HERBICIDE CARRYOVER AND CROP ROTATION TO CORN

Summary

Soil residual herbicides extend the duration of weed control but can also injure subsequent crops. The major factors affecting the persistence of residual herbicides can be grouped into herbicidal characteristics, soil characteristics, and environmental conditions. An understanding of how these factors interact can help to prevent herbicide carryover problems.

Factors Contributing to Herbicide Carryover

Because of the many interacting factors, there can be variability in how long a herbicide will persist in the soil. A listing of factors influencing herbicide carryover potential are:

- Soil characteristics (texture, organic matter, pH)
- Environmental conditions
- Total amount and distribution of rainfall
- Herbicide chemistry and half-life
- Herbicide rate and application frequency
- Herbicide application date
- Rotational crop sensitivity to herbicide

Soil Characteristics

Soils with higher amounts of organic matter (OM) and clay have a higher potential for herbicide persistence or carryover. Herbicides can be adsorbed to the surface of OM and clay making them temporarily unavailable for plant uptake, downward movement in the soil, or degradation. Adsorption is greatest in finer textured soils having a higher percentage of clay particles and in soils with a higher OM content.

Soil pH is another characteristic that can affect herbicide availability and persistence. A high soil pH can cause greater persistence of triazine and sulfonylurea herbicides and shorter persistence of imidazolinone herbicides. Most other herbicides are unaffected by pH and their soil longevity is affected more by other factors.

Environmental Conditions

Weather is usually the driving component of herbicide carryover problems. Degradation of herbicides is usually rapid when there is adequate soil moisture and warm temperatures. The majority of herbicide degradation resulting from microbial activity occurs during the summer and early fall after the herbicide is applied. 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. 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. Late spring or summer herbicide applications combined with dry fall weather and a cold, extended winter can set up the conditions for carryover problems.

Herbicide Chemistry

The herbicide chemistry and half-life (time it takes for 50% of the herbicide to break down) along with the rate of application impacts the persistence of phytotoxic residues in the soil. Herbicides vary in their potential persistence and carryover. Herbicide families with persistent active ingredients include triazines (atrazine), phenylureas (diuron), sulfonylureas (chlorimuron), imadazolinones (imazaquin), dinitroanilines (trifluralin), isoxazolidinones (clomazone), and diphenylethers (fomesafen). Most of the herbicides that have carryover problems have re-cropping intervals of 9-10 months or longer (Table 1). Of the persistent herbicides mentioned, corn is tolerant to atrazine or diuron and can be planted as a rotational crop without any carryover injury concerns. Herbicide carryover problems in a corn following soybean rotation most often involves fomesafen or chlorimuron chemistry products.

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Table 1. Corn following soybean rotational restrictions.

Group	Herbicide Site of Action	Active Ingredient	Planting of Field Corn (months after application)
1	Lipid Synthesis Inhibitors	clethodim	1
		sethoxydim	1
		fluazifop	2
		quizalofop	4
2	ALS Inhibitors	flumetsulam	0
		thiencarbazone	0
		imazethapyr	8.5
		chloransulam	9
		chlorimuron	9
		imazaquin	9.5
3	Microtubule Inhibitors	pendimethalin	0
		trifluralin	12
4	Auxin Inhibitors	2,4-D	0
		dicamba	0
		clopyralid	0
5	PSII Inhibitors	atrazine	0
		metribuzin	4
6		bentazon	0
7		diuron	0
		linuron	12
9	EPSPS Inhibitor	glyphosate	0
10	GS Inhibitor	glufosinate	0
13	Pigment Inhibitor	clomazone	9
14	PPO Inhibitors	flumiclorac	0
		lactofen	0
		saflufenacil	0
		flumioxazin	1
		fomesafen	10
		sulfentrazone	10
15	Fatty Acid Inhibitors	acetochlor	0
		metolachlor	0
19	Auxin Transport Inhibitor	diflufenzopyr	0.25 (7 days)
22	PSI Inhibitor	paraquat	0
27	HPPD Inhibitors	isoxaflutole	0
		mesotrione	0
		tembotrione	0
		topramezone	0

An increasing problem has been corn injury from fomesafen carryover (Figure 1). Fomesafen herbicide products are being used in soybeans to help manage tough-to-control weeds like waterhemp and Palmer amaranth, which can result in multiple and late-season applications. Fomesafen is relatively persistent, and when less than average late-season rainfall occurs, the product can carryover into corn as a rotational crop. Dry and cold weather during the fall and winter can reduce herbicide dissipation and contribute to a carryover problem.

Figure 1. Corn injury from carryover of fomesafen. The primary symptom is striped leaves due to chlorotic or necrotic veins on the leaves.

Sulfonylurea herbicide products like chlorimuron can also lead to carryover problems in corn (Figure 2). Herbicides with sulfonylurea chemistry are labeled for use on both corn and soybeans. Products in this family may persist in the soil, particularly if soil pH is above 6.8 and post-application rainfall has been limited. Although they have the same general chemistry, different herbicides are used on corn and soybeans, and injury of corn may develop the season following sulfonylurea herbicide application to soybean fields.

Figure 2.
Corn injury from carryover of chlorimuron. Corn injury typically shows up as reduced root systems, often described as "bottle-brush" roots. Roots often grow flat or parallel to the soil surface and may turn brown. Stems and midribs can purple, and the stem will be short and thick below the whorl. Mid– to late-season symptoms include short internodes, malformed leaves, poor root systems, and pinched ears.

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Dinitroaniline herbicide products like trifluralin function by inhibiting root and shoot growth. Corn damage can occur due to carryover from an application made the previous season (Figure 3). Pigment inhibitors like clomazone can also carryover to cause corn injury (Figure 4). Shallow planting or stress conditions that slow seedling metabolism can increase the potential for clomazone injury. Damage to corn seedlings the season following an application may occur, especially if soil pH is below 6.0. Affected plants are distinctly white or bleached, and most corn plants recover with new leaves having normal color.

Figure 3. Corn injury from carryover of trifluralin. Seedling roots are pruned and clubbed. Stunting and purplish discoloration may occur above ground.

Figure 4. Corn injury from carryover of clomazone.

How to Minimize the Chance of Herbicide Carryover

- Always read the herbicide label and follow crop rotation intervals.
- Keep records of which fields received a residual herbicide with dates of application and rates applied.
- 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 being set up for carryover injury with a persistent residual herbicide, plant the same crop as last year.
- Consider tillage in fall and spring to help dilute herbicide residues and encourage degradation.
- Maintain soil pH of 6.5-7.0 to reduce herbicide carryover potential.

Sources

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