

The Turfgrass Industry Officially Loses MSMA

J. T. Brosnan
Assistant Professor -
Turfgrass Weed Science
University of Tennessee

G. K. Breeden
Extension Assistant -
Weed Science
University of Tennessee

A. J. Patton
Assistant Professor -
Turfgrass Specialist
University of Arkansas
Division of Agriculture

Introduction

Monosodium methanearsonate (MSMA) is a commonly used herbicide in warm-season climates. Since the 1960s, this product has been used to manage infestations of various crabgrass species (*Digitaria* spp.) as well as goosegrass (*Eleusine indica*) and dallisgrass (*Paspalum dilatatum*) in warm-season turf. MSMA, an organic arsenical herbicide, contains an organic form of the element arsenic. In its organic form, arsenic is relatively nontoxic. For example, the herbicide MSMA is far less toxic than aspirin.^{1,2} However, in an inorganic state, arsenic can be highly toxic. It is important to note that **MSMA only contains organic arsenic**. Furthermore, research has continually shown that MSMA is tightly bound to soil organic matter and is not readily leached.

However, water samples from two golf courses in Florida tested high in arsenic in 2006. This spurred a ruling by the United States Environmental Protection Agency (EPA) to cancel the registration of MSMA in all aspects of agriculture, including turfgrass management. There was a concern that organic arsenic from MSMA could convert into the more toxic, inorganic form in the environment.

Multiple public comment periods followed the ruling, and the response from various facets of agriculture was overwhelming. The MSMA task force, an alliance of chemical companies that manufacture the product, and the cotton industry formulated a response. Concerns were raised on a number of issues about the ruling, particularly that no information was provided regarding the type of arsenic detected in the water (i.e., organic or

inorganic), the source of the arsenic found, and that there was no way to conclusively say that the arsenic was from applications of MSMA.

Final Ruling on MSMA Use for Turfgrass Weed Management

On September 30, 2009, the EPA announced the final decision regarding the use of MSMA for agricultural weed management.³ Impacts on the turfgrass industry were significant, with repercussions that will change weed control strategies.

Golf Courses

Registrants of MSMA will not be permitted to sell the product for golf course use after December 31, 2012; however, distributors will be able to sell products containing MSMA until June 30, 2013. Use of MSMA on golf courses after December 31, 2013, will be prohibited.

Until the December 31, 2013 deadline, newly constructed courses will be allowed one broadcast application, and existing courses will be able to use MSMA only as a spot treatment, providing that spots are less than 100 ft² and no more than 25 percent of the course is treated within a given year. These restrictions were made effective on September 30, 2009.

Sod Farms

Registrants of MSMA will not be permitted to sell the product for sod farm use after December 31, 2012; however, distributors will be able to sell products containing MSMA until June 30, 2013. Use of MSMA on sod farms after December 31, 2013, will be prohibited.

*Arkansas Is
Our Campus*

Visit our web site at:
<https://www.uaex.uada.edu>

Until the December 31, 2013 deadline, two broadcast applications of MSMA will be allowed per season, and a 25-ft buffer strip will be required for farms bordering permanent waterbodies. These restrictions were made effective on September 30, 2009.

Highway Rights-of-Way

Registrants of MSMA will not be permitted to sell the product for use on highway rights-of-way after December 31, 2012; however, distributors will be able to sell products containing MSMA until June 30, 2013. Use of MSMA on highway rights-of-way after December 31, 2013, will be prohibited.

Until the December 31, 2013 deadline, two broadcast applications of MSMA will be allowed per year, and a 100-ft buffer strip will be required when spraying near permanent waterbodies. These restrictions were made effective on September 30, 2009.

Residential Turf, Commercial Turf and Sports Turf Maintenance

Registrants of MSMA for use on residential turf, commercial turf and sports turf can no longer sell the product; however, distributors will be able to sell products purchased before December 31, 2009, until December 31, 2010. After December 31, 2010, existing stocks of MSMA can legally be used for weed control on residential, commercial and sports field turf until they are exhausted, provided that these uses comply with the EPA-approved label and labeling of the affected product.

Other uses that fall under this restriction include forestry, non-bearing fruit and nuts, citrus (bearing and non-bearing), seed production (bluegrass, fescue and ryegrass), drainage ditch banks, railroad, pipeline, utility rights-of-way, fence rows and storage yards.

Dealing With the Restrictions

The loss of MSMA will certainly make managing weeds in warm-season turf more difficult and, inevitably, more expensive. The EPA has agreed to conduct a scientific review in 2012 evaluating available information describing the mode of action of MSMA and benefits conferred by its use as a herbicide.⁴ If this review is favorable, use of MSMA on golf courses, sod farms and highway rights-of-way may continue beyond 2013.

Until then, research is continually evaluating new compounds as well as combinations of existing compounds that will help soften the blow of losing MSMA as an option for weed control in turf. To follow the latest research being conducted at the University of Tennessee, visit <http://tennesseeturfgrassweeds.org>.

Focusing on a few key principles may help turfgrass managers better cope with the deletion of MSMA from the turfgrass marketplace.

1. Cultural practices

The best defense against any weed invasion is a healthy, dense, vigorous turf stand. Implementing

cultural practices (aerification, fertility, mowing, etc.) to maximize turf density will make fields less susceptible to weed encroachment. For example, goosegrass thrives in compacted, poorly drained soils. Soils of this nature are commonly found in high-traffic areas on sports fields where there is minimal turfgrass cover. Improving soil conditions in these areas through aerification and topdressing will reduce the likelihood of a goosegrass infestation.

2. Use the product while it is still available

Turf managers dealing with infestations of annual grassy weeds should use MSMA while it is still legal to do so. Make a diligent effort to control these weeds now and then shift the focus to preemergence control of annual grasses after 2010.

This point especially rings true for dallisgrass, as there are no good options other than MSMA for selective postemergence control of dallisgrass in turf. Herbicides such as foramsulfuron (trade name, Revolver) and trifloxysulfuron (trade name, Monument) will only provide dallisgrass suppression, not control. Research is currently exploring new chemistries as well as combinations of existing chemistries to provide selective dallisgrass control in both warm- and cool-season turf.

3. Effective preemergence practices

The loss of an effective, economical postemergence herbicide like MSMA renders preemergence control of annual grassy weeds more important than ever. When applied correctly, preemergence herbicides such as prodiamine (trade name, Barricade), oxadiazon (trade name, Ronstar), dithiopyr (trade name, Dimension) and pendimethalin (trade name, Pendulum) can provide effective control of annual grassy weeds like crabgrass and goosegrass for extended periods of time. Other existing herbicides and some new herbicides also provide preemergence control of grassy weeds and some broadleaves. It is imperative that these materials be applied prior to the germination of weed seed and are watered in after application. Most labels require ½ inch of irrigation or rainfall after application.

4. Use alternative postemergence herbicides

Turf managers have applied MSMA for post-emergence control of annual grasses like crabgrass and goosegrass, in addition to perennials such as dallisgrass, purple nutsedge and yellow nutsedge. A list of commercially available herbicides exhibiting efficacy against these weeds is presented in Table 1. It is important to remember that herbicides exhibiting some degree of efficacy will not always result in complete control.

The use of brand or trade names is for clarity and information and does not imply the endorsement of a product to the exclusion of others that may be of similar, suitable composition. It does not guarantee or warrant the standard of a product.

TABLE 1. Commonly used postemergence (POST) herbicides that exhibit efficacy against weeds commonly controlled with applications of MSMA.

Herbicide	Tolerant Turfgrasses	Application Rates in Product/Acre (ai/acre)	Use Precautions
CRABGRASS (<i>Digitaria</i> spp.)			
Acclaim Extra (fenoxaprop)	Creeping Bentgrass Fine Fescue Ky. Bluegrass Tall Fescue Zoysiagrass	13 to 39 fl oz (0.06–0.17 lb ai)	<ul style="list-style-type: none"> Safe to apply to well-established turfgrasses listed. Do not apply to bermudagrass. Can be used on creeping bentgrass at 3.5 oz/A (see specific directions in product label). Can be applied to newly plugged zoysiagrass.
Dimension 40WSP (dithiopyr) Dimension 2EW (dithiopyr)	Bermudagrass Centipedegrass Creeping Bentgrass Fine Fescue Ky. Bluegrass P. Ryegrass St. Augustinegrass Tall Fescue Zoysiagrass	0.95 to 1.25 lbs (0.38–0.5 lb ai) 1.5 to 2.0 pints (0.38–0.5 lb ai)	<ul style="list-style-type: none"> Provides PRE and early POST control of crabgrass (up to 1 tiller stage). Post activity is improved with addition of a nonionic surfactant (0.5% v/v). Apply to well-established turfgrasses that have received at least 2 mowings. See label for variety susceptibility. All formulations restrict use on creeping bentgrass golf greens. Do not apply more than 1.5 lbs ai/A per year. Do not reseed within 4 months of last application. Bermudagrass can be overseeded with perennial ryegrass 8 weeks after the last application. For summer annual grass control, make a second application 5 to 10 weeks after the initial application. Apply ½" of irrigation within 24-48 hours of any application.
Drive XLR8 (quinclorac)	Bermudagrass Creeping Bentgrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass	2 quarts (0.75 lb ai)	<ul style="list-style-type: none"> Drive will not interfere with seeding, reseeding or overseeding of tall fescue, zoysiagrass or bermudagrass. Delay applications for 28 days after the emergence of perennial ryegrass, Kentucky bluegrass and fine fescue. When applied prior to seeding (7 days or greater), no time restrictions are required. Do not use a surfactant with applications to seedling turf. Do not apply to fine fescue unless part of a blend. May cause temporary discoloration of fine fescues, hybrid bermudagrass and creeping bentgrass; discoloration can be mitigated with chelated iron or soluble N fertilizer. May be applied before or after sprigging bermudagrass and zoysiagrass. Do not use on golf course greens or collars. Do not mow for 2 days before or after application. Requires the addition of a methylated seed oil when applied to mature turf. Allow application to dry for 24 hours. Reduced rates are required for applications to creeping bentgrass. Do not apply more than 1.5 lbs ae/acre per year. Avoid drift to non-target vegetation (especially tomatoes).
Echelon (prodiamine + sulfentrazone)	Bermudagrass Centipedegrass Creeping Bentgrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass	8 to 36 fl oz (0.25–1.125 lb ai)	<ul style="list-style-type: none"> Exhibits early POST control of seedling crabgrass and predominately PRE activity against large and smooth crabgrass. Do not apply to golf greens or tees. Do not apply to creeping bentgrass mowed lower than 0.5 inches. Application rates for bermudagrass exceed those of other tolerant species (see label). Application to certain varieties of chewing fine fescue or tall fescue may result in undesirable injury. Delay applications to newly established turfs until after the second mowing has occurred. Do not apply more than 36 fl oz of product per acre each season. Reseeding, overseeding or sprigging of treated areas within 3 to 12 months after application could inhibit the establishment of desirable grasses (see label for exact times). Do not harvest sod within 90 days after application.
Fusilade II (fluazifop)	Tall Fescue Zoysiagrass	2 to 6 fl oz (0.03–0.09 lb ai)	<ul style="list-style-type: none"> Rates vary for tall fescue and zoysiagrass (see label). Avoid applications when desirable turf is under stress. Labeled for use in residential areas but not home lawns.
Onetime (quinclorac + MCPP + dicamba)	Bermudagrass Creeping Bentgrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass	2 quarts (1.225 lb ai)	<ul style="list-style-type: none"> Will provide POST control of large and smooth crabgrass in addition to several broadleaf weeds. Do not apply to fine fescue unless part of a blend. May cause temporary discoloration of fine fescues, hybrid bermudagrass and creeping bentgrass; discoloration can be mitigated with chelated iron or soluble N fertilizer.

(CONTINUED ON NEXT PAGE)

Herbicide	Tolerant Turfgrasses	Application Rates in Product/Acre (ai/acre)	Use Precautions
CRABGRASS (<i>Digitaria</i> spp.) – CONTINUED			
(continued) Onetime (quinclorac + MCPP + dicamba)			<ul style="list-style-type: none"> Requires the addition of a methylated seed oil. Do not use on golf course greens and collars. Do not mow for 2 days before or after application. Clippings from the first 3 mowings should be left on the treated area. Do not apply more than 2 applications per year. Do not make repeat applications in less than 30-day intervals. Do not apply to turfgrass grown for sod. Avoid drift to non-target vegetation (especially tomatoes).
Q-4 (quinclorac + sulfentrazone + 2,4-D + dicamba)	Bermudagrass (DORMANT) Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass (DORMANT)	7 to 8 pints (1.35–1.54 lb ai)	<ul style="list-style-type: none"> Will provide POST control of large and smooth crabgrass in addition to several broadleaf weeds Do not use on golf course greens, tees and/or collars. Delay application of this product to new seedlings until after the second or third mowing, or at least 28 days after emergence. If applied prior to seeding, wait at least 28 days before applying new seed. Delay application of this product 3 to 4 weeks after sodding, sprigging or plugging any turfgrass species. Do not apply to turf under stress. Do not apply when temperatures exceed 90°F. Do not apply more than 2 applications per season. Do not irrigate within 24 hours after application. Do not mow for 2 days before or after application.
Segment (sethoxydim)	Centipedegrass	2.25 pints (0.28 lb ai)	<ul style="list-style-type: none"> Can be used only on centipedegrass. In new plantings, do not apply until centipedegrass has 3 inches of new stolon growth. In established centipedegrass, do not apply until at least 3 weeks after spring green-up. Do not mow for 7 days before or after application. Do not apply to turfgrasses other than centipedegrass (other turfgrasses spot treatment only). On newly established, do not apply more than 1.5 pt/A per application and 3 pt/A per season. On mature centipedegrass, do not apply more than 2.25 pt/A per application and 4.5 pt/A per season. Does not control dallisgrass, annual bluegrass or sedges.
Solitaire (quinclorac + sulfentrazone)	Bermudagrass Centipedegrass Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass	1 to 2 lbs (0.75–1.5 lb ai)	<ul style="list-style-type: none"> Will provide POST control of large and smooth crabgrass in addition to several broadleaf weeds. See label for use rates for cool- and warm-season species. Use of a surfactant is not recommended. Do not apply to golf course greens, collars or tees. Do not apply to turf under stressed conditions. Delay reseeding, overseeding or sprigging for one month after application. Overseeding of bermudagrass with perennial ryegrass can be done at 2 to 4 weeks after an application can be done, if slight injury to perennial ryegrass can be tolerated. Do not apply to sod within 3 months of harvest.
Tenacity (mesotrione)	Bermudagrass (DORMANT) Centipedegrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue (actively growing) St. Augustinegrass (sod farms only)	4 to 8 fl oz (0.125–0.250 lb ai)	<ul style="list-style-type: none"> For best postemergence control, apply to less than 4 tiller crabgrass and goosegrass. Exhibits POST activity against large and smooth crabgrass. Efficacy is reduced on mature (>2 tiller) crabgrass. Mixtures with PSII and PPO inhibiting herbicides widen the spectrum of weed control. Beginning in 2010, labeled use sites include golf courses, sod production, athletic fields, parks and home lawns (spot treatment only). Applications result in foliar bleaching (whitening) of sensitive species. Do not apply more than 5 fl oz/A to perennial ryegrass or fine fescue. Do not apply more than 16 fl oz/A in one season. Efficacy can be affected by temperature, humidity and light. Sequential applications are required to provide complete control of most species. To reduce movement onto sensitive species, such as bentgrass, withhold traffic until spray has dried and irrigate lightly to move product from turf foliage before resuming normal irrigation. Do not apply an organophosphate or carbamate insecticide within 7 days of application, as turf injury may occur. Do not use on golf course greens and maintain a 5-ft buffer between treated areas and golf greens. Do not apply more than 0.5 lb ai/acre per season. Safe for use at and soon after seeding most labeled grasses.

Herbicide	Tolerant Turfgrasses	Application Rates in Product/Acre (ai/acre)	Use Precautions
DALLISGRASS (<i>Paspalum dilatatum</i>)			
Fusilade II (fluazifop)	Tall Fescue Zoysiagrass	2 to 6 fl oz (0.03–0.09 lb ai)	<ul style="list-style-type: none"> Will only provide dallisgrass suppression, not control. Start applications in April as dallisgrass emerges from winter dormancy. Tank-mix 32 fl oz of Turflon Ester to reduce herbicide injury on tall fescue and zoysiagrass. Rates vary for tall fescue and zoysiagrass (see label). Avoid applications when desirable turf is under stress. Labeled for use in residential areas but not home lawns.
Monument (trifloxysulfuron)	Bermudagrass Zoysiagrass	0.53 oz (0.02 lb ai)	<ul style="list-style-type: none"> Will only provide dallisgrass suppression, not control. Tracking of applied herbicide onto non-target species by maintenance equipment or human traffic should be considered. It is recommended that light, frequent irrigation be used to wash the herbicide from the leaf surface into the soil profile the 2 mornings after application. Care should be taken when herbicide could move with surface water onto non-target susceptible species, such as creeping bentgrass or perennial ryegrass. Repeat applications may be necessary for complete control of difficult-to-control weeds. Do not apply more than 1.7 oz of product/A each year. On newly established stands, delay applications for 4 weeks after sprigging, sodding or seedling emergence. On bermudagrass, this product may be applied up to 3 weeks prior to overseeding with perennial ryegrass. Do not apply to turfgrass under stress.
Revolver (foramsulfuron)	Bermudagrass Zoysiagrass	1.5 to 2.0 oz/gallon spot treatment	<ul style="list-style-type: none"> Will only provide dallisgrass suppression, not control. Apply when daily average temperature exceeds 70°F. Do not exceed 1.25 fl oz of product/1,000 sq ft per season. Allow product to dry for at least 2 hours on foliage. On bermudagrass, this product may be applied up to 1 week prior to overseeding with perennial ryegrass. On newly established (seeded and sprigged/stolonized) bermudagrass stands, delay applications for 2 weeks; for zoysiagrass stands, allow 3 weeks. Labeled for use on overseeded bermudagrass greens only. Care should be taken when herbicide could move with surface water onto non-target susceptible species, such as bentgrass or perennial ryegrass. Tracking of applied herbicide onto non-target species by maintenance equipment or human traffic should be considered. It is recommended that light, frequent irrigation be used to wash the herbicide from the leaf surface into the soil profile the 2 mornings after application.
Roundup ProMax (glyphosate)	Bermudagrass (DORMANT)	22 to 44 fl oz (0.95–1.9 lb ai)	<ul style="list-style-type: none"> Will injure all desirable turf species. Spot applications recommended. Fall applications to actively growing dallisgrass plants in dormant bermudagrass often provide control.
GOOSEGRASS (<i>Eleusine indica</i>)			
Acclaim Extra (fenoxaprop)	Creeping Bentgrass Fine Fescue Ky. Bluegrass Tall Fescue Zoysiagrass	13 to 39 fl oz (0.06–0.17 lb ai)	<ul style="list-style-type: none"> Safe to apply to well-established turfgrasses listed. Do not apply to bermudagrass. Can be used on creeping bentgrass at 3.5 oz/A (see specific directions in product label). Can be applied to newly plugged zoysiagrass.
Fusilade II (fluazifop)	Tall Fescue Zoysiagrass	2 to 6 fl oz (0.03–0.09 lb ai)	<ul style="list-style-type: none"> Will only provide dallisgrass suppression, not control. Tank-mix 32 fl oz of Turflon Ester to reduce herbicide injury on tall fescue and zoysiagrass. Rates vary for tall fescue and zoysiagrass (see label). Avoid applications when desirable turf is under stress. Labeled for use in residential areas but not home lawns.
Illoxan (diclofop-methyl)	Bermudagrass	32 to 43 oz (0.75–1.0 lb ai)	<ul style="list-style-type: none"> RESTRICTED-USE PESTICIDE. For use on golf courses only. Provides postemergence goosegrass control in bermudagrass greens, tees, fairways and closely mowed roughs. Apply only to well-established bermudagrass. Do not reseed for at least 2 months after application. Thorough spray coverage is essential. Product is most effective on goosegrass under close mowing. Use high rate when goosegrass has 4 leaves or more.

Herbicide	Tolerant Turfgrasses	Application Rates in Product/Acre (ai/acre)	Use Precautions
GOOSEGRASS (<i>Eleusine indica</i>) – CONTINUED			
Revolver (foramsulfuron)	Bermudagrass Zoysiagrass	17.4 fl oz (0.026 lb ai)	<ul style="list-style-type: none"> Will only provide dallisgrass suppression, not control. Apply when daily average temperature exceeds 70°F. Do not exceed 1.25 fl oz of product/1,000 sq ft (54.5 fl oz/A) per season. Allow product to dry for at least 2 hours on foliage. On bermudagrass, this product may be applied up to 1 week prior to overseeding with perennial ryegrass. On newly established (seeded and sprigged/stolonized) bermudagrass stands, delay applications for 2 weeks; for zoysiagrass stands, allow 3 weeks. Labeled for use on overseeded bermudagrass greens only. Care should be taken when herbicide could move with surface water onto non-target susceptible species, such as bentgrass or perennial ryegrass. Tracking of applied herbicide onto non-target species by maintenance equipment or human traffic should be considered. It is recommended that light, frequent irrigation be used to wash the herbicide from the leaf surface into the soil profile the 2 mornings after application.
Tenacity (mesotrione)	Bermudagrass (DORMANT) Centipedegrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue (actively growing) St. Augustinegrass (sod farms only)	4 to 8 fl oz (0.125–0.250 lb ai)	<ul style="list-style-type: none"> For best postemergence control, apply to less than 4 tiller crabgrass and goosegrass. Mixtures with PSII and PPO inhibiting herbicides widen the spectrum of weed control. Beginning in 2010, labeled use sites include golf courses, sod production, athletic fields, parks and home lawns (spot treatment only). Applications result in foliar bleaching (whitening) of sensitive species. Do not apply more than 5 fl oz/A to perennial ryegrass or fine fescue. Do not apply more than 16 fl oz/A in one season. Efficacy can be affected by temperature, humidity and light. Sequential applications are required to provide complete control of most species. To reduce movement onto sensitive species, such as bentgrass, withhold traffic until spray has dried and irrigate lightly to move product from turf foliage before resuming normal irrigation. Do not apply an organophosphate or carbamate insecticide within 7 days of application, as turf injury may occur. Do not use on golf course greens, and maintain a 5-ft buffer between treated areas and golf greens. Do not apply more than 0.5 lb ai/acre per season. Safe for use at and soon after seeding most labeled grasses.
SEDGES (<i>Cyperus</i> spp.) and KYLLINGAS (<i>Kyllinga</i> spp.)			
Basagran T/O (bentazon)	Bermudagrass Centipedegrass Creeping Bentgrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass	2 pts (1 lb ai)	<ul style="list-style-type: none"> Do not apply to golf greens. For optimum sedge control, do not mow within 3 to 5 days before or after application. Do not apply if rain is anticipated within 48 hours. Make repeat application when sufficient re-growth occurs (approximately 10 to 21 days after initial application). Use a minimum of 1 gallon of water carrier per 1,000 ft².
Certainty (sulfosulfuron)	Bermudagrass Centipedegrass Creeping Bentgrass Ky. Bluegrass Zoysiagrass	0.75 to 1.25 oz (0.035–0.06 lb ai)	<ul style="list-style-type: none"> Certain ornamental and native grasses exhibit tolerance to this product (see label). Do not exceed 2.66 oz of this product per acre per year. Heavy rainfall or irrigation within 2 hours may wash this product off the foliage, and a repeat application may be required for adequate control. Repeat applications may be necessary for complete control of difficult-to-control weeds. Do not apply to tall fescue. Applications to creeping bentgrass require lower use rates (see label). Only apply to perennial ryegrass and fine fescue if they are part of a mixture with Kentucky bluegrass.
Dismiss (sulfentrazone)	Bermudagrass Centipedegrass Creeping Bentgrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass	0.25 to 0.75 pints (0.125–0.375 lb ai)	<ul style="list-style-type: none"> See label for use rates for cool- and warm-season species. Do not apply to golf course greens and tees. Delay reseeding, overseeding or sprigging for one month after application. Overseeding of bermudagrass with perennial ryegrass can be done at 2 to 4 weeks after application, if slight perennial ryegrass injury can be tolerated. Do not apply to sod within 3 months of harvest. Use of surfactants is not recommended.

Herbicide	Tolerant Turfgrasses	Application Rates in Product/Acre (ai/acre)	Use Precautions
SEDGES (<i>Cyperus</i> spp.) and KYLLINGAS (<i>Kyllinga</i> spp.) – CONTINUED			
Dismiss South (sulfentrazone + imazethapyr)	Bermudagrass Centipedegrass Zoysiagrass	9.5 to 14.4 fl oz (0.29–0.45 lb ai)	<ul style="list-style-type: none"> Exhibits greater efficacy against purple nutsedge (<i>Cyperus rotundus</i>) than Dismiss. Do not apply to golf course greens or tees. Delay reseeding, overseeding or sprigging for one month after application. Overseeding of bermudagrass with perennial ryegrass can be done at 2 to 4 weeks after an application, if slight perennial ryegrass injury can be tolerated. Do not apply to sod within 3 months of harvest. Use of surfactants is not recommended. Mixtures with trinexapac-ethyl (Primo Maxx) are not recommended.
Echelon (prodiamine + sulfentrazone)	Bermudagrass Centipedegrass Creeping Bentgrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass	8 to 36 fl oz (0.25–1.125 lb ai)	<ul style="list-style-type: none"> Do not apply to golf greens or tees. Do not apply to creeping bentgrass mowed lower than 0.5 inches. Application rates for bermudagrass exceed those of other tolerant species (see label). Application to certain varieties of chewing fine fescue or tall fescue may result in undesirable injury. Delay applications to newly established turfs until after the second mowing has occurred. Do not apply more than 36 fl oz of product per acre each season. Reseeding, overseeding or sprigging of treated areas within 3 to 12 months after application could inhibit the establishment of desirable grasses (see label for exact times). Do not harvest sod within 90 days after application.
Image 70 DG (imazaquin)	Bermudagrass Centipedegrass St. Augustine-grass Zoysiagrass	8.5 to 11.4 oz (0.37–0.50 lb ai)	<ul style="list-style-type: none"> May induce temporary yellowing of tolerant species for 7 to 14 days if applied under stressful conditions. Do not apply to golf greens. Do not apply to warm-season grasses overseeded with perennial ryegrass. If tall fescue is present and desired, do not apply. Do not reseed or overseed or sprig turfgrasses for at least 45 days after last application. Do not apply within 6 weeks of initiation of green-up. Do not apply during spring green-up or fall transition to dormancy. Apply 0.25–0.5 inches of irrigation or rainfall within 1 to 7 days after application. Do not apply within 30 days of harvesting sod.
Katana (flazasulfuron)	Bermudagrass Centipedegrass Zoysiagrass	1.5 to 3.0 oz (0.023–0.047 lb ai)	<ul style="list-style-type: none"> Do not apply to new seeded, sodded or sprigged turfgrass until well-established. Do not use on golf course putting greens. Care should be taken when herbicide could move with surface water onto non-target susceptible species, such as creeping bentgrass or perennial ryegrass. Tracking of applied herbicide onto non-target species by maintenance equipment or human traffic should be considered. It is recommended that light, frequent irrigation be used to wash the herbicide from the leaf surface into the soil profile the 2 mornings after application.
Monument (trifloxy-sulfuron)	Bermudagrass Zoysiagrass	0.28 to 0.56 oz (0.01–0.02 lb ai)	<ul style="list-style-type: none"> Tracking of applied herbicide onto non-target species by maintenance equipment or human traffic should be considered. It is recommended that light, frequent irrigation be used to wash the herbicide from the leaf surface into the soil profile the 2 mornings after application. Care should be taken when herbicide could move with surface water onto non-target susceptible species, such as creeping bentgrass or perennial ryegrass. Repeat applications may be necessary for complete control of difficult-to-control weeds. Do not apply more than 1.7 oz of product/A each year. On newly established stands, delay applications for 4 weeks after sprigging, sodding or seedling emergence. On bermudagrass, this product may be applied up to 3 weeks prior to overseeding with perennial ryegrass. Do not apply to turfgrass under stress.
Q-4 (quinclorac + sulfentrazone + 2,4-D + dicamba)	Bermudagrass (DORMANT) Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass (DORMANT)	7 to 8 pt (1.35–1.54 lb ai)	<ul style="list-style-type: none"> Do not use on golf course greens, tees and/or collars. Delay application of this product to new seedlings until after the second or third mowing, or at least 28 days after emergence. If applied prior to seeding, wait at least 28 days before applying new seed. Delay application of this product 3 to 4 weeks after sodding, sprigging or plugging any turfgrass species. Do not apply to turf under stress. Do not apply when temperatures exceed 90°F. Do not apply more than 2 applications per season. Do not irrigate within 24 hours after application. Do not mow for 2 days before or after application.

Herbicide	Tolerant Turfgrasses	Application Rates in Product/Acre (ai/acre)	Use Precautions
SEDGES (<i>Cyperus</i> spp.) and KYLLINGAS (<i>Kyllinga</i> spp.) – CONTINUED			
SedgeHammer (halosulfuron)	Bermudagrass Centipedegrass Creeping Bentgrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass	0.66 to 1.33 oz (0.031–0.062 lb ai)	<ul style="list-style-type: none"> Do not apply to golf greens. May require a repeat application 6 to 10 weeks after the initial application. Do not make more than 4 applications per year. Do not apply more than 5.33 oz of product per acre per year. Including a nonionic surfactant at 0.25-0.50% v/v will improve control. For optimum control, do not mow within 2 days before or after application.
Solitaire (quinclorac + sulfentrazone)	Bermudagrass Centipedegrass Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass	16 to 32 fl oz (0.75–1.5 lb ai)	<ul style="list-style-type: none"> See label for use rates for cool- and warm-season species. Use of a surfactant is not recommended. Do not apply to golf course greens, collars or tees. Do not apply to turf under stressed conditions. Delay reseeding, overseeding or sprigging for 1 month after application. Overseeding of bermudagrass with perennial ryegrass can be done at 2 to 4 weeks after an application, if slight injury to perennial ryegrass can be tolerated. Do not apply to sod within 3 months of harvest.
Surge (sulfentrazone + 2,4-D + MCPP + dicamba)	Bermudagrass Creeping Bentgrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass	2.75 to 4 pt (0.75–1.09 lb ai)	<ul style="list-style-type: none"> Do not apply to creeping bentgrass greens or tees. Do not broadcast apply at temperatures above 90°F. Do not apply to turf under stress. Do not apply to warm-season turf transitioning into or out of winter dormancy. The addition of sulfentrazone often allows this herbicide to provide improved efficacy in cooler weather compared to other three-way mixtures. Treated areas may be reseeded 3 weeks after application. Do not make more than 2 applications per season. Allow foliage to dry for at least 6 hours after application. Avoid mowing for 2 days before and after treatment.
Tenacity (mesotrione)	Bermudagrass (DORMANT) Centipedegrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue (actively growing) St. Augustinegrass (sod farms only)	4 to 8 fl oz (0.125–0.250 lb ai)	<ul style="list-style-type: none"> Mixtures with PSII and PPO inhibiting herbicides widen the spectrum of weed control. Beginning in 2010, labeled use sites include golf courses, sod production, athletic fields, parks and home lawns (spot treatment only). Applications result in foliar bleaching (whitening) of sensitive species. Do not apply more than 5 fl oz/A to perennial ryegrass or fine fescue. Do not apply more than 16 fl oz/A in one season. Efficacy can be affected by temperature, humidity and light. Sequential applications are required to provide complete control of most species. To reduce movement onto sensitive species, such as bentgrass, withhold traffic until spray has dried and irrigate lightly to move product from turf foliage before resuming normal irrigation. Do not apply an organophosphate or carbamate insecticide within 7 days of application, as turf injury may occur. Do not use on golf course greens, and maintain a 5-ft buffer between treated areas and golf greens. Do not apply more than 0.5 lb ai/acre per season. Safe for use at and soon after seeding most labeled grasses.

References

- ¹ Anonymous. 1997. *Acetylsalicylic Acid (Aspirin) – Material Safety Data Sheet*. Available at <http://avogadro.chem.iastate.edu/MSDS/aspirin.htm>. Accessed February 15, 2009.
- ² Anonymous. 2001. *MSMA 6 Plus – Material Safety Data Sheet*. Available at <http://www.cdms.net/LDat/mp47P000.pdf>. Accessed February 15, 2009.

³ U.S. Environmental Protection Agency. 2009. *Federal Register: September 30, 2009*. Available at <http://www.epa.gov/fedrgstr/EPA-PEST/2009/September/Day-30/p23319.pdf>. Accessed January 2010.

⁴ U.S. Environmental Protection Agency. *Pesticide Reregistration – Organic Arsenicals*. Web page: http://www.epa.gov/pesticides/reregistration/organic_arsenicals_fs.html. Accessed June 2010.

University of Tennessee Publication No. W#243 • University of Arkansas Division of Agriculture Publication No. FSA6145

DR. J. T. BROSNAN is assistant professor - turfgrass weed science and **MR. G. K. BREEDEN** is Extension assistant - weed science with the University of Tennessee, Knoxville, Tennessee. **DR. A. J. PATTON** is assistant professor - turfgrass specialist with the Horticulture Department, University of Arkansas Division of Agriculture, Fayetteville, Arkansas.

FSA6145-PD-7-10RV

Pursuant to 7 CFR § 15.3, the University of Arkansas System Division of Agriculture offers all its Extension and Research programs and services (including employment) without regard to race, color, sex, national origin, religion, age, disability, marital or veteran status, genetic information, sexual preference, pregnancy or any other legally protected status, and is an equal opportunity institution.