FIELD FACTS

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# Glyphosate Impact on Crops and Soils

## Introduction

Glyphosate is one of the most widely used crop protection agents in modern crop production. Due to its widespread use in corn and soybean production, questions have arisen regarding the persistence of glyphosate in the environment as well as its effects on disease resistance and yield. There are hundreds of publications on the environmental fate of glyphosate. The following article is a brief summary of the latest science related to glyphosate and its effect on yield and the environment.

## Glyphosate Persistence

Glyphosate is considered a semi-persistent herbicide. This classification is based on the field "half life" of glyphosate compared to other commonly used herbicides (Table 1). The field half life is the time it takes for 50% of the chemical to degrade in a field soil. Note that glyphosate is significantly less persistent than paraquat, atrazine and s-metolachlor. Due to its chemical nature, glyphosate binds very rapidly to soil and for this reason has no preemergence activity. There is no scientific validation for reports in the popular press that glyphosate is persistent in the soil for multiple years.

**Table 1**. Field half life* of common herbicides.

| Herbicide | Field Half Life (Days) |
|---|---|
| s-metolachlor (Cinch, Dual[1]) | 122 (sandy loam)<br>97 (loamy sand)<br>124 (silty clay loam) |
| atrazine | 60 |
| **glyphosate** | 47 |
| dicamba | 10 |
| flumioxazin (Valor) | 18 |
| paraquat | 1000 |

*Based on environmental fate research found in the Herbicide Handbook published by the Weed Science Society of America.

In a recent publication in the Journal of Environmental Pollution (Volume 158, Issue 10, October 2010, Pages 3172-3178) researchers compared the environmental impact of glyphosate-based weed control programs to conventional programs, including those specifying soil-applied herbicides.

Weed-free glyphosate-tolerant soybean field. Glyphosate-tolerant soybeans were higher yielding than non-glyphosate-tolerant soybeans in Iowa State studies (see below).

The authors concluded that "The impacts of GT systems were lower than those of non-GT systems…". Justifications for this conclusion were based on lower pesticide loads and reduced carcinogenic concerns in some conventional herbicides.

A similar environmental impact study on glyphosate systems was reported in the Journal of Transgenic Research (Volume 17. 1059-1077. 2008). The authors reported similar conclusions stating that "Results showed that the environmental impact of herbicide regimes solely relying on the active ingredients glyphosate (GLY) or glufosinate-ammonium (GLU) is lower than that of herbicide regimes applied in non-GMHR maize." Among the numerous publications on the environmental fate of glyphosate the two reported above represent the most current science related to the environmental impact of glyphosate systems.

## Yield Effects of Glyphosate Systems

Reports in the popular press present interesting notions that glyphosate causes increased disease occurrence and can shorten crop maturity. In 2010, Mike Owen, Extension Weed Specialist with Iowa State University, reported on a study comparing the glyphosate- and glufosinate-based systems to conventional herbicide programs in soybeans. In this research (Crop Science 50:2597-2604. 2010), the authors reported that conventional systems were between 8 to 9% lower yielding compared to glyphosate or glufosinate (Ignite) based systems.

The reason for the yield disadvantage in conventional systems could be attributed to reduced control of woolly cupgrass,

crop injury or poor-yielding conventional varieties. Since the conventional varieties in this study were not related to the glyphosate or glufosinate lines, it is plausible the conventional system was limited by lower-yielding varieties. This makes a very important point for modern grain producers. The glyphosate trait in Pioneer germplasm is forward bred into the most advanced, high-yielding and disease-resistant lines. Any potentially negative effect of glyphosate application on plant physiology has been selected against in plant breeding programs and conventional lines are not necessarily higher yielding. In production agriculture, management systems that provide superior weed or insect control improve odds of optimizing yield potential for the grower.

In a study comparing the yield potential of glyphosate and conventional systems in corn, Zuver (Weed Technology 20:172-178. 2006) reported that conventional programs were lower yielding at two of eight locations. The lower yield in the conventional program was attributed to poorer weed control and crop response from conventional herbicides.

## Glyphosate Effects on Micronutrients

Zobiole (Plant Soil 328:57–69. 2010) published a series of studies involving applications of glyphosate to soybean. In this research, he compared the plant growth of varieties containing glyphosate resistance with near sister lines not containing genes for glyphosate resistance. In these greenhouse studies, he reported reduced concentrations of zinc, manganese, and copper in plants after treatment with glyphosate. Partially explaining the reduced mineral status was the observation that glyphosate-treated plants exhibited reduced root mass compared to controls. Although this is very interesting plant physiology, it is important to keep in mind that these results are based on greenhouse studies in non-commercial lines. Greenhouse studies can provide meaningful perspectives on plant growth, but they do not necessarily represent field conditions. Micronutrient nutrition in glyphosate systems remains an active area of research in the industry.

## Conclusions

The most current research indicates that:

- Glyphosate is not persistent in soils.
- Glyphosate-tolerant cropping systems are often higher-yielding than non-GT systems.
- Glyphosate-based weed control programs are not inherently more harmful to the environment than conventional herbicide- or tillage-based systems.

To optimize on-farm profit, farmers should:

- Select the highest yielding varieties.
- Use the most effective weed control programs available.