rapidly at 95°F (35°C), suggesting optimal germination and emergence occur at much higher soil temperatures than is common in most corn-producing areas (Figure 1).

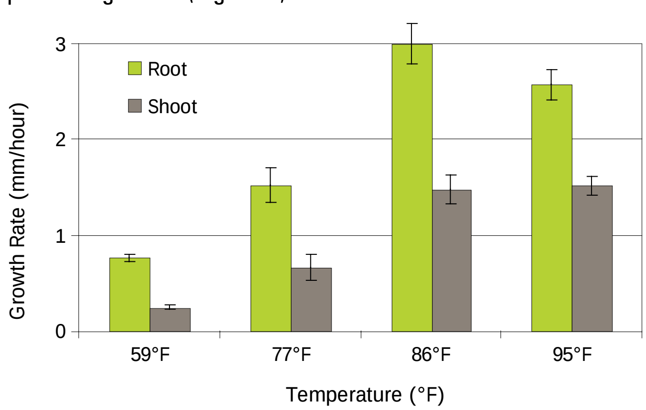


Figure 1. Average early root and shoot growth rates for three hybrids under four soil temperatures ranging from 59 to 95°F.

Genetic Differentiation for Cold Emergence

Soil temperatures after planting are a good indication of stress level – stands may be reduced when average soil temperatures are below 50°F (Figure 2). Pioneer provides stress emergence (SE) scores for all North America commercial hybrids to help growers manage early-season risk. Choosing hybrids with higher SE scores can help reduce genetic vulnerability to stand loss due to cold soil temperatures.

In 2009, DuPont Pioneer's stress emergence field plots experienced a wide range of stress conditions and soil temperatures. To demonstrate how SE scores relate to stand establishment in the field, hybrids were grouped by "low SE" (70 hybrids) and "high SE" (146 hybrids). Early stand counts for all hybrids within each group were averaged at each location.

As stress level increased, both the low SE and high SE hybrids experienced stand loss. However, the hybrids with a SE score of 6 or 7 were able to maintain higher stands as compared to those with a low SE score of 3 to 4 (Figure 2).

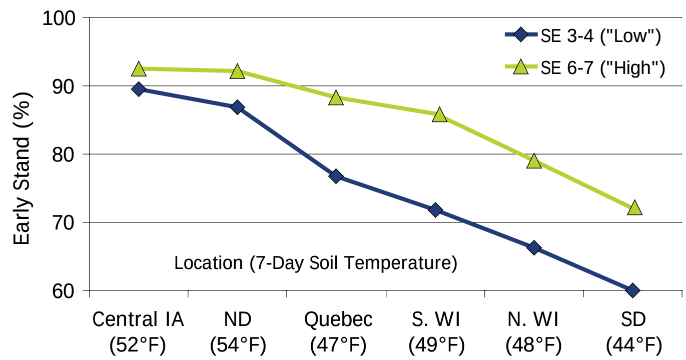


Figure 2. Average stand establishment for high and low SE score hybrids in six stress emergence locations in 2009. Locations are sorted from least stressful (left) to most stressful (right) based on average early stand.

Planting date remains a critical management factor to help minimize the risks associated with sub-optimal conditions for germination. Planting into cold, wet soils inflicts stress on corn seed emergence, as does planting just ahead of a cold spell. In some years, corn may be planted prior to a cold rain or snow. This imposes very high stress on corn emergence due to seeds imbibing chilled water or prolonged exposure to cold, saturated soils.

Timing of Cold Stress Impacts Germination

To help understand the importance of the timing of cold stress, two hybrids with SE scores of 4 (below average) and 7 (above average) were allowed to germinate in rolled towels for 0, 24 or 48 hours at 77°F (25°C). The hybrids were then subjected to a stress of melting ice for three days and allowed to recover for four days at 77°F (25°C). Hybrids were evaluated for the number of normal seedlings and this was reported as percent germination (Figure 3).

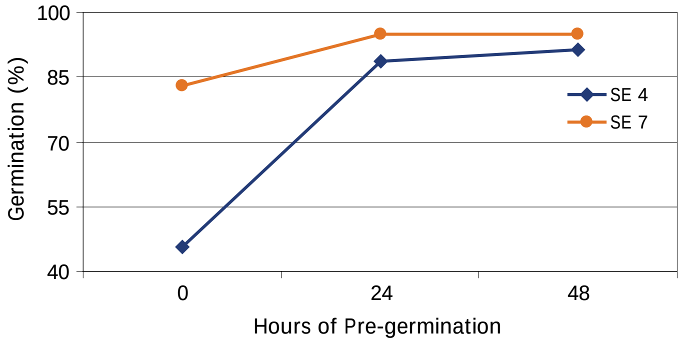


Figure 3. Germination of corn seed by stress emergence score after an ice treatment was imposed following three levels of pre-germination in warm conditions.

Both hybrids showed significant stand loss when the cold stress was imposed immediately (0 hours). However, the hybrid with a higher SE score had a higher percent germination than the hybrid with a low SE score. Germination rates for both hybrids were greatly improved if allowed to uptake water and germinate at warmer temperatures for at least 24 hours before the ice was added.

Data suggest that planting just before a stress event such as a cold rain or snow can cause significant stand loss. The chances of establishing a good stand are greatly improved if hybrids are allowed to germinate at least one day in warmer, moist conditions before a cold-stress event. Also, choosing a hybrid with a higher stress emergence score can help moderate stand losses due to cold stress.

One reason why temperature during imbibition is critical to corn emergence is the fact that seed imbibes most of the water needed for germination very rapidly. To illustrate the rapid timing of water uptake, seed was submerged in 50°F water for 3 hours and weighed at intervals of 30, 60, 120 and 180 minutes to determine water uptake (Figure 4).

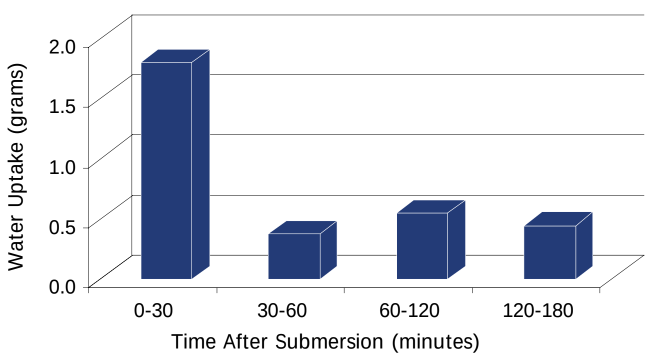


Figure 4. Amount of water uptake by corn seed during the first three hours after submersion in 50°F water.

The data show that seed imbibes the most water within the first 30 minutes after exposure to saturated conditions. If this early imbibition occurs at cold temperatures, it could kill the seed or result in abnormal seedlings. Growers should not only consider soil temperature at planting, but also the expected temperature when seed begins rapidly soaking up water. Seed planted in warmer, dry soils can still be injured if the dry period is followed by a cold, wet event.

Soil Temperature Fluctuations and Emergence

Growers are often able to plant fields with sandier soils earlier in the spring because they dry out faster than heavier soils. However, reduced stands after early planting have often been noted in sandier soils. Sandy soils are more porous and have lower water-holding capacity than heavier soils. As such, they tend to experience wider temperature fluctuations, especially on clear nights with cold air temperatures.

In 2009, soil temperatures were recorded at a 2-inch depth in a stress emergence location with sandy soils near Eau Claire, WI. Daytime soil temperatures reached acceptable levels for corn development (over 50°F) for the first week after planting. However, the early morning soil temperatures dipped to as low as 35°F (Figure 5), and on some days the soil temperature difference between 6 AM and 6 PM was close to 20°F. An average 25% stand loss was observed at this location, suggesting that day-night temperature fluctuation after planting can pose an added stress on germinating corn. Growers should be aware of expected nighttime temperatures when choosing a planting date.

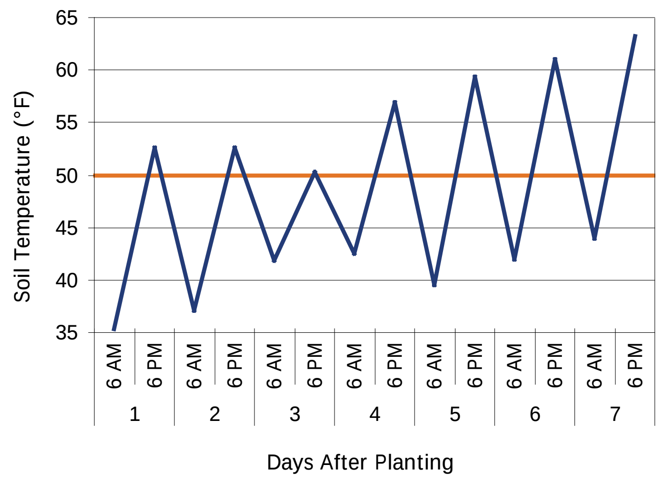


Figure 5. Soils temperatures at 6 AM and 6 PM for seven days after planting in a stress emergence field location near Eau Claire, WI, in 2009.

Impact of Crop Residue on Soil Temperature

Another factor to consider when choosing planting date is the amount of residue in the field. High amounts of residue can present management challenges. Residue tends to hold excess water and significantly lower soil temperature in the spring, depriving seed of critical heat units needed for rapid emergence. These conditions can also promote seedling disease, particularly in fields that are not well drained or have a history of seedling blights.

In 2011, soil temperature data loggers were placed in a field near Perry, IA, to assess early soil temperatures in a strip-till field. One data logger was placed in the tilled planting strip (low residue), and one was placed in between the rows under high residue. Soil GDUs were calculated from the data logger temperatures to approximate how long emergence would take under low and high residue conditions. In general, approximately 125 soil GDUs are needed after planting for corn emergence. From April 1 to April 30, soils under low residue were able to accumulate 99 soil GDUs. During the same time frame, neighboring soils under heavy residue accumulated only 28 soil GDUs.

Even in late May after the crop had emerged, an 11°F midday temperature difference was noted in the same field between soil under low residue and soil under heavy residue using a soil thermometer (Figure 6). Using row cleaners to clear residue off the row in high residue fields allows for development of warmer daytime soil temperatures and faster GDU accumulation.

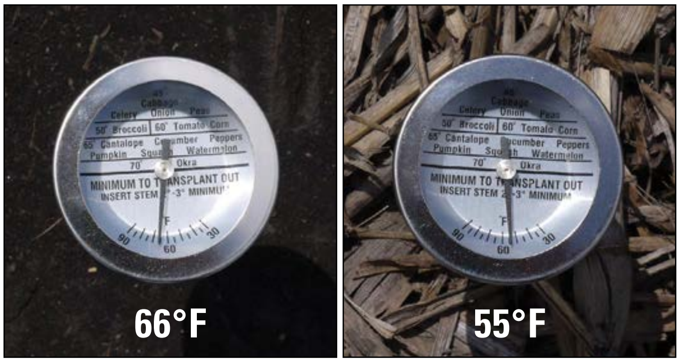


Figure 6. An 11°F difference was observed midday in late May 2011 in central Iowa between soils under no residue (left) and soils under heavy residue (right).

Tips to Help Mitigate Early-Season Stress Effects on Emergence

Delayed emergence due to cold, wet conditions lengthens the duration during which seed and seedlings are most vulnerable to early season insects and diseases. Seed treatments can help protect stands from both disease and insect pests. In areas with high nematode or insect pressure (such as cut worm or wireworm), growers can choose the added protection of Poncho® 1250 + VOTiVO® seed treatment. The standard treatment in Canada includes multiple fungicides and an insecticide component.

Planting date is one of the most important factors in stand establishment. The likelihood of reduced stands is greatest when planting in to cold, wet soils or directly before cold, wet weather is expected. To help mitigate risk, consider the following tips:

- If a cold spell is expected around planting time, it is advisable to stop planting one or two days in advance. Allow seed to begin hydration in warmer soils in order to minimize damage due to cold imbibition.
- In sandy fields, be aware that low nighttime temperatures can dip soil temperatures below advisable planting levels. Large temperature swings in lighter soils can also hurt emergence.
- If planting in fields with high amounts of residue, consider strip-tillage, or use row cleaners to allow soils to warm up faster.
- Selecting hybrids with higher stress emergence scores and the right seed treatment can help reduce the risks associated with planting in cold-stress conditions.

Optimizing Corn Seeding Rates

Average corn seeding rates used by growers in the U.S. and Canada have increased from about 23,000 seeds/acre in 1985 to nearly 31,000 seeds/acre today or approximately 300 seeds/acre per year. During the same time period, average U.S. yields increased from about 105 to nearly 160 bu/acre or 2 bu/acre per year. These parallel trends infer that increased seeding rates have played a major role in the corn yield increases over the last 25 years.

Optimizing corn seeding rate is critical to achieving top yields and profits. Average rates differ significantly by state, productivity level of the field, hybrid, and grower preference. Acres planted at 33,000 seeds/acre or above is approaching 35 percent in North America as a whole, having grown by over 15 percentage points in the last four years (Figure 1).

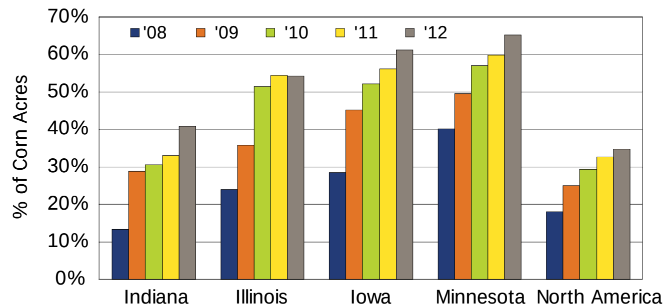


Figure 1. Percent of corn acres with seeding rates above 33,000 seeds per acre in major corn-producing states and in all of North America. Source: Pioneer Brand Concentration Survey.

Optimum Planting Rate by Hybrid

Each year, DuPont Pioneer Agronomy Sciences researchers study plant population responses in multiple environments across the U.S. and Canada. The individual hybrid population response curves that follow are derived from these studies. In these graphs, the "***optimum economic seeding rate***" (represented by the triangle below each curve) is the seeding rate at which maximum profitability is achieved when considering seed cost, corn grain price and yield.

There are three possible curves on each graph, representing data grouped by yield levels greater than 200 bu/acre, between 150 and 200 bu/acre, and below 150 bu/acre (see legend below). The economic optimums were calculated using a seed cost of $3.10/1,000 seeds and a corn grain price of $6.25/bu. A five percent overplant is assumed to achieve desired stands.

Legend for Hybrid Population Response Curves

Yield Range	Estimated Optimum Economic Seeding Rate
High: > 200 bu / acre	▲
Mid: 150 - 200 bu / acre	▲
Low: < 150 bu / acre	▲
Grain Price ($/bu)	$6.25
Seed Cost ($/1,000 seeds)	$3.10
Rate adjusted for stand loss:	5%

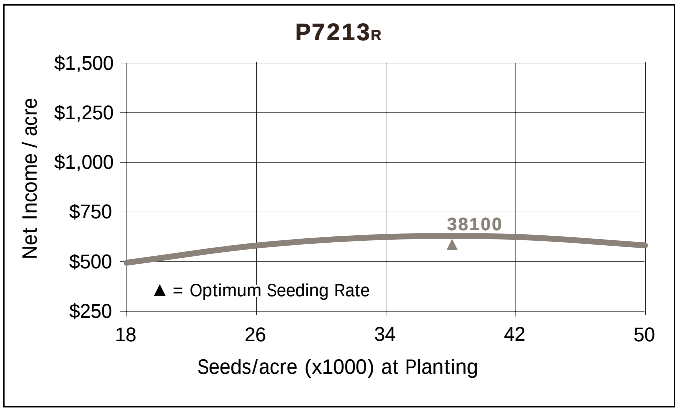


Figure 2. P7213R (72 CRM, RR2) planting rate response.

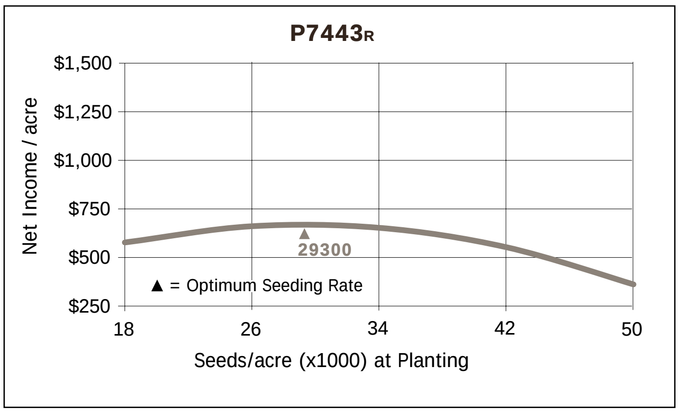


Figure 3. P7443R (74 CRM, RR2) planting rate response.

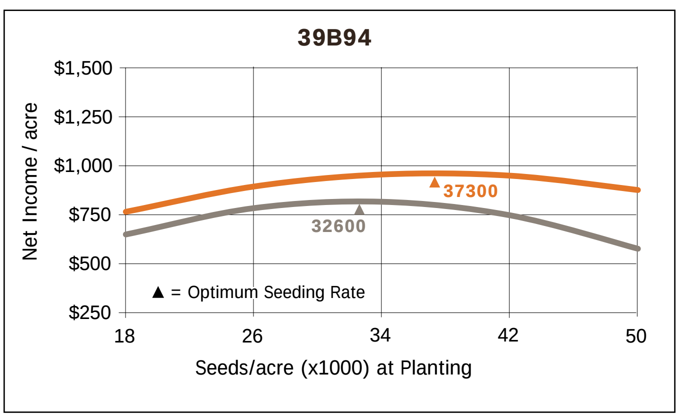


Figure 4. 39B94 (79 CRM, HX1, LL, RR2) planting rate response.

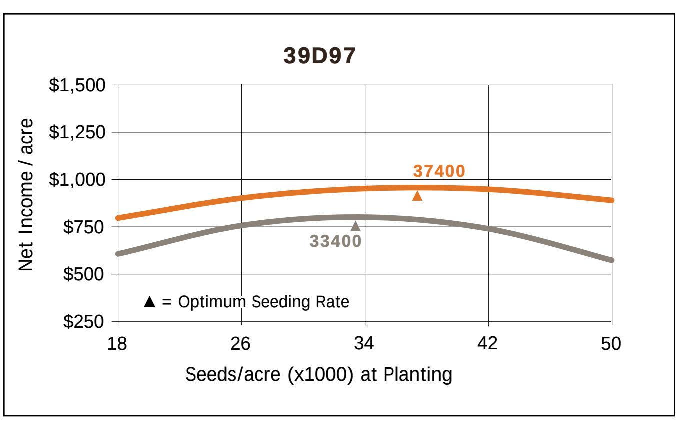


Figure 5. 39D97 (79 CRM, HX1, LL, RR2) planting rate response.

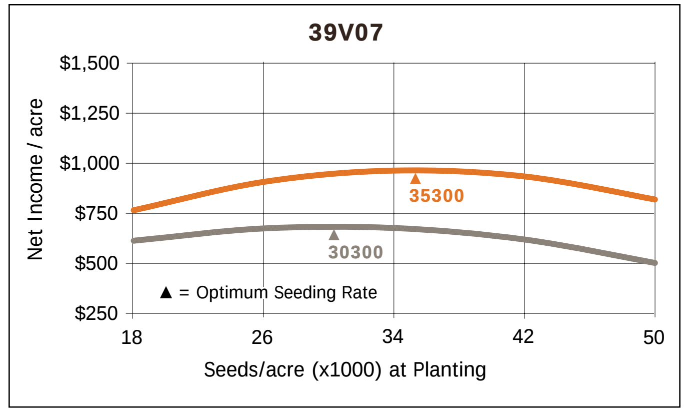


Figure 6. 39V07 (80 CRM, HX1, LL, RR2) planting rate response.

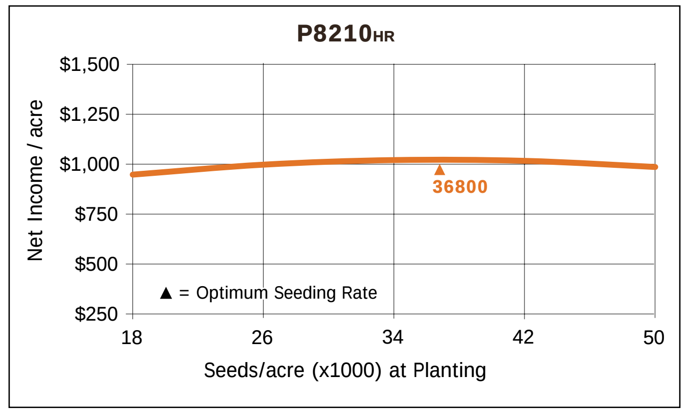


Figure 7. P8210HR (82 CRM, HX1, LL, RR2) planting rate response.

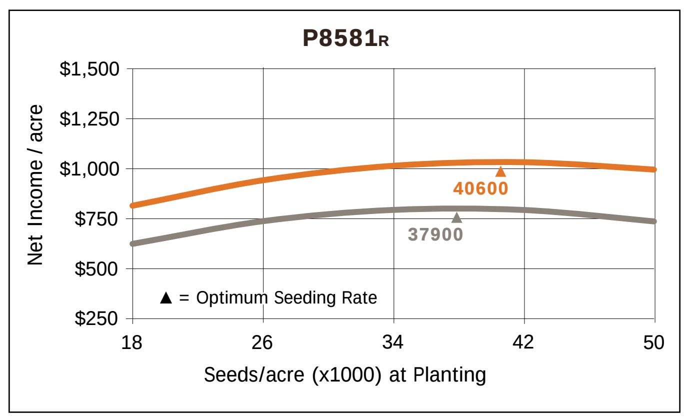


Figure 8. P8581R (85 CRM, RR2) planting rate response.

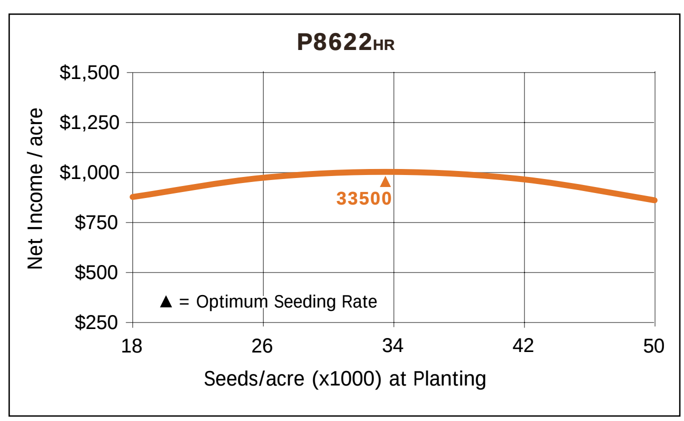


Figure 9. P8622HR (86 CRM, HX1, LL, RR2) planting rate response.

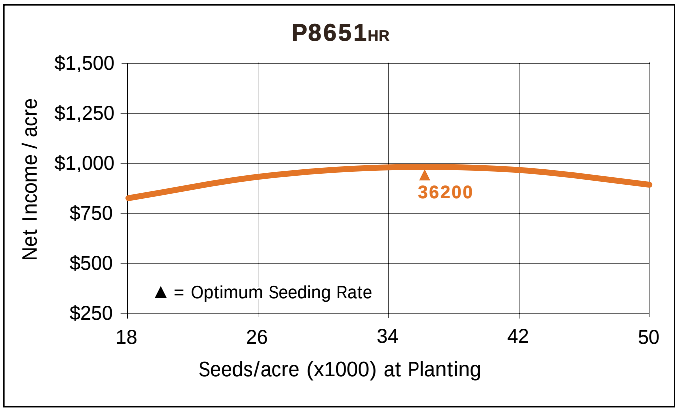


Figure 10. P8651HR (86 CRM, HX1, LL, RR2) planting rate response.

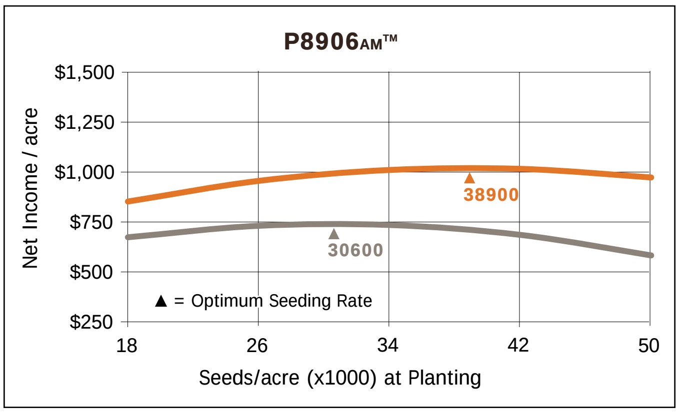


Figure 11. P8906AM™ (89 CRM, AM, LL, RR2) planting rate response.

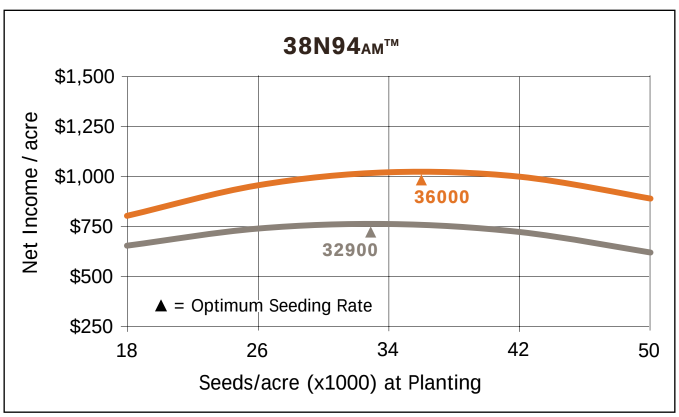


Figure 12. 38N94AM™ (92 CRM, AM, LL RR2) planting rate response.

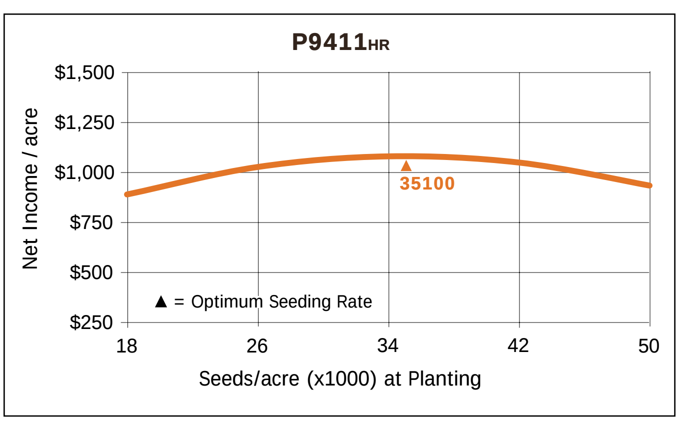


Figure 13. P9411HR (94 CRM, HX1, LL, RR2) planting rate response.

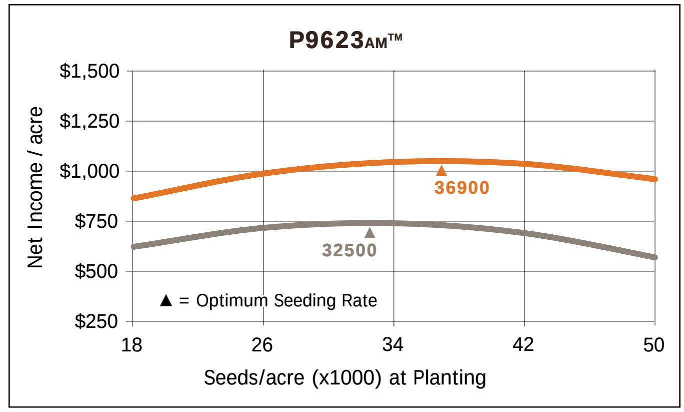


Figure 14. P9623AM™ (96 CRM, AM, LL, RR2) planting rate response.

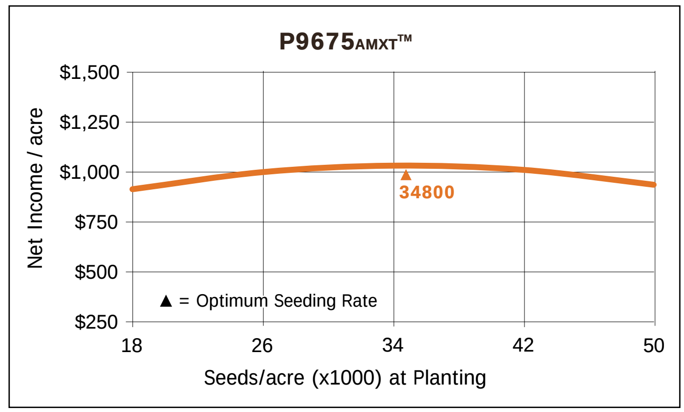


Figure 15. P9675AMXT™ (96 CRM, AMXT, LL, RR2) planting rate response.

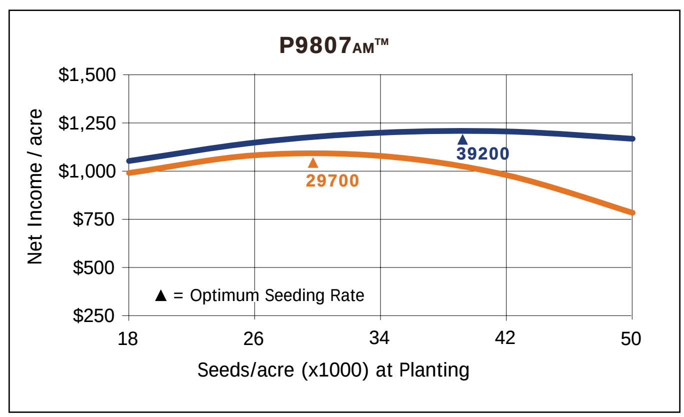


Figure 16. P9807AM™ (98 CRM, AM, LL, RR2) planting rate response.

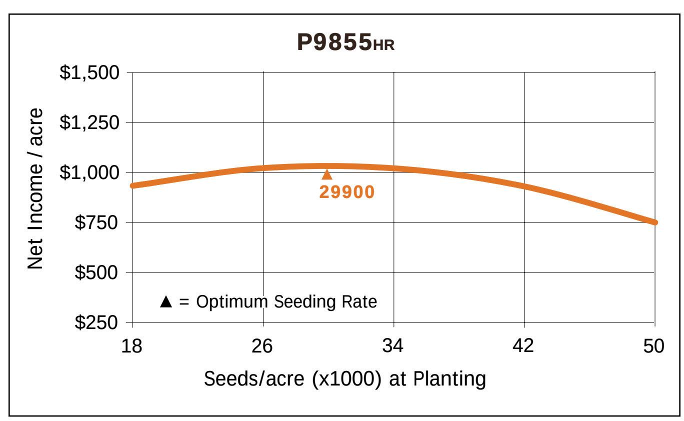


Figure 17. P9855HR (98 CRM, HX1, LL, RR2) planting rate response.

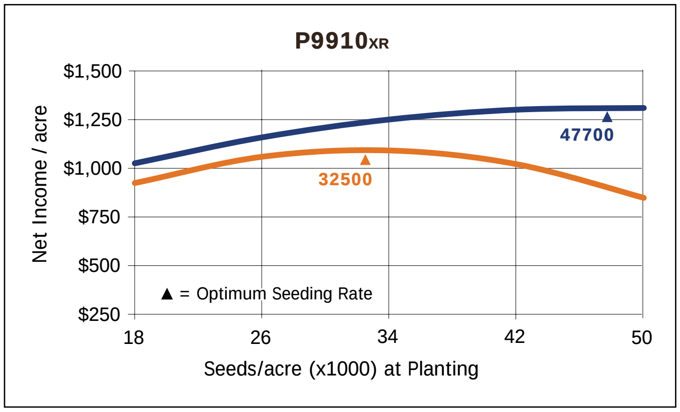


Figure 18. P9910XR (99 CRM, HXX, LL, RR2) planting rate response.

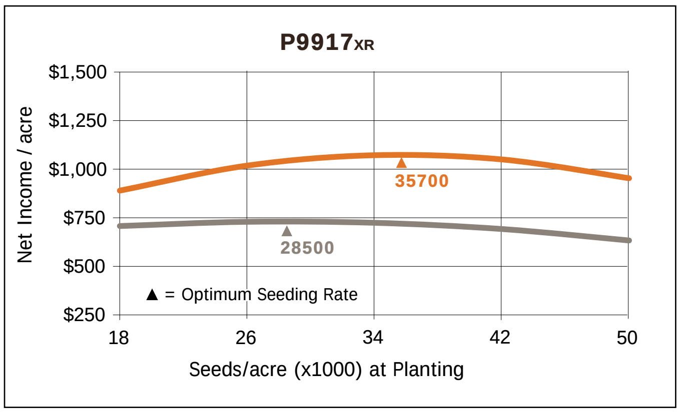


Figure 19. P9917XR (99 CRM, HXX, LL, RR2) planting rate response.

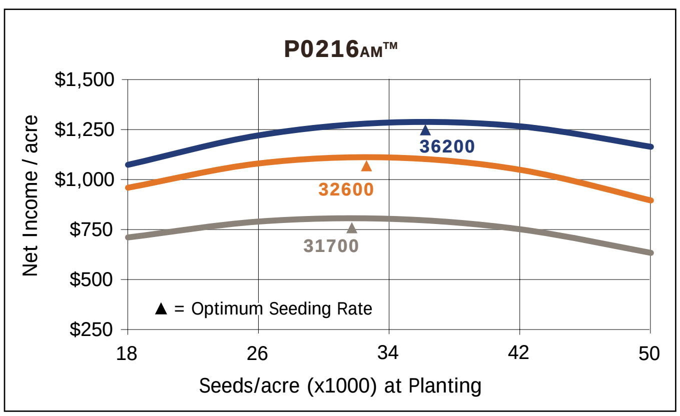


Figure 20. P0216AM™ (102 CRM, AM, LL, RR2) planting rate response.

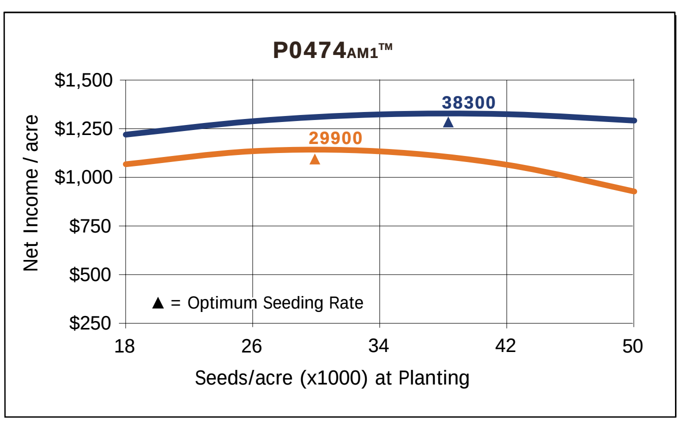


Figure 21. P0474AM1™ (104 CRM, AM1, LL, RR2) planting rate response.

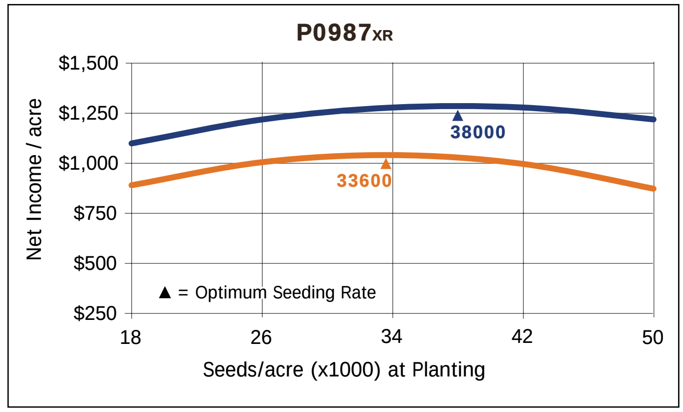


Figure 22. P0987XR (109 CRM, HXX, LL, RR2) planting rate response.

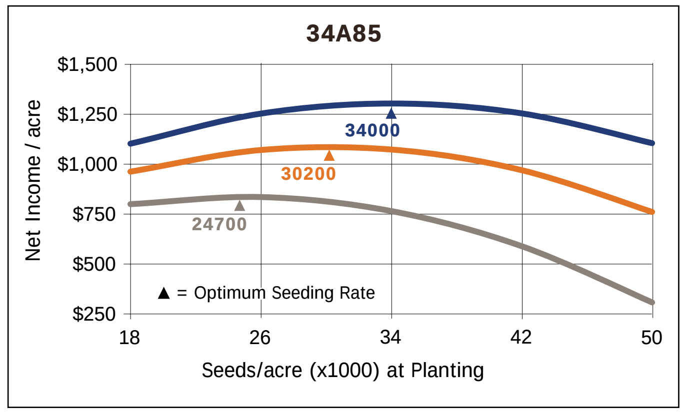


Figure 23. 34A85 (109 CRM, RR2) planting rate response.

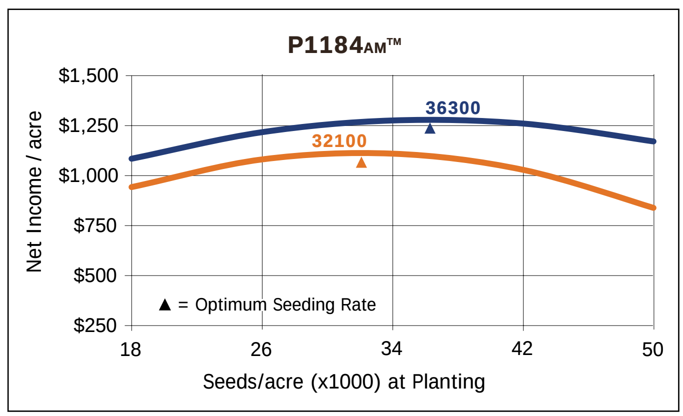


Figure 24. P1184AM™ (111 CRM, AM, LL, RR2) planting rate response.

Variation in Corn Yield Across Planter Width

Key Research Findings

- DuPont Pioneer researchers conducted on-farm trials in 2011 to determine variability in corn yield associated with wheel traffic compaction across the width of planter passes.

- The average corn yields of the rows planted by the outside wing segments were significantly greater than those planted by the center segment at 9 of the 12 trial locations.

  - Outside wing segments yielded an average of 11.3 bu/acre more than center segments across locations.

- These findings show that the variation in yield effect due to inter-row compaction across the width of the planter could unfairly bias a split-planter trial.

- Growers should avoid splitting planter passes into more than two strips to ensure the most accurate possible yield comparison.

Excessive soil compaction can reduce corn yield by restricting root growth and limiting water and air infiltration into the root zone. A common source of soil compaction is wheel traffic, most frequently associated with large machinery at harvest, particularly when soils are wet. However, wheel traffic compaction is also created between crop rows during planting.

Previous research has shown that soil compaction does not have to be directly on top of a row to impede plant growth and that compaction created in the inter-rows at planting can decrease yield. Research conducted in the early 1990s on effects of inter-row wheel traffic on corn yield showed that rows with no wheel traffic in the adjacent inter-rows yielded better than those with wheel traffic in one or both of the adjacent inter-rows (Kaspar et al., 1995).

Larger and heavier equipment increases the potential for compaction at planting. Compaction also tends to be more variable in the field with wider planters since the tractor wheel tracks are impacting a smaller proportion of the total planter pass width. Center fill planters may exacerbate this effect by further concentrating wheel traffic weight in the center of the planter pass.

Research Objectives

In 2011, DuPont Pioneer conducted 12 on-farm trials in Minnesota looking at variability in corn yield associated with wheel traffic compaction across the width of planter passes. The objectives of this study were to:

1. Evaluate corn yields across the width of large modern planters by comparing the center segment, where wheel traffic is concentrated, to the outer wing segments.

2. Determine implications for best practices when setting up split-planter trials.

Study Description

Location and Treatments

Twelve field-length strip experiments were conducted on farms in southern Minnesota in 2011 (Figure 1). A single hybrid was used across the entire trial within each location. The number of replicates varied by location, from 3 to 18. All trials were harvested using a corn head that was one-third the width of the planter. The two outside one-third planter passes (or the wing segments) were harvested and their mean yield compared to the inside one-third planter pass (or the center segment). It should be noted that after the planter pass, the center segments may have had additional wheel traffic (e.g., sprayer pass, fertilizer pass, etc.) that was not characterized as part of this study.

Planter Configurations

Three different planter configurations were included in this study:

- 36 rows, 22-inch spacing, center fill (3 locations)
- 48 rows, 20-inch spacing, row-unit boxes (4 locations)
- 36 rows, 20-inch spacing, center fill (5 locations)

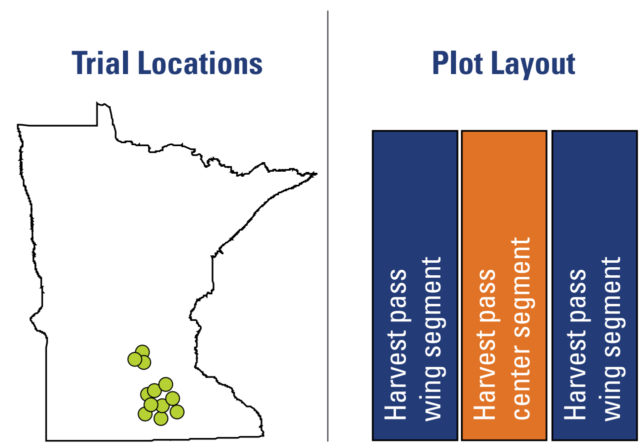


Figure 1. Trial locations and plot layout of planter width yield trials conducted in southern Minnesota in 2011. Number of replications varied by location.

Results

- Results from this study showed that corn yield varied across planter width.
  - The average corn yields on the outside wing harvest passes were significantly greater than those of the center harvest passes at 9 of the 12 trial locations.
  - The difference in yield between the outside wing passes and center passes varied by location, and the average across all locations was 11.3 bu/acre (Figure 2).
  - The variation in yield effects across locations was not unexpected; because the degree of soil compaction caused by wheel traffic varies with soil moisture, the yield impact of wheel traffic at planting should vary among environments based on soil conditions.

It is important to note that all of the locations in this study were planted in narrow rows (20 and 22 inches). Because corn planted in narrow rows is in closer proximity to a compacted wheel track in the inter-row, it is possible that overall yield effect of wheel traffic compaction at planting could be greater in narrow rows than in 30-inch rows.

Conclusions

Results from this study confirm findings of previous research showing that soil compaction created in the inter-rows at planting can reduce corn yield in the adjacent rows, creating variability in yield across the width of the planter.

Unfortunately, aside from avoiding planting when soils are too wet, there is often little growers can do to reduce inter-row compaction at planting. However, it is important to be aware of the potential yield effects when conducting a split-planter comparison:

- If the planter is divided into three or more strips, which may be convenient with the size of modern planters, the results from these trials may be unfairly biased due to the differential impact of wheel traffic among the strips.
- Consequently, growers should avoid splitting planter passes into more than two strips to ensure the most accurate possible yield comparison.

References

Carter, Paul. 1996. Wheel traffic between corn rows crop insights, Vol. 6, No. 22. Pioneer Hi-Bred, Johnston, IA.

Kaspar, T.C., S.D. Logsdon, and M.A. Prieksat. 1995. Traffic pattern and tillage system effects on corn root and shoot growth. Agron. J. 87:1046-1051.

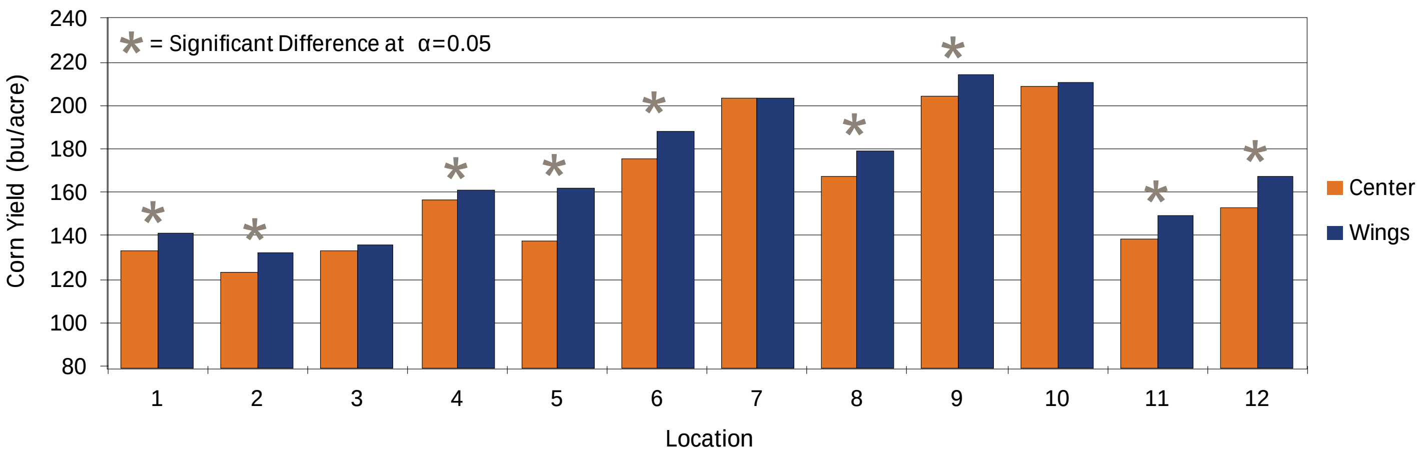


Figure 2. Corn yield difference between wing harvest passes and center harvest passes in 12 on-farm field-length strip trials conducted in southern Minnesota in 2011. Asterisks denote locations where yield was significantly different between wing and center harvest passes.

Notes

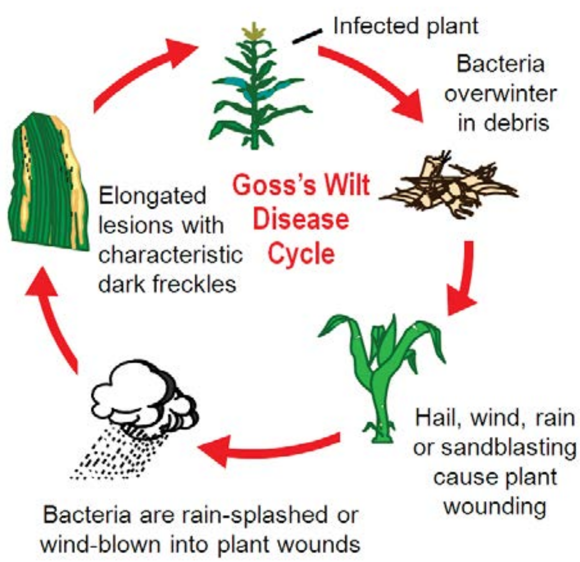
Managing Goss's Wilt in Western Canada

Disease Facts

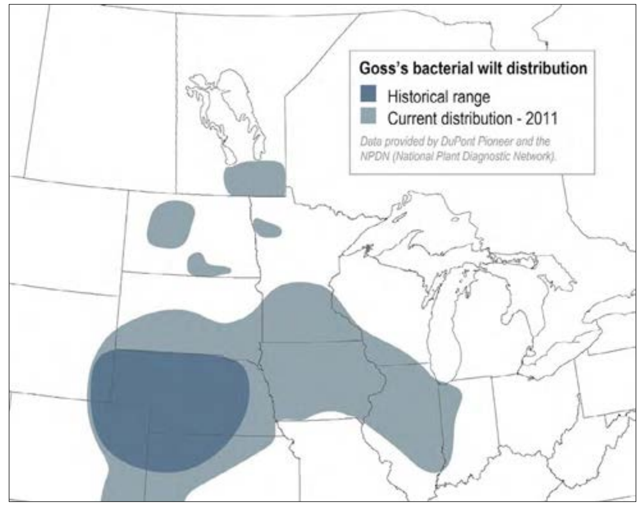
- Disease is caused by a bacterial pathogen that over-winters in residue of corn and several grasses.
- Historically, damage to corn had been confined mostly to the Great Plains states.
- In recent years, significant crop damage caused by Goss's Wilt has been reported in central Corn Belt states and Manitoba, Canada (see map at right).
- Depending on conditions, disease may cause only minor problems or devastating damage with grain yield losses approaching 50%.

Goss's Wilt Development

- Bacteria infects plant tissue through wounds caused by wind, hail, sandblasting, etc.
- Lesions develop along leaf vascular tissues and may progress rapidly under wet or humid conditions.
- Goss's wilt can affect the plant at early growth stages and can spread throughout the canopy after infection.
- Scout for symptoms near the silking stage of development.
- Yield reduction is caused by premature death.
- Bacteria is transported from infected fields to near-by fields by wind carrying infected soil or stubble .

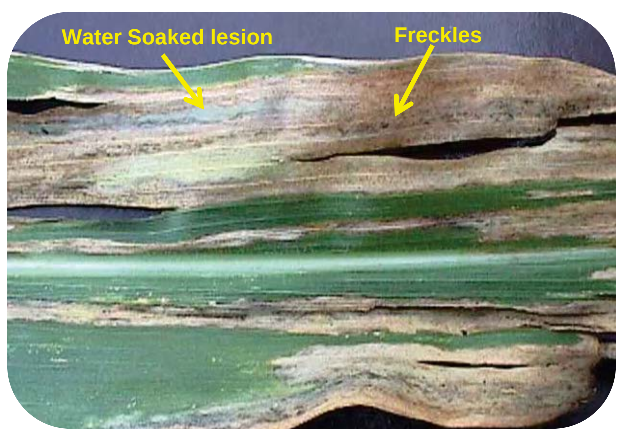


Presence of Goss's Wilt in Corn in North America.



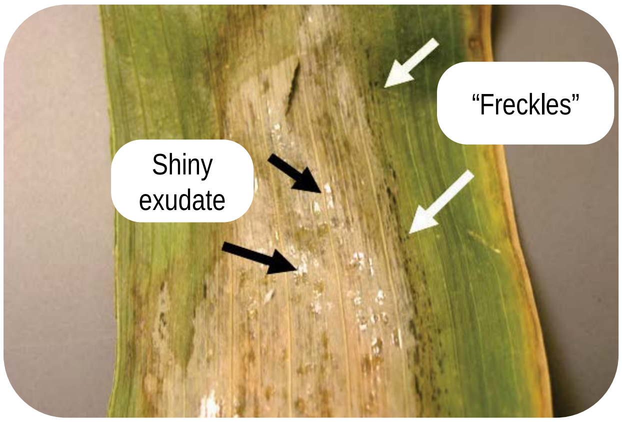
Goss's Wilt Symptoms

- Early leaf symptoms are elongated lesions of water soaked, grayish-green tissue that progress to long wavy lesions with water-soaked margins.
- Dark green or black freckles within the lesions are distinguishing features of Goss's Wilt.
- Under wet and humid conditions the bacteria exudate appears as a shiny egg white-like substance.
- Symptoms often appear on upper leaf canopy and spread downwards with wet conditions.
- Symptoms often appear in small patches along field edges where debris from adjacent fields blew in.



Distinguishing Features of Goss's Wilt Lesions

- **Freckles** – dark green to black water soaked spots, often near lesion edges (white arrows).
- **Shiny Exudate** – bacteria ooze to leaf surface and may appear shiny after drying (black arrows).



Breeding for Resistance

- DuPont Pioneer has been screening and breeding for Goss's wilt resistance for decades in the western US.
- This bacterial disease has spread into the northern Corn Belt and Manitoba, Canada, over the last few years.
- DuPont Pioneer researchers in Canada were able to leverage the vast experience and knowledge available within the company globally to diagnose, characterize, and select resistant early-maturity genetics.
- This work will lead to improved Goss's wilt resistance in the corn hybrids sold in Western Canada.

Hybrid genetics contain natural differences in tolerance to Goss's wilt.
Pictured above is a sampling of different Pioneer® brand hybrids exhibiting varying degrees of tolerance to Goss's wilt in a PKP trial. (Manitoba, 2009)

Field of Pioneer® brand corn hybrid 39V05 (RR2) that was planted into a previous field of corn that was susceptible to Goss's wilt. Aerial photo was taken in August 2012 by Arty's Air Service, Winkler, Manitoba.

Goss's Wilt Management

1. Genetic Resistance
   - Use as a primary management method.
   - Pioneer researchers inoculate, screen and rate hybrids for resistance.
   - Hybrids are also rated under natural infestations in affected states.
   - Pioneer researchers screen hybrids locally in Manitoba to increase levels of resistance.
   - See your local DuPont Pioneer sales professional for help in selecting appropriate hybrids for your field.
2. Reduce Corn Residue
   - Disease can become problematic in corn-on-corn, high-residue fields.
   - Crop rotation is effective in reducing residue.
   - Tillage encourages residue breakdown.
3. Control Grassy Weeds
   - Several grassy weeds are hosts for the bacteria, including green foxtail, barnyard grass, shattercane and others.
4. Prevention/Avoidance
   - Harvest and till affected fields last, and clean equipment to avoid spreading the pathogen to uninfected fields.
5. Fungicide application is NOT effective for this bacterial disease.

Optimal Fungicide Timing for Reducing Deoxynivalenol Accumulation in Corn Grain

Victor LIMAY-RIOS and Art SCHAAFSMA
University of Guelph, Ridgetown Campus, Ridgetown, Ontario, Canada

Introduction

Gibberella ear rot, caused by the fungus *Fusarium graminearum*, is the most important corn disease associated with mycotoxin contamination in the Great Lakes region of North America. *F. graminearum* infection and deoxynivalenol (DON) accumulation in grains are frequently reported in southwestern Ontario. Swine are particularly susceptible to DON ingestion causing feed refusal, weight loss and immune-suppression that may predispose them to disease infection.

Two major outbreaks of gibberella ear rot were recently observed in Ontario in 2006 and 2011. During these years, mean DON concentrations were higher than the maximum tolerable level in swine diets recommended by the Canadian Food Inspection Agency, as well as levels problematic to the ethanol industry. High rainfall and moderate temperatures during the period from silking to grain filling are associated with DON accumulation in the grain. Although fungicides are commonly used for fusarium head blight in wheat, no fungicide had been registered for *F. graminearum* control in corn until very recently. Our experiments show that the use of a new generation of triazoles, including prothioconazole and metconazole, can reduce DON contamination levels in grain corn.

Study Description

In 2010 and 2011, controlled replicated experiments were carried out in small-scale misting irrigation plots and in commercial field trials in Ridgetown, Ontario. In the misting trial, 10 primary ears of two susceptible corn hybrids were inoculated twice with 1mL of 2.0x104 *F. graminearum* macroconidia at silk emergence and at the beginning of silk browning. Natural contamination was measured in field trials in a single hybrid. The recommended dose rate for prothioconazole (200 g a.i./ha) was sprayed at different stages of silk emergence, elongation and senescence in susceptible hybrids planted in mid-June. A high clearance sprayer equipped with flat fan drop nozzles directed toward corn ears was used for fungicide application in field trials. The percentage of prothioconazole efficacy was evaluated by comparing mean levels of DON in treated plots relative to the levels of untreated control plots.

Results and Discussion

No significant differences in toxin content in harvested grain were found between hybrids and years ($P<0.005$) in the misting trial. Highly significant toxin reduction was observed when fungicide was applied at the beginning silk stage and three days later (full silking) with a mean reduction of 58% and 67%, respectively, relative to the untreated control ($P<0.0001$, Figure 1).

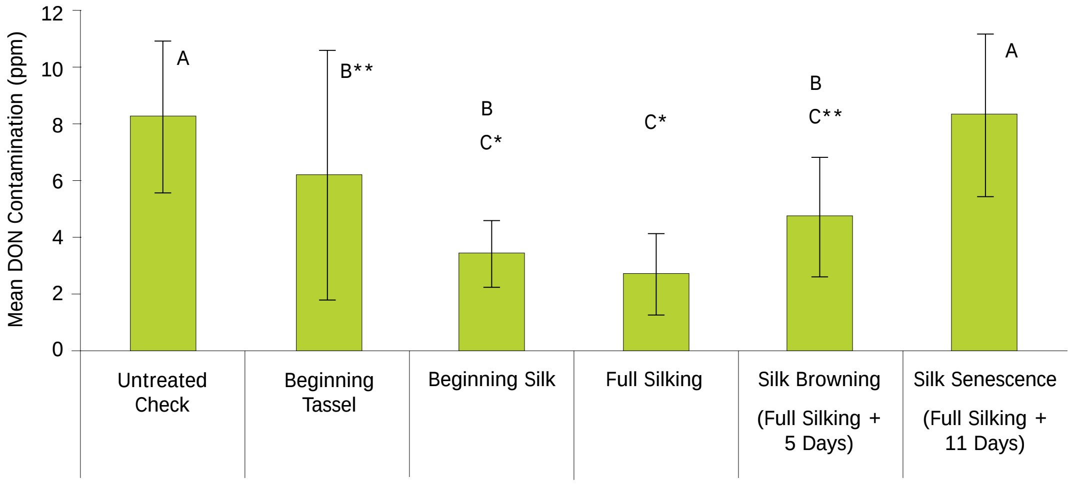
Ear of corn showing symptoms of Gibberella ear rot (pink mold between kernels). Infection usually begins in ear tip.

In the field trial, significant differences were found between years and treatments ($P<0.005$). Highly significant toxin reduction was observed in both years when fungicide was applied during beginning silk and full silking stages with a mean reduction of 56% and 59% respectively relative to the untreated control ($P<0.0001$, Figure 2).

Silk emergence is the most important factor affecting the efficacy of prothioconazole in corn. Combined results of these trials showed that under ideal conditions, a significant reduction of DON levels in harvested grain was achieved by spraying 200 g a.i./ha of this fungicide from beginning silk to full silk emergence. Toxin reduction was also found at beginning silk of <50% and at the beginning of silk browning of >50%. No toxin reduction was found when fungicide was sprayed at silk senescence when it was dry and brown.

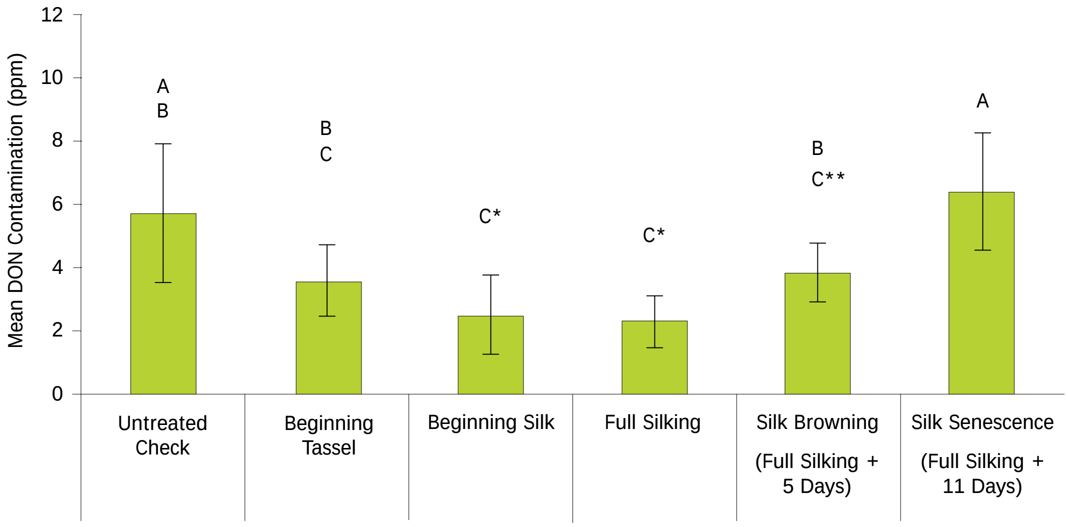
What is not yet known is how fungicide interacts with corn genetics. However, using experience with winter wheat as a guide, it is expected that best results might be obtained by combining hybrids that have a greater susceptibility with a well-timed fungicide application. While a 60% reduction of a high concentration of mycotoxin could still result in an unacceptably high level of mycotoxin in the grain, this approach is intended to take the edge off of a bad year, allowing more opportunities to manage highly contaminated grain lots at the farm level.

These two triazole fungicides (prothioconazole and metconazole) have the added benefit of controlling leaf diseases like rust, northern corn leaf blight, grey leaf spot and eyespot, so it is reasonable to expect a return on investment based on yield protection against these leaf diseases, with the added benefit of a reduction in mycotoxin level. While strobilurin fungicides like Headline® are effective at controlling the same leaf diseases, they are ineffective at reducing the levels of mycotoxin. In fact, there are published reports in which the levels of mycotoxins have actually increased in grain after a strobilurin was used at the flowering stage of the crop.



*Error bars represent the S.D. of two hybrids, two years and four replicate. Means within treatment followed by the same letter are not different according to Fisher's Protected LSD Test. * p <0.0001, ** p<0.005*

Figure 1. 2010 and 2011 misting trails: deoxynivalenol reduction in two hybrids after spraying 200g a.i./ha prothioconazole at different stages of silk and kernel development.



*Error bars represent the S.D. of two hybrids, two years and four replicate. Means within treatment followed by the same letter are not different according to Fisher's Protected LSD Test. * p <0.0001, ** p<0.005*

Figure 2. 2010 and 2011 field trails: deoxynivalenol reduction after spraying 200g a.i./ha prothioconazole at different stages of silk and kernel development.

Notes

Foliar Fungicide Application Effect on Corn Yield 2012

Background and Objective

- On-farm trials were conducted in Ontario, Quebec, and Manitoba in 2012 to determine yield response of corn hybrids treated with fungicide compared to the same hybrid not treated with a fungicide.

Foliar fungicide on-farm trial locations in 2012.

Study Description

Plot Layout:	Field-length strips
Replicates:	1-2 per location
Locations:	29 locations in Ontario, Quebec and Manitoba
Treatments:	Fungicide, untreated

- Treatments were compared on the same corn hybrid within a location.
- Corn hybrid maturities ranged from 74 to 108 CRM.
- Fungicide products tested included: Acapela™, Headline®, Proline® and Quilt®.

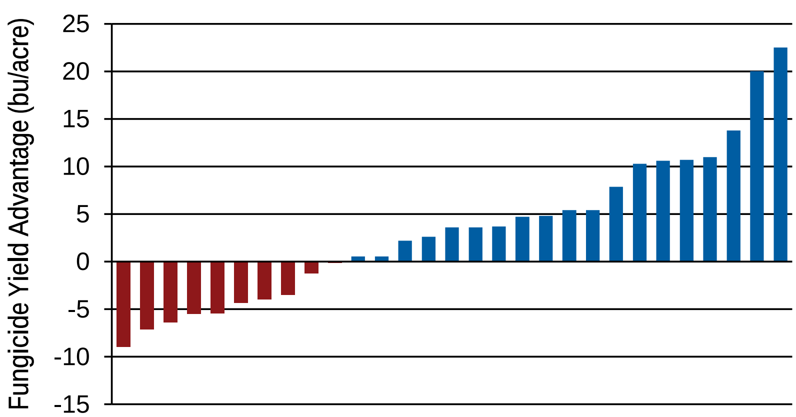
Growing Conditions in 2012

- Many of these locations were under drought stress, as was much of the corn growing area in Canada in 2012.
- Foliar diseases, such as northern leaf blight and gray leaf spot, are generally favored by high moisture and moderate temperatures, so lower disease pressure would be expected in a drought year.

Results

- Corn yield was increased by an average of 3.4 bu/acre with fungicide treatment across 29 on-farm trials.
- A positive yield response was observed in 62% of trials (18 of 29).

Corn Yield Response to Foliar Fungicide Application in 29 On-Farm Trials



- A previous survey of foliar fungicide trials conducted between 2007 and 2011 found an average yield response of 4.1 bu/acre to foliar fungicide application across 67 trials conducted in Alberta, Manitoba, Ontario and Quebec.
- An average yield response of 7.0 bu/acre was observed across 475 U.S. and Canada locations between 2007 and 2011.
- With the dry conditions experienced in many areas in 2012, it would be expected that foliar fungicides would provide a lower than average yield benefit.

2012 data are based on average of all comparisons made in 29 locations through November 20, 2012. Multi-year and multi-location is a better predictor of future performance. Do not use these or any other data from a limited number of trials as a significant factor in product selection. Product responses are variable and subject to a variety of environmental, disease, and pest pressures. Individual results may vary. All products are trademarks of their manufacturers.

Effect of Foliar Fungicide Timing on Corn Yield

2011-2012

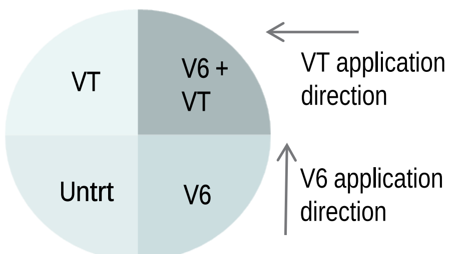
Objective

- Compare yield response to early and late season foliar fungicide applications on corn.

Study Description

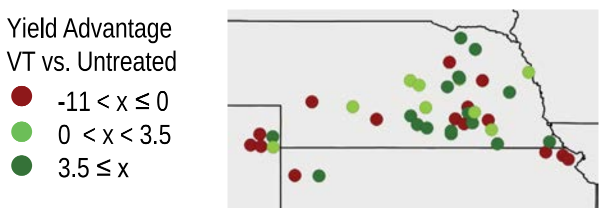
Locations: 38 on-farm trials across Nebraska, Kansas and eastern Colorado in 2011 and 2012

Plot Layout: 100+ acre fields split into ¼'s



Hybrids: 18 hybrids (treatments were compared using the same hybrid within a location)

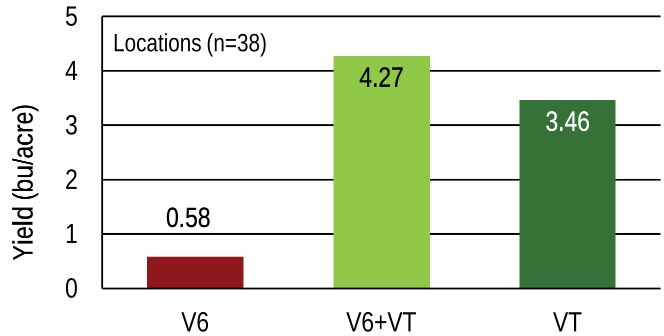
Treatments: Fungicide application at V6, VT, V6+VT growth stages



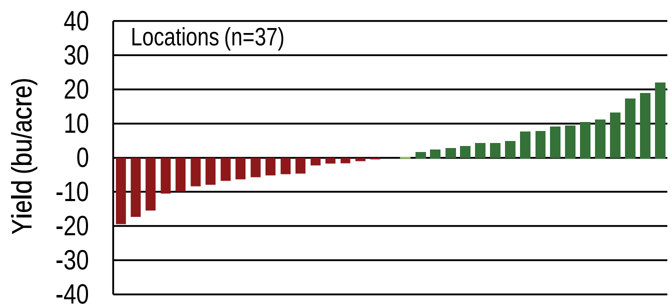
Results

- Foliar disease pressure was generally low in 2011 and 2012 across locations.
- Fungicide application at V6 was associated with a slight increase in average yield across all site-years.
- Application of foliar fungicide at VT growth stage resulted in a 3.46 bu/acre average yield increase across all site-years.
- Sequential application of foliar fungicide at V6 followed by VT resulted in an average yield advantage of 4.27 bu/acre across all site-years.
- The average yield response to treatments including a VT fungicide application was below long-term averages seen in other studies, likely due to below average disease pressure in 2011 and 2012.

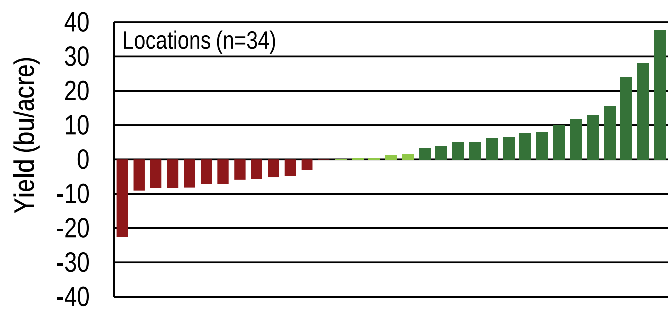
Average Yield Response by Treatment



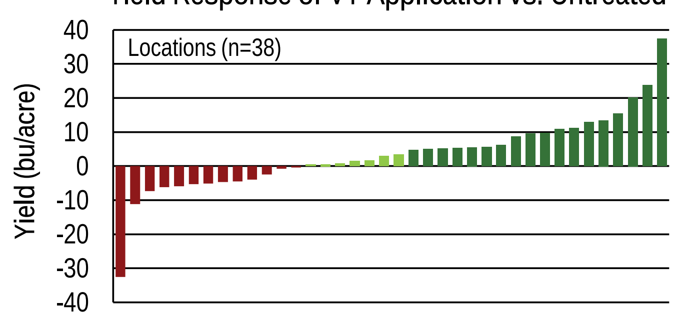
Yield Response of V6 Application vs. Untreated



Yield Response of V6+VT Application vs. Untreated



Yield Response of VT Application vs. Untreated



2011-2012 data are based on average of all comparisons made in 38 locations through November 21, 2012. Multi-year and multi-location is a better predictor of future performance. Do not use these or any other data from a limited number of trials as a significant factor in product selection. Product responses are variable and subject to a variety of environmental, disease, and pest pressures. Individual results may vary.

Weed Management in the Era of Glyphosate Resistance

The last 15 years can rightly be referred to as the "glyphosate era" of weed control. Glyphosate rapidly replaced other herbicides in soybean and by 2002, was used on 79% of soybean acres in the U.S. (Young, 2006). Adoption was slower in corn, but by 2010, glyphosate had become the most widely used herbicide in corn as well, with 66% of U.S. corn acres treated (USDA NASS, 2011).

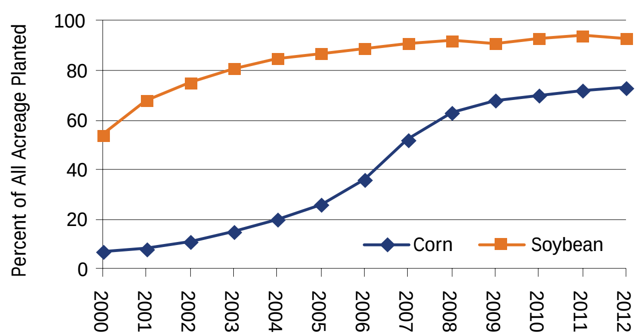


Figure 1. U.S. corn and soybean acres planted with genetically modified herbicide-resistant crops (USDA ERS).

Many areas are now transitioning into a post-glyphosate era with glyphosate-resistant weeds now requiring additional or alternative management tools for satisfactory control. To date, glyphosate resistance has been confirmed in 24 weed species worldwide, including 14 in North America (Heap, 2012). Glyphosate-resistant weed populations have been confirmed in 29 states and two Canadian provinces (Figure 2).

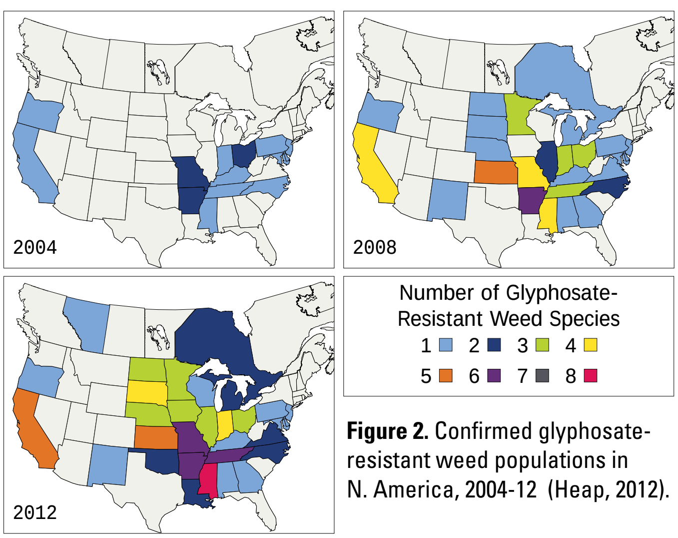


Figure 2. Confirmed glyphosate-resistant weed populations in N. America, 2004-12 (Heap, 2012).

Weeds with Multiple Herbicide Resistance

Despite the rapid increase in glyphosate resistance cases over the last several years, glyphosate has a relatively low incidence of resistance evolution compared to many other herbicides. For example, the number of weed species with glyphosate resistance (24) is still relatively small compared to ALS inhibitor resistance (127) and triazine resistance (69). Resistant weeds do not eliminate the usefulness of glyphosate; it will continue to be an important and useful weed control tool for years to come, most likely in combination with other herbicides. There are a small number of weed species, however, for which resistance to multiple herbicides now leaves growers with few viable options for control (Table 1).

Multiple Herbicide Resistance - Definition

Resistance to several herbicides resulting from two or more distinct resistance mechanisms occurring in the same plant.

Table 1. Weed populations with multiple resistance (in the same plant) to glyphosate and one or more other herbicide modes of action in the U.S. and Canada.

Species	State	Modes of Action
Common Waterhemp	MO, IL[1]	Glyphosate, ALS inhibitors, PPO inhibitors
	IL	Glyphosate, ALS inhibitors
	IL[2]	Glyphosate, ALS inhibitors, PPO inhibitors, photosystem II inhibitors
	IA	Glyphosate, ALS inhibitors, 4-HPPD inhibitors
Palmer Amaranth	GA, MS, TN	Glyphosate, ALS inhibitors
Giant Ragweed	OH, MN	Glyphosate, ALS inhibitors
Common Ragweed	OH	Glyphosate, ALS inhibitors
Horseweed	OH, ON	Glyphosate, ALS inhibitors
	MS	Glyphosate, paraquat
Kochia	AB	Glyphosate, ALS inhibitors

[1] (Hager, 2011), [2] (Bell et al., 2009), all others (Heap, 2012).

The most troublesome multiple-resistant weeds for North American crop production are two pigweed species, common waterhemp and Palmer amaranth. Common waterhemp resistant to glyphosate, ALS inhibitor, and PPO inhibitors is becoming increasingly common in Illinois (Hager, 2011) and Missouri. A population resistant to these three modes of action plus photosystem II inhibitors (atrazine) has been documented in Illinois. In Iowa, a new type of resistance was added to common waterhemp's already impressive list when a population resistant to glyphosate, ALS inhibitors and 4-HPPD inhibitors was discovered in 2011. Palmer amaranth resistant to glyphosate and ALS inhibitors has only been documented in three southern states so far but will likely spread within the South as well as north into the Corn Belt (Hager, 2005).

Following the amaranths on the list of troublesome multiple-resistant weed species are common and giant ragweed. Populations resistant to both glyphosate and ALS inhibitors have been confirmed for these two species. Other important multiple-resistant weed species are kochia and horseweed. Resistance to both glyphosate and ALS inhibitors has evolved in populations of these species. Horseweed resistant to glyphosate and paraquat has been documented in Mississippi.

With glyphosate no longer being a viable control option for these weed species in an increasing number of cases, growers are often forced to turn to less effective and flexible herbicide options. The increasing dependence on a dwindling number of viable chemical control options for the worst multiple-resistant weed species will accelerate the rate at which these options fail. This may leave a shortage of new weed control options to help deal with problematic weeds.

Giant ragweed, a species with multiple herbicide resistance.

Outlook for New Weed Control Options

Herbicide Discovery: Since the introduction of glyphosate-resistant crops in 1996, no new herbicide modes of action have been commercialized. In fact, the most recent class of herbicides to reach the market, the HPPD inhibitors, were first commercialized nearly 30 years ago. New herbicide products have continued to come to market but all have been either new premixes, formulations of existing active ingredients, or new active ingredients in existing herbicide classes. This has occurred as industry resources dedicated to developing new herbicide modes of action have sharply declined in recent years (Duke, 2011, for a number of reasons:

- Widespread adoption of glyphosate-resistant crops and glyphosate-based weed management programs.
- Price reductions following the glyphosate patent expiration and that of other active ingredients.
- Extensive consolidation and downsizing in the crop protection industry, from 45 companies in 1970, 30 in 1980, 15 in 1990, 10 in 2000 and still fewer today.

Finally, a further roadblock for developing new herbicide modes of action is the increased cost of bringing a new product to market. In 2008, an estimate of the combined costs of discovery and development of a new product put the total cost at $248 million (Bomgardner, 2011). Products coming to market now face many more regulatory hurdles than when currently available modes of action were developed.

Expanded Options with Existing Herbicides: Several new types of herbicide resistant crops coming to the market this decade will expand weed control options with existing herbicides. These crops will generally include resistance to multiple herbicides, increasing the available weed management options for growers. With new herbicide modes of action unlikely to appear anytime soon, multiple herbicide-resistant crops are the immediate future for weed control. These technologies will expand grower options for dealing with resistant weeds but in all cases, rely on existing active ingredients that already have documented resistance issues of their own.

One alternative herbicide-resistant crop technology that is already available is glufosinate resistance (LibertyLink®). All Pioneer® brand corn hybrids with Herculex® Insect Protection also have the LibertyLink gene for glufosinate resistance. Growers have often not used glufosinate for weed control, despite their capability to do so, preferring to use glyphosate instead. Glufosinate-resistant soybeans have become increasingly available in recent years, primarily due to the need to manage multiple-resistant pigweeds. The limited use of glufosinate for weed control has not created nearly the level of selection intensity that has been experienced with glyphosate; however, resistance has been documented in two weed species in the last few years. The first known case of resistance was goosegrass in Malyasia in 2009, a species with an extensive history of developing resistance to several different herbicides including glyphosate. Italian ryegrass resistant to both glufosinate and glyphosate was discovered in Oregon the following year.

Two upcoming technologies involve crops resistant to synthetic auxin herbicides, 2,4-D (Enlist™ Weed Control System) and dicamba (Roundup Ready® Xtend). Synthetic auxin herbicides have been widely used for many years and are known to have a relatively low risk for weed resistance (Gustafson, 2008); however, multiple cases of weed resistance to 2,4-D, dicamba or both have been documented over the course of their long histories.

Resistance to 2,4-D was first documented in 1957 and has since occurred in several weed species, although most are not important weeds in North America row-crop production. One notable exception is common waterhemp; a resistant population was discovered in 2009 in a grass seed production field in Nebraska that had received one or two 2,4-D applications annually for many years (Bernards et al., 2012).

Dicamba resistance has also been documented in multiple weed species, including kochia in the western U.S. and Canada and common lambsquarters in New Zealand. Resistance in kochia is noteworthy due to the existence of several known glyphosate resistant populations in the same region. Any herbicide resistance issues in common lambsquarters take on an enhanced significance due to the fact that it is ubiquitous across much of the Corn Belt. Glyphosate resistance has not occurred to date in common lambsquarters, but variability in response has been documented (Sivesind et al., 2011).

Another forthcoming herbicide resistance technology is soybean resistant to 4-HPPD inhibitor herbicides (active ingredients in products such as such as Callisto®, Laudis®, and Balance® Flexx) being co-developed by Syngenta and Bayer. The 4-HPPD inhibitor herbicides are relatively new, which has limited the selection for resistant weeds to date. So far, the only weed species to evolve resistance to this mode of action is common waterhemp, with resistant populations first discovered in 2009. Resistant populations have now been documented in three Midwestern states: Illinois, Iowa, and Nebraska. Populations with multiple resistance to 4-HPPD inhibitors, ALS inhibitors and PS II inhibitors have been confirmed in Illinois and Iowa; a population resistant to 4-HPPD inhibitors, ALS inhibitors and glyphosate was documented in Iowa.

Lessons from Glyphosate Resistance

One lesson that glyphosate resistance in weeds has taught us is that all herbicides are susceptible to resistant weed evolution given enough time and repetition of use. Overuse of any of the new herbicide-resistant crop technologies will lead to its failure, and there is no guarantee that other solutions will be coming to market very soon.

Weed Resistance to Herbicides Used with Current and Future Herbicide-Resistant Crops

Glufosinate

- Resistant goosegrass in Malaysia in 2009; Italian ryegrass resistant to both glufosinate and glyphosate discovered in Oregon in 2010.
- Low use of glufosinate, to date, has limited the selection intensity for resistant weeds; if glufosinate use becomes more widespread, resistance cases will likely increase.

Dicamba

- Resistance documented in several weed species.
- Noteworthy cases include dicamba-resistant kochia in several western states and common lambsquarters in New Zealand.

2, 4-D

- Resistance documented in numerous weed species, mostly outside of North America.
- 2,4-D-resistant waterhemp discovered in Nebraska in 2009.

4-HPPD inhibitors (mesotrione, isoxaflutole)

- Mesotrione-resistant waterhemp confirmed in Illinois, Iowa and Nebraska. Iowa population resistant to both mesotrione and isoxaflutole.
- The relatively recent introduction of this mode of action has limited the selection intensity for resistant weeds. Resistance cases will likely increase.

The most important way to prolong the usefulness of a herbicide is to not rely on it exclusively, instead using a variety of weed management tools as part of an overall program. Rotating or combining herbicide modes of action is an important step in this direction and can help reduce the selection intensity of any one active ingredient. Multiple resistant weeds can make achieving this a challenge.

A truly integrated strategy should incorporate non-chemical control tactics as well. Mechanical weed control and crop rotation are examples of two such tactics available to growers, but the feasibility of their implementation will vary depending on the characteristics of a cropping system. The following list includes several strategies for mitigating the evolution and spread of herbicide resistance in weeds.

Best Management Practices for Managing Herbicide Resistance (Norsworthy et al., 2012)

- Understand the biology of the weeds present.
- Use a diversified approach toward weed management focused on preventing weed seed production and reducing the number of weed seed in the soil seedbank.
- Plant into weed-free fields, and then keep fields as weed free as possible.
- Plant weed-free crop seed.
- Scout fields routinely.
- Use multiple herbicide mechanisms of action that are effective against the most troublesome weeds or those most prone to herbicide resistance.
- Apply the labeled herbicide rate at recommended weed sizes.
- Emphasize cultural practices that suppress weeds by using crop competitiveness.
- Use mechanical and biological management practices where appropriate.
- Prevent field-to-field and within-field movement of weed seed or vegetative propagules.
- Manage weed seed at harvest and after harvest to prevent a buildup of the weed seedbank.
- Prevent an influx of weeds into the field by managing field borders.

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Soybean Response to High Fertility Management

2012

Objective

- Evaluate soybean yield response to a high soil fertility system in the Red River Valley of the North.

Study Description

Plot Layout: On-farm, full field

Locations: Elbow Lake, MN
Mahnomen, MN

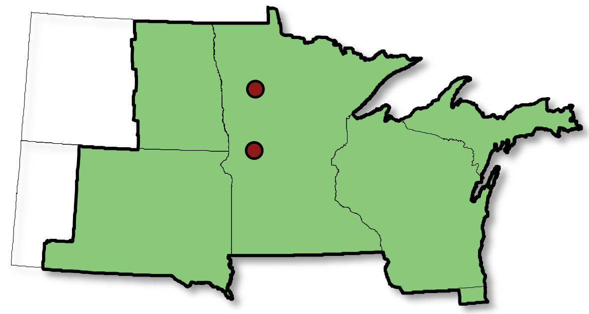
Pioneer® Brand Variety: 90Y70 (RR)

Soil Fertility: High Fertility Program
- 12 lbs/acre Nitrogen
- 40 lbs/acre Phosphorous
- 60 lbs/acre Potassium
- 10 lbs/acre Sulfur

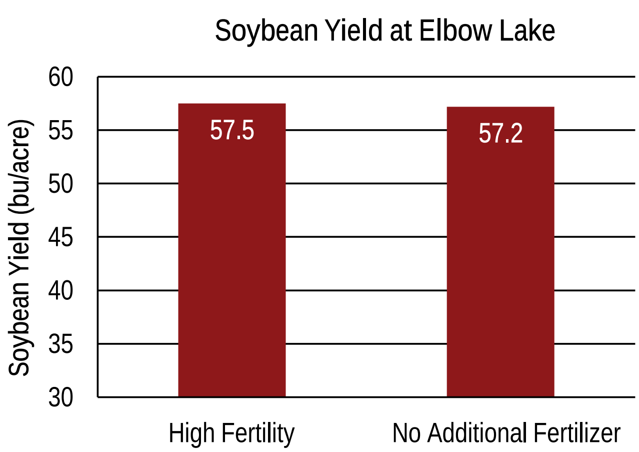
No Additional Fertilizer

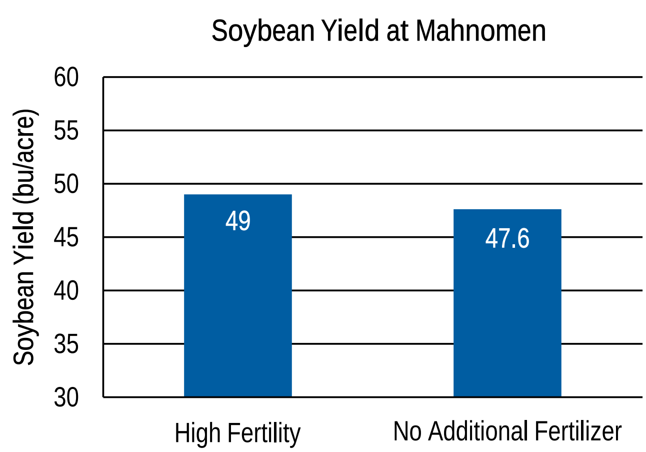
- Fertilizer treatments were applied immediately after planting.

Northern Agronomy Research



Results





- Soybean yields were similar between high fertility and normal fertility programs at both locations.
- Results presented here are for year one of a multiyear study.

RR - Contains the Roundup Ready® gene.

Roundup Ready® is a registered trademark used under license from Monsanto Company.

PIONEER® brand products are provided subject to the terms and conditions of purchase which are part of the labeling and purchase documents. 2012 data are based on average of all comparisons made in 2 locations through November 21, 2012. Multi-year and multi-location is a better predictor of future performance. Do not use these or any other data from a limited number of trials as a significant factor in product selection. Product responses are variable and subject to a variety of environmental, disease, and pest pressures. Individual results may vary.

Production Practices to Help Maximize Soybean Yields

Yield increases for soybeans have not kept pace with those of corn. Over the last 25 years, US average corn yields have increased by 1.5% per year while soybeans have only achieved a 1.1% per year gain. This may be in part to a lower level of management often applied to soybeans than to a corn crop. This article will examine agronomic practices to help increase soybean yields and profits, including variety selection, planting practices, soil fertility, crop rotation, weed control, use of inoculants and other practices.

Variety Selection for Top Yields

Right Product on the Right Acre: Matching soybean varieties to the specific requirements of individual fields is a core practice for maximizing soybean yields. Soil type, tillage system, drainage, geographic location, expected rainfall, potential diseases and other local factors must all be accounted for in choosing an appropriate variety. All varieties considered should have high yield potential, good standability and the ability to withstand environmental stresses. But in addition, resistance to specific races of SCN, resistance or field tolerance to Phytophthora root rot, other diseases, or iron deficiency chlorosis may be key to achieving high soybean yields in a particular field. Your local DuPont Pioneer sales rep can help you select the best soybean varieties for each field.

Newest Varieties: Soybean breeders at DuPont Pioneer make yield gains and agronomic improvements every year, using new genetic tools such as Accelerated Yield Technology (AYT) as well as marker-assisted selection. Sampling top new varieties each year and ramping these up to significant acreages can quickly have a significant impact on overall farm yields.

Planting Practices

Row Width: A review of soybean row spacing studies published within the past 10 years generally confirms previous results comparing 30-inch rows and drilled narrow rows. In five studies, drilled soybeans out-yielded 30-inch row soybeans by an average of 4.1 bu/acre. Six studies that compared 30-inch rows and 15-inch rows found similar results, with 15-inch rows holding a 3.6 bu/acre yield advantage. Yields were similar between 15-inch rows and drilled narrow-rows (Figure 1).

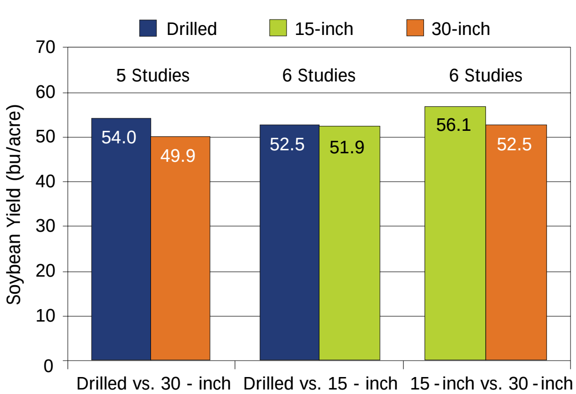


Figure 1. Average yield results from seven soybean row spacing studies published during the last ten years.

Planting Date: Soybean planting is trending earlier, particularly in operations with a planter dedicated to soybeans. DuPont Pioneer and university studies have shown that planting soybeans in the last half of April or first part of May often results in maximum grain yield potential. Early planting extends reproductive growth by initiating flowering earlier and prolonging the rate of reproductive development. This allows the crop to accumulate more nodes, increasing the potential for greater pod and seed number. In addition, recent studies indicate that full-season varieties respond better to early planting than short-season varieties. Today's fungicide + insecticide seed treatments have a proven role in early planting yield increases - helping protect seeds and seedlings from a myriad of stand-reducing soil borne diseases that otherwise could reduce stands and yields.

Seeding Rate: DuPont Pioneer research studies from 2006 to 2008 in 30-inch rows showed that optimum economic seeding rates for soybeans varied from 128,000 to 168,000 seeds/acre. Within this range, the appropriate rate depended on seed cost, grain price and whether a seed treatment was used. Fungicide/insecticide seed treatments were more effective than fungicide treatments alone in protecting stands and reducing seeding requirements. Growers should consider individual production practices and seedbed conditions when deciding on their seeding rate, including local soil type, residue levels, planting date, row width, etc. Though soybeans can adjust to lower stands, too much reliance on this ability can lead to poor stands and the need to replant in some situations.

Soil Fertility

Phosphorus / Potassium: Some soybean producers depend on residual corn fertility to supply nutrients to their soybean crop. When soils are routinely maintained at high or very high levels of P and K, this may be a safe strategy, but when P and K are low, yield reductions are likely. A 60 bushels/acre soybean crop would remove about 48 lbs P2O5 and 84 lbs K2O from the soil in the grain. This is 33% less phosphorus but 55% more potassium than a 200 bu/acre corn crop removes in the grain. Soil testing can determine if field levels are adequate to supply these or other required amounts.

K deficiency in soybeans.[1]

Soil pH: Many chemical and biological processes in the soil are affected by pH, and maintaining pH in the proper range will maximize the efficiency of other crop inputs and decrease the risk of yield losses. Soybeans thrive in the pH range of 6.0 to 6.8 (in mineral soils). Liming acid soils or utilizing varieties with good iron deficiency chlorosis scores on high pH soils will help prevent yield reduction.

Nitrogen: Soybeans are high in protein and therefore in nitrogen, which removes about four lbs of N from the soil for each bushel of grain produced. This compares to less than a lb of N removed per bushel of corn grain produced. However, soybeans supply most of their own N needs by fixation of atmospheric N_2 into ammonium (NH_4+), a form that is readily available to the plant. Additional N is scavenged from the soil through organic matter cycling and rainfall deposition to supply N needs not met by the nodulation process.

Research has shown that if ammonium or nitrate is available to be absorbed from the soil when nodules are present, N-fixation will decrease proportionally. For this reason, N fertilization in soybeans rarely results in agronomic or economic yield increases when nodulation is normal and is generally not recommended. However, research in some irrigated, high-yield environments has demonstrated that N applied during the pod or seed stages of soybean development may increase yield.

Foliar Fertilizer, Banding: In studies conducted in Iowa, foliar feeding increased yields only 15 to 20% of the time. However, it may be useful when soil nutrients are inadequately supplied, such as production on sandy soils or high-yielding irrigated fields. Studies in Iowa and Minnesota with banding fertilizer close to the row have not proven beneficial. Rather, stands were reduced and yields were not improved.

Crop Rotation

Crop rotation is important in all crops to break disease and insect cycles and increase yield. Diseases, such as soybean cyst nematode, white mold, brown stem rot and sudden death syndrome, survive in the soil or in crop residue and readily attack a successive soybean crop. Most soybean diseases survive more than one or two years in the soil, so rotation does not eliminate the problem. But time away from soybeans diminishes the amount of disease inoculum available to infect the next crop and thereby lessens its severity.

Rotation studies in Minnesota and Wisconsin showed that soybeans in a corn/soybean rotation yielded 8% more than continuous soybeans. These studies were conducted in good growing environments where moisture was not severely limiting. Soybeans following five years of continuous corn yielded 15 to 17% more than continuous soybeans.

Other Practices for Increasing Soybean Yields

Tillage has long been used to bury crop residue, prepare a seedbed and control weeds. Current planting equipment and herbicides now allow growers to achieve excellent soybean stand establishment and weed control with little or no tillage. No-till or reduced till practices can help minimize soil loss and increase organic matter levels that contribute to long-term productivity. Research studies have demonstrated that soybeans yields are similar across conventional till, minimum till and no-till. For this reason, growers can choose a tillage system that makes sense economically, environmentally and logistically and focus on optimizing other management practices within that tillage system.

Weed Control: If weeds compete with soybeans for moisture, light and nutrients during the critical development period from the second trifoliate stage to beginning flowering, yield may be reduced, even if weeds are ultimately controlled. The development of more and more weed populations resistant to glyphosate makes the use of other herbicide modes of action an important component of a weed management system. Use of a pre-emergence herbicide followed by glyphosate is a system that allows for multiple active ingredients to be applied, while also controlling weeds earlier than glyphosate-only programs.

Soybean Inoculants: Newer inoculant products now offer several advantages over traditional (non-sterile, peat-based) products. New formulations deliver high populations of bacteria, on the order of 10 to 100 times more than traditional products. Use of sterile carriers prevents competition from other bacteria, and the ability to adhere to the seed has been improved. Also, newly available rhizobia strains have demonstrated improved nitrogen-fixing ability in some studies. "Extenders" prolong inoculant life when applied to seed long before planting or when a fungicide is also used.

In 2008, Pioneer studies in seven locations showed a 1.0 to 1.9 bu/acre advantage for inoculant products. In 41 DuPont Pioneer comparisons in the early 2000's, the average yield advantage for inoculants vs. un-inoculated seed was two bu/acre. University research has also demonstrated positive responses of about one to two bu/acre in general. These positive results should encourage growers to at least test new inoculant products. No-till soybeans planted in high crop residue with cooler, wetter soils may benefit most from new inoculant products.

Testing New Practices on Your Farm

Many growers may want to test various planting practices, seed treatments or inoculants, fertility options, or other factors prior to using them in full-scale production. Below are some tips for conducting your own treatment comparisons:

- Identify objectives: what do you want to measure and why?
- Design treatments to represent a single specific practice, and be careful to control other variables.
- Pick a uniform site to conduct the comparison, but do not always choose the most productive soil by default.
- Be sure the plot is large enough to identify small differences but not so large as to make weighing it difficult.
- Position comparisons in the field so all treatments have an equal chance. Replicate if possible.
- Measure yield, but also record other supporting observations.
- Do not depend solely on results from one location and one year. When possible, consider results over several years and locations.
- To compare two treatments across an entire field or field area, use the split-planter comparison tool of DuPont Pioneer. See your local Pioneer sales rep for details on this procedure.

[1] Photo of potassium deficiency in soybeans courtesy of Robert Mullen, Ohio State University.

Planting Timing and Variety Maturity Effects on Soybean Yield 2012

Objective

- Compare yield of adapted maturity and later maturity soybean varieties at early and late planting timings in Ontario.

Study Description

Plot layout: Field-length strips
Replicates: 1-2 per location
Locations: 5 locations in Ontario
Factors:
Planting timing: Early (before May 10)
Late (10-14 days after early planting)
Variety maturity: Adapted maturity vs. later maturity

Pioneer® brand soybean varieties:
91M01 (RR) and 91Y61 (RR) – 3 locations
91Y61 (RR) and 92Y12 (RR) – 2 locations

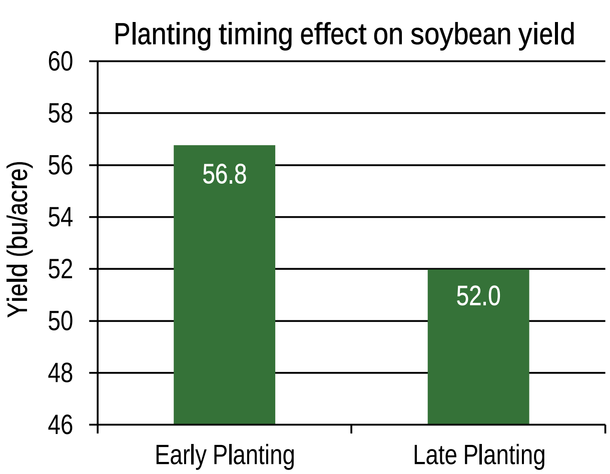
Soybeans on the left planted May 10; soybeans on the right planted May 30. Early-planted soybeans were at 3rd trifoliate on May 31 and started to flower with 6+ trifoliates on June 21.

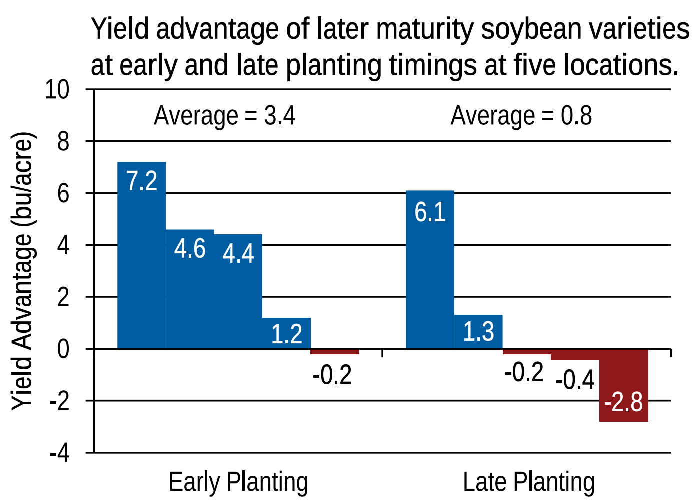
Plans for 2013

- This study will be repeated in 2013 across Eastern Canada. If you are interested in participating, please contact your local Pioneer Sales Representative.

Results

- Soybean yield was significantly affected by planting timing. Early planting resulted in an average yield increase of 4.8 bu/acre compared to late planting.
- Soybean variety maturity did not have a consistent effect on yield at either planting timing. Results suggest the possibility of a greater yield advantage with later maturity varieties at early planting compared to late planting; however, the effect was not statistically significant in this study. This will be explored further in 2013.





RR - Contains the Roundup Ready® gene. Roundup Ready® is a registered trademark used under license from Monsanto Company.

AGRONOMY SCIENCES
RESEARCH UPDATE

DUPONT
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Acapela™ Fungicide Application Effect on Soybean Yield 2012

Background and Objective

- DuPont™ Acapela™ fungicide is a new and advanced strobilurin fungicide for disease control in cereals, corn, soybeans and dry edible beans. Acapela provides broad-spectrum disease control with superior uptake, movement and post-infection properties.
- On-farm trials were conducted in Ontario, Quebec, and Manitoba in 2012 to determine yield response of soybeans treated with Acapela fungicide compared to untreated soybeans.

Acapela fungicide on-farm trial locations in 2012.

Study Description

Plot Layout: Field-length strips
Replicates: 1-2 per location
Locations: 45 locations in Ontario, Quebec and Manitoba
Treatments: Acapela, untreated

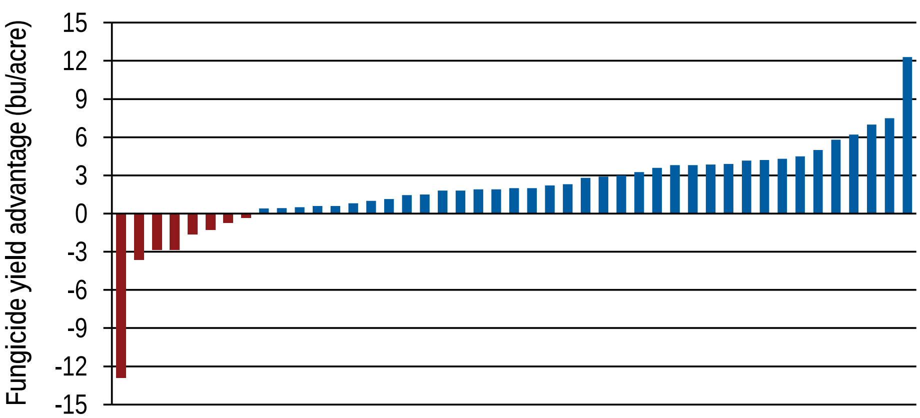
- Treatments were compared on the same soybean variety within a location.
- Soybean maturities ranged from group 00 to 3.

Disease	Rate	Acapela Application Information
White mould (suppression)	0.35 L/acre	Initial preventative application at R1 (beginning bloom). Follow with 2nd application 7–10 days later at R2 (full bloom). Apply in a minimum volume of 10 gal/acre. Penetration of spray droplets into the lower canopy is critical to achieve optimum efficacy. Ensure spray volume and spray pressure are optimized to achieve thorough coverage.
Frogeye leafspot, Septoria Brown spot	0.24 L/acre	Apply at R2 (full bloom) stage of development. Apply in a minimum volume of 10 gal/acre.

Results

- Soybean yield was increased by an average of 2 bu/acre with Acapela fungicide treatment across 45 on-farm trials.
- A positive yield response was observed in 82% of trials (37 of 45).

Soybean yield response to Acapela foliar fungicide application in 45 on-farm trials



- Results were similar to those of a recent survey of Pioneer on-farm foliar fungicide trials conducted in the U.S. and Canada from 2007-2011 that found an average yield response of 2.5 bu/acre, with a positive yield response in 82% of the trials.

PIONEER® brand products are provided subject to the terms and conditions of purchase which are part of the labeling and purchase documents. 2012 data are based on average of all comparisons made in 45 locations through November 2, 2012. Multi-year and multi-location is a better predictor of future performance. Do not use these or any other data from a limited number of trials as a significant factor in product selection. Product responses are variable and subject to a variety of environmental, disease, and pest pressures. Individual results may vary. All products are trademarks of their manufacturers.

Stink Bug Damage to Soybeans

Stink bugs are found throughout the temperate and tropical areas of the world and are pests of many crops. In North America, plant-feeding stink bugs are most often associated with soybean, corn, tobacco, peaches, crucifers, tomatoes, small grains, red clover and cotton. They can also be found feeding on many weed species.

Species, Identification and Life Cycle

Redbanded stink bug.

In the US, many species of stink bugs are found, and several can infest soybean fields. The green stink bug, *Acrosternum hilare*, is the most common, but the brown stink bugs, *Euschistus* spp., can also be found attacking soybean pods and seeds. Stink bugs are typically more of a problem in the Southern states, and additional species are found there. This includes the southern green stink bug, *Nezara viridula*, and the redbanded stink bug, *Piezodorus guildini*. The southern green stink bug can be distinguished from the green stink bug by a more rounded spine between its hind legs. The redbanded stink bug has a distinct red band across its back.

Green stink bug nymphs have a flashy display of black, green and yellow or red colors on their backs and short, stubby, non-functional wing pads. The green stink bug adults are large (approximately 5/8 inch in length), light green and shield-shaped with fully developed wings.

Stink bug nymphs emerging from eggs.

Stink bugs go through a simple metamorphosis, which includes egg, nymph and adult stages. During warm months, female stink bugs lay eggs, which are stuck in clusters to leaves and stems. After hatching, the wingless nymphs molt several times before becoming full-sized, winged adults.

Green stink bug adult (green-colored) and nymphs (multi-colored) on soybean pods.

Large nymphs or adults are the overwintering stage. Stink bugs normally complete only one life cycle per year in the northern states, one to three in the Midwest and two to five in the South, depending on species and location.

Crop Damage and Symptoms

Green stink bug adult.

Stink bug nymphs and adults primarily attack the pods and seeds of soybean plants, using their piercing and sucking mouthparts to inject digestive enzymes into the plant and remove pre-digested plant fluids. Their injury may be difficult to assess before harvest because their mouth-parts leave no obvious feeding scars. However, at harvest, the damage becomes obvious. Young seeds can be deformed, undersized or even aborted, and older seeds will be discolored and shriveled.

In addition to extracting nutrients and reducing seed size, the stink bug feeding wound provides an avenue for diseases to gain entry into the pod, reducing seed quality. Affected beans may further deteriorate in storage, and the germination rate will also be reduced.

Stink bugs also feed on soybean plant stems, foliage and blooms. On close examination, the location of feeding punctures can be identified by the presence of small brown or black spots.

Indirectly, feeding damage by stink bugs can delay plant maturity and cause the abnormal production of leaflets and pods. This condition is referred to as "green stem syndrome."

Soybean field with stink bug feeding showing green stem syndrome.

Irregular shaped areas or patches in the field remain green with the rest of the field maturing normally. Plants within green areas tend to have green leaves, petioles and stems. Plants may have few pods or may have pods at most nodes, but pods are small, dried and contain few, if any, seeds.

Scouting Technique[1]

Use the drop-cloth technique in row plantings and the sweep-net technique for narrow row and drilled beans.

The drop-cloth method involves using a 90 cm (36 in.) long piece of white cloth positioned on the ground between two rows of soybeans. Vigorously shake the plants over the cloth in each of the two rows. Count the number of adults and nymphs, and divide the number by 6 to obtain the average number of stink bugs in a 30-cm (1-ft.) row. Repeat this in at least four more areas of the field. Be careful not to disturb the plants prior to shaking them on the cloth.

Using a 38-cm (15-in.) diameter sweep net, take 20 sweep samples (in a 180°-arc sweep) in five areas of the field. Determine the average number of adults and nymphs per sweep by dividing the total count by 100.

Action Threshold

Control may be warranted in IP food grade and seed soybeans if an average of one stink bug per 30 cm (1 ft) of row or 0.2 bugs per sweep is found during the late R5-R6 stages.

Management Strategies

- Apply foliar insecticide if thresholds are reached.
- Be aware of the preharvest intervals for products.
- Some natural enemies parasitize or feed on stink bug eggs.

[1] Scouting technique, action threshold and management strategies taken directly from, "*Insects and Pests of Field Crops: Soybean Insects and Pests*" - OMAFRA , 2011. Online at: http://www.omafra.gov.on.ca/english/crops/pub811/13soybean.htm#green.

Brown Marmorated Stink Bug (BMSB), A New Pest of Soybeans in Many Areas

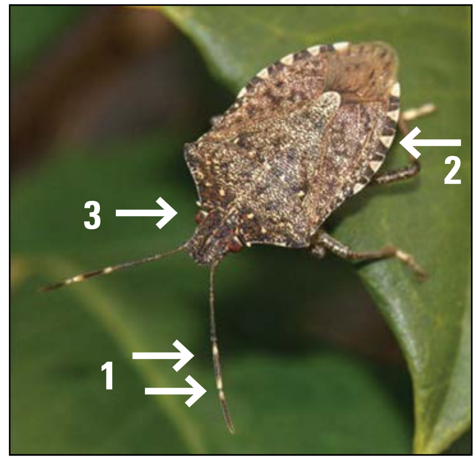
The brown marmorated stink bug, *Halyomorpha halys*, is a relatively new pest of soybean. Introduced to the mid-Atlantic region of the US in the late 1990s from Asia, this species is dispersing broadly across the US. In fact, it has now been confirmed in all states east of the Mississippi and also in Minnesota, Iowa, Nebraska, Arizona, California, Oregon and Washington.

Although this insect may not develop as a significant pest until five or more years after detection in a region, it is here to stay and will have to be dealt with along with other stink bug species. Few natural enemies exist for this insect in North America, partially because it is distasteful to predators.

Hosts for brown marmorated stink bug include over 20 tree, shrub, and small fruit species and many vegetables and field crops, including corn and soybeans. Typical of other stink bugs, brown marmorated stink bug (BMSB) emits a pungent odor when disturbed.

Soybeans are vulnerable to yield loss after R3 and may develop green stems and mature improperly. Seed quality can be negatively impacted.

Identification and Differentiation from Brown Stink Bug



Brown marmorated stink bug. (Jeff Wildonger, USDA-ARS-BIIR).

1. BMSB has distinct doubled white bands on antennae. On brown stink bug (BSB), white band is single or non-existent.
2. BMSB has a broad white pattern on abdomen. Pattern is narrow on BSB.
3. BMSB has red compound and simple eyes. BSB has brown or black eyes.

Additional Management Considerations for BMSB

- Scout soybeans from R2 till mid-August.
- Scout field edges especially, and treat them separately if warranted.
- In soybean, the threshold is 2.5 to 3.5 brown marmorated stink bugs every 15 sweeps.
- Populations will be highest at dusk and dawn, and reinvasion is possible after a pesticide treatment.
- Many insecticides are labeled for stink bug control; however, BMSB may be more tolerant of many pesticides than other stinkbugs.
- Nymphs are more sensitive to insecticides than adults.
- Check local control recommendations, and always read and follow label instructions.

Notes

Stair Steps to Quality Silage: DuPont Pioneer Inoculant Development

Inoculating silage crops is a critical component in fermentation success. Bacterial inoculants have been around for many years, but only recently have the efforts of microbiologists been employed to improve on the original strains used in the industry. Today, advanced bacterial inoculants from Dupont Pioneer are designed to perform in a variety of fermentation environments. These modern inoculants are capable of delivering a higher level of performance in protecting, preserving and enhancing the quality of silage during all phases of fermentation and feedout.

In the world of bacterial inoculants, there are two key families of bacteria that are used for silage crops, namely *Lactobacillus plantarum* and *Lactobacillus buchneri*. Extreme differences exist between these two families as well as within each family. These differences influence fermentation success and the ability to perform well under different environments.

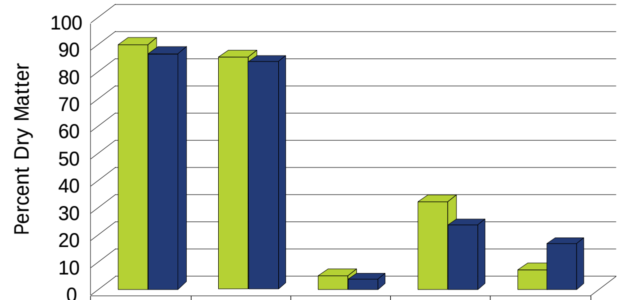
DuPont Pioneer microbiologists have been working since 1978 to understand these differences and have developed the scientific capabilities to screen, quantify and evaluate bacterial strain combinations as well as test performance in the field. This scientific capability has led to a continuous progression of new bacterial inoculants designed to be compatible with the major silage crops in the world.

Today, Pioneer® brand silage inoculants are very efficient at fermentation, resulting in enhanced dry matter recovery of silages during both early fermentation and feedout. These inoculants are designed to be crop specific and to enhance the nutrient value of the ensiled crop. The end result is improved animal performance and feed cost savings.

Step 1: Control Fermentation

The process of fermentation is both biological and chemical in nature. One of the most fundamental chemical activities that occurs is the production of acids that reduce silage pH. Lowering silage pH together with oxygen elimination prevents spoilage organisms from growing and thus stabilizes the silage. Without the addition of a bacterial inoculant designed to control this process, only naturally occurring epiphytes are available to produce these acids and lower pH. Although the end result may be an ensiled crop, the cost of allowing the natural bacteria to ferment the crop can be extremely high.

The initial fermentation process is accomplished when homo-fermentative bacteria (*L. plantarum*) convert sugars (energy source) to lactic acid. Naturally occurring bacteria are typically very inefficient during this process and consume more energy than is required of the most efficient *L. plantarum* strains. Pioneer® brand inoculants have been developed to contain the most efficient strains of bacteria available. These efficient strains help to reduce the "energy cost" of preservation. These energy savings directly translates to reduced shrink and allows for greater dry matter recovery of three to five percent during the initial phase of fermentation (Figure 1).



	Treated	Control	Difference	% Difference	Cents/Cow per Day Savings*
Alfalfa	90.0	85.1	4.9	32.2	7
Corn Silage	86.7	83.4	3.3	23.2	17

Figure 1. Dry matter recovery of Pioneer brand inoculated and control silage in university studies, 1981-1995.

Step 2: Right Bacteria, Right Crop (Target Specific Crops with Inoculants)

Bacterial inoculants are designed to work best with specific crops. In studying bacterial strains that improve front end fermentation, Pioneer microbiologists discovered that some strains of bacteria were better for corn, others were better for alfalfa and still others worked better for grasses. Matching strain and crop helps drop the pH level more quickly and allows more efficient preservation of dry matter than before. Using this approach, Pioneer® brand 1132 for corn silage, Pioneer® brand 1189 for high moisture grain and Pioneer® brand 11H50 for alfalfa silage were developed to meet specific crop needs (Figure 2).

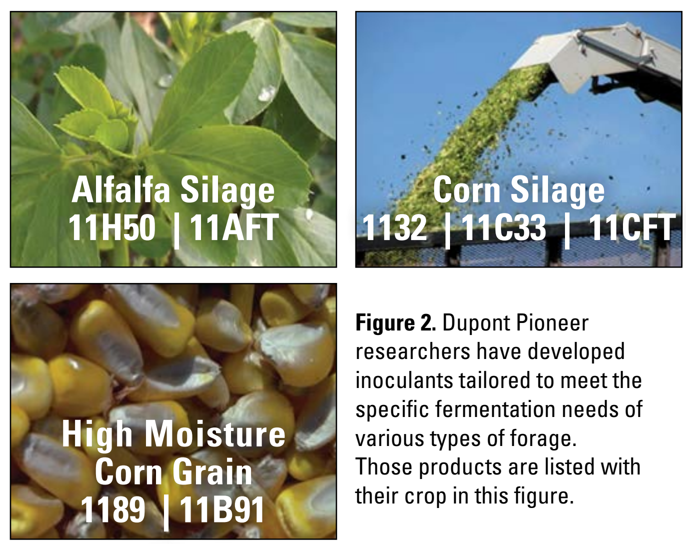


Figure 2. Dupont Pioneer researchers have developed inoculants tailored to meet the specific fermentation needs of various types of forage. Those products are listed with their crop in this figure.

Step 3: Manage Aerobic Stability at Feedout

The ability to deliver fresh feed from the silo to livestock is critical. When silage is re-exposed to oxygen at feedout time, the aerobic organisms present in the silage begin to grow again. These organisms are typically yeasts and mold-producing fungi. When they grow, they consume energy, often resulting in heating that is very costly in both the quantity and quality of fed silage. In fact, one of the primary energy sources for growth of yeasts and fungi is lactic acid. As these organisms consume lactic acid, pH rises again and even more damage can occur to silage, resulting in moldy, lower energy feed.

In the 1990s, Dupont Pioneer researchers identified strains of *Lactobacillus buchneri* that could be put in combination with crop-specific, fermentation-controlling bacteria that dramatically improves aerobic stability (bunk life). These inoculants provide on average 100 more hours of stability (time before heating occurs) than untreated silage (Figure 3).

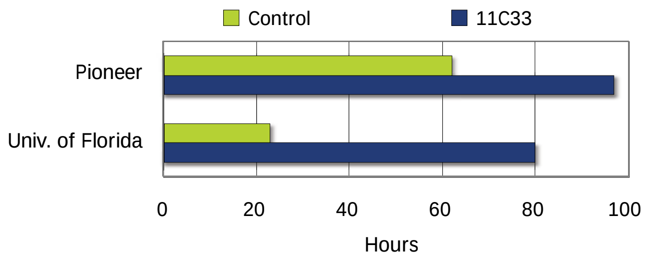


Figure 3. Aerobic stability: time required to increase silage temperature by 5°F after exposure to air.

L. buchneri is a hetero-fermentative species and will typically produce 50% lactic acid and 50% acetic acid. Acetic acid is a weaker acid than lactic acid, so it will lower the pH at a slower rate and the final pH is typically slightly higher. However, acetic acid is a very good yeast inhibitor and reduces heating and the resulting losses during feedout. By preventing yeast formation, the resulting feed is more consistent and stable while maintaining high forage quality.

Today, Pioneer offers inoculant technology that combines *L. plantarum* strains that produce lactic acid with *L. buchneri* strains that produce acetic acid to preserve quality from initial storage through feedout. These combination inoculants are designed for each crop species being ensiled and include Pioneer® brand 11C33 for corn, Pioneer® brand 11B91 for high-moisture corn and Pioneer® brand 11G22 for grass and alfalfa.

Step 4: Enhance Fiber Digestibility and Nutrient Availability

The most recent innovation in bacterial inoculants from Pioneer has targeted enhanced fiber digestibility and nutrient availability of the ensiled crop. Researchers discovered a unique strain of *L. buchneri* producing two key enzymes (ferulate and acetyl esterase enzymes) that improve silage quality, especially the digestibility of fiber.

Grass and legume plants contain three primary structural components to help them stand – lignin, cellulose and hemicellulose. Lignin bonds with the cellulose and hemicellulose. However, lignin is indigestible in ruminant animals and will pass through along with some of the cellulose and hemicellulose. As a result, animals cannot take full advantage of the energy in the cellulose and hemicellulose. The enzymes produced by the unique *L. buchneri* strains found in Pioneer® brand Fiber Technology inoculants can separate the lignin from the cellulose and hemicellulose, allowing rumen microbes to use these two fiber sources as energy.

A 2009 to 2010 study by Canadian researchers at the Lethbridge Research Centre (Agriculture and Agri-Food Canada, Lethbridge, Alberta) shows the results of Fiber Technology on animal performance. When beef cows were fed barley silage treated with Pioneer® brand 11GFT inoculant, the treated silage improved aerobic stability and feed efficiency. Steers consuming 11GFT-treated barley gained more weight per pound of ration with an overall feed efficiency improvement of 8.9% (Table 1).

Table 1. Results from Lethbridge (AAFC) Barley Silage Feeding Trial (Addah, et al., 2011).

Fermentation	Control	11GFT	Advantage
Silage pH	3.99[a]	4.43[b]	
Lactic acid %	7.40[b]	3.85[a]	
Acetic acid %	1.73[a]	4.24[b]	
Lactic: Acetic acid ratio	4.3	0.9	
Aerobic stability (days)[1]	6	21	+15 days
Animal Performance	**Control**	**11GFT**	**Advantage**
Animal start weight (lbs)	535	534	
Dry matter intake (lbs/day)	16.80[b]	15.74[a]	-1.06
Gain (lbs/day)	2.84	2.89	0.04
Feed conversion (Gain/DMI)	0.169[a]	0.183[b]	-0.014 units

[1] Times in days for silage to rise above ambient temperature.

[a, b] Treatment means within a row significantly different ($P<0.05$).

With Fiber Technology inoculants, ruminant animals can take advantage of lignin-bound energy, and livestock operations will need less supplemental energy from corn grain, soybeans or some other energy source. Many livestock operations can save a substantial amount of money on rations by dropping the amount of costly supplemental energy feed ingredients they need to provide.

Pioneer offers three products with Fiber Technology: Pioneer® brand 11CFT for corn silage, Pioneer® brand 11AFT for alfalfa silage and Pioneer® brand 11GFT for grass silage.

With high feed costs for animal operations, preserving, protecting and enhancing silage quality is more important than ever. Great silage experiences depend on several key factors: proper silage moisture, elimination of oxygen, efficient reduction of silage pH, aerobic stability and enhanced forage digestibility at feedout, and prevention of losses due to yeasts and molds on feedout. The best way to manage these factors involves checking moisture prior to harvest, good packing, and the use of an *L.buchneri* inoculant.

References

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Harvesting Earlage and Snaplage Silage - Insights for Success

Dairy and beef producers have recently adopted a new method of harvesting high-moisture (HM) grain as earlage or snaplage (in this article, snaplage and earlage are used interchangeably). This high-moisture grain product is the result of harvesting the whole ear including husks, cob, ear shank and grain. It is harvested by attaching a corn snapper head to a forage chopper with a kernel processor onboard. This equipment allows for one-step harvest and kernel processing and results in substantial time and fuel savings compared to other methods.

Harvesting earlage increases yield by 10 to 15% compared to harvesting only the HM grain. Earlage will have intermediate feed value to HM grain and corn silage. Quality of earlage depends on how much cob, husk and leaves are included in the final harvested product. In most cases earlage will have NEL more similar to HM grain than corn silage.

Achieving high earlage yields with the highest levels of energy and starch availability is the goal of harvesting earlage. This article will discuss key management techniques for successful harvest of high quality earlage.

Table 1. Average nutrient composition in HM ear corn (100% DM Basis).

Component	Protein %	Starch %	NDF %	Ash %
Grain	9.87	68.99	7.82	1.44
Cob	1.92	-	84.29	1.32
Husk/shank	4.00	-	78.97	3.81
Whole ear	8.23	52.14	23.74	1.56

Proportions (on a dry-weight basis) of a corn plant at maturity:
Grain: *45.9%* Stalk: *27.5%* Leaf: *11.4%* Cob: *8.2%* Husk: *7%*

Harvest Moisture is Key to Success

- Harvest moisture is the biggest key to success with earlage or snaplage. When harvest moisture is ideal, it increases harvest efficiency and maximizes yield and earlage processing. This results in better fermentation success and maximizes earlage quality and starch availability.
- Ideal harvest moisture is between 36 and 42% for the final snaplage or earlage product (kernel moisture will be at about 34 to 36% at this stage). At this moisture, corn is physiologically mature (black layer is just evident) and maximum starch production has occurred. In addition, the digestibility of the cob is high. Research shows that cob digestibility declines rapidly as drydown occurs.
- If snaplage moisture content gets below ~35%, consider switching to harvesting only the grain as HM corn. This helps prevent potential feeding and digestibility concerns.

Equipment and Equipment Adjustment for Earlage or Snaplage

- Technically, earlage includes only grain and cob and is harvested with a combine adjusted to retain the cob portion after going through the rotor or shelling part of the combine.
- Snaplage is the harvest of whole ears including husks, shanks, cob and some leaves. This product is harvested with a snapping head mounted on a forage chopper. Most major manufacturers of forage chopping equipment also make snapper heads. There are also compatible aftermarket snapper heads available for purchase, especially for self-propelled choppers.
- As with all equipment operations, set up and adjustment can have a large influence on the quantity and quality of the harvested product. For snaplage, it is critical to retain corn ears, shanks and some leaves, but avoid harvesting excessive leaf or stalk material. In addition, the leaves that are harvested should be cut up or shredded rather than having long leaf strands in the mixture.
- Adjust equipment to maximize kernel and cob damage. This is accomplished by using a very short chopping length and using fine-toothed rollers adjusted 2 to 3 mm apart. Also, the differential speed of the rollers may need to be set higher with snaplage than for silage. All corn kernels should be cracked, and cob pieces should be smaller than your thumbnail. As always, consult your owner's manual for proper adjustment information.

Storage, Fermentation and Feedout

- Snaplage and earlage are high moisture silages that are stored in silos and preserved through fermentation. All types of silos can make good storage structures for snaplage when proper silage storage principles are followed.
- Pack earlage properly to exclude oxygen quickly. Because snaplage is mostly grain, it will achieve a higher density than corn silage and should pack more easily. Use key packing strategies, including thin layers and adequate tractor weight when packing silo bunkers.
- Cover bunkers and silos quickly after filling to prevent oxygen penetration into the silo. Use several layers of plastic when possible, and use tires to hold it down tightly to the packed snaplage.
- Use Pioneer® brand 11B91 HM grain inoculant for best results in fermentation and in maintaining aerobic stability on feedout. This is a high value feed and 11B91 inoculant will help reduce the risk of shrink loss associated with fermentation and feedout.
- For silage bags, monitor plastic for holes and repair as quickly as possible to avoid oxygen penetration into the bag. Check for evidence of wildlife activity around silage bags.
- On feedout, maintain high feeding rates and a clean silage face. This helps to avoid losses due to heating and spoilage.

Performance of Pioneer® Brand Products

Data collected from a 2005 earlage study in LaSalle, Colorado, demonstrates how harvest date can affect grain components and nutrient composition. Table 2 shows that average grain percentage generally increased between the first and last harvest date, and was nearly maximized by the third date. During this same time, cob percent declined from 18 to 14% while husk and leaf percentage remained the same. Hybrids showed some variability for grain percentage over time.

Table 2. Percent grain in HMEC by Pioneer® brand hybrid.

Harvest Date	35A30	34A86	35Y65	35D28
Sept 13	77.2	70.8	70.3	73.6
Sept 20	78.2	73.7	74.7	73.3
Sept 27	82.3	75.6	76.8	74.4
Oct 4	82.2	77.6	77.5	75.4

In this same study, the NDF content was measured for each harvest period. Here we can see the dramatic increase in NDF content of the cob and to a lesser extent the husk and shank with later harvest periods. Keeping non-grain components of snaplage highly digestible is best achieved by maintaining higher moisture content.

Table 3. Percent NDF in HMEC by harvest period (100% DM Basis).

Component	Sept 13	Sept 20	Sept 27	Oct 4
Grain	7.55	8.03	7.89	7.82
Cob	78.92	84.58	85.81	87.86
Husk/shank	76.78	78.51	80.01	80.06
Whole ear	23.53	23.40	23.30	24.74

In 2012, several growers in Wisconsin harvested side-by-side plots of Pioneer® brand corn products as snaplage. The data is presented in Table 4 and provides some insight into the harvest and yield of key corn hybrids for this area in 2012.

Overall, snaplage yields were very good and differed by location. The variation in starch content, NDF, CP and Invitro Starch Digestibility is likely a result of different harvest equipment setup and environmental conditions. These products were very similar in maturity and produced a similar end product. Harvest ease was evaluated by the operator and very few differences were noted among hybrids.

At each location, the product with the highest harvest moisture also had the highest Invitro Starch Digestibility percentage. This indicates in part that the kernels were likely more easily broken and more finely ground.

At two locations, a sample of five ears were harvested, hand shelled and ear components weighed. The grain percentage was very similar among products and between the two locations ranging from 82 to 84%.

Table 4. 2012 Wisconsin Snaplage Trial Pioneer® brand Products.

Coleman, WI – Harvested: 9/12/2012							
Product	Earlage Yield[1]	%[2]	Earlage Moist.%	CP %	NDF %	Starch %	Starch Digest.[3]
P9910AM1™[4]	6.11	102	34.9	8.3	14.8	61.6	63.0
P9917AM1™[4]	5.95	99	35.6	8.3	16.8	59.1	62.4
P9807HR[5]	5.45	91	38.2	8.1	15.9	59.2	66.8
P9748HR[5]	5.94	99	39.5	8.3	14.1	62.5	69.3
P9630AM1™[4]	5.80	97	31.7	8.5	13.7	63.3	60.1
P9519AM™[6]	5.87	98	34.8	8.7	17.0	60.9	64.3
Average	5.85		35.8	8.4	15.4	61.1	64.3
Mosinee, WI – Harvested: 9/13/2012							
Product	Earlage Yield[1]	%[2]	Earlage Moist.%	CP %	NDF %	Starch %	Starch Digest.[3]
P9910AM1™	6.58	101	38.5	7.7	15.4	60.7	68.9
P9807HR	6.43	99	39.8	8.1	14.0	62.6	71.5
P9748HR	6.26	96	37.0	8.4	13.4	63.3	69.2
P9519AM™	6.41	99	36.4	8.9	13.2	63.1	65.5
Average	6.42		37.9	8.3	14.0	62.4	68.7
Dorchester, WI – Harvested: 9/21/2012							
Product	Earlage Yield[1]	%[2]	Earlage Moist.%	CP %	NDF %	Starch %	Starch Digest.[3]
P0115AM1™[4]	6.73	96	31.8	7.8	11.1	65.9	58.0
P9910AM1™	6.67	95	29.0	7.9	10.6	66.1	54.2
P9675AM1™[4]	7.33	105	28.5	8.2	14.2	64.0	53.4
P9630AM1™	7.11	102	27.2	8.1	12.9	64.1	55.5
P9519AM™	7.31	105	29.0	8.2	18.0	59.2	55.1
P9411AM1™[4]	7.26	104	27.7	8.4	13.2	63.2	55.3
Average	7.07		28.9	8.1	13.3	63.8	55.3

[1] Tons/acre at 35% moisture.

[2] Earlage yield as a percent of P9910AM1/P9519AM.

[3] In vitro starch digestibility, 7 hour.

[4] Traits = (AM1, LL, RR2) | [5] Traits = (HX1, LL, RR2) | [6] Traits = (AM, LL, RR2)

Conclusions

- Earlage or snaplage continues to grow in popularity because it allows the production of a high-energy feed product that is easily harvested, stored and fed. For livestock producers, harvesting corn as earlage or snaplage eliminates grain drying costs and produces an excellent feed for ruminant animals.
- Harvesting high moisture grain as earlage or snaplage results in 15 to 20% higher yields per acre than harvesting only HM grain. Also, it is similar in quality and energy availability.
- Harvest moisture is a big key to success with earlage or snaplage. Targeting 38 to 42% final moisture helps maintain high yields and high quality.

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Are You Shorting Potassium in Your Forage Fertility Program?

Good forage crops place a high demand for potassium (K) on the soil's nutrient-supplying power. Potassium is critical for alfalfa and corn silage in order to achieve high yields and quality that maximizes animal performance and profitability.

In recent years, the price of potash (K_2O) has risen to very high levels and is characterized by greater volatility than in the past. During the years of extremely high potash prices and challenging grain or milk prices, growers have pulled back on applying full rates of K.

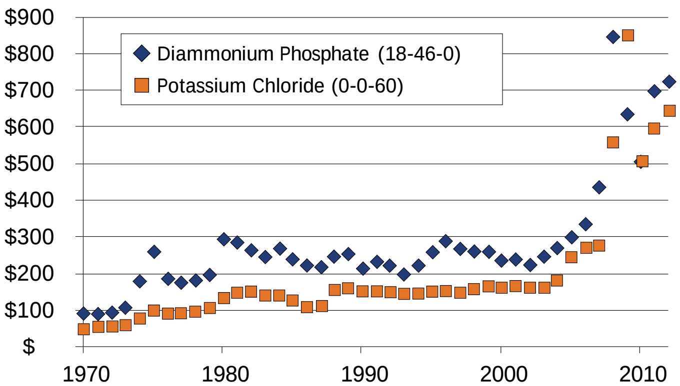

Figure 1. Average US Farm Prices of K-containing fertilizers from 1970-2012 ($ / ton). Source: USDA Economic Research Service - Fertilizer Use and Price, 2012.

Soil potassium levels have also been influenced by a transition to more corn silage acres and higher yields of corn silage and alfalfa on dairy farms. Higher yields result in higher K removal rates from the field. Many growers have not adjusted their K fertility programs for these changes.

Role of K in Alfalfa and Corn Plant Growth

Both alfalfa and corn require potassium for proper growth and development. Potassium plays an indirect role by acting as a catalyst regulating enzymatic processes in the plant.

Corn leaves showing potassium deficiency, as indicated by yellowing and necrosis of the leaf margin.

Photosynthesis, cell division, carbohydrate production, protein synthesis, root development, and tolerance to temperature extremes are all influenced by K. Potassium can also improve the crop's tolerance to drought by regulating water use and can minimize susceptibility to disease.

Healthy, high-yielding alfalfa crops require adequate potassium.

In alfalfa, potassium is responsible for helping the plant withstand extreme cold temperatures during the winter months. It also helps with the critical process of nitrogen fixation and nitrogen utilization by the growing plants. For alfalfa production, proper fertility must be teamed with a quality liming program to take full advantage of applied nutrients.

In corn, potassium deficiency can shorten the duration of leaf photosynthesis during the season and reduce the transport of nutrients and sugars within the stem. As a result, plant integrity is compromised, starch formation is hindered, and use of N is limited. Lodging of corn or small grains is often related to low K levels through reduced stalk strength and higher incidence of stalk disease.

The real value of potassium to crop plants is most evident in times of stress. Adequate and balanced nutrition maintains a plant's vigor and reduces its vulnerability to stress. When in proper balance with nitrogen, phosphorus, sulfur and other micronutrients, sufficient potassium ensures high yields of quality forage.

Drought and Potassium Availability

Growers testing soil for K following the 2012 summer drought may be surprised at below-average soil test levels.

Potassium becomes tightly fixed between clay layers under dry soil conditions and does not become available until water moves through the soil again. The K accumulated by corn plants will only be released when rainfall allows for residue breakdown and movement of K into the soil once again. Expect that K test levels will increase to more normal values following a significant fall rain event.

With lower than normal soil tests for K, growers will need to rely on both long-term average soil tests from each field and estimates of crop removal rates.

Soil Availability of Potassium

There are three types of potassium found in the soil. The first is found in soil minerals. This type of potassium makes up more than 90 to 98 percent of soil potassium. It is tightly bound, and most is unavailable for plant uptake. The second is non-exchangeable potassium. Non-exchangeable potassium acts as a reserve to replenish potassium taken up or lost from the soil solution. It makes up approximately 1 to 10 percent of the soil potassium. The last type is the exchangeable or plant available potassium at one to two percent. It is found either in the soil solution or as part of the cation exchange.

Soil type and environmental conditions have an effect on the amount of potassium available for plant use. Potassium availability is highest under warm, moist conditions in soils that are well-aerated with a pH that is neutral or slightly acidic. Too much water in the soil profile lowers oxygen levels, which in turn decreases plant respiration, reducing potassium uptake. In clay soils, potassium availability can be affected due to its competition with calcium and magnesium for sites on the cation exchange. Both calcium and magnesium can easily displace potassium from the cation exchange.

Crop Removal of Potassium

Both alfalfa and corn silage remove a tremendous amount of potassium from the soil profile. A corn crop takes up nearly as much potassium as it does nitrogen, yet management of each nutrient is entirely different. Managing K for corn silage production is different than for high moisture grain, snaplage or earlage harvest.

Crop	K_2O Removed per Unit*	Yield Level	K_2O Removed per Acre
Alfalfa	60 lbs per ton	10 tons	600 lbs/acre
Corn Silage	8-9 lbs per ton	25-30 tons	225-270 lbs/acre
Corn Grain	0.3 lbs/bu	200-230 bu	60-70 lbs/acre

*Source: UW-Madison. 2012. A2809 Nutrient application guidelines for field, vegetable and fruit crops in Wisconsin.

Managing Potassium for Alfalfa

For alfalfa, potassium is best applied based on yields and harvest schedule. Potassium needs increase with harvest frequency and under high yield situations. Young plants are higher in potassium content and protein level. With bud-stage harvest practices, the high quality feed is removing up to 25% more potassium from the field than at the early- to mid-flower stage.

New seedings: It is important to build up soil test K to the optimum or high range before seeding because this is the only opportunity during the life of the stand to mix the nutrients through the topsoil.

Established stands: The time at which alfalfa needs the most K is in preparation for winter. In order to boost the winterhardiness of the crop, a good supply of K needs to be added before the critical fall growth period. Potassium is needed during this period to enhance storage of soluble carbohydrates in the roots.

Applications are best made prior to the last six weeks of the growing season. Following the first hay cutting is another convenient time to apply K. Avoid applying high levels of K in the spring prior to first cut. This can lead to excessively high K concentration of first-growth alfalfa and can cause milk fever in dairy cattle.

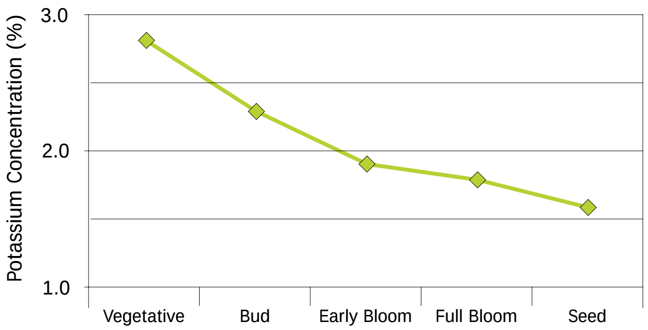

Figure 2. Potassium concentration in alfalfa plants at various growth stages. Source: Adapted from Figure 37-2, (Barton and Reid, 1977) in Lanyon, L.E. and F.W. Smith. 1985. Potassium nutrition of alfalfa and other forage legumes: temperate and tropical. In Potassium in Agriculture, ASA-CSSA-SSSA, Madison, WI.

When high nutrient application rates are needed to boost soil fertility, splitting the total required amount into two or more applications is recommended in order to avoid salt injury and luxury consumption beyond the alfalfa nutritional requirement.

Multiple applications assure potassium availability during the most critical growth periods of the season. Alfalfa potassium concentration should be maintained between two to three percent for maximum yield potential and winterhardiness. The very highest alfalfa yield crops have K concentrations as high as three percent. When K concentration drops below two percent, the alfalfa plants are much more susceptible to winter injury.

As alfalfa stands age, the response to K fertilization increases. Fewer plants per acre combined with less efficient root systems means that access to K is more limited. It is critical to continue to fertilize aging stands at a high level to maintain maximum productivity.

Managing Potassium for Corn Silage and High Moisture Grain

Corn plants take up nearly as much potassium as nitrogen, yet each nutrient is managed differently. Managing potassium is relatively simple because of the reaction of K in the soil. Potassium fertility management requires a long-term commitment to maintaining optimum soil test levels.

In addition, growers need to assess the removal rates of this nutrient in the harvested crop. Corn silage and alfalfa will remove the highest amount of K since it accumulates in the vegetative material of a growing plant. Nutrient uptake mirrors plant growth. The highest demand period for K is during the grand growth phase of corn from V6 through silking. Therefore, having high available K at this time is critical to ensuring successful plant development and growth.

Most growers will apply potassium ahead of planting or during the previous fall just prior to tillage. This is often supplemented with starter fertilizer applications in the seed zone made during planting. No matter which plant parts are harvested from the field, the growing corn plant will have the same potassium needs. The big difference is in replacement of nutrients removed; corn silage fields may take five to six times more potassium than fields where only the grain was removed.

Increased price volatility of fertilizers coupled with higher removal rates of potassium in forage crop systems has resulted in more concerns about potassium fertilization of alfalfa and corn. Many growers are experiencing crop issues that can in some cases, be the result of insufficient K fertility. Maintaining very high yields of alfalfa and corn for grain or silage requires optimum to high soil test levels of K. These levels are best maintained through a renewed emphasis on soil testing and making adjustments for K removal rates from a field. Finally, a potassium fertility program for your farms requires a balanced approach. It is important to provide all the essential nutrients in the proper amounts.

Taking It to the Field

- **Test:** Soil test your fields regularly to track K levels, especially after alfalfa and corn silage crops.
- **Calculate:** Measure or estimate annual crop removal of potassium. Account for manure and other fertilizer sources applied to the field.
- **Plan:** Make a plan to replace potassium based on removal rates, manure use and soil test level.
- **Alfalfa:** Apply twice per year – once after first harvest and once after last summer harvest.
- **Corn:** Apply needed potassium prior to planting and work into the soil.

Notes

BMR Technology - The DuPont Pioneer Difference

DuPont Pioneer brought industry-leading brown midrib (BMR) technology to the field beginning in 2011 with Pioneer® brand P1376XR (HXX,LL,RR2). This product offers an alternative corn silage option with reduced lignin content together with an agronomic and technology package for yield and stability. Pioneer is advancing proven BMR products which meet our requirements for silage yield, forage quality and plant health.

Pioneer® brand hybrid showing distinct brown midrib phenotype that develops at the V4 to V6 growth stage.

Silage yield is of primary importance to DuPont Pioneer.

- Yield of the Pioneer® brand BMR hybrid is superior or equal to competitor hybrids. Data from 2012 show better yields than nearly all Mycogen® brand BMR hybrids.
- Pioneer has three years of side-by-side data comparing our BMR hybrid to Mycogen's hybrids (Figure 1). An even larger database is available comparing Pioneer® brand conventional hybrids to Mycogen BMR hybrids.
- Due to variations in single side-by-side plots, Pioneer recommends including 20 or more comparisons of this plot type to make sound hybrid decisions.

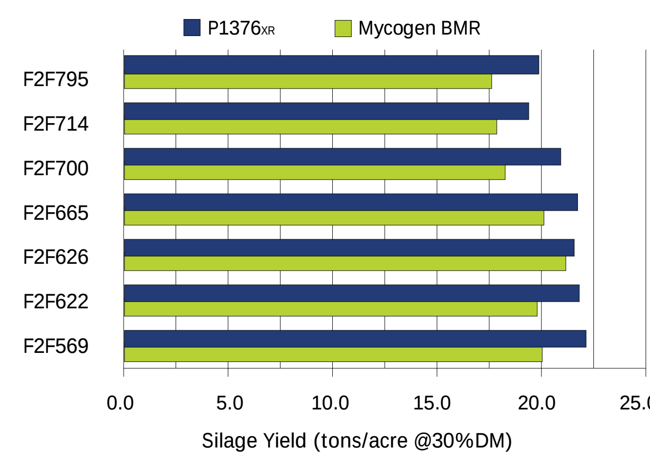

Figure 1. Silage yield comparison of P1376XR and Mycogen® brand BMR hybrids. Data based on 198 side-by-side comparisons in the northern US during 2010-2012.

- Pioneer offers conventional and BMR hybrids with top silage yields (Figure 2).

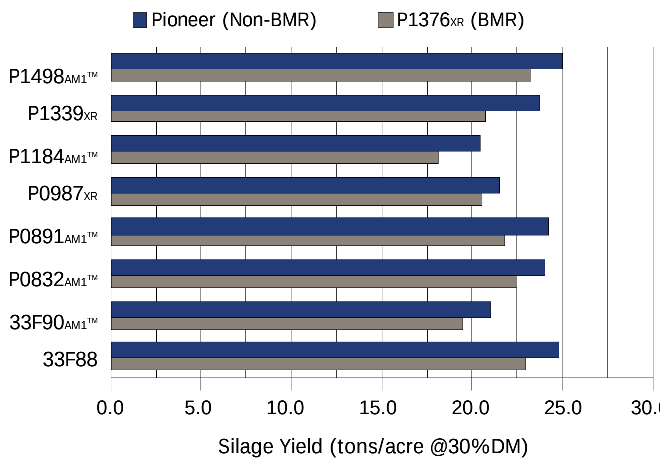

Figure 2. Silage yield comparison of P1376XR and Pioneer® brand non-BMR hybrids. Data based on 326 side-by-side comparisons in the northern US during 2010-2012.

Silage quality is essential in Pioneer® brand hybrids.

- On average, starch content of Pioneer® brand BMR hybrids is 2 to 2.5 points higher than that of competitor hybrids (Figure 3).

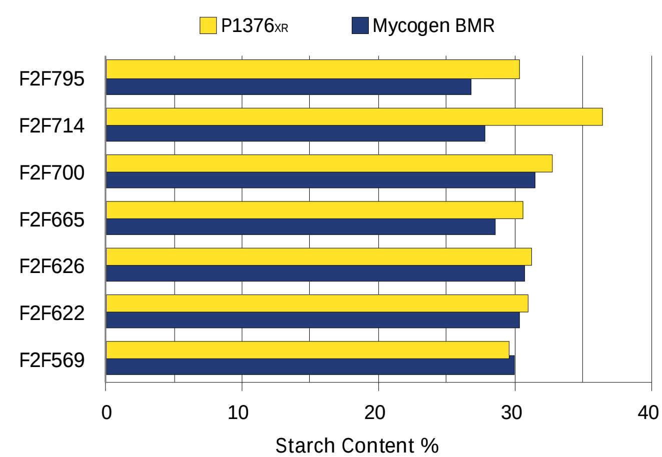

Figure 3. Starch content comparison of P1376XR and Mycogen® brand BMR hybrids. Data based on 198 side-by-side comparisons in the northern US during 2010-2012.

- BMR corn silage delivers higher fiber digestibility. Every 1% increase in NDFD equals approximately a 0.55 pound increase in milk production per cow per day.
  - Note: This conclusion was made as a result of studies* conducted by Michigan State University based on NDFD of the total ration, not on corn silage itself.
- NDFD content is at near-parity with that of our competitors (Figure 4). The data set includes NIR and wet chemistry data from third-party labs.

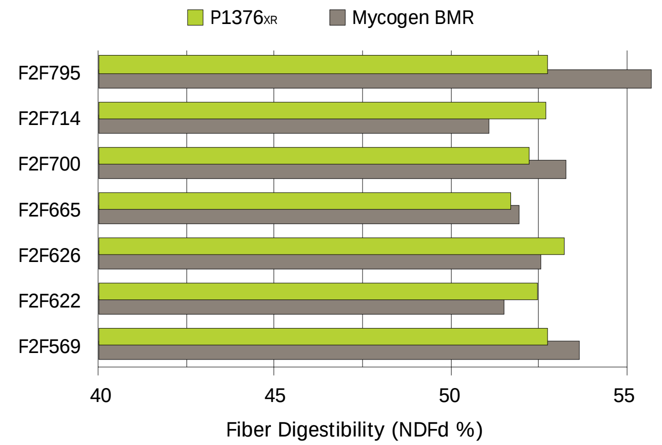

Figure 4. Fiber digestibility comparison of P1376XR and Mycogen brand BMR hybrids. Data based on 198 side-by-side comparisons in the northern US during 2010-2012.

- Pioneer expects its BMR products to have similar dry matter intake and milk performance responses as those currently on the market. Several on-farm side-by-sides in 2013 will compare P1376XR to competitive BMR hybrids and non-BMR corn silage hybrids during feedout.

Agronomic performance is critical to Pioneer.

- Seed emergence, drought tolerance, disease resistance, root strength and other agronomic traits are all important to growing a healthy, productive hybrid that can sustain yield even under stress.
- Pioneer is continuing to develop new BMR hybrids including earlier maturity offerings. These hybrids are expected to have superior agronomic traits.

Several BMR genes are available to Pioneer.

- Pioneer® brand P1376XR contains the BM1 gene mutation. Future BMR hybrids may contain either BM1 or BM3 gene mutations and will be selected based on yield performance, fiber digestibility and agronomic stability.
- Four BMR mutants exist including BM1, BM2, BM3 and BM4. Of these, corn hybrids with the BM1 and BM3 genes contain the lowest lignin levels and the highest cell wall degradability.
- There is only one known study** comparing hybrids containing BM1 and BM3 genes. Various lab methods show small differences between the two. Small cell wall degradability differences coupled with hybrid genetics and environmental factors mean the rumen microbes of the dairy cow will not show performance differences.

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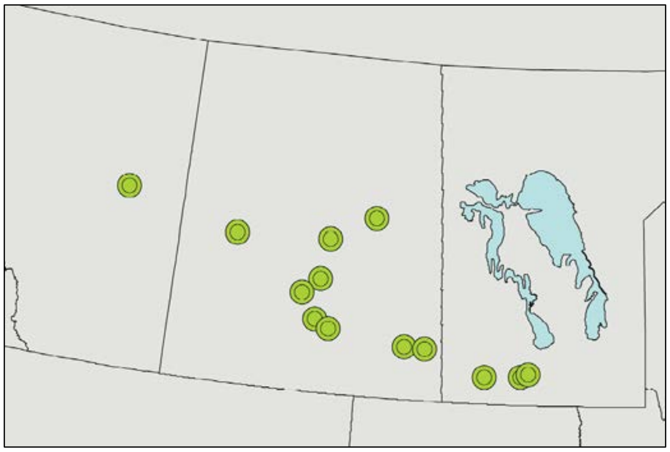
Canola Response to Decreased Seeding Rates

2012

Rationale and Objectives

Seeder technology has improved dramatically in the past 5 years. With this improvement, seeder manufacturers have recommended that seeding rates of canola can be decreased to 3 lbs/acre and still have an adequate plant stand. However, seeding rates measured in lbs/ac do not take into account differences in seed size.

If seed size is large, the recommendation of 3 lbs/acre may not be enough seed to make a proper stand of canola. Also, agronomic factors, such as maturity, weed control, lodging, swathability and harvestability, may be affected with a decreased plant stand. This study will determine if a recommendation of 3 lbs/acre is a sound recommendation when the seed size is large. It will also determine the effect of decreased seeding rates on agronomic factors.

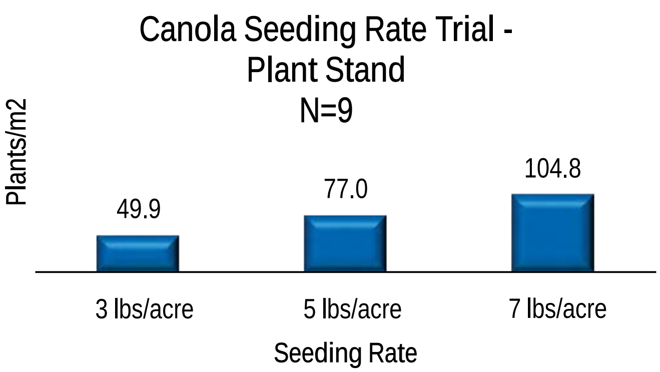


Locations of eleven field-scale seeding rate trials conducted in western Canada 2012.

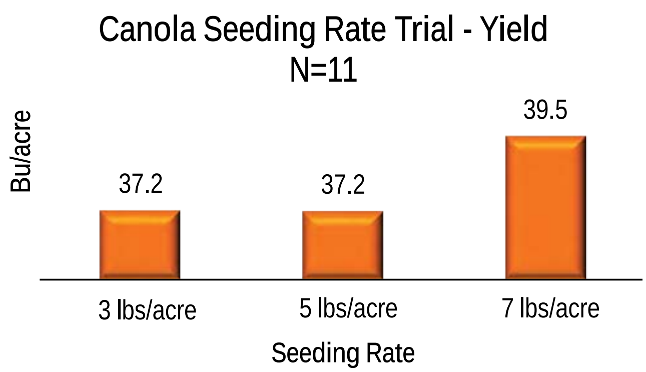
Study Description

Locations:	11 locations across western Canada
Pioneer® Brand Varieties:	45H29
Seeding Rate:	3, 5, and 7 lbs/acre
Seed Size (TSW):	5.9

Study Results



- Average plant stand increased with increasing seeding rates.



- Average canola yields were equal when seeded at 3 and 5 lbs/acre rates. An increased seeding rate of 7 lbs/acre had a yield advantage of 2.3 bu/acre in 2012 field scale trials.

PIONEER® brand products are provided subject to the terms and conditions of purchase which are part of the labeling and purchase documents. Pioneer is a brand name; numbers identify varieties and products. 2012 data are based on average of all comparisons made in 11 locations through Nov 19, 2012. Multi-year and multi-location is a better predictor of future performance. Do not use these or any other data from a limited number of trials as a significant factor in product selection. Product responses are variable and subject to a variety of environmental, disease, and pest pressures. Individual results may vary.

Study Results

A 3 lbs/acre seeding rate established an average of 49.9 plants/square meter. Fewer canola plants gave more room for weeds to establish and made weed control critical. The canola also grew larger stems and branched more in order to fill space, which also reduced harvestability. The result was a similar yield as the 5 lbs/acre seeding rate but a higher incidence of weeds and slightly delayed maturity.

A 5 lbs/acre seeding rate established an average of 77.0 plants/square meter. Having more canola plants made the crop more competitive against weeds. The stem size and amount of branching was also reduced, which improved harvestability. The result was a similar yield as the 3 lbs/acre seeding rate but with lower incidence of weeds and no delay in maturity.

A 7 lbs/acre seeding rate established an average of 104.8 plants/square meter. Having more canola plants made this seeding rate the most competitive against weeds and resulted in a slightly higher yield. The stem size and amount of branching was greatly reduced, improving harvestability. There was no delay in maturity, and the canola maturity came in more evenly.

Study Conclusion:

Yield differences between treatments were not large, but the 3 lbs/acre seeding rate resulted in some detrimental agronomic differences that are important to note: 1) Weed control was not as good as there was much more room for weeds to establish; 2) crop maturity was delayed with the lower seeding rate, as the crop had more space and resources to grow; and 3) Harvestability was reduced as larger stem sizes resulted because the canola had more space to grow. This study will be continued in 2013 with a continued focus on yield and agronomics but also an emphasis on how seeding rate can affect disease pressure in canola.

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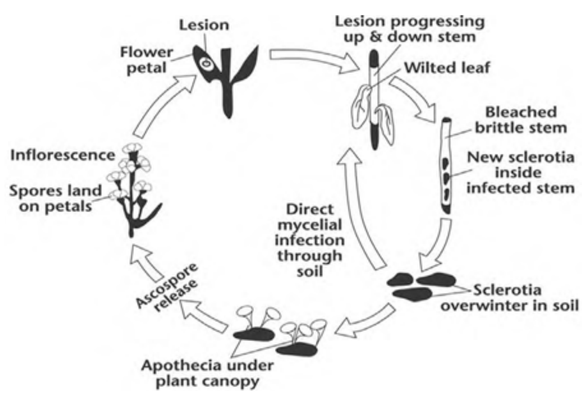
Sclerotinia Stem Rot of Canola

Sclerotinia stem rot is a disease that affects western Canadian canola on a yearly basis. Incidence and severity of the infection can be sporadic, but in high rainfall regions, it can often become severe. In addition, a host range of over 400 species of plants are known to be susceptible to sclerotinia, mostly broadleaf species. Sunflower, safflower and occasionally flax crops are quite susceptible to this disease. Mustard, field peas, beans, carrots, crambe, potatoes, lentils, soybeans, fababeans, clovers and alfalfa are also susceptible to some degree. Some weed species can also be hosts to sclerotinia stem rot and produce sclerotia after infection. Some of these common weeds include:

- chickweed
- false ragweed
- hemp-nettle
- narrow-leafed hawk's-beard
- shepherd's purse
- stinkweed
- thistles
- wild mustard

This alone emphasizes the importance of control of all weeds and also shows how sclerotinia can infest many fields through a variety of vectors.

Sclerotinia Disease Cycle



(From Canola Growers Manual, courtesy of Canola Council of Canada.)

Challenges to Successful Management

Each year can be a challenge for producers to determine whether to apply a fungicide for the disease, as well as when to spray to maximize protection. Although there are tools to help in the decision process, there is still some "guess work" needed as weather conditions prior to and during the flowering period contribute to the level of severity.

The percent of infected plants can vary due to many factors:

- plant genetics – sclerotinia tolerant canola hybrids
- differences in the quantity of infectious spores
- plant population
- crop height and vigor
- severity of lodging
- rainfall
- soil moisture
- temperature

Weather conditions prior to and during the flowering period contribute to the level of sclerotinia severity.

Heavy infections can develop with a combination of many of the above factors. Even after plants are infected, the severity of stem rot symptoms and the resulting effect on yield will vary according to temperature, rainfall, crop density and especially the stage of crop growth at the time of infection.

Heavier stands of canola tend to lodge, and infection can spread from plant to plant by direct contact, especially in wet weather. In swaths that are wet, heavy and are touching the ground, the infection can spread down the swath and can result in additional sclerotia bodies being returned to the soil at harvest, completing the disease cycle.

Originally, rotation was used to help control sclerotinia stem rot. However, with the 1-in-2 rotation of today, this is not a viable option. Sclerotia bodies can survive from 5 to 10 years in the soil, which defeats these type of rotations in managing the disease. In addition, spores may blow in from neighboring fields.

Two canola hybrids show differences in maturity. Fungicide application must be timely relative to flowering to help prevent sclerotinia infection but may still only achieve 70% protection.

Some have suggested that lower seeding rates of canola (resulting in lower plant populations and giving more air movement through the canopy) can serve to reduce the incidence as well as severity of sclerotinia development. Though this may be true in the right situation, research conducted at the Canola Council of Canada showed that lower plant populations (below five plants/ft^2) had sclerotinia incidence as high as higher plant populations (greater than 10 plants/ft²). Much of this infection can be attributed to longer exposure to sclerotinia spores in the environment as a result of the extended days of flowering associated with the multi-branching that occurs with lower plant populations.

Forecasting systems have been developed for stem rot in canola that use either petal testing, a checklist, or environmental risk maps based on environmental conditions. While no forecast system is 100% accurate, they do provide practical direction in making a decision to control the disease.

Factors Involved in Sclerotinia Forecasting

Many factors influence a forecasting system and its relationship to the actual incidence of disease. Most predictive models evaluate several environmental and crop variables such as:

- field cropping history
- field disease history
- apothecia presence
- neighboring or nearby crop and disease histories
- rainfall through months of June and July
- soil moisture
- weather forecast
- canopy density

Other important variables affecting the relationship and incidence of the disease include:

- changing inoculum levels during flowering
- heat units
- daily and weather related inoculum fluctuations
- light penetration
- leaf area index
- crop height

Field and nearby field cropping and disease history are an indirect means of measuring the potential for presence of spores. While sclerotia within the field are considered the main source of spores, those produced in nearby fields and blown into the crop can also be important in disease development.

Management of Sclerotinia in Canola

Management options for sclerotinia stem rot in canola are often limited due to the nature of the disease and the practical alternatives available. The most common control options include use of a fungicide, crop rotation and selecting canola hybrids that have genetic resistance built into the seed.

Spraying a fungicide to control the disease requires proper timing, as well as the use of appropriate water volumes to ensure maximum petal coverage for disease prevention. However, in most cases, the fungicide provides only about 70% protection. The fungicide decision typically involves much second guessing about when conditions no longer favor the growth and development of the disease.

Use of genetic resistance reduces much of the guesswork in sclerotinia management as well as helps producers maximize yield while minimizing the disease. Canola hybrids with the Pioneer Protector® Sclerotinia resistance trait provide moderate genetic resistance that can act as part of a management plan to help control sclerotinia and increase flexibility and insurance when timing fungicide applications.

Pioneer Protector Sclerotinia resistant canola hybrids include 45S51, 45S52, 46S53, and 45S54. All the Pioneer Protector Sclerotinia resistant hybrids have shown a reduction in sclerotinia levels of more than 50% (through reduction of stem incidence and transfer into the stem). In years where weather conditions are not extreme and/or where conditions are good for the early development of sclerotinia but turn unfavorable in the later flowering stages, Pioneer Protector Sclerotinia resistant hybrids can offer a level of protection against the disease and reduce the necessity to spray with a fungicide.

Pioneer Protector® Sclerotinia hybrids have in-plant genetic resistance to help protect against sclerotinia.

With these resistant hybrids, sclerotinia protection is built right into the seed, potentially providing season-long control. This in-plant trait helps protect against the disease regardless of weather patterns throughout the growing season. However, when weather conditions are extreme in promoting disease development (wet conditions in June and July, warm weather, high humidity and a heavy canopy), even the Pioneer Protector Sclerotinia resistant hybrids may warrant a fungicide application to help control the disease.

To maximize both genetic yield potential and resistance, ensure proper seeding practices with Pioneer Protector Sclerotinia resistant canola hybrids. Primarily, check that seeding rates are set to achieve plant stands ranging from 6 to 10 plants/ft² at 21 days after emergence. Plant stands higher than this can result in higher incidence of disease due to the thicker canopy created and increased lodging potential which further increases the development and severity of the disease.

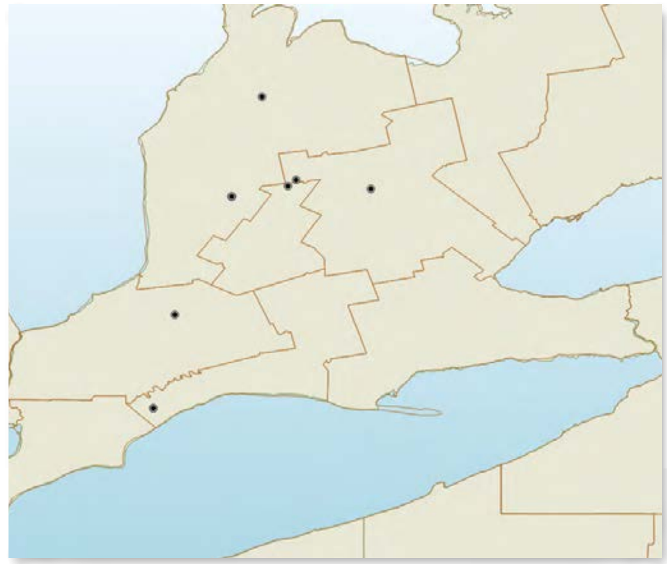
References

Sclerotinia disease cycle taken from Canola Growers Manual, page 1014c. Courtesy of Canola Council of Canada.

Yield Response of Fungicide-Treated Wheat to Nitrogen Rate 2012

Rationale and Objectives

- Previous research has shown evidence of a positive interaction between fungicide and nitrogen inputs in their effect on wheat yield.
  - Small plots trials conducted in 2008-2010 found a greater yield response to nitrogen fertilizer rate in fungicide-treated wheat than non-treated wheat.
- Field-scale on-farm trials were conducted in 2012 to determine the yield response of wheat treated with fungicide to nitrogen fertilizer rate.



Locations of seven field-scale nitrogen rate trials conducted in southern Ontario in 2012.

Study Description

Locations: 7 locations across southern Ontario

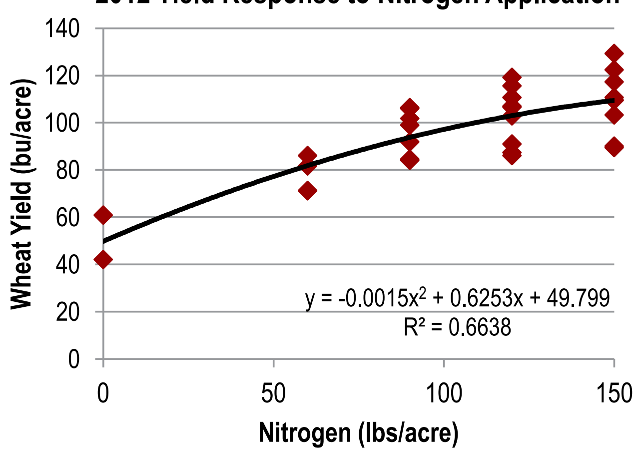
Pioneer® brand varieties: 25R40, 25R39 and 25R34

Nitrogen rate: 60, 90, 120 and 150lbs/acre

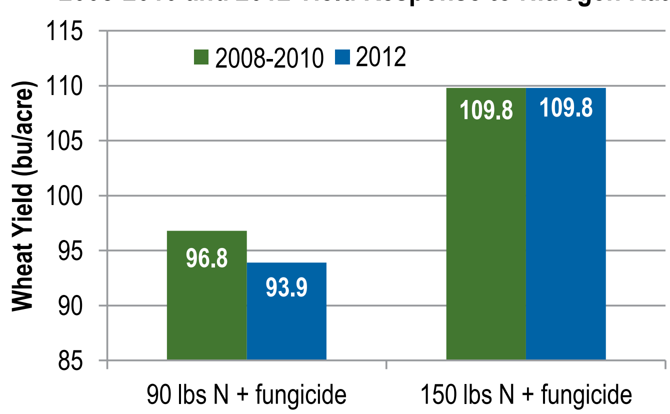
- Wheat varieties varied by location; each location included a single variety.
- Not all nitrogen rates were applied at all locations.

Results

- Average yield of wheat treated with a fungicide at T3 increased with nitrogen fertilizer rate up to the highest treatment rate of 150 lbs/acre.



- Average wheat yields with 90 and 150 lbs/acre of nitrogen were very similar to those observed in field-scale trials conducted by OMAFRA in 2008-2010.



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AMXT (Optimum® AcreMax® XTreme) - Contains a single-bag integrated refuge solution for above- and below-ground insects. The major component contains the Agrisure® RW technology, the YieldGard® Corn Borer gene, and the Herculex® XTRA genes.

AM - Optimum® AcreMax® Insect Protection system with YGCB, HX1, LL, RR2. Contains a single-bag integrated refuge solution for above-ground insects. In EPA-designated cotton growing counties, a 20% separate refuge must be planted with Optimum AcreMax products.

AMX - Optimum® AcreMax® Xtra Insect Protection system with YGCB, HXX, LL, RR2. Contains a single-bag integrated refuge solution for above- and below-ground insects. In EPA-designated cotton growing counties, a 20% separate refuge must be planted with Optimum AcreMax Xtra products.

AM1 - Optimum® AcreMax® 1 contains the LibertyLink® gene and can be sprayed with Liberty® herbicide. The required corn borer refuge can be planted up to half a mile away. Some Optimum® AcreMax®, Optimum® AcreMax® RW and Optimum® AcreMax® Xtra Insect Protection products are not resistant to Liberty herbicide. Please check the seed label or contact your sales professional for more information.

AMRW - Optimum® AcreMax® RW Rootworm Protection system with a single-bag integrated corn rootworm refuge solution includes HXRW, LL, RR2.

HX1 - Contains the Herculex® 1 Insect Protection gene which provides protection against European corn borer, southwestern corn borer, black cutworm, fall armyworm, western bean cutworm, lesser corn stalk borer, southern corn stalk borer, and sugarcane borer; and suppresses corn earworm.

HXX - Herculex® XTRA contains the Herculex 1 and Herculex RW genes.

HXRW - The Herculex® RW insect protection trait contains proteins that provide enhanced resistance against western corn rootworm, northern corn rootworm and Mexican corn rootworm.

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