Controlling Herbicide-Resistant Weeds: Consider Adding Alfalfa in a Corn/Soybean Rotation

John Gronwald, USDA-ARS and Jeff Gunsolus, University of Minnesota

Herbicide-Resistant Weeds Are A Serious Problem

In 1968, the first confirmed case of herbicide resistance in weeds was reported in Washington state. An atrazine-resistant biotype of common groundsel was discovered in a field after multiple years of applying atrazine. In the 46 years since, the number of herbicide-resistant weeds in the U.S. has increased dramatically. In 2013, it was estimated there were 144 unique herbicide-resistant biotypes in the U.S. A major reason for the recent increase has been the development of glyphosate-resistant weeds. In the U.S., 14 weed species have evolved resistance to glyphosate and resistance has been reported in 32 states. There are also increasing reports of weeds exhibiting resistance to multiple herbicides. Multiple herbicide resistance occurs when a weed has at least two resistance mechanisms that allow it to survive treatment with two or more different herbicides that have different sites of action. For example, a giant ragweed biotype found in Minnesota is resistant to both glyphosate and another herbicide acting at a different target site.

How Herbicides Select For Herbicide-Resistant Weeds

Experience has shown the best way to increase the chances of developing herbicide-resistant weeds is to apply the same herbicide, or herbicides with the same site of action, repeatedly. This tactic is largely responsible for the increase in glyphosate-resistant weeds in recent years. The lack of herbicide diversification exerts a high selection pressure for rare weed biotypes that are naturally resistant to herbicides. Weeds are genetically diverse and slight differences in many genes exist within a population. In most cases, these differences do not confer any advantage to the weed. However, when a herbicide is applied repeatedly it will kill all weeds except those that have some type of gene variation that confers resistance to that herbicide. Because herbicide resistance traits are rare, only a few weeds in a field (perhaps only one) will survive the initial herbicide application. Early on, it may not be apparent that a herbicide resistance problem is developing. However, over time as the herbicide-resistant weeds produce seed, herbicide-resistant weed patches will appear in the field. If the same herbicide or one with the same site of action is applied year after year, the weed population that is resistant will increase and so will the number of herbicide-resistant seeds in the soil.

Applying More Herbicides Is Not The Solution

Should producers expect new herbicides with new sites of action to control existing herbicide-resistant weeds? Probably not - at least not in the near future. The last release of a new herbicide class was 20 years ago and new herbicides with different sites of action may be years away. In response to the outbreak of glyphosate-resistant weeds, agrochemical industries have developed crops that are genetically modified to have combined resistance to glyphosate and other herbicides such as 2,4-D or dicamba. These genetically modified crops are described as having "stacked" herbicide resistance traits. Crops with stacked herbicide resistance traits will allow farmers to spray 2,4-D or dicamba to control glyphosate-resistant weeds in corn and soybeans without injury to the crop. However, this strategy is not without risk. Without a more integrated approach, spraying 2,4-D or dicamba to control glyphosate-resistant weeds will increase selection for 2,4-D or dicamba resistance in the glyphosate-resistant weed population. This approach may increase the chances of developing multiple herbicide resistance in weeds.

Integrated Weed Management: A Sustainable Approach for Controlling Herbicide-Resistant Weeds

It is becoming apparent that preventing and controlling herbicide-resistant weeds long term will require the use of a diversified, integrated weed management (IWM) program. An IWM program means using all the tools in the weed control toolbox, not just herbicides. Increasing the diversity of weed control measures reduces the ability of weeds to adjust to one type of weed control method such as the use of herbicides. Developing an IWM program requires effort and planning. It involves integration of chemical, mechanical, and cultural weed control strategies. Herbicides and herbicide-resistant crops are part of an IWM program, but must be used judiciously. When using herbicides, it is important to consider using tank mixes and rotating herbicides with different sites of action to avoid selecting for herbicide-resistant weeds. Where appropriate, mechanical tillage can also be used to control weeds. Two important cultural weed control strategies involve the use of cover crops and crop rotations. Rotating to another crop frequently allows herbicides with different sites of action to be used for weed control.

Consider Controlling Herbicide-Resistant Weeds by Incorporating Alfalfa in a Corn/Soybean Rotation

Incorporating alfalfa into a corn/soybean rotation has a number of benefits including increased soil nitrogen and organic matter, enhanced soil tilth, and reduced soil erosion. The nitrogen put into the soil by alfalfa can reduce or eliminate the need for adding nitrogen when rotating back into corn. A rotation into alfalfa is also an effective way to control weeds including herbicide-resistant weeds. Growing alfalfa suppresses weed seed production because of its dense canopy and the multiple cuttings that are made throughout the year. Growing alfalfa for 2-3 years will break the production of herbicide-resistant seed and significantly reduce the amount of herbicide-resistant seed in the soil. In one study it was found that the amount of giant ragweed seed in the soil was reduced by more than 90% after two years if no new seed was added. Hence, rotating into alfalfa for two years will significantly reduce the seed bank of multiple herbicide-resistant giant ragweed found in some mid-western states. When rotating into alfalfa to control herbicide-resistant weeds it is important to control weeds during the first year until a vigorous stand is established. If a herbicide needs to be applied to control weeds in the first year of alfalfa, be sure the herbicide has a site of action that will control the herbicide-resistant weeds..