

Corn Herbicide Management Guide

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Summary

- To assist producers in selecting and managing their herbicide programs, Pioneer has developed a Corn Hybrid-Herbicide Management Guide.
- Use of herbicide by hybrid information based on data from limited replicates (e.g., less than 30 replicates) can be misleading and risky to growers.
- Pioneer research has generally indicated that crop injury is primarily due to the environmental conditions the herbicide and hybrid encountered.
- Pioneer has identified some interactions between herbicide and hybrid or variety. The communication of this information to its customers is critical.
- Customers are encouraged to contact their Pioneer sales professional for the Corn Hybrid-Herbicide Management Guide. Pioneer sales reps can access the guide at this link: http://nasweb.phibred.com/salesdocs_int/brdrbooks/corn/07hhmstr.pdf
- This *Crop Insights* will describe the rating system for Pioneer® brand hybrids, as well as the research studies, field observations and other information used to derive the ratings.

Pioneer Hi-Bred routinely conducts screening trials to evaluate corn hybrid response to herbicides. The primary goal of this screening program is to identify the hybrids with below average tolerance to commonly used herbicides. This information is given to corn producers to help them minimize the chances of herbicide injury to their crops.

Other seed companies have similar goals, but their testing philosophies differ. Some companies test many herbicide products across a few environments rather than major herbicide families at a relatively large number of locations. This article will discuss the scientific basis, methods and results of Pioneer's herbicide testing program.

Research Studies Give Mixed Results

For many years, Pioneer, other seed companies and universities have conducted research studies to evaluate hybrid tolerance to herbicides. The published results have been mixed. For example, Wych and Schoper (1988) evaluated five hybrids and five herbicides (Dual, Bladex,



Eradicane, Banvel, and Buctril) from 1984 to 1987. They found no differences among hybrids in injury ratings for any of the five herbicides, nor were there any significant hybrid by rate interactions. However, there were significant environment by herbicide interactions. This indicates a specific environment was needed for crop injury to occur.

Lund (1995) reported that hybrids differed in sensitivity to herbicides. He concluded that in the years that herbicides showed significant early season crop injury, hybrids with injury were consistently lower yielding when compared to less sensitive hybrids.

University publications also suggest that hybrids differ in their response to herbicides. For example, the 2003 Illinois Agronomy Handbook states that "hybrids and varieties vary also in their tolerance to herbicides and environmental stress factors". Many chemical companies' labels also hint of interactions, suggesting that growers consult their seed representative for hybrid tolerance information.

Pioneer Agronomy Sciences Research Results

Pioneer has been conducting research on tolerance of its seed products to herbicides for more than 25 years. The results have generally confirmed that environmental conditions at or following application play a much greater role in crop injury than hybrid or variety selection.

In a study conducted by Pioneer Agronomy Sciences (1993-1995), cyanazine (Bladex), dicamba (Banvel), metolachlor (Dual) and nicosulfuron (Accent) herbicides were applied to leader hybrids at 0, 1, 2 and 4 times the labeled rate. At

labeled rates, the results indicated there were no significant hybrid by herbicide interactions for crop injury score or grain yield. The research also indicated that the primary reason for crop injury was not poor tolerance of the hybrid, but the environmental conditions the herbicide and hybrid encountered.

In a more recent study (2001-2003) Pioneer Agronomy Sciences evaluated five hybrids and five herbicides across ten locations. The herbicides evaluated were Bicep II, Harness Xtra, Steadfast, Balance Pro and Clarity. The experiment detected an environment by herbicide by hybrid interaction for crop response and grain yield. This three-way interaction indicates that the environment during or after the herbicide application (or crop emergence) affected different hybrids and herbicides at different locations. When comparing the relative variation due to hybrid, herbicide and environment to the total experimental variability for grain yield, the variation due to environment was overwhelming (Figure 1). These results are similar to findings from a previous study (Gaspar, 1998).

Grain Yield

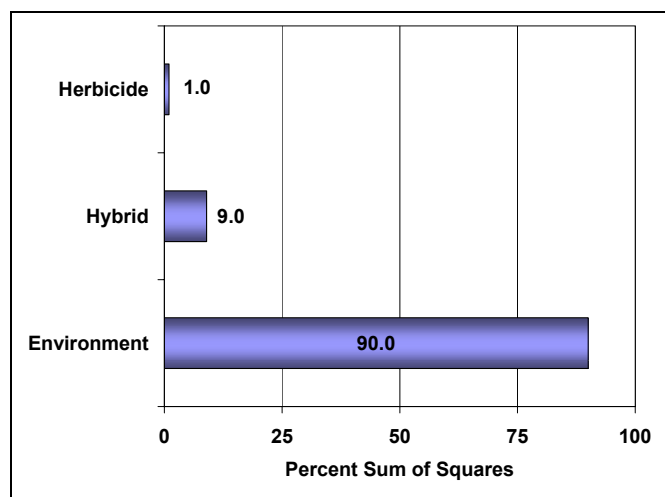


Figure 1. Percent of experimental variation for grain yield associated with hybrid, rate and environment

Even though environment was the primary cause of hybrid response in this study, additional Pioneer research on new herbicides has identified some potential hybrid and variety by herbicide interactions. The communication of these interactions to Pioneer representatives and customers is critical. For this reason, Pioneer has continued its herbicide-testing program over multiple years and environments.

Current Herbicide Research Efforts at Pioneer

Because a specific environment is usually needed to produce a crop response, multiple environments must be evaluated to increase the chances of detecting herbicide sensitivity. To determine the number of locations needed, Pioneer Agronomy Sciences applied a statistical procedure to data previously collected from herbicide by hybrid trials (Table 1).

Table 1. Number of locations required to determine if hybrids show a differential response to labeled rates of corn herbicides for the trait grain yield (bu/acre) (2001 to 2003 research data).

Prob > F	LSD (bu/acre)			
	5	<u>10</u>	15	20
	----- Locations Needed -----			
<u>0.01</u>	39	<u>10</u>	4	2
0.05	22	5	2	1
0.10	15	4	2	1
0.20	9	2	1	1

Assumes 3 replicates/location.

The results of this procedure suggest that 10 locations with three replications per location are needed to find significant treatment effects of greater than 10 bu/acre at a Prob > F value of 0.01. A value of 0.01 indicates that if the same study were repeated, results would be different only 1% of the time.

Conducting tests at an adequate number of locations helps ensure that research results are statistically sound. The primary trait measured in Pioneer’s research trials is grain yield. Another important trait used to identify hybrid or variety tolerance is early season injury or “crop response”. Pioneer researchers evaluate plots at designated intervals following herbicide application to generate these crop response ratings. In addition to the research data, field observations by Pioneer representatives, as well as herbicide



Corn plant response to direct application of a sulfonylurea herbicide.

company recommendations are considered in determining hybrid ratings. Since the 1990’s, Pioneer has evaluated hybrid tolerance to four major herbicide families: amides, benzoic acid/phenoxy, 4-HPPD inhibitors, and sulfonylureas (Table 2). Herbicide families not listed in the chart below showed no evidence of a hybrid by herbicide interaction concern.

With the information generated by evaluating Pioneer hybrids treated with these four herbicide families, a Corn Hybrid-Herbicide Management Guide is developed annually. The management guide assists growers in selecting and managing herbicide programs for specific hybrids.

Table 2. Herbicide families used in Pioneer testing to detect hybrid sensitivities.

Herbicide Family Evaluated	Trade Name Tested	Other Example Products in Herbicide Family
Amide (Chloroacetamide and Others)	Harness [®]	Surpass [®] , Dual [®] II, Magnum [®] , Outlook [®] , Lasso [®] , Topnotch [®] , Degree [®] , Define [®] , Ramrod [®] , Cinch [®] ,
Benzoic Acid, Phenoxy (Synthetic Auxins)	Clarity [®]	Banvel [®] , and 2,4-D
Isoxazole (4-HPPD Inhibitors)	Balance [®] Pro	Callisto [®] , Impact [®]
Sulfonylurea (ALS Inhibitors)	Steadfast [®]	Accent [®] , Basis [®] , Beacon [®] , Elim [®] , Option [®] , Permit [®] , Resolve [®] , and sulfonanilides (Python [®])

Corn Management Guide Tolerance Ratings

Four ratings are used in the management guide for corn. Ratings are based on replicated research trials, chemical company recommendations and field observations.

- Adequate Tolerance
- Requires Careful Management
- Crop Response Warning
- Insufficient Data

Adequate Tolerance ●

An adequate tolerance rating indicates that the hybrid has acceptable tolerance to the herbicide. Thus, under normal growing conditions, research and field observations suggest injury is unlikely to occur when label recommendations are followed.

Requires Careful Management ▼

This rating indicates that these hybrids may warrant careful management to avoid herbicide injury under challenging environments such as sandy soils, low organic matter soils, high pH soils, cool wet conditions or hot and humid conditions. University research indicates products within a herbicide class may vary in their degree of crop selectivity (Hartzler, 2000). The potential for seed product-herbicide interaction may also be impacted by the labeled herbicide rate used and the method or timing of application. The additional care needed to avoid damage will depend on the specific herbicide family.

Crop Response Warning ■

In field observations and research studies, crop injury has occurred with this herbicide/hybrid combination.

Insufficient Data □

Additional testing is needed to evaluate the herbicide/hybrid combination.

Amides (chloroacetamide and others)

Injury from amide herbicides is more prevalent on sandy soils with low organic matter. Additional conditions that may increase the potential for injury are deep planting, cool, wet conditions and/or soil crusting. Management options to consider with hybrids with less tolerance to chloroacetamides are listed below:

- Monitor planting depth.
- Avoid sandy soils with low organic matter.
- Use a chloroacetamide herbicide with a safener.
- Aid emergence by rotary hoeing if crusting occurs.
- Avoid ultra-early planting dates.

Benzoic Acid/Phenoxy

The potential for crop injury from benzoic acid or phenoxy herbicides increases when the hybrid is under stress and/or the hybrid is sprayed at a late stage of growth. The additional management suggestions below are helpful in reducing potential for injury:



Corn brace roots showing Banvel injury.

- Apply herbicide early within label recommendations (up to 5 - 6" or V3 for dicamba).
- Avoid spraying when the daytime temperatures are high and corn plants are growing rapidly.
- Follow recommended rates for different stages of growth.
- Avoid spraying when conditions such as drought, cold soils or wind damage cause abnormal stress.
- Read the labels carefully. Many herbicides have growth regulator herbicides as part of their pre-mix. Many tank mixes require the use of NIS or other additives, which may increase injury potential.

Isoxazole (HPPD Inhibitors)

Crop injury from pre-plant or pre-emergence applications of HPPD inhibitor herbicides are more probable on sandy soils

with low organic matter. Cool, wet-growing conditions may also increase the potential for damage. Injury from post emergence applications of HPPD products is more likely when the corn is sprayed when plants are exposed to a stress, such as cool, dry conditions. Suggestions that may reduce the likelihood of injury include:

- Follow recommended rates for specific soil types.
- Avoid sandy soils with low organic matter.
- Plant seed at least 1.5 inches deep with good seed furrow closure.
- Aid emergence by rotary hoeing if crusting occurs.
- Avoid ultra-early planting dates to prevent extended slow emergence under cold conditions.
- Avoid post emergence spraying when the corn is under stress extremes, such as hot and humid or cool and dry conditions.



Left: Isoxazole (Balance) injury to corn seedlings.
Right: Normal seedlings.

Sulfonylureas

Injury from sulfonylureas is more likely when the corn is sprayed after the plant is 10-12 inches tall and/or the plant is exposed to a stress, such as cool, dry conditions. Additional management suggestions when applying sulfonylureas are:

- Apply the herbicide early in the recommended application window (before the hybrid is 10 - 12 inches tall).
- Avoid spraying when the corn is under stress extremes, such as hot and humid or cool and dry conditions.
- Since some sulfonylurea products have restrictions on hybrids less than 88 CRM, review the label before application to these hybrids.

Conclusions

The purpose of this guide is to assist growers in selecting and managing their herbicide programs. However, under certain

environmental conditions, a herbicide may become more active and/or crop tolerance may be reduced. In these cases, crop injury may occur on hybrids that have acceptable tolerance to the applied herbicide. The environmental conditions are the key factor in hybrid or variety by herbicide interactions observed in the field.

Predicting the environmental conditions a producer will encounter in a given year is nearly impossible. Because of this uncertainty, producers must select appropriate strategies to reduce the chances of herbicide injury and maximize yield. First, growers should select the highest yielding set of products for their fields. Secondly, select the least stressful herbicide for the weed pressure present on a given field. Finally, apply the herbicide at the recommended rate and time to minimize possible crop injury and optimize weed control. For more information, please contact your Pioneer sales professional or herbicide representative.

References

Gaspar, P.E. 1998. Environment influence on herbicide-hybrid sensitivity. Proc. 53rd Annual Corn and Sorghum Research Conference. American Seed Trade Association.

Hartzler, B. and M. Owen. 2000. 2000 Iowa State Univ. Herbicide Manual of Ag Professionals. Extension Pub WC-92.

Lund, M.G. 1995. Interaction of hybrid and herbicide on corn grain yield. Proc. 50th Annual Corn and Sorghum Research Conf. P. 228-242. American Seed Trade Association.

Sprague, C.L. and A.G. Hager. 2003. Weed control for corn, soybeans and sorghum. *In* Ill. Agronomy Handbook. Urbana, IL. http://iah.aces.uiuc.edu/pdf/Agronomy_HB/16chapter.pdf

Paszkiwicz, S.R., K.D. Reese, P.R. Carter, and S.T. Butzen. 1996. Corn hybrid response to cyanazine, dicamba, metolachlor, and nicosulfuron. Presented at the 1996 American Society of Agronomy Annual Meeting.

Paszkiwicz, S.R. 1997. Unpublished.

Wych, R.D., and J.B. Schoper. 1988. Evaluation of herbicide tolerance of corn inbred lines. Proc. 42nd Annual Corn and Sorghum Research Conference. P. 141-161. American Seed Trade Association.

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