



Factors Influencing the Residual Herbicidal Activity of Rimsulfuron

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Summary

- Rimsulfuron, 1 of the active ingredients in DuPont™ LeadOff®, Basis® Blend, and Alluvex™ herbicides, provides postemergence burndown and residual control of winter annual and other weeds.
 - LeadOff® allows rotational crop flexibility to corn, cotton, peanuts and soybeans.
 - Basis® Blend allows rotation to corn or soybeans depending on application timing and rate.
 - Alluvex™ is a set up treatment for corn.

Alluvex™ / Basis® Blend / LeadOff® Geographies

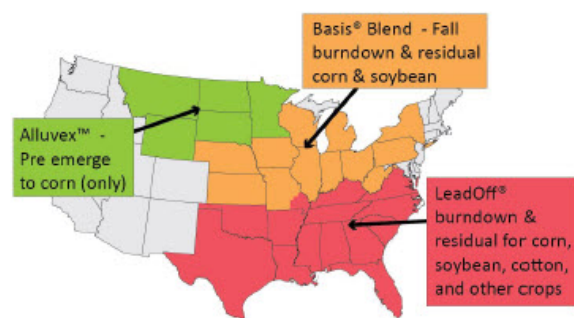


Figure 1. Geographies of burndown herbicides containing rimsulfuron.

- Rimsulfuron is most active as a herbicide postemergence when applied to young, actively growing weeds and is most active preemergence on germinating weed seeds and newly germinated weed seedlings.
- The location of rimsulfuron in the soil dramatically affects residual activity; rimsulfuron located in the seed germination and root zones produces the maximum level of weed control.
- The length of residual control with rimsulfuron depends on the sensitivity of the weed, the soil pH, percent organic matter, and soil temperature.
- Rimsulfuron provides maximum residual activity in cooler environments and in low organic matter (< 3%) or low CEC soils (< 15) with a pH between 6.5 and 7.5.

Introduction

Rimsulfuron, an active ingredient in several herbicide products, is 1 of only a few herbicides that offers the following package of benefits:

- Provides control of winter annual weeds with postemergence applications from fall postharvest to early spring (**Figure 2**).
- Has sufficient soil residual activity to maintain clean fields until planting.
- Allows growers the flexibility to plant corn, cotton, or soybean in a normal crop rotation.

Rimsulfuron is a Group 2 herbicide that can be tank-mixed with several commonly used herbicides with no loss in weed control activity due to antagonism. These include glyphosate (a Group 9 herbicide), 2,4-D (a Group 4 herbicide), flumioxazin (a Group 14 herbicide), and paraquat (a Group 22 herbicide). Combinations of rimsulfuron with these other herbicides or with a tillage program allows for excellent control of troublesome winter annual weeds such as dandelion and henbit. Because these herbicide combinations include multiple modes of action,

the risk of weed populations developing resistance is greatly reduced.



Figure 2. Controlling winter annual weeds results in a cleaner seedbed at planting. The field was treated with a tank mixture of LeadOff®.

Note: (1.5 oz/ac) plus glyphosate (22 oz/ac) plus 2,4-D (12 oz/ac) on Nov. 28, 2012. Pictures were taken April 29, 2013.

As with any herbicide, environmental conditions influence rimsulfuron performance. A better understanding of these influences on rimsulfuron herbicidal activity can help applicators and farmers maximize weed control with their rimsulfuron-containing products.

Biological Activity of Rimsulfuron

Rimsulfuron is a sulfonylurea herbicide that stops plant growth by inhibiting the formation of isoleucine, leucine, and valine - amino acids essential for cell division and plant growth. Individual cells that have already formed when the weed is exposed to rimsulfuron continue to grow to maturity. However, these cells cannot divide to form new cells (**Figure 3**). The weed eventually starves to death for lack of the specific amino acids needed to support cell division or plant growth.

Cell division is most prolific in young, actively growing plants. When rimsulfuron-containing products are used postemergence, the best weed control occurs when applied in the fall or early spring to weeds less than 3 inches tall.



Figure 3. Rimsulfuron inhibits cell division during germination. The seed embryo contains the cells to start root and shoot growth. However, rimsulfuron prevents these cells from dividing to form secondary roots or root hairs.

For these young plants, any rimsulfuron that lands on leaf surfaces when the herbicide is sprayed translocates only a short distance to stop cell division in meristematic regions of the plant. In addition, these young plants have limited amounts of isoleucine, leucine, and valine in reserve to combat the inhibitory effects of the herbicide.

Late fall and early spring applications also allow rimsulfuron to express maximum preemergence herbicidal activity. Research studies show that rimsulfuron provides the best weed control when rimsulfuron is already present in the seed germination zone or in the root zone as seed germination or early root growth begins (**Figure 4**).

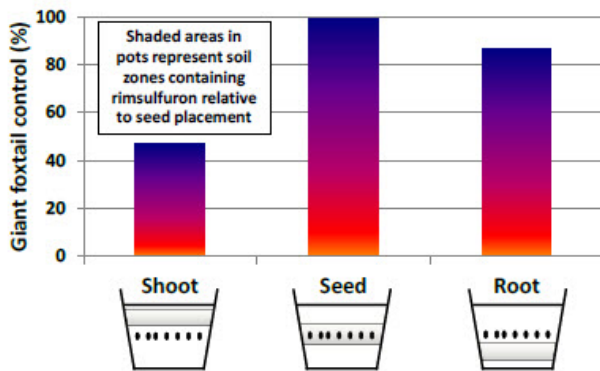


Figure 4. Greenhouse studies demonstrate that the location of rimsulfuron in the soil alters the level of weed control.

As Figure 4 indicates, rimsulfuron located above the seed germination zone produced substantially less weed control than the 2 deeper placements. This has profound implications in a field situation. If all of the soil-applied rimsulfuron remains on the soil surface, its ability to control weeds is greatly reduced. Fortunately, however, rimsulfuron moves as the soil water moves. Rainfall events in the fall and early spring provide the necessary water to move rimsulfuron into the soil zones where seed germination and early root formation occur. In those zones, targeted weeds are well-controlled (Figure 4).

For some soils, the minimum rainfall amount to move rimsulfuron down into its active zone is about 0.75 inch. However, even with much higher rainfall amounts, rimsulfuron largely stays within the top 6 inches of soil, due to the physical properties of the molecule. This is important, as most weeds germinate and emerge from above this depth.

Rimsulfuron moves with water from the soil surface into the soil profile, as long as the soil remains unfrozen. Freezing temperatures that stop water and rimsulfuron movement in the soil also stop plant growth. When temperatures warm up and new plant growth begins, rimsulfuron is still located where it needs to be for maximum weed control.

Chemical Characteristics of the Molecule and the Soil

The length of residual activity for rimsulfuron depends on how fast the herbicide molecule breaks down in soil and how sensitive the plant is to rimsulfuron. In general, the primary methods of degradation of sulfonylurea herbicides are acid hydrolysis in acidic or low pH soils and microbial degradation in higher pH or alkaline soils. However, rimsulfuron is different than most SU herbicides in that it degrades primarily via a process known as "bridge contraction." Bridge contraction refers to a molecular rearrangement within the rimsulfuron molecule that renders it inactive, and is strictly a chemical process.

Degradation of rimsulfuron via bridge contraction is about 10 times faster than degradation by acid hydrolysis in acidic soils and microbial degradation in higher pH soils. Because this process is a chemical reaction, it is possible to estimate the rate of breakdown as a function of soil pH and soil temperature (Figure 5).

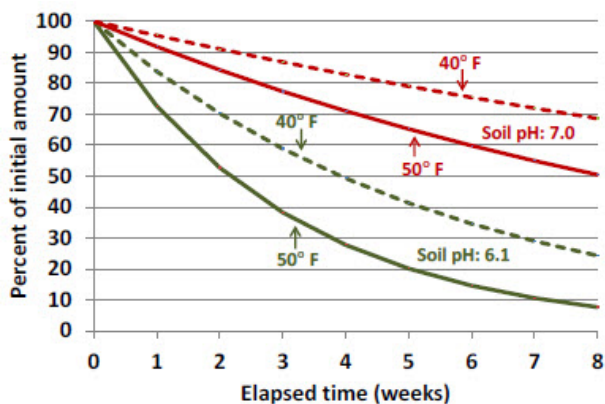


Figure 5. Soil pH and temperature govern the rate of degradation of rimsulfuron.

Rimsulfuron is most stable in a pH 7 soil. The rate of breakdown is about 5 times faster at pH 6 and at pH 8. Because its stability is highest at a pH 6.5 to 7.5, rimsulfuron shows the longest residual activity in near-neutral pH soils.

The rate of breakdown of rimsulfuron can also be estimated as a function of soil temperature. In a pH 7 soil, rimsulfuron degrades about 5 times faster in a 70-degree soil versus a 40-degree

soil ([Table 1](#)).

Table 1. Soil temperature and pH affect residual levels of rimsulfuron.

Soil Temp (°F)	Percent of initial concentration 1 week after application		
	pH 6.1	pH 7.0	pH 8.1
30 F	90.9%	97.5%	93.8%
40 F	83.8%	95.4%	87.3%
50 F	72.6%	91.8%	75.8%
60 F	56.8%	85.9%	57.6%
70 F	37.5%	76.8%	34.3%

As [Table 1](#) indicates, the rate of breakdown of rimsulfuron in cold or frozen soils is very slow. Thus, for fall-applied products containing rimsulfuron, the amount of rimsulfuron in the soil when the soil starts to thaw in early spring is similar to the amount of rimsulfuron that was in the soil in late fall when the soil began to freeze. This suspension of degradation of rimsulfuron during the cold winter months allows fall-applied rimsulfuron to continue to show residual herbicidal activity in the early spring when new winter annual weeds are germinating. Depending on spring temperatures and the planting date, effective residual activity of rimsulfuron may last well into the planting season.

Residual herbicidal activity of rimsulfuron is also affected by the amount of organic matter in the soil. As a general rule, for each 1% increase in soil organic matter, the residual concentration of rimsulfuron must double to provide equivalent herbicidal activity in the 2 soils. For those herbicide products in which rimsulfuron is part of a "burndown plus residual" weed control program, the label rate of rimsulfuron provides effective residual control in soils with up to about 3% organic matter or with a maximum cation exchange capacity of about 15.

Conclusions

Like most herbicides, rimsulfuron performance, and particularly its residual activity, is impacted by weather conditions and soil properties. When soil-applied, rimsulfuron is most effective if the herbicide molecule is already present in the seed germination and the seedling rooting zones before germination and root growth start. For some soils, a minimum of three-quarter inch of rainfall is required to move rimsulfuron into these zones. Cooler soils with a pH near 7 allow for the slowest rate of degradation of rimsulfuron and are therefore best suited to allow the herbicide to show maximum residual activity. In addition, soil organic matter makes the rimsulfuron molecule less available for plant uptake. Rimsulfuron therefore shows greater residual activity in soils with low organic matter or a low cation exchange capacity.

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DuPont™ LeadOff®, Alluvex™ and Basis® Blend herbicides may not be available in all states. See your DuPont representative for details and availability in your state.

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