Herbicide Carryover and Crop Rotation to Sugarbeet

Thomas J. Peters, Extension Sugarbeet Agronomist and Weed Control Specialist, North Dakota State University and the University of Minnesota.

Key Messages

1. Many herbicides are broken down in soil by microbes.
2. Moisture, soil temperature, soil texture and 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 weed management 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 it is not desirable for herbicides to persist across 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.

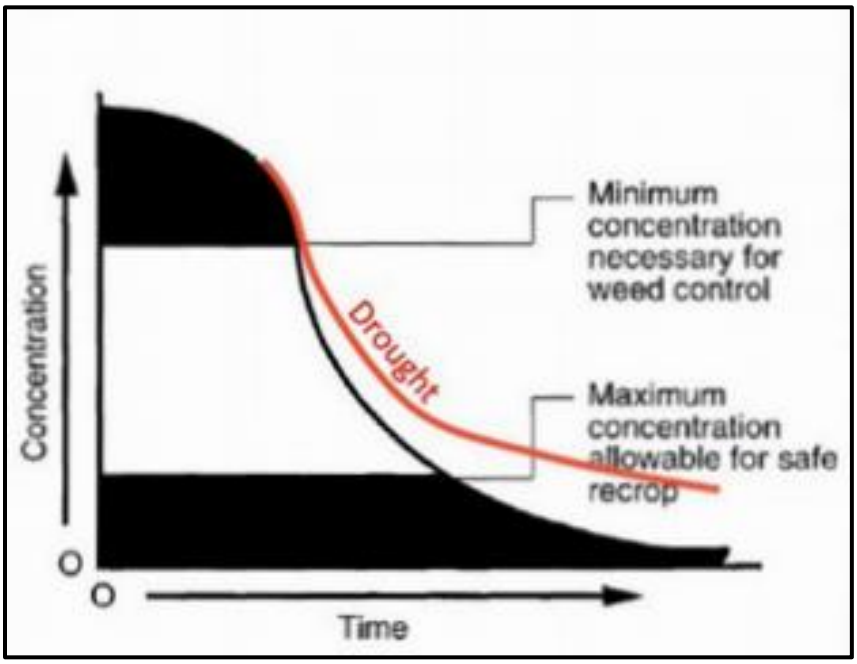

Figure 1. Herbicide degradation across time. Source: Adapted from Persistence of herbicides in Soil. Penn State University, 1999 and Pulse Knowledge, Saskatchewan Pulse Growers, 2020.

Factors Influencing Herbicide Carryover

Degradation of residual herbicides occurs over time. Some residual herbicides such as the chloroacetamides (group 15) degrade rapidly, 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 occurs in different ways. Degradation by microbes in the soil is primarily responsible for herbicide breakdown. Speed of degradation is influenced

by environmental and soil adaptic 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. 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 slow down as 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 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. Note I have concentrated on products with less than a 24-month restriction. There are additional products that could be listed with long carryover concerns. Additional information and a complete list of crop rotation restrictions for herbicides is found on page(s) 6 and 100 to 104 of the 2021 North Dakota Weed Control Guide.

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

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

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

Assessing Herbicide Residues in Soil

Soil samples can be collected and processed for chemical analysis to measure herbicide residues prior to seeding the next crop. However, there is very low correlation between the concentrations of an active ingredient in a soil test with crop injury response, because of the relative plant availability of those herbicides due to organic matter and clay content. Plant bioassays can also be conducted by growing a sensitive rotational crop in soil from a field with suspected residues 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 be a source of variation with these tests. Analysis is compromised if soil is sampled too deep, diluting residues and increasing the risk of a false negative. Samples should be collected from the top two inches of soil.

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 and herbicide company representatives to determine the best rotational cropping options, which may be to plant a more tolerant crop the following year to minimize the risk of crop injury.