Herbicide Carryover and Planting Bare-Root Tree Seedling in New Windbreaks

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Agricultural producers must be mindful of previous herbicide applications when converting cropland or pastures to a new windbreak. Newly planted tree seedlings are sensitive to many environmental stressors. One stressor that is often forgotten is herbicide residue from the previous cropping systems. The failure to consider this stress has resulted in the failure of newly planted windbreaks.

Herbicides used for managing weeds in agricultural land may persist for months or years following application. If the ground is converted to a windbreak, the newly planted bare-root tree seedlings may be adversely affected. This stress can result in discolored foliage, slow establishment, decline or mortality. This is referred to as herbicide carryover injury.

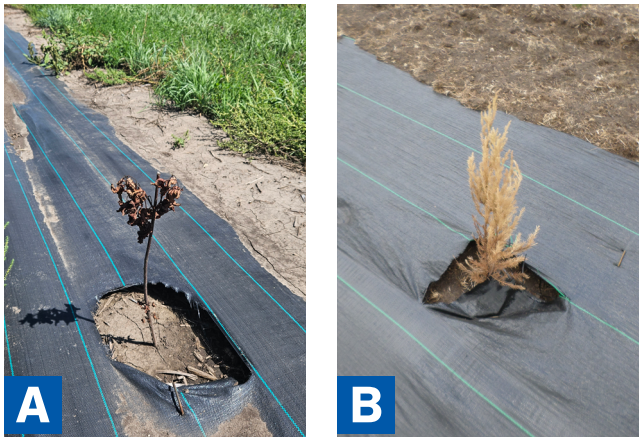

Figure 1a. Acetochlor herbicide carryover injury on maple.
Figure 1b. Atrazine carryover injury to eastern redcedar seedling

Carryover injury occurs when herbicides persisting at soil concentrations high enough to harm plants the following growing season or beyond. Some herbicides degrade in a few weeks or months to concentration no longer harmful to newly planted tree seedlings. The residue left by other herbicides may persist at harmful concentrations for years following the application.

There are no inexpensive or reliable means of knowing if the residue in soil is at a concentration high enough to result in carryover injury. Lab testing of herbicide present in the soil is inconclusive. There is little published data that associates herbicide residue concentrations with plant injury. At best, lab testing can indicate that a specific herbicide is present at detectable levels, but not necessarily at harmful levels.

Bioassays are impractical with seedling trees. Planting seedling trees in containers filled with field soil does not provide the same environmental conditions present in the ground. It also can take weeks to months before any injury may become apparent when testing in pots. This is why we use rotational crop restrictions on the labels to determine when the risk of carryover injury has passed.

The active ingredient(s) in herbicide is the dominant factor in determining the rate of degradation and the period for carryover concerns. Table 1 in this publication provides a guideline for the period between the application of a specific herbicide active ingredient and planting bare-root seedlings. If a herbicide is listed with a rotation restriction of 24 months, this means it

can be as long as two years between the herbicide application and when the seedlings can be planted without a risk carryover injury. These restrictions are a baseline for herbicide degradation to levels that are not harmful to susceptible plants.

Factors that affect carryover period

There are many factors that can affect the herbicide degradation rate. Microbial activity is the common pathway for degrading many herbicides. Certain soil microorganisms, mainly bacteria and fungi, utilize herbicides as a food source, breaking them down in a process called biodegradation.

These microorganisms are herbicide specific. A microbe population can increase when a specific herbicide is repeatedly used so the carryover period becomes shorter. The carryover period may be longer if the active ingredients in the herbicide had not been previously applied to the soil.

Environmental conditions that favor soil microorganisms are factors in the rate of herbicide degradation. Microorganisms require soils that are moist and well-drained, having adequate moisture but not so much as to limit soil aeration. They also thrive in fertile soils with a neutral pH.

The soil is also a factor in the degradation rate of herbicides. It has an indirect effect through its influence on microorganism growth which affects degradation rates. The soil physical properties also have a direct effect on the rate. The soil texture, organic matter content and pH all influence herbicide persistence and the likelihood of carryover injury.

The soil pH can influence the rate of degradation. This is most common for the triazine (atrazine) and sulfonylureas (chlorimuron, metsulfuron, nicosulfuron, prosulfuron) herbicide groups. The chemical degradation of these herbicides slows in soil that are slightly alkaline (soil pH 7.4-7.8) and higher. This means the carryover injury period may be longer than listed. The herbicides where this influence is a concern are identified in the note's column in Table 1. Herbicides can also bind to soil particles and organic matter which also can influence persistence.

Herbicide molecules can bind to organic matter and soil particles in the soil profile through precipitation. Some herbicides are more prone to binding to soil particles while other herbicides are not simply due to the chemical structure of each herbicide. Important factors that dictate if a herbicide will bind to the soil are clay types, minerals present, percent organic matter, pH, and soil water content. Clay particles have a negative charge and minerals (i.e., calcium or potassium) or herbicides with a positive charge will bind to these particles.

Organic matter in the soil carries a negative charge as well that attracts herbicides that have a positive charge. While pH does not directly influence herbicides binding to the soil, soils with higher pH usually have an excess of minerals that have a positive charge and bind to many of the negative charges in the soil. Therefore, the herbicides with a positive charge cannot bind to these herbicide particles to be released later. Conversely, in lower pH soils, there are more binding sites for the herbicides in the soil. Since pH can also influence the degradation of a herbicide, certain soil types will influence if the herbicide will be able to bind to soil particles before breaking down.

Herbicides can be lost from the soil via leaching and volatilization. These losses are greatest in coarse-textured soils with low organic matter content (<3%). Fine-textured soils and those with higher organic matter content can bind the herbicide to particles. While this reduces the herbicide activity following an application, it can also lengthen the time in which carryover injury is possible.

The weather also plays a role in the degradation rate of herbicides. The rate often increases in warm, moist soil due to increases in chemical processes and microorganism activity. The period of carryover injury lengthens during drought. This is a greater concern with the imadalzolinones (imazapyr, imazapic, imazaquin, imazethapyr), isoxazolidinone (clomazone), and pyridines (aminopyralid, clopyralid, picloram) herbicide groups.

Herbicide carryover will likely occur in pockets rather than uniform across the area that has been sprayed. Soil characteristics can vary over a small area. Therefore, if herbicide carryover does injure trees, often these seedings will appear scattered throughout the newly planted windbreak. Most herbicides persist in pockets that possess favorable soil characteristics. Tillage can also help "dilute" any herbicides persisting in the area to be converted into a windbreak as this practice will mix the soil. Soil with high herbicide concentration may be mixed with soils of very low herbicide concentration. This may dilute the herbicide levels to a concentration that does not injury the seedlings.

There are also differences in herbicide tolerance among

tree species. The most sensitive are leguminous trees and shrubs. Black locust, honeylocust, Kentucky coffeetree and Siberian peashrub are sensitive to injury from herbicides containing aminopyralid or clopyralid. This is noted in Table 1. This means the rotation period may be longer than listed.

The basis for these carryover restriction guidelines

These are guidelines, however, as injury to tree seedlings is not assessed as part of the labeling requirements for herbicide crop rotations. The guidelines in this publication follow the rotational crop restriction for “other crops” or the longest rotation listed for any named crop on the label – whichever period is longest. This provides a conservative safeguard for planting seedling bare-roots trees following a specific herbicide application. Some of these herbicides can be applied to established trees without injury as mature plants are more resilient compared to bare-root seedlings.

While the guidelines for tree planting restrictions are not included for most herbicide active ingredients, all herbicide labels will provide crop rotation restrictions. Use the most restrictive rotation period to ensure no injury to newly planted trees.

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Table 1. Herbicide Carryover Period Restrictions for Bare-Root Tree Seedling Plantings.

Brand name	Common Name of Active Ingredient	Crop	Months Following Application	Notes[1]
2,4-D	2,4-D	Corn, wheat, pasture	>12	
Accent	Nitosulfuron	Corn	12	
Ally XP	Metsulfuron	Wheat	36	Soil pH >7.9
Amber	Triasulfuron	Wheat, pasture	36	
Assure II	Quizalofop-P-ethyl	Corn	>12	
Atrazine	Atrazine	Corn	36	Soil pH > 7.5
Authority[2]	Sulfenrazone	Soybean	36	Soil pH > 7.5
Balance	Isoxaflutole	Corn	18	
Banvel	Dicamba	Corn, Wheat	>12	
Basagran	Bentazon	Corn, Soybean	>12	
Basis	Rimsulfuron + Thifensulfuron	Corn	>12	
Battle Star	Formesafen	Soybean	18	
BroadAxe	Sulfentrazone + Metolachlor	Soybean	12	Soil pH>7.5
Callisto	Mesotrione	Corn	18	
Clarity	Dicamba	Wheat	>12	
Command	Clomazone	Soybean	18	
Classic	Chlorimuron	Soybean	24	Soil pH >7.0
Curtail	Clopyralid + 2,4-D	Wheat	12	Legume trees
Dual II	S-metolachlor	Corn, Soybean	12	
Enlist One	2,4-D	Corn, Soybean	>12	
Escort	Metsulfuron	Pasture		
Finesse	Chlorsulfuron + Metsulfuron	Wheat	36	Soil pH >7.9
FirstRate	Cloransulam	Soybean	36	
Flexstar	Fomesafen	Soybean	18	
Forefront	Aminopyralid + 2,4-D	Pasture	24	Legume trees
Garlon	Triclopyr	Pasture		
Grazon	Aminopyralid	Pasture	24	Legume trees
Grazonnext	Aminopyralid + 2,4-D	Pasture	24	Legume trees
Harness	Acetochlor	Corn	12	
Harness Xtra	Acetochlor + Atrazine	Corn	36	
Hornet	Flumetsulam + Clopyralid	Corn	24	Soil pH >7.8
Milestone	Aminopyralid	Pasture	24	Legume trees
Peak	Prosulfuron	Wheat	24	Soil pH >7.8
Prowl	Pendimethalin	Corn, Soybean, Wheat	24	
Pursuit	Imazethapyr	Alfalfa, Soybean	40	
Python	Flumetsulam	Corn, Soybean	24	
Raptor	Imazamox	Alfalfa	26	
Reflex	Fomesafen	Soybean	18	
Sandea	Halosulfuron	Wheat	36	
Scepter	Imazaquin	Soybean	18	
Spartan	Sulfentrazone	Soybean	12	
Starane	Fluroxypyr	Wheat	>12	
Status	Dicamba + Diflufenzopyr	Corn	12	
Stinger	Clopyralid	Corn	10	Legume trees
Surpass	Acetochlor	Corn	Following spring	
Tordon	Picloram	Pasture	36	
Transline	Clopyralid	Pasture	Following spring	Legume trees
Treflan[3]	Trifluralin	Corn	18	

[1] Soil pH or trees species that may require a longer carryover period restriction
[2] Authority is also sold as Authority Assist, Edge First, MTZ, and Preview. These have cloransulam, imazethapyr, methribuzin, metolachlor, or pyroxasulfone in addition to sulfentrazone. The carry-over period is the same for all.
[3] For Treflan products labelled for crops. There are Treflan products that can be applied to the soil before tree planting.