TURFGRASS TRENDS

HERBICIDE USE

Sulfonylureas Hold Promise in Turfgrass Systems if Used Judiciously

By Scott McElroy, Shawn Askew and Fred Yelverton

Sulfonylurea herbicides are an important component of turfgrass weed management. With the introduction of several new herbicides in this chemical family, they are increasing in importance. The sulfonylurea herbicide family includes currently used herbicides, such as halosulfuron (Manage) and chlorsulfuron (Corsair), as well as several recently released herbicides (Table 1).

Sulfonylurea herbicides are nothing new to turfgrass weed management, but understanding them better can help improve their efficacy.

Sulfonylurea herbicides are commonly used at low rates (usually measured in ounces or fractions of an ounce per acre) and are relatively safe toxicologically (Anderson, 1996). They are all rapidly absorbed by foliage of target weeds and don't persist long in turfgrass systems.

However, probably the most important attribute of sulfonylurea herbicides is the potential adaptability to many turfgrass management situations and the specificity of weed control. Weeds that once had few selective control options, such as green kyllinga and purple nutsedge, can now be selectively controlled with specific sulfonylurea herbicides. Sulfonylurea herbicides also have other uses, such as aiding pre- and post-dormancy bermudagrass transition by controlling annual bluegrass in the fall and overseeded cool-season grasses in the spring.

But with the benefit of newer herbicides to the turfgrass industry, there should also be prudence in their use. Before you go out and start using these herbicides, you should be aware of a few aspects that could help you improve their efficacy and avoid any potential problems down the road.

Herbicide absorption

All sulfonylurea herbicides are applied as liquid foliar sprays — none of them are applied as a granular. Foliar applications are made because herbicides in this family are largely foliar absorbed and move throughout the rest of the plant to provide effective control. However, some researchers have shown that these herbicides can enter the plant through root absorption, thus aiding in weed control.

Research at North Carolina State University in Raleigh was conducted to compare the root vs. foliar absorption of halosulfuron and trifloxysulfuron by two perennial sedges: green and false-green kyllinga. Plants grown in a greenhouse were treated with herbicide at three levels: herbicide applied only to the foliage (foliar only), herbicide

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TABLE 1

Examples of common sulfonylurea herbicides labeled for use in turfgrass.

CHEMICAL NAME	PRODUCT NAME	GENERAL LABELED USAGE	WEED CONTROL USAGE
Chlorsulfuron	Corsair	For use in several turfgrass areas, including sod farms. Not for use on tall fescue and ryegrasses.	Various grass and broadleaf weeds
Halosulfuron	Manage	Numerous warm- and cool-season grasses grown in residential and nonresidential turf, including home lawn, sod farms, and athletic fields.	Primarily sedges. Yellow and purple nutsedge, nontuberous sedges, *Kyllinga* spp.
Foramsulfuron	Revolver	Bermudagrass and zoysiagrass grown on sod farms, golf courses, athletic fields, residential and non-residential turf.	Various warm- and cool-season annual and perennial grasses.
Metsulfuron	Manor, Blade	Kentucky bluegrass, fine fescue, bermuda, St. Augustine, zoysia and centipede grasses grown as residential and nonresidential turf, including golf courses	Various annual and perennial grasses and broadleaves, including bahiagrass.
Rimsulfuron	TranXit GTA	Warm-season grasses on sod and seed farms, golf courses, college and professional sports fields, nonresidential turf	Annual bluegrass control prior to overseeding bermudagrass.
Trifloxysulfuron	Monument	Bermudagrass and zoysiagrass grown on sod farms, golf courses and nonresidential areas.	Wide range of sedges, grasses, and broadleaf weeds.

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applied only to the soil (soil only), and herbicide applied to both the foliage and to the soil (foliar + soil).

Foliar-only herbicide applications were made by covering the soil with activated charcoal, thus intercepting herbicide before it reached the soil surface. Soil-only herbicide applications were made by applying the herbicide in a syringe to the soil surface, making sure not to contact the foliage. Foliar + soil applications were made by spraying the plants normally and letting the herbicide contact both the foliage and soil.

While it was initially thought that foliar absorption was the major mode of entry of sulfonylurea herbicides into the plant, the results from this study indicated that plant absorption of the herbicide from the soil was just as important (Table 1). For both trifloxysulfuron and halosulfuron, foliar-only treatments reduced shoot numbers to less than half of the soil plus foliar herbicide treatment. Further, the soil-applied treatment (root and rhizome absorption) of trifloxysulfuron controlled the *Kyllinga* spp. greater than the foliar-applied treatment, indicating that root absorption is actually more important than foliar absorption for this herbicide (Table 1).

Potential for movement and tracking

Because of the importance of herbicide absorption by the plant from the soil for complete control, it stands to reason that application methods that maximize both root and foliar absorption could increase efficacy. Irrigating after application or applying the herbicide at higher spray volume could potentially put greater amounts of the herbicide in contact with the soil to be absorbed by roots and rhizomes.

However, caution should be taken to minimize the lateral movement of sulfonylurea herbicides in surface water. Heavy irrigation or rainfall soon after herbicide application could move the herbicide laterally and injure sensitive species (see photo, page 54). Application

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It's important to monitor rainfall and irrigation levels so sulfonylureas don't move laterally and damage other turf.

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in the proximity of sensitive species, such as around green complexes, should be done with caution.

If you must apply a sulfonylurea herbicide in the proximity of a sensitive nontarget plant species, here are some general suggestions:

- Plan your herbicide application as best you can around the weather. Apply when you know rain will not occur for at least two days.
- Apply the herbicide and allow it to absorb into the foliage for four to six hours. Maximum foliar absorption of sulfonylurea herbicides occurs within four hours (Askew and Wilcut, 2002; McElroy et al., 2004). Thus, the remaining herbicide does not need to stay on the foliage.
- After four hours, use two or three light, frequent irrigations to move the herbicide into the soil profile. Make sure irrigations are light enough to wash the remaining herbicide from the leaf, but not enough to create mass water flow over the surface. Irrigation rates are especially important on heavy clay soils with low infiltration rates.

These three suggestions can aid in preventing off-target movement of sulfonylurea herbicides and can also help in maximizing herbicide absorption in roots. But it must be remembered that the safest route is to not apply them upslope of sensitive species.

These steps can also aid with another potential problem with sulfonylurea herbicides: relocation by equipment and human traffic. Tracking of sulfonylurea herbicides can occur when sufficient quantities of the herbicide remains on wet foliage and, before the herbicide can dry, traffic moves the herbicide on to nontarget species. Sometimes herbicide is slow to dry because conditions are not optimal for drying on the foliage. Weather conditions such as overcast skies with high humidity could potentially reduce herbicide drying. In other cases, herbicide may dry properly but the chemical remains on the leaf surface and is later redissolved with dew. The injury tracks were caused when a mower was driven across a dew-covered treated area one day after treatment (see photo, page 56). Thus, precautions should be taken to insure that herbicide is washed from treated leaves after maximum absorption has occurred.

Potential for herbicide-resistance development

Probably the biggest threat to the family of sulfonylurea herbicides is weed-resistance development. Sulfonylurea herbicides bind to a specific enzyme, acetolactate synthase (ALS), within plant species, thus rendering that specific enzyme inactive. Without the activity of the ALS enzyme, plants cannot produce the branched chain amino acids essential for survival.

For a plant to develop herbicide resistance, however, only one small component of the enzyme has to change (Eberlin et al., 1999).

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TABLE 2

Effect of herbicide treatment and placement level on green and false-green kyllinga.

HERBICIDE	PLACEMENT	SHOOT NUMBER REDUCTION[a]
		%
Trifloxysulfuron	Foliar	46 c
	Soil	68 b
	Soil + Foliar	99 a
Halosulfuron	Foliar	39 c
	Soil	33 c
	Soil + Foliar	83 ab

[a]Reduction in shoot number averaged across green and false-green kyllinga plants is relative to the non-treated control plants (0 percent reduction). Shoot number reduction numbers followed by the same letter are statistically equivalent.

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Resistance to sulfonylurea herbicides has developed in as many as 27 weed species worldwide and can occur in as few as four years after sulfonylurea herbicide use has begun (Anderson et al., 1998; Burnet et al., 1994).

Plants that become resistant to one sulfonylurea herbicide will most likely be resistant to other sulfonylurea herbicides, as well as other herbicides that inhibit activity of the ALS-enzyme, such as imazaquin and imazapic. It is therefore imperative that precautions be taken to ensure that resistance does not develop to herbicides within the sulfonylurea family. Here are some suggestions to take to aid in the fight against potential resistance development:

Rotate modes of action. If you have a certain species that is a perennial problem, use an herbicide with a different mode of action to combat the problem. Other herbicide families target other physiological processes within the plant, thus eliminating individual plants that could develop resistance.

Tank mix other modes of action with sulfonylurea herbicides. Herbicides such as MSMA and carfentrazone do not affect the overall effectiveness of sulfonylurea herbicides and in some cases, can improve effectiveness.

Use an integrated approach to weed management. By using cultural practices to increase the growth and development of your desired turfgrass, you increase the competitive ability of the desired turfgrass against developing weeds. The more competitive the turfgrass, the less chance a weed will have to invade.

Sulfonylurea herbicides have great potential for solving problems that previously had few to no solutions. Their ability to selectively control weeds in various turfgrass species, with little to no environmental consequences, makes them an invaluable tool for turfgrass managers. However, precautions should be taken to minimize the off-target movement of these herbicides through tracking or surface water movement on to sensitive species.

Additionally, in order to keep this herbicide family in our arsenal of solutions, we should take the necessary steps to preserve the herbicide effectiveness and prevent weed-resistance development. By taking precaution now, we will maximize the effectiveness of sulfonylurea herbicides now and ensure their usefulness in the future.

This off-target movement of a sulfonylurea herbicide occurred after it was tracked by a mower.

Probably the biggest threat to the family of sulfonylurea herbicides is the development of weed resistance.

McElroy is an assistant professor in the Department of Plant Sciences at the University of Tennessee. Askew, is an assistant professor at Virginia Tech in the Department of Plant Pathology, Physiology, and Weed Science. Yelverton is a professor in the Crop Science Department at North Carolina State University.

REFERENCES

Anderson, D. D., S. J. Nissen, A. R. Martin, and F. W. Roeth. 1998. "Mechanism of primisulfuron resistance in a shattercane (*Sorghum bicolor*) biotype." *Weed Sci.* 46:158-162.

Anderson, W. P. 1996. *Weed Science: Principles and Applications*, 3rd ed. New York: West Publishing Co. pp. 219-226.

Askew, S. D. and J. W. Wilcut. 2002. "Absorption, translocation, and metabolism of foliar-applied CGA-362622 in cotton, peanut, and selected weeds." 50:293-298.

Burnet, M.W.M, J. T. Christopher, J.A.M. Holtum, and S.B. Powles. 1994. "Identification of two mechanisms of sulfonylurea resistance within one population of rigid ryegrass (*Lolium rigidum*) using a selective germination medium." *Weed Sci.* 42:468-473

Eberlin, C. V., M. J. Guttieri, P. H. Berger, et al. 1999. "Physiological consequences of mutation for ALS-inhibitor resistance." *Weed Sci.* 47:383-392.

McElroy, J. S., F. H. Yelverton, I. C. Burke, and J. W. Wilcut. 2004. "Absorption, translocation, and metabolism of CGA-362622 and halosulfuron in green and false-green kyllinga (*Kyllinga brevifolia* and *K. gracillima*)." *Weed Sci.* (*submitted*).

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How to Categorize Organic Materials in Turfgrass Root Zones

By Deying Li

The term "soil organic matter" means different things to people of different fields. In agriculture, it implies high soil fertility and should be maintained against soil deterioration. In environmental science, it is regarded as a sink for carbon dioxide (CO_2), a filter for water, and a buffer to contaminants. In engineering, it may imply a less stable foundation. Perhaps in no other area can organic matter create more controversies and misunderstandings than in the field of turf management.

The term raises many questions, such as what materials are considered to be soil organic matter, how are they distinguished, which are beneficial and what is the optimum amount for turf root zones.

Most importantly, turf managers want to know how to attain an ideal root-zone media for their turf. While many papers have been published on isolated issues of this topic, a view of the whole picture will help turf managers solve the organic puzzle.

Soil organic materials

There are different types of organic materials in a turf root zone, including soil organic matter, soil organic residues and soil biomass. Many turf managers are confused with the terms, mistaking thatch for soil organic matter, for example. As a result, turf managers are often indifferent about organic sources and are unsure about how to maintain high soil fertility and a low level of thatch accumulation in the turf.

The Glossary of Soil Science Terms Committee (GSSTC) of the Soil Science Society of America (SSSA) defines "soil organic matter" as "the organic fraction of the soil exclusive of undecayed plant and animal residues."

Soil organic matter is synonymously used with "humus." Soil organic matter is divided into two subgroups, nonhumic substances and humic substances. Nonhumic substances belong to the known classes of biochemistry, such as amino acids, carbohydrates and fats, while humic substances are of unclear molecular structures with high molecular weights and of brown and other dark colors. Humic substances are further divided into humins, humic acids and fulvic acids in accordance to their solubility in acid and alkali.

The second component of organic material in turf root zones is thatch, defined as "an intermingled organic layer of dead and living shoots, stems and roots that develop between the zone of green vegetation and the soil surface" (Beard, 1980). Turgeon (1979) excluded living tissues in his more academic definition. There are some synonyms for thatch, but most of them are loose or misleading, such as mat.

It is important to note that thatch is classified as organic residues by soil scientists and should not be considered as soil organic matter. Until thatch is decomposed, it will not return any nutrients back to the soil but tie up nutrients. In fact, a heavily thatched turf may not have enough soil organic matter because of the diminished decomposition and mineralization.

The third component of soil organic material, soil biomass, is the collection of living organisms in soil. Soil microbes are of particular importance because they are essential for soil organic matter regeneration and mineralization. It is commonly believed that new sand-based greens are sterile. Research showed that newly constructed greens are colonized rapidly by a large number and wide arrange of microorganisms within the first year regardless of sand, peat and fumigant source.

Effects of soil organic matter on turf

Soil organic matter has many beneficial effects on root-zone media. For instance, it improves and stabilizes the structure of soil-based root zones through aggregation. It also enhances physical properties of both soil-based and sand-based root-zone media by balancing water and air-holding porosity.

Furthermore, it increases the cation exchange capacity (CEC), which acts as a storehouse of nutrients and supplies significant amounts of nitrogen (N), sulfur (S), phosphorus (P) and

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TABLE 1

Chemical and physical properties of organic materials for use in turf

ORGANIC SOURCES	PH	OM (%)	CEC ($CMOL_C$/100G)	EC (DS/M)	C/N RATIO[1]	NUTRIENT RELEASE	MICROBIAL ACTIVITIES[2]	HAZARDOUS RISKS[3]	BULK DENSITY (KG/M^3)	BLENDING HOMOGENEITY WITH SAND	PHYSICAL PROPERTIES FOR SAND MIX
Reed sedge peat I	5.1-7.5	>85	>140	1.0-1.5	23:1	Slow	Low	Low	190	Excellent	Excellent
Sphagnum peat	3-4	>95	100-200	2.0-3.0	47:1	Low	Very low	Low	72-112	Good	Good
Hypnum moss peat	5-7	<80	140	0.7	35:1	Low to moderate	Very low	Low	80-160	Good	Medium
Reed sedge peat II	4-5	30-80	100-150	2.4	40:1	Low	Very low	Low	160-288	Excellent	Excellent
Peat humus	5.0-7.5	<50	1-120		48:1	Moderate	Low	Low	320-641	Excellent	Good
Rice hulls	6.4	72	60	0.95	19-50:1	Low	Moderate to high	Low	500	Medium	poor
Cotton burr compost	5-7.5	38	200	1.7	8-22:1	High	High	Moderate	1,200	Poor	Poor
Composted bark	4-5.5	64	50	2.5	115:1	Low	Moderate	Moderate	400	Poor	Poor
Manure	6-8	4-36	75-100	7.4	12:1	Moderate to high	Very high	Low	700	Poor	Good
Biosolid	6.6-7.2	24	80	2.2-3.5	20-100:1	Moderate	Moderate	High	1,400	Good	Moderate
Recommend range	6.0-7.5	>80	>100	<1	<30:1	Slow	Medium or lower	Low	<500	Good or better	Good or better

1. Carbon-to-nitrogen ratio can be manipulated by adding chemicals. and the result is short-lived.
2. Microbial activities indicate the microbe population (both beneficial and harmful) before turf establishment.
3. Hazardous risks donate potential count.

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other nutrients after mineralization. Finally, soil organic matter ties up toxic ions to decrease its availability to plants and lessen the chance of contaminating ground water.

The optimum amount of organic matter depends on whether the root zone media is sand- or soil-based. Three to 5 percent of organic matter is adequate for sand-based root-zone media. In soil-based root zones, 10 percent of soil organic matter is acceptable.

Under normal management, soil organic matter content reaches a balance at about 4 percent decades after establishment in many golf course putting greens and fairways (Qian and Follett, 2002). Conversely, .5 inch (equivalent to 1 percent by weight) or more of thatch usually causes problems in turf.

Cause, prevention, and mitigation of thatch

More rapid accumulation than decomposition and mineralization of plant residue results in thatch. This is caused by poor soil physical conditions, such as deficient aeration, excessive or inadequate moisture and insufficient interaction among plant residue and soil particles. This prevents the colonization and activity of microbes in the breakdown of the thatch layer.

Arranging traffic away from trouble spots during times of disruptive moisture levels will help to reduce the degree of soil compaction. Often, rearranging rounds of golf is not an option. It is therefore critical to build a sports turf root zone with a medium that is less susceptible to compaction, such as sand or a sand/peat mixture.

Extremely acidic soil (pH of less than 5) or alkali soil (pH more than 8) is unsuitable for the life of microorganisms because most of the beneficial fungi can not survive the high pH, while the useful bacteria can not tolerate low pH. Regardless of species, microorganisms require a favorable total carbon and nitrogen ratio in the soils because they consume certain parts of nitrogen for each part of carbon they digest. Overdoses of nitrogen often stimulate faster shoot growth and thatch accumulation. Frequent use of insecticides and fungicides also kills nontarget soil