(Re) Learning to Accept Herbicide Injury to Crops

One of the advantages of herbicide resistant crops (Roundup Ready, Liberty Link, etc.) is that the margin of safety for their companion herbicide is much higher than occurs with conventional herbicides. After more than a decade of herbicide resistant crops, many farmers have become hesitant to use herbicides that might cause crop damage. The spread of herbicide resistant weeds is forcing a return to herbicides with a lower margin of crop safety than glyphosate. This article will review factors that affect crop injury from postemergence herbicides and the potential these herbicides have to affect crop yields.

Differential metabolism is the most common selectivity mechanism for herbicides. Tolerant plants metabolize the herbicide more quickly than susceptible plants, thus preventing the herbicide from reaching the site of action at toxic concentrations. Factors that increase the amount of herbicide entering the crop, or decrease the ability of the crop to metabolize the herbicide, may cause an adverse response by the crop.

Herbicide rate, spray additives, and environmental conditions influence crop tolerance by affecting the amount of herbicide that enters the plant. An increase in herbicide rate results in more herbicide entering the plant, and therefore increases the potential for injury. Spray additives such as surfactants and crop oil concentrates increase movement of herbicides from the leaf surface into the leaf; therefore they influence the risk of injury. Crop oil concentrates and methylated seed oils generally are more active than surfactants, and therefore oil-based additives may increase the risk of an adverse crop response compared to a surfactant. In situations where an oil-based additive is recommended, the risk of crop injury due to the use of the additive is usually less than the cost associated with poor weed control that might be achieved if a less active adjuvant were used.

The weather preceding herbicide application may influence crop and weed responses to herbicides. The primary barrier to absorption of foliar applied herbicides is the cuticle. This structure is in constant flux depending on a plant's need to manage water loss via evaporation. Cool, cloudy and wet conditions result in a cuticle structure that is easily penetrated by herbicides, therefore increasing the risk for injury. Plants need to conserve moisture during hot, dry conditions, thus resulting in a cuticle that is less permeable to herbicides. Crop injury is more likely during conditions that favor penetration of the cuticle by herbicides.

The potential for crop injury from herbicides is also increased when a plant's ability to metabolize the chemical is compromised. When a plant is under stress due to weather or other factors, biochemical processes within the plant may produce toxic compounds. Plants have protective systems that can detoxify these compounds before they cause permanent damage, but these are the same systems that metabolize herbicides. A plant has a limited capacity to deal with phytotoxic compounds, and the combination of herbicides and stress-related toxins may overload the protective systems. Combinations of pesticides can also increase the risk of a phytotoxic response. Organophosphate insecticides can directly interact with the enzyme systems that metabolize certain herbicides and greatly increase crop response.

Herbicides are evaluated to insure that under typical use conditions they do not cause injury that reduces crop yield potential. However, due to the highly variable conditions which herbicides are used, situations occasionally occur in which yield is reduced by herbicides. A common observation in studies evaluating crop responses to postemergence herbicides is that the injury symptoms visible shortly after application are not a good predictor of the likelihood of a yield response.
The most extensive study investigating the effect of postemergence herbicides on soybean yield involved 27 experiments in Iowa and Illinois shortly after the introduction of Roundup Ready soybean (Young et al. 2003). The experiments evaluated soybean response to Roundup (Group 9), Pursuit (Group 2) and Blazer (Group 14), and included two planting dates and two post application dates. Averaged over experiments, planting dates and application timings (108 treatments), Blazer resulted in a 1.5% yield reduction, whereas Pursuit caused a 2.1% yield loss. Blazer reduced soybean leaf area index by 14%, whereas Pursuit reduced it only 6%, supporting the lack of relationship between foliar response and yield. Roundup did not affect soybean yield.

Researchers in Virginia reported that the response of soybean to postemergence herbicides differed between two years (Johnson et al. 2002). In a year with limited moisture, 18% of the herbicide treatments caused yield loss. The majority (5 out of 6) of the treatments causing a yield response were on an early-maturing variety, and the researchers speculated the yield response was more common with this variety due to its shortened developmental period. In a subsequent year of the study, soybean yields were higher due to more favorable rainfall, and none of the herbicide treatments affected yield. This data suggests that other stresses on the soybean reduce the ability of the crop to recover from injury caused by herbicides.

With the high cost of establishing a crop, it is understandable why farmers are hesitant to select herbicide programs that might threaten crop vigor. However, research has shown that early-season foliar injury is not a good indicator of lost yield potential, and that most herbicide applications do not affect crop yields. It is important to remember that the threat to yield potential from uncontrolled weeds is much greater than what might occur from injury by registered herbicide treatments. Thus, herbicide programs should be selected first on their ability to consistently control the specific weed problem, and then on the potential for crop injury.

References cited:


Prepared by
Bob Hartzler
Department of Agronomy
Iowa State University Extension
hartzler@iastate.edu

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Note: This article was prompted by the reaction of a crowd in Northwest Iowa when I suggested they must learn to accept using herbicides that might occasionally cause crop injury.