HERBICIDE CARRYOVER AND CROP ROTATION TO SUGARBEET

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Key Messages

1. Many herbicides are broken down by microbes in the soil.
2. Moisture, soil temperature, soil texture, organic matter, and soil pH influence herbicide degradation.
3. On farm conditions ultimately will determine herbicide persistence.
4. Gauge the risk of herbicide carryover based on accumulated rainfall between June 1 and September 1.

Introduction

Soil residual is an important characteristic of herbicides for crops planted in sequence with sugarbeet. It is desirable for herbicides to provide season-long weed control, especially for control of *amaranthus* species, but is not desirable for herbicides to persist across growing seasons (Figure 1). While pesticide labels provide guidance for crop rotation restrictions, environmental conditions, especially precipitation, will ultimately dictate the persistence of herbicides. Producers should be extra cautious when planning crop rotations for 2022, especially in geographies receiving less than 6-inch rainfall between June 1, 2021 to September 1, 2021.

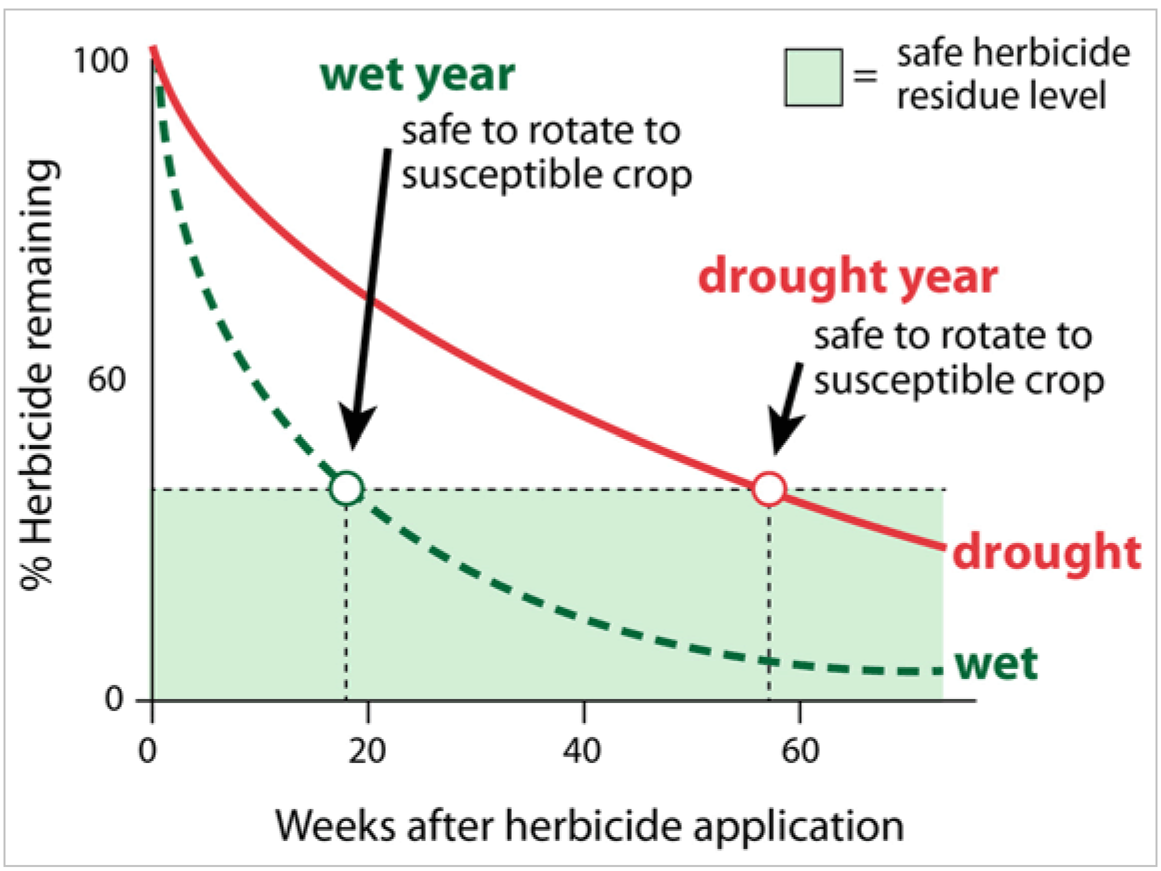

Figure 1. Colquhoun, J. 2006. Herbicide persistence and carryover. University of Wisconsin Extension publication A3819.

Factors Influencing Herbicide Carryover

Degradation of residual herbicides occur over time. Some residual herbicides, such as the chloroacetamides (group 15), degrade rapidly or in approximately three weeks. Other herbicides, such as Authority® products (group 14) or Firstrate® products (group 2), require many months before sugarbeet can be safely planted. Degradation of residual herbicides occur in different ways. Degradation by microbes in the soil is primarily responsible for herbicide breakdown. Speed of degradation is influenced by environmental and soil adaptation factors. Soil moisture and temperature are by far the most important factors in microbial activity.

Herbicide residues in the soil are deactivated in various ways including:

- Breakdown by soil microbes (most common method of degradation).
- Breakdown by chemical hydrolysis (water breaks herbicide molecules into less active pieces).
- Escape to the atmosphere as a gas (volatilization).
- Breakdown by light (photo degradation).
- Tightly bound to soil particles.

Moisture is the most important factor impacting herbicide breakdown, with microbial activity being greatest under moist but not saturated soil conditions. Herbicide breakdown by soil microbes is reduced under dry or drought conditions and carryover into the next growing season may occur. Herbicide adsorption (binding) to soil particles may also be increased with dry conditions since the herbicide moves from the soil solution as moisture is lost and is attached to soil colloids. Additionally, breakdown by chemical hydrolysis is slower when rainfall and soil moisture are limited during the growing season.

Temperature. Optimum soil microbial activity occurs in June, July, and August when soil temperatures are warm or between 70F and 85F. Herbicide breakdown is negligible before June or after August with minimal microbial activity below 50F soil temperatures. Herbicides that are broken down by chemical hydrolysis can also reduce since chemical reactions occur more slowly at lower temperatures.

Soil texture and organic matter. Herbicide degradation decreases in course textured soils or as soil organic matter decreases, due to reduced soil water holding capacity and less microbial activity. Soils with low clay content have decreased adsorption of residual herbicides, which increases the potential availability of the herbicide to sensitive plant roots when a significant rainfall occurs. Potential for injury on subsequent sensitive crops increases as organic matter and clay content decrease.

Soil pH. Chemical hydrolysis of residual herbicides within groups 2, 5, 14, and 15 are influenced by soil pH.

- Group 2 imidazolinones (IMI) persist longer under acid (low pH) soil conditions, whereas sulfonylureas (SU) persist longer in high pH soils.
- Group 5 triazines degrade slower under high pH soils.
- Group 14 sulfentrazone (Authority®) dissipates faster in high pH soils.
- Group 15 pyroxasulfone (Zidua®) dissipates faster in high pH soils.
- Group 27 mesotrione (Callisto®) dissipates faster in high pH soils.

Degradation varies across the field because soil texture, soil organic matter, pH, soil temperature, and soil moisture can also vary across the field.

Crop Rotation Restrictions

The crop rotation restrictions for residual herbicides is the period of time between herbicide application and when a sensitive crop can be planted under normal environmental conditions. Crop rotation restrictions may need to be extended by an additional season and/or a more tolerant crop seeded under drier conditions or when June 1 to September 1 rainfall is less than 6-inch. Crop rotation restrictions for a selected list of corn, soybean, or wheat herbicides used in 2020 or 2021 that may potentially affect sugarbeet in 2022 can be found in Table 1. Note Table 1 focuses on products with less than a 24-month restriction to sugarbeet. There are additional products that could be listed with long carryover concerns. Sugarbeet herbicides may also carryover to crops in the sequence (Table 2). Additional information and a complete list of crop rotation restrictions for herbicides is found on page(s) 6 and 100 to 104 of the 2022 North Dakota Weed Control Guide. In addition to a time interval, labels may also list conditions under which a particular crop may or may not be planted.

Table 1. Crop rotation restrictions for selected herbicides used before sugarbeet.[a]

Product	Active Ingredient	Group	Labeled Crop	Sugarbeet (months)
AcuronFlexi	metola, mesotr, bicyclo, benox	5,15,27,27	corn	18
Aatrex 4L	atrazine	5	corn	NCS
Armezon Pro	topramezone & dimethenamid	15, 27	corn	18
Capreno	tembo, thiencarbazone & isox	27, 2	corn	18
Callisto	mesotrione	27	corn	18
Diflexx Duo	dicamba, tembotrione & safener	4, 27	corn	10
Dimetric/Sencor	metribuzin	5	soybean	18
Everest	flucarbazone & safener	2	wheat	9
Fierce EZ	flumioxazin & pyroxasulfone		soybean	12
Flexstar	fomesafen	14	soybean	18
Halex GT	mesotr, glyph & metola	14, 9, 15	corn	18
Huskie	bromo, pyrasulf & mefenpyr	6, 27	wheat	9
Huskie Complete	bromo, pyras, mefen & mfnpr	6, 27, 2	wheat	9
Huskiie FX	bromo, pyras, flurox & mefenpy	6, 27, 4	Wheat	9
Impact	topramezone	27	corn	18
Laudis	tembotrione & safener	27	corn	10
Prowl EC/H20	pendimethalin	3	edible bean/ potato/ soybean	2CS
Raptor	imazamox	2	edible bean	18
Resicore	clopyralid, acetochlor & meso	4, 15, 27	corn	18
Starane Flex	florasulam & fluroxypyr		wheat	9
Sonalan HFP	ethafluralin	3	edible bean/ potato/ soybean	2CS
Talinor	bromoxynil & bicyclopyrone	6, 27	wheat	15
Treflan	trifluraline	3	soybean	2CS
Valor	flumioxazin	14	soybean	4-10
Varisto	bentazon & imazamox	6, 2	wheat	18
Varro	thiencarbazone & mefenpyr	2	wheat	9
Wolverine Advanced	fenox, pyrasu, bromo & mefenp	1, 27, 6	wheat	9

[a]NCS, next cropping season; 2CS, two cropping seasons

Table 2. Carryover risk to corn, soybean, and sugarbeet from commonly used herbicides.

MOA/ Family	Trade Name	Common Name	Primary Dissipation Mode	Risk of carryover injury following application to:		
				Corn	Soybean	Sugarbeet
Auxin	Stinger	clopyralid	Microbial	-	Moderate	-
ALS	Pursuit	imazethapyr	Microbial	Moderate	-	High
HPPD	Callisto	mesotrione	Microbial	-	Very low	High
HPPD	Laudis	tembotrione	Microbial	-	Low	High
PPO	Authority	sulfentrazone	Microbial	Low	-	High
PPO	FlexStar	Fomesafen	Microbial	Moderate	-	High
PPO	Sharpen	saflufenacil	Microbial	-	Low	Low
PPO	Valor	flumioxazin	Microbial	Low	-	Moderate
PSII	Aatrex	atrazine	Microbial	-	High	High
PSII	Sencor	metribuzin	Microbial	Low	-	High

Assessing Herbicide Residue in Soil

Soil samples can be collected and processed for chemical analysis to measure herbicide residue prior to seeding the next crop. While herbicide concentration can be easily measured, interpreting the result are challenging since it is difficult to associate carryover with laboratory value. Moreover, organic matter, clay content, and environment conditions, including soil moisture, will influence binding to soil. Plant bioassays are a second option and can also be conducted by growing a sensitive rotational crop in soil from a field with suspected herbicide residue and comparing to plants grown in soil that was not treated with the herbicide. However, because of field variability, the results of plant bioassays may not provide reliable recommendations. Field sampling error may also bias results, especially if soil is sampled too deep, diluting residues and increasing the risk of a false negative. Soil samples should be collected from the top two inches of soil. We recommend producers discuss both sampling and sampling location in fields with their crop consultant or agriculturalist if they intend to sample for chemical analysis or plant bioassay.

Summary

The best advice for growers in low rainfall situations following residual herbicide application is to assess their risk based on rainfall from June 1 to September 1. Consult with your agronomist, crop consultant, and/or herbicide company representatives to determine the best rotational cropping options, including planting a more tolerant crop the following year to minimize the risk of crop injury.