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### **Roundup Ready® Crops**

Few weed management tools have had an impact on agriculture as immediate or dramatic as Roundup Ready® crops.

Within a few years after their introduction, Roundup Ready® soybeans accounted for 70 percent of soybean acres. Other crops available with the Roundup Ready® trait include corn, cotton, and canola. Sugar beets, alfalfa, and wheat have also been developed and will likely reach farmers' fields in coming years. With the introduction of these new crops, producers in the High Plains growing region may soon have the ability to utilize Roundup Ready® crops in consecutive years.

The herbicide glyphosate (the active ingredient in Roundup®, Touchdown®, and many other products) has been used successfully for more than 25 years. Roundup Ready® crops have expanded the use of

glyphosate into conventional cropping systems. Increased use of any herbicide increases the likelihood that resistant weeds will develop. The expanded use of glyphosate in Roundup Ready® crops has caused many to fear that glyphosate-resistant weeds will appear and render the technology useless.

It must be noted that weeds resistant to the triazine, ALS inhibitor, thiocarbamate, and dinitroaniline herbicide families (among others) have all been confirmed, and yet all of these herbicide families remain important tools in modern agriculture.

So while the claim that a glyphosate-resistant species will destroy Roundup Ready® technology is unfounded, every effort should be made to delay and manage glyphosate-resistant weeds in order to avoid the economic impacts and management problems these weeds could create.

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## Glyphosate Resistance and Management

Glyphosate resistance has been confirmed in six weed species worldwide, two of which have been found in the United States.

One of these species, horseweed (also known as marestail), has created management problems in Roundup Ready® soybean fields in the eastern U.S. Increased use of Roundup Ready® crops in the future will likely result in additional weed species developing glyphosate resistance. It is important that appropriate measures be taken to delay the appearance of resistant weeds in the High Plains growing region.

Resistance management strategies for other herbicide families typically include rotating herbicides with different modes of action on an annual basis. While this strategy is effective in delaying resistance, it may not be the ideal recommendation for glyphosate resistance management.

A key difference between glyphosate and many other herbicides is its mode of action.

Glyphosate acts at a unique target site, inhibiting the shikimic acid pathway in plants.

By contrast, herbicides like Glean®, Option®, Accent®, and UpBeet® are all sulfonylurea herbicides and all have the same mode of action. A species such as kochia that evolves resistance to one of these herbicides will likely be resistant to all of them.

Resistance to sulfonylurea herbicides also differs in that it usually results from a genetic difference in plants that confers absolute resistance, regardless of herbicide rate. Glyphosate resistance, on the other hand, has generally been attributed to differences in the uptake or movement of the herbicide within the plant.

Increased rates of glyphosate will usually have activity on resistant plants while increased rates of the sulfonylurea herbicides will have no impact.

This difference may play a key role in the way resistance management plans are designed.

Increased rates of sulfonylurea herbicides (and many other families) result in a greater selection pressure on the weed population and consequently in the more rapid appearance of resistant weeds. This is why recommendations are made to rotate herbicide modes of action as well as tank mixing herbicides with different modes of action. The chance that a given weed will have the genetic makeup to survive two different herbicide modes of action is quite small.

As previously noted, resistance to glyphosate usually arises from an inability to move the herbicide effectively within a plant.

It would follow that if lower rates of glyphosate are applied, plants will be more likely to survive and produce seed. The next generation will share this trait, thereby enriching the gene pool for resistance, and over time could develop into a resistant weed population.

However, if the plants are effectively controlled with a high rate of glyphosate, no plants will survive to pass on the tolerance mechanism, and a resistant weed population will be successfully avoided.

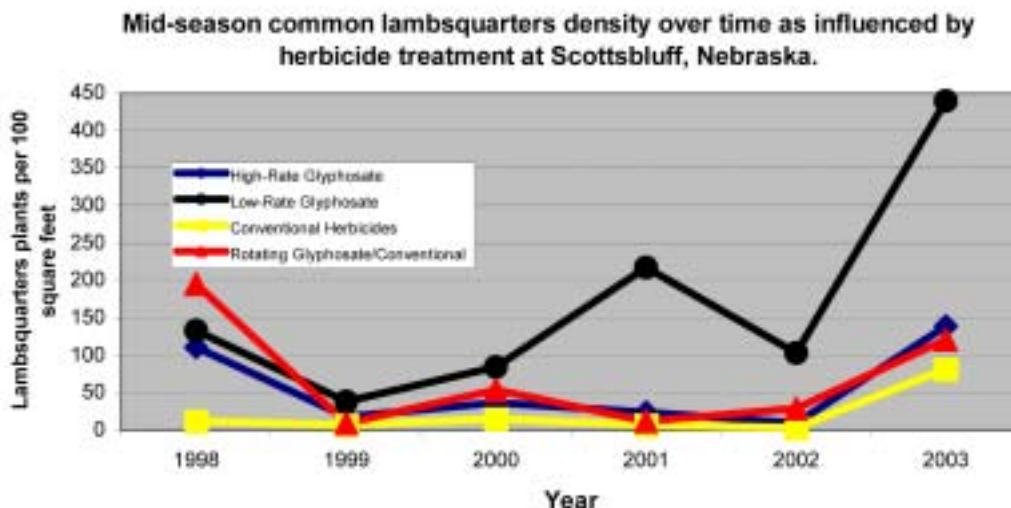
Field research conducted at the University of Wyoming, University of Nebraska, and Colorado State University supports the high-rate strategy for glyphosate resistance management. The continuous use of glyphosate at labeled rates in Roundup Ready® cropping systems over six years was just as effective at controlling all weed species when compared to rotating conventional herbicides in alternating years.

No weeds have been found to develop glyphosate resistance after six years of continuous glyphosate use. However, reducing the rate of glyphosate to half the recommended rate (13 ounces per acre of Roundup UltraMax®) caused a dramatic increase in common lambsquarters at all three locations, and wild buckwheat increased at two locations. Investigations into possible tolerance mechanisms in common

lambsquarters are being initiated to determine if the application of low rates of glyphosate have indeed selected for increased tolerance to the herbicide.

## Summary of Glyphosate Resistance Management Recommendations

- Always apply glyphosate at labeled rates. Reducing the rate may be the first step in developing a resistant weed population.
- Using alternative herbicides in Roundup Ready® crops is not necessary as long as consistent weed control is achieved.
- Roundup Ready® crop use in consecutive years of a rotation is sustainable provided volunteer crops can be effectively controlled and labeled rates of glyphosate are applied in a timely manner.
- In order to manage the appearance of glyphosate-resistant weeds, vigilant scouting for weed escapes is encouraged. Notify Cooperative Extension Service educators if glyphosate consistently fails to provide acceptable control of a particular weed species.



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