

## Dry, Cool Soils Can Increase the Risk of Herbicide Carryover

### What You'll Learn...

- Residual herbicides provide weed control, but may have the potential to carryover into subsequent growing seasons.
- Potential for herbicide carryover is influenced by herbicide rate, soil moisture, soil properties, and temperature.
- Soil microorganisms contribute to the primary method of herbicide degradation and are most active in warm, moist soils.
- Symptoms of herbicide injury in corn from fomesafen, imazaquin, and chlorimuron.
- Symptoms of herbicide injury in soybean from atrazine.

### Dry Conditions and Herbicide Carryover

Residual herbicides are applied to the soil and persist: providing weed control that diminishes over time due to degradation by microbial activity and chemical breakdown. However, some residual herbicides may have the potential to carryover and damage rotational crops in subsequent years. Several factors that contribute to the potential of herbicide carryover include applying higher than labeled rates for soil properties, low soil moisture, and cold soil temperatures.

### Factors that Influence Herbicide Carryover

**Amount and Timing of Precipitation.** The amount of rainfall received during the first few weeks following residual herbicide application is an important factor that will influence potential herbicide carryover. When adequate rainfall is not received during this time, the chemical and microbial processes needed to degrade herbicides in the soil will be reduced. Rainfall occurring later in the season will have much less effect on herbicide degradation than if it had occurred near the time of herbicide application.

**Soil Properties.** Soils with high amounts of organic matter (OM) and clay have a higher potential for herbicide persistence or carryover. Some herbicides are adsorbed to the surface of organic matter and clay, making them temporarily unavailable for plant uptake, downward movement through the soil profile, or microbial degradation. Low soil moisture conditions cause herbicides to be

**Table 1. Herbicides with Carryover Potential.<sup>2</sup>**

Herbicide Common Name	Examples of Herbicide Trade Names
<b>High Risk Potential</b>	
atrazine	numerous products
chlorimuron	Premixes containing chlorimuron include Authority® XL, Canopy®, Envive®, Valor® XLT, others
imazaquin	Scepter®
simazine	Princep®, others
<b>Moderate to Slight Risk</b>	
fomesafen	Reflex®, Flexstar®, Prefix®
clopyralid	Hornet®
chloransulam	First Rate®, Hornet®, Gauntlet®, others
imazethapyr	Pursuit®
pendimethalin	Prowl®, others
trifluralin	Treflan®, others
isoxaflutole	Balance® Flexx
mesotrione	Callisto®, Lumax®, Lexar®
tembotrione	Laudis®, Capreno®
topramezone	Impact®

adsorbed or bound more tightly to soil colloids. Also, several herbicides have label limitations concerning needing minimum amounts of rainfall received throughout the season, in order to plant specific crops within certain time periods.

Additionally, soil pH can influence the breakdown of some herbicides by a process known as chemical hydrolysis. Hydrolysis is slowed under high pH (basic) soil conditions. Also, the rate of hydrolysis is slowed during dry and cold soil conditions.<sup>3</sup> Triazine and sulfonyleurea herbicides are degraded by hydrolysis. Herbicide labels define soil properties to avoid application where potential carryover is high due to soil characteristics.

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### Herbicide Breakdown by Soil Microbes

Soil microorganisms represent the primary method of breakdown for many herbicides.<sup>3</sup> These microorganisms include various species of fungi, bacteria, actinomycetes, and algae. The majority of herbicide degradation resulting from microbial activity occurs during the summer and early fall after herbicide application. Soil temperature and soil moisture are two factors that greatly influence soil microorganism activity. Herbicide degradation by microbes is usually rapid when there is adequate soil moisture and warm temperatures. Under extremely dry conditions the rate of herbicide degradation by soil microbes can be slow enough to allow herbicides to persist into the next season. Minimal microbial activity occurs when soil temperatures are less than 40° Fahrenheit.<sup>3</sup> Microbes become more active as soils warm in the spring, but a short time until planting can limit the amount of herbicide degradation that occurs.

### Herbicide Carryover Examples and Symptoms

#### Fomesafen (Reflex®, Flexstar®) Carryover on Corn

Symptoms on corn include veinal leaf chlorosis or necrosis, which results in a striping effect on corn leaves (Figure 1). In some instances the leaf can appear translucent.<sup>4</sup> Generally there are no symptoms on corn roots.<sup>4</sup> Flexstar® has a 10 month rotational crop restriction to plant corn.



Photo courtesy of Iowa State University

Figure 1. Fomesafen carryover on corn

#### Atrazine Carryover on Soybean

Symptoms on soybean usually occur after the cotyledon and unifoliate leaves emerge. Initial injury symptoms include chlorosis (yellowing) of the leaf margins or tips (Figure 2). Older and larger leaves are affected first. Injured leaf tissue will eventually turn brown and die (Figure 3). Injury symptoms are likely to be more pronounced on high pH soils (greater than 7.2 pH).<sup>5</sup>



Figure 2. Initial symptoms from atrazine carryover. Chlorosis along leaf margins.



Figure 3. Necrosis along leaf margins and older leaves from atrazine carryover.

#### Imazaquin and Chlorimuron Carryover on Corn

Symptoms on corn include stunting, interveinal yellowing or purpling of leaves. Corn seedlings often exhibit inhibited root growth or “bottle-brush” roots. Emerging leaves may not unfurl properly from the whorl.<sup>5</sup> Imazaquin has 9.5 month rotational crop restriction to plant corn, and chlorimuron has a 9 month rotational crop restriction to plant corn.



Figure 4. Stunted seedlings with interveinal yellowing of leaves and purple-reddish stem and leaf midrib.



Figure 5. Stunted, chlorotic seedling, inhibited root growth, “bottle-brush” roots.

#### Sources:

<sup>1</sup> Bradley K., 2012. Consider herbicide carryover potential before planting wheat or forage grasses this fall. University of Missouri IPM Program. <http://ipm.missouri.edu/> (verified 05/23/14).

<sup>2</sup> Hartzler, B. and M. Owen. 2012. Carryover concerns for 2013. Integrated crop management news, Iowa State University. <http://www.extension.iastate.edu/> (verified 05/23/14).

<sup>3</sup> Hager, A. 2013. Remain aware of the potential for herbicide carryover in 2013. The bulletin, University of Illinois. <http://bulletin.ipm.illinois.edu/> (verified 05/23/14)

<sup>4</sup> Hager, A. 2000. Flexstar carryover symptoms on corn. The bulletin, University of Illinois. <http://bulletin.ipm.illinois.edu/> (verified 05/23/14).

<sup>5</sup> Gunsolus, J.L and W. Curran. 2002. Herbicide mode of action and injury symptoms. University of Minnesota, North central regional extension publication 377. <http://www.cof.orst.edu/> (verified 05/23/14).

**Individual results may vary**, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible.

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