Sulfonylurea Herbicides: Key to a Successful Overseeding Program

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Introduction

Sulfonylurea (SU) herbicides have been used to selectively control various weeds in agricultural crops for the last 25 years but they have recently introduced to control weeds in established turfgrasses. All the sulfonylurea herbicides have a general backbone consisting of an aryl group, a sulfonylurea bridge and a nitrogen-containing heterocycle. Most of the sulfonylurea herbicides have low acute oral, dermal and inhalation toxicity in mammals. The acute oral LD_{50} value of table salt in rats is 3000 mg kg^{-1} while most of the sulfonylurea herbicides have LD_{50} values greater than 4000 mg kg^{-1} of body weight (Sax Irving, 1979).

Study of the mode of action of sulfonylureas was first reported by Ray (1982) and Hatzios and Howe (1982). Sulfonylurea herbicides inhibit the activity of an enzyme called acetolactate synthase(ALS) also known as acetohydroxyacid synthase (AHAS), which is a key enzyme in the branched chain amino acid biosynthetic pathway of bacteria, fungi, and higher plants. The branched chain amino acid pathway is responsible in producing three essential amino acids, valine, isoleucine and leucine (Hatzios and Howe 1982). All the sulfonylurea herbicides display unusual "slow-binding" behavior with the enzyme, and this behavior may help explain the efficacy of the herbicides. These herbicides are also called as ALS or AHAS herbicides.

Sulfonylurea herbicides can be used as selective post-emergence control of certain sedges, grasses and broadleaf weeds in warm-season turfgrasses like bermudagrass, and zyosiagrass (Yulverton, 2004). These herbicides can also be used a tools in a successful overseeding program. They can be used on the bermudagrass before overseeding with cool-season turfgrasses like perennial ryegrass or *Poa trivialis* in the fall or can be used during spring transition to remove the cool-season turfgrass in the spring. Several sulfonylurea herbicides have been registered for use on golf courses like metsulfuron (Manor or Blade), chlorsulfuron (Corsair), foramsulfuron (Revolver), halosulfuron (Manage), rimsulfuron (TranXit GTA), flazasulfuron (Katana), trifloxysulfuron (Monument) and sulfosulfuron (Certainty). Another new herbicide bispyribac-sodium (Velocity) has also been introduced which works on the same ALS enzyme.

Poa Control before Overseeding

Poa annua infestation in an overseeded stand of perennial ryegrass is a major problem for golf course superintendents. Introduction of various sulfonylurea herbicides has given golf course superintendents new tools in managing *Poa annua*. The best strategy to control *Poa* is to apply sulfonylurea herbicides before overseeding but care should be taken not to apply the herbicides to close to overseeding. Trifloxysulfuron, foramsulfuron, rimsulfuron and sulfosulfuron are very effective in controlling annual bluegrass. Since sulfonylurea

herbicides are systemic in nature, the absorption, translocation and inhibition of the ALS enzyme takes at least 14 days to observe optimum control of *Poa*.

Trifloxysulfuron application at 7.06 g/acre (0.24 ounces/acre) can control over 90% of the *Poa annua* population within 28 days after application. Lower rate of application of trifloxysulfuron (7.06 g/acre) was as effective as higher rate of application (9.33 g/acre) for controlling *Poa* (Figure 1). Formasulfuron applied at 6 ml 1000 sq. ft^2 (0.2 fl. ounces/1000 ft^2) controlled over 90% of *Poa* within 28 days after treatment (DAT). Optimum control was achieved between 30 and 60 DAT (Figure 1).

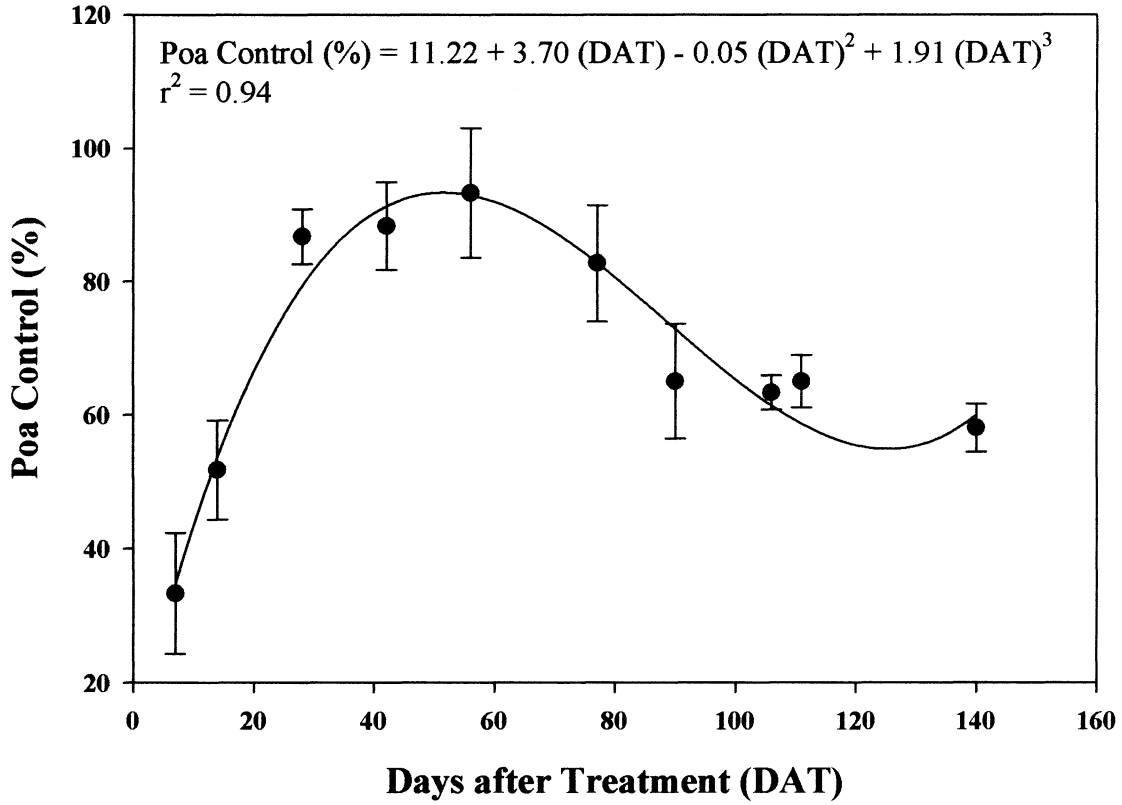

Figure 1. *Poa annua* control with a single application of foramsulfuron at 6 ml/1000 ft^2.

Efficacy of a single application of foramsulfuron reduced after 90 DAT. Sequential application of sulfonylurea herbicides are more effective in controlling *Poa* compared to a single application. Sequential application of foramsulfuron within 4 to 6 weeks after the first application would increase the efficacy of foramsulfuron in controlling *Poa* over a longer period.

Sulfosulfuron is also very effective in controlling *Poa* when applied at 75 g/acre rate. Optimum control was achieved between 21 and 45 DAT with a single application of sulfosulfuron (Figure 2). The efficacy of a single application of sulfosulfuron reduced after 75 DAT. Sequential application would increase the window for *Poa* control. *Poa* plants are

very aggressive and are prolific seedhead producers so they start to produce new plants as soon as the efficacy of sulfonylurea herbicides reduces. Hence sequential applications are needed to achieve long term control of *Poa* population.

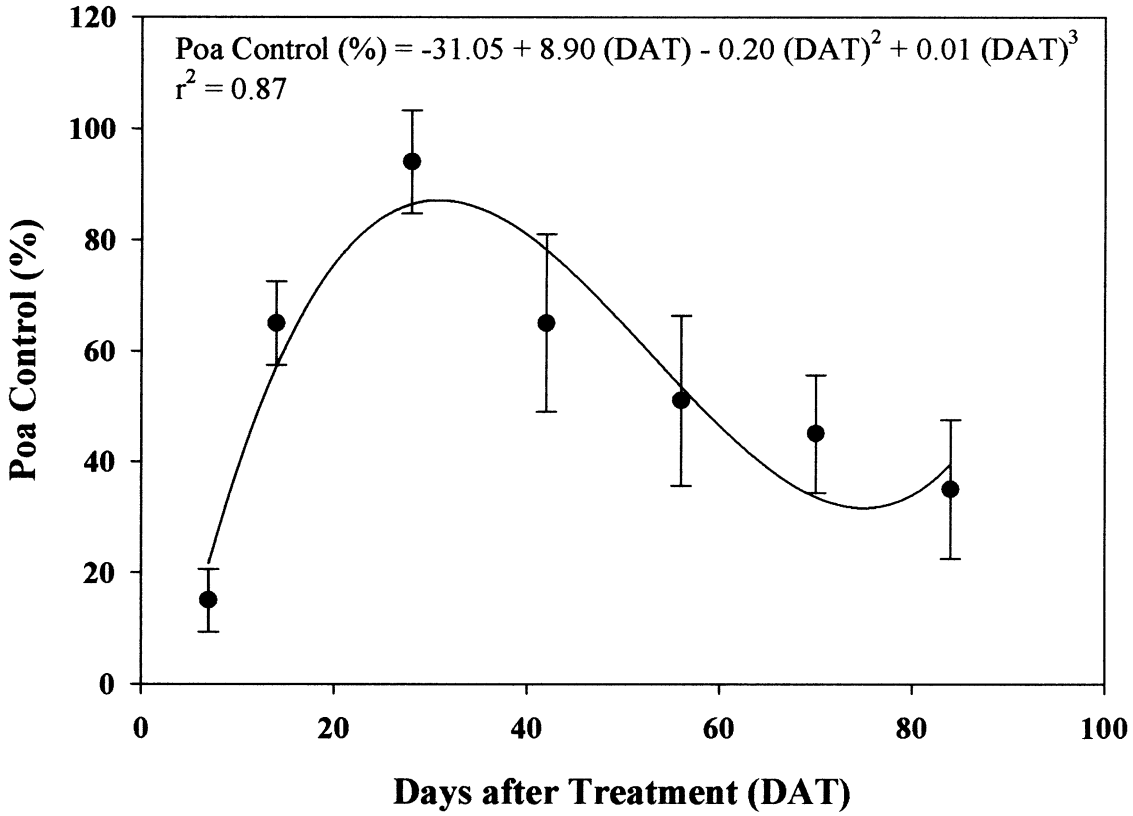

Figure 2. *Poa annua* control with a single application of sulfosulfuron at 75 g/Acre applied 10 days before overseeding.

Trifloxysulfuron application at 9.33 g/acre controlled *Poa* effectively and the optimum level of control was achieved between 30 and 70 DAT (Figure 4). The efficacy of a single application of trifloxysulfuron reduced after 80 DAT. An experiment was conducted on dormant bermudagrass to evaluate the efficacy of *Poa* control with two different rates of Monument (7.03 and 9.33 g/acre). *Poa annua* plants were counted in a 25 sq. ft grid and then extrapolated to no. of plants in 1000 sq. ft. Sequential application of trifloxysulfuron at 9.33 g/acre and formasulfuron application at 257 ml/acre were very effective in controlling *Poa annua* till 140 DAT (Figure 3).

Ryegrass Injury

SU herbicides are wonderful tools in controlling weeds before overseeding bermudagrass tees and fairways but the biggest problem with these products is the chances of injury to ryegrasses. Hence, the application timing of the SU herbicides is very important. In our

experiments minimum injury to perennial ryegrass was observed with 9.33 g/acre rate of trifloxysulfuron when applied 21 days before overseeding (DBO) compared to the application made 10 DBO. The extent of injury was not very severe (approximately 12% injury). The ryegrass was stunted and showed some yellowing after 8 weeks after overseeding (WAO).

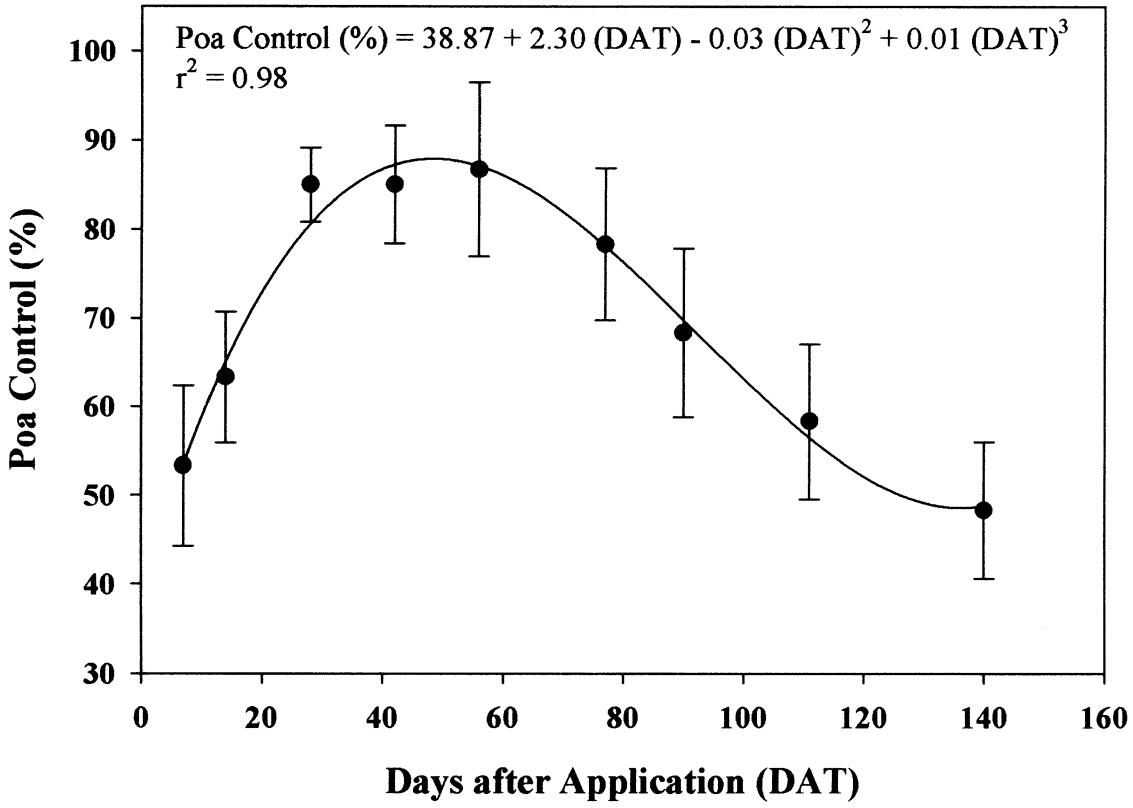

Figure 3. *Poa annua* control with a single application of trifloxysulfuron at 9.33 g/Acre.

Maximum ryegrass injury (about 12% injury, 3 WAO) with sulfosulfuron applied at 36 g/acre rate was observed in our experiments when the herbicide was applied 7 days before overseeding (Figure 4). No injury to ryegrass was observed when sulfosulfuron was applied at 27 g/acre 10 DBO. Application of glyphosate at 6 oz/acre (0.4 L/ha) on dormant bermudagrass applied 3 DBO controlled over 90% of annual bluegrass and injured only 6% of the perennial ryegrass 3 WAO. The stand of perennial ryegrass recovered from the injury by 7 WAO. When glyphosate (6 oz/acre) was tank-mixed with 140 g/acre of sulfosulfuron and applied 3 DBO it resulted in 48% injury of ryegrass 3 WAO which increased to over 70% injury to ryegrass by 7 WAO.

Rimsulfuron at 54g/acre applied 7 days before overseeding resulted in over 45% injury of perennial ryegrass 3 weeks after overseeding (Figure 5). The injury increased to 60% at 5 WAO and even at 7 WAO 50% of the perennial ryegrass stand was lost. Rimsulfuron was very effective in controlling annual bluegrass within 3 WAO. In order to minimize injury to

ryegrass rimsulfuron has to be applied 10 or 14 days before overseeding and probably lower rates can be used.

Clumpy Ryegrass Control

When perennial ryegrass survives the summer or when it escapes the overseeded area, this turf species can become clumpy and is unsightly (Yelverton, 2003). Clumpy ryegrass is more difficult to control than an overseeded stand of dense perennial ryegrass. Pronamide is not effective in controlling clumpy ryegrass but some of the SU herbicides have been reported to be very effective (Yelverton, 2003).

In our experiments foramsulfuron applied at 0.4 fl. oz (11.8 ml) per 1000 sq. ft was very effective on controlling clumpy ryegrass 5 weeks after application. A sequential application at 4-6 weeks after the initial application provided superior control of clumpy ryegrass compared to a single application. Formasulfuron applied during late spring or early summer provided optimum control of clumpy ryegrass compared to early spring applications. Foramsulfuron is mainly taken up by plants through the foliage hence under higher temperatures when the plant is actively growing the herbicide is absorbed and translocated in the plant faster compared to translocation at lower temperatures.

The early application of foramsulfuron (spring) was not as effective as the later application (early and late summer) in controlling clumpy ryegrass for all rates of application as observed by the slopes of the regression curves (Figure 4). For all the application times the optimum rate was around 0.6 fl. oz/1000 sq. ft as observed by the maxima of the regression curves for percent control of clumpy ryegrass at 4 weeks after each treatment (WAT).

The highest rate of foramsulfuron (1.2 oz/1000 sq. ft) controlled 100% of the clumpy ryegrass at 8 WAT. The sequential application of foramsulfuron at 0.6 oz/acre during the early application (spring) did not result in significantly higher percentage control of clumpy ryegrass. At 4 WAT the 1.2 oz/1000 sq. ft rate of application controlled 68% of the clumpy ryegrass when applied during the spring while it controlled 88% when applied during early summer and 100% control when applied during late summer. Hence a higher level of control was achieved when foramsulfuron was applied later on during the summer. The higher summer temperatures exposed the clumpy ryegrass plants to heat stress and may have increased the activity of foramsulfuron due to increased uptake and translocation of the herbicide when applied at the later application date.

A single application of 0.6 oz/1000 sq. ft of foramsulfuron controlled 37% of the clumpy ryegrass at 4 WAT compared to 85% control when applied at early summer and 100% control when applied during late summer. The role of the sequential application became more critical during the later application timings which resulted in higher levels of clumpy ryegrass control. During the late summer application timing the sequential applications resulted in significantly higher level of clumpy ryegrass control at all rating dates (Figure 4).

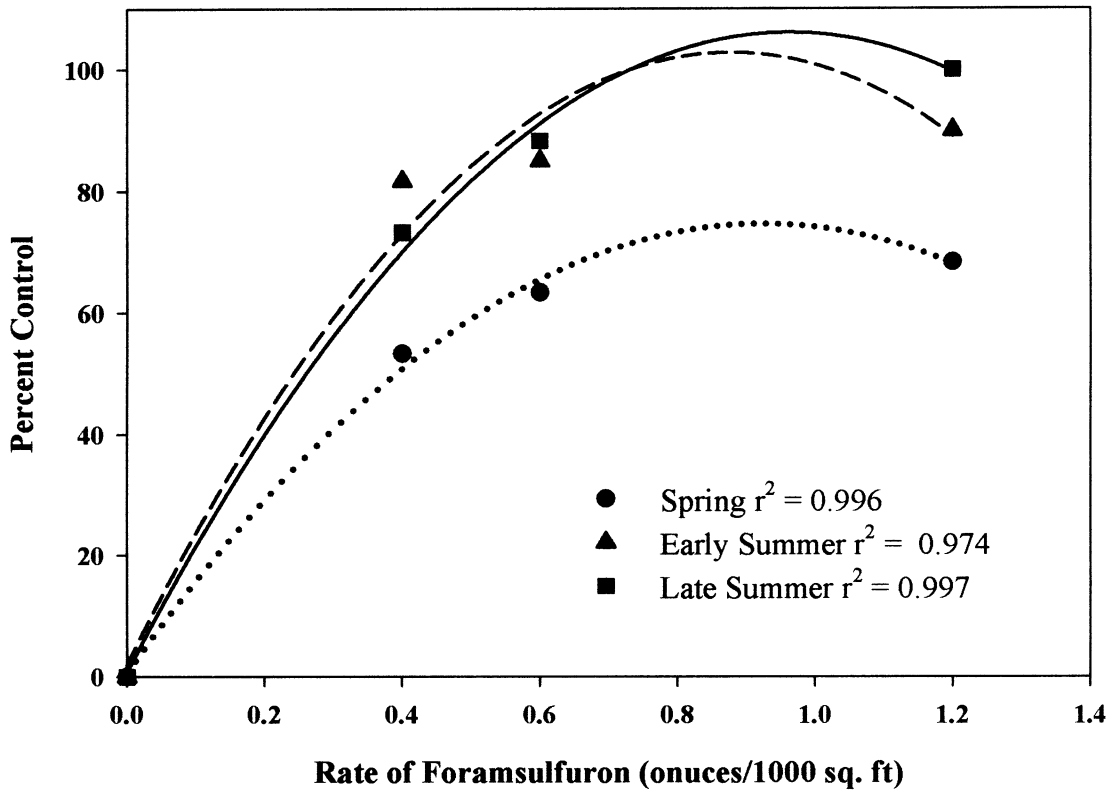

Figure 4. Effect of application timing and rate of foramsulfuron 4 weeks after each application on clumpy ryegrass control

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