

Getting the Most from Soil-Applied Herbicides

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While soil-applied herbicides can be quite valuable in weed control, misuse can cause crop injury or failure to control weeds. This guide is an overview of factors that influence the fate, effectiveness and persistence of soil-applied herbicides.



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SOIL-APPLIED PREPLANT INCORPORATED (PPI)

and preemergence (PRE) herbicides can be very valuable tools: they control early season weeds and, if they are residual, can provide season-long weed control. They are especially useful when wet weather delays post-emergence spraying or cultivation. However, miscalculations in the use of soil-applied herbicides could cause crop injury or fail to control weeds. This guide reviews several factors that influence the fate, effectiveness and persistence of soil-applied herbicides.

Five basic concepts of soil-applied herbicides.

1. Germination and early seedling growth are the most vulnerable stages in the weed's life cycle.
2. Soil-applied herbicides should be located within the top 2 inches of the soil surface to get in close contact with actively growing weeds.
3. Preventing early weed establishment provides crops with a competitive advantage that could last for the rest of the growing season.
4. Crop tolerance to many soil-applied herbicides is less than for postemergence herbicides. Thus, careful sprayer calibration, accurate application, and proper incorporation are critical.
5. Applications of soil-applied herbicides should be done prior to weed emergence and should be justified on the basis of the expected weed abundance and species composition. Scout your fields during the previous summer and fall to anticipate the weed abundance.

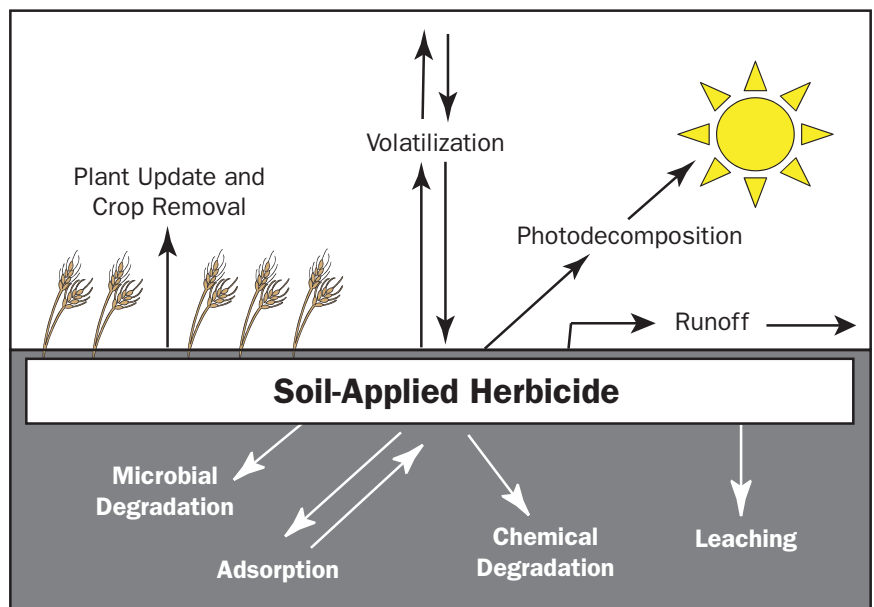
Where does all that herbicide go?

After spraying, the concentration and persistence of soil-applied herbicides depend on the herbicide properties, the weather conditions, and soil factors such as texture, pH, moisture and organic matter (OM). To maximize the efficiency of soil-applied herbicides, it is important to understand the different factors affecting their fate (Figure 1).

Herbicides have electrical charges that cause them to bind to the positive or negative charges in the soil and organic matter particles. This process, similar to the attraction of iron to a magnet, is called adsorption. Herbicide adsorption varies with soil pH, soil organic matter content and climate. When spraying a soil-applied herbicide, remember:

- Soils high in organic matter or clay are the most adsorptive. These soils may require higher rates or more frequent herbicide applications than sandy and coarse soils.

FIGURE 1. Factors affecting the fate of soil-applied herbicides.



- Herbicide carryover and crop injury are more likely to occur in sandy and coarse soils, as less herbicide is adsorbed to the soil.
- The risk of herbicide carryover varies with soil pH.

Herbicide volatilization refers to the transformation of solid or liquid herbicide into gas. Volatilization increases with air temperature, soil temperature, and wind speed. Volatilization decreases with high relative humidity. Air currents can carry away volatilized herbicides from the treated area, and this invisible vapor drift may cause crop injury for long distances downwind.

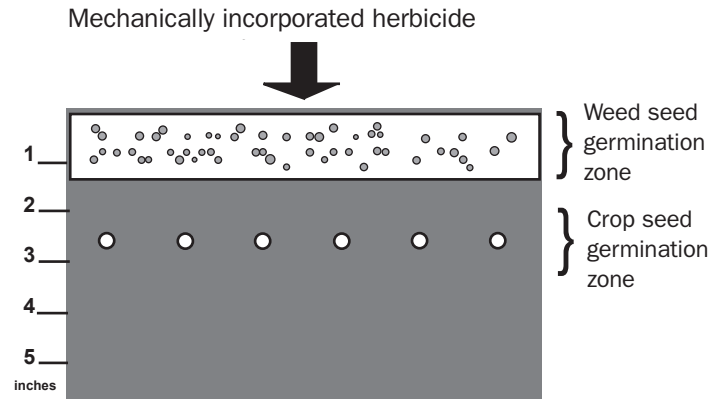
Volatilization can be reduced through the incorporation of the herbicide into the soil by mechanical incorporation, irrigation or precipitation. Proper incorporation ensures that volatile herbicides such as Treflan (trifluralin) can penetrate germinating weed seedlings as a gas. Take care so that the herbicide does not move into the crop germination zone. For example, if herbicides are incorporated too deeply or wheat is seeded too shallow, the herbicide may come in contact with the developing wheat root system and inhibit its growth (Figure 2).

To ensure good results, incorporate with two perpendicular passes, 24 hours after application. The second incorporation pass usually should be done more shallowly so that untreated soil will not be moved into the herbicide zone. Follow the label instructions concerning incorporation depth, and adjust equipment based on soil characteristics, crop residue and preplant tillage. If the field has more than 40 to 50 percent crop residue cover, it may be necessary to till it prior to herbicide application and incorporation. Also, if the soil is too wet, incorporation could result in uneven herbicide distribution. Other tactics could help reduce herbicide volatilization and drift injuries, such as:

- Using formulations with lower vapor pressure.
- Increasing the size of spray droplets.
- Checking the weather. The potential for crop damage due to vapor drift increases with temperature and low relative humidity.

Soil-applied herbicides can also be lost through photodegradation, microbial degradation and chemical degradation. Photodegradation is the breakdown of herbicide by the action of sunlight. For example, herbicides such as trifluralin and Eptam (EPTC) are photosensitive and can be lost from the soil if left on the surface. Microbial degradation refers to the breakdown of herbicide by microorganisms present in the soil. Chemical degradation is the disappearance of a herbicide by soil

FIGURE 2. Soil applied herbicides should be incorporated into the weed germination zone to allow them to be in close contact with weed seeds but not with crop seeds.



processes not involving living organisms. These processes are widely influenced by soil temperature and humidity. Table 1 lists the photodegradation and microbial degradation potential of several herbicides commonly used in Montana. As a general rule,

- Mechanical soil incorporation, incorporation by rainfall, or irrigation reduces herbicide losses due to sunlight.
- Microbial and chemical degradation increase with temperature and soil moisture

Leaching refers to herbicide movement through the soil profile with water. Among the factors that influence leaching are the herbicide water solubility, the soil structure and texture, and the amount of water passing through the soil profile. For example, while Roundup (glyphosate) and trifluralin have low leaching potential due to their strong adsorption to soil, moderately to weakly adsorbed herbicides such as Eptam can be lost from the soil profile with water. It is important to remember that:

- Herbicide molecules that are strongly adsorbed to soil particles are less likely to leach.
- Herbicide leaching increases in coarse and sandy soils with low organic matter.
- Although herbicide leaching in Montana is generally low, take care to prevent groundwater contamination.
- Always read the label. If there is a precaution regarding leachability, use caution to handle and apply the herbicide.

Surface water runoff results in water contamination as water or eroding soil moves herbicides out of crop fields. Herbicide losses from runoff will increase if a heavy rain occurs after spraying.

TABLE 1. Properties of herbicides commonly used in Montana. Most of the information compiled from the Herbicide Handbook. Weed Science Society of America, Eighth Edition, 2002.

Product Name (chemical name)	Behavior and Persistence in Soil	Volatilization	Photodegradation
Banvel, Clarity (dicamba)	Low to medium leaching potential. Dicamba is mobile, but degrades rapidly in the soil. Rapid degradation, but may persist longer under conditions of low soil moisture.	Low to moderate	Negligible
Maverick (sulfosulfuron)	Due to its high level of activity, very low level residues can persist in the crop to cause crop injury 1 to 3 years after application, depending upon soil and climate.	Negligible	Extensive degradation observed at pH 7.0
Spartan (sulfentrazone)	Stable in soil (half life = 18 months) with low affinity for organic matter. Potential of crop injury due to carryover varies with soil pH and organic matter content (OM).	Moderate risk	Should be incorporated immediately
Roundup, Touchdown (glyphosate)	Rapidly and tightly adsorbed to soil. OM, clay, silt, sand content, or soil pH have minimal effect on adsorption. Moderate persistence and low mobility. Degraded by microbes in soil and water.	Negligible	Negligible
Treflan (trifluralin)	Strongly adsorbed to OM. Adsorbed to clay. More rapidly degraded in flooded conditions than in moist aerobic soils.	Slightly volatile	Degraded by UV light
Far-Go (triallate)	Not mobile in soils with high OM. Could provide up to six to eight weeks of wild oat control. Degraded by microbes.	Substantial when applied to warm soils without proper incorporation	Negligible
Ro-Neet, Marathon (cycloate)	Moderately adsorbed. Microbial degradations could be very high when incorporated in the soil to a depth of two to three inches.	High when left on the surface of moist soils, but low on dry soil surfaces	Negligible
Sutan (butylate)	Weakly to moderately adsorbed to soils. Provides approximately four to seven weeks of weed control. Rapidly metabolized by microbes.	High in wet soils with no incorporation. Little loss after application to dry soils	Negligible
Eptam (EPTC)	Adsorbed onto dry soils. Adsorption increases with OM. Provides up to four to six weeks of weed control but it can be degraded by microbes.	Can be lost if not incorporated after application to moist soils	Can be significant; incorporate immediately after application

For that reason,

- If heavy rains are expected, consider delaying herbicide applications.
- Remember that soil compaction increases surface water runoff.
- No-till and conservation tillage practices diminish herbicide movement due to surface water runoff because soil is less compacted and water more readily absorbed into the soil profile.

Tolerant plants, crops or varieties can uptake and metabolize the herbicide by breaking it into non-toxic compounds. Herbicide residues are then removed from cropland at crop harvest.

How long do herbicides persist after spraying?

Knowing the length of time that a herbicide persists in the soil can help you reduce the risk of crop injury and determine the expected weed control period. Herbicide labels list the product half-life, defined as the length of

time it takes for 50 percent of the herbicide to break down to inactive compounds. Herbicide adsorption and breakdown vary with soil temperature, soil pH and soil moisture. For example, Montana's producers have recently added Spartan (sulfentrazone) to their farming toolbox as a way to manage kochia, Russian thistle, buckwheat, common lambsquarters, pigweed spp. and green foxtail. Unfortunately, farmers and researchers at Montana State University have reported wheat, barley and dry pea injury due to Spartan carryover. Although it is unclear why Spartan carryover can be seen in some locations but not in others; it is suspected to be due to a combination of soil factors, climate conditions and seeding depth. It is important to remember:

- Long persistence of a soil-applied herbicide may cause problems due to leaching, runoff or vaporization.
- Pay attention to the recrop intervals on the herbicide label. Doing so can help you avoid carryover injury to the following crop.

Summary

In summary, soil-applied herbicides are valuable tools to manage early emerging weeds. However, if these herbicides are applied without care, they could damage the crop or contaminate the groundwater. To ensure effective and safe applications, it is important to understand the different factors affecting the fate of soil-applied herbicides. Always remember that the goals of controlling weeds are:

- Prevent or minimize yield loss due to competition,
- Minimize future weed problems, and
- Prevent interference at harvest.

Consider the integration of soil-applied herbicides with other practices including mechanical practices, modified planting dates and the use of more competitive crop varieties to reduce weed burden.

Common chemical and trade names are used in this publication for clarity by the reader. Inclusion of a common chemical or trade name does not imply endorsement of that particular product or brand of herbicide, and exclusion does not imply nonapproval.



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