
HERBICIDE CARRYOVER AND CROP ROTATION TO SOYBEANS

Herbicide Application and Carryover Potential^{1,2,3,4}

Herbicides are applied for weed control in most agronomic crops. Understanding how long they persist, or the length of time they remain active in the soil, is important to prevent potential injury to subsequent crops, including soybeans. The potential for carryover injury to rotational crops is influenced by the amount of herbicide present in the soil, the susceptibility of the rotational crop, and conditions that occur after application.

Factors that influence potential herbicide carryover include:

- Chemistry of herbicide applied,
- Rate and timing of herbicide application,
- Environmental conditions after application,
- Soil properties, and
- Rotational crop sensitivity to herbicide.

Herbicide Chemistry^{1,2,4}

Herbicides differ from one another by their chemical properties which affect persistence in the soil. The most important factor to keep in mind is a product's half-life— the amount of time it takes for 50% of the specific herbicide to break down in the soil, either by microbial or chemical degradation. Herbicides that remain active in the soil for long periods of time pose the greatest threat to rotational crops. Most herbicides that have carryover problems have re-cropping intervals of 9 to 10 months or longer. Herbicide families with persistent active ingredients include triazines (atrazine), phenylureas (diuron), sulfonyleureas (chlorimuron), imadazolinones (imazaquin), dinitroanilines (trifluralin), isoxazolidinones (clomazone), and diphenylethers (fomesafen).

Rate and Timing of Application^{1,2}

The rate of herbicide application and seasonal timing impact carryover. Misapplication, either by applying more than the labelled rate or overlapping spray patterns, increases the potential for herbicide carryover. Likewise, the later an herbicide with residual activity is applied in a growing season, the higher the potential risk of carryover. Herbicide effect can also be cumulative in the soil. Herbicides that target related plant metabolic systems may build up in the soil and result in injury to subsequent crops.

Environmental Conditions^{1,2,4}

Weather is the major factor in herbicide carryover. It takes adequate soil moisture and warm temperatures for soil microbes to degrade herbicide residues. 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. Cold soil temperatures decrease microbial activity, and moisture during the winter may not increase microbial activity enough to enhance the rate of herbicide degradation. Late spring or summer herbicide applications followed by dry weather conditions and cool temperatures that extend into early spring can provide the perfect scenario for herbicide carryover problems.

Soil Properties^{1,2,4}

Soil properties can make a difference in herbicide persistence. Soils with higher amounts of organic matter (OM) and clay tend to have a greater potential for herbicide carryover. Finer textured soils with a high percentage of OM and clay slow plant herbicide uptake, the downward movement of herbicides in the soil, and microbial degradation of herbicide residue. Potential injury to rotational crops can then occur by the release of herbicide residues in the spring.

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Soil pH is another factor that can affect herbicide persistence and availability. For example, high soil pH can lead to greater carryover of triazine and sulfonyleurea herbicides but shorter persistence of imidazolinone herbicides. Most other herbicides are unaffected by soil pH, however.

Soil microbes are responsible for most herbicide degradation. Therefore, good soil conditions for microbial growth are important, including moisture, temperature, pH, oxygen, and minerals. Warm temperatures, adequate moisture, good aeration and fertility combined with a medium pH work best for herbicide breakdown.

Rotational Crop Sensitivity to Herbicide^{5,6,7,8}

Several herbicides or pre-mixtures used in corn have longer crop rotational intervals, which can indicate the potential for longer persistence in the soil, particularly during dry conditions (Table 1). The HPPD inhibitor herbicides are labeled for pre- and post-emergence applications in corn and are part of several pre-mix herbicide products. Under normal conditions these herbicides have a low risk of carryover, but dry conditions during the previous season followed by a cold, wet spring has been shown to contribute to the carryover potential of these herbicides and injury to soybeans. These herbicides are degraded primarily by soil microbes. Low soil moisture, cool temperatures, and changes in soil pH can inhibit microbial degradation. HPPD carryover injury to soybean has occurred in spray overlap areas where elevated application rates increased the risk for carryover. For more information, please see the Agronomic Spotlight, Soybean Herbicide Injury.

Soil residual herbicides are an important component of weed management, and carryover problems generally do not occur under normal conditions. Fall-seeded crops and cover crops may also have limited tolerance to some herbicide residues.⁵ Cropping plans may need to be changed in fields where carryover could occur. Good weed management planning and recordkeeping is necessary to help minimize potential carryover to rotational crops.

Crop rotational intervals can vary between herbicides within the same group, local environmental conditions, and use practices (Table 2). Product users should consult individual product labels for specific recommendations and precautions. Information on herbicide characteristics, crop tolerance, and performance under local conditions should be obtained from local experts.

How to Minimize the Chance of Herbicide Carryover

- Always read herbicide labels and follow crop rotation intervals.
- Keep records of which fields received a residual herbicide with application dates and rates.
- Make applications early to control weeds and try to minimize late-season applications.
- Be careful during application to apply the correct rate and avoid boom overlaps in the field.
- If you know conditions are likely for carryover injury, plant the same crop as last year.
- Consider tillage in fall and spring to help dilute herbicide residues and encourage breakdown.
- Maintain a medium soil pH to reduce herbicide carryover potential.

Table 1. Common herbicide active ingredients (group/site of action) with carryover potential.

High Risk Potential*	Moderate to Slight Risk Potential**	
atrazine	fomesafen	isoxaflutole
chlorimuron	cloransulam	mesotrione
	pendimethalin	topramezone

*Potential injury to rotational crops under "normal" conditions.

**Occasionally cause injury or with half lives that may cause problems under abnormal conditions.

Source: Hartzler, B. and M. Owens. 2012. Carryover concerns for 2013. Iowa State University.

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Table 2. Crop rotational guidelines for some common herbicide active ingredients.*

		Months (unless otherwise specified) NS - next season*
Site of Action	Herbicide	Soybean
ALS Inhibitor	chlorimuron	None
	cloransulam	None
Microtubule Inhibitor	pendimethalin	None
Auxin Inhibitor	2,4-D	15 days
	dicamba	15 days
	clopyralid	10 to 18
PSII Inhibitor	atrazine	NS
	metribuzin	None
	diuron	6 to 12
	fluometuron	9
PSII Inhibitor	prometryn	NS
EPSP Inhibitor	glyphosate	None
GS Inhibitor	glufosinate	None
PPO Inhibitor	flumioxazin	None
	fomesafen	None
	saflufenacil	1 to 2
	sulfentrazone	None
Fatty Acid Inhibitor	acetochlor	NS
	metolachlor	None
PSI Inhibitor	paraquat	None
HPPD Inhibitor (27)	mesotrione	10
	topramezone	9

* Rotational crop intervals taken from 2013 Weed Control Manual for Tennessee and 2014 Weed Control Guidelines for Mississippi. The plant-back intervals provided are guidelines only. Always refer to the herbicide product label for specific plant-back intervals and use instructions for rotational crops.

Sources:

- ¹ Stahl, L., Gunsolus, J., and Sackett-Eberhart, J. Using herbicides and cover crops in corn and soybean. University of Minnesota Extension. <https://extension.umn.edu/cover-crops/using-herbicides-and-cover-crops-corn-and-soybean#herbicide-persistence-740311>
- ² Curran, W.S. 2001. Persistence of herbicides in soil. Penn State Extension. Agronomy Facts 36.
- ³ Hartzler, B. 2020. Herbicide Carryover concerns for 2020. Iowa State University Extension and Outreach. <https://crops.extension.iastate.edu/blog/bob-hartzler/herbicide-carryover-concerns-2020>
- ⁴ Ikley, J. and Johnson, B. 2018. Factors Affecting Herbicide Carryover in 2018. Purdue University. Extension Entomology. Pest&Crop Newsletter. <https://extension.entm.purdue.edu/newsletters/pestandcrop/article/factors-affecting-herbicide-carryover-in-2018/>
- ⁵ Gallans, S. and Carlson, S. 2014. Herbicide carryover injury to cover crops. www.practicalfarmers.org
- ⁶ Hartzler, B. and Owens, M. 2012. Carryover concerns for 2013. Iowa State University Integrated Crop Management.
- ⁷ Hager, A. 2013. Remain aware of the potential for herbicide carryover in 2013. University of Illinois, The Bulletin.
- ⁸ Nice, G. and Johnson, B. 2011. Mesotrione carryover in soybean. Purdue University Extension Weed Science.

Legal Statements

Performance may vary, from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields.

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