

# TURFGRASS SCIENCE

at the UT Institute of Agriculture

## Use of MSMA for Weed Management in Turf

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### 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.<sup>1,2</sup> 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 U.S. 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.

### Current Status of MSMA use for Turfgrass Weed Management

On Sept. 30, 2009, the EPA announced a decision regarding the use of MSMA for agricultural weed management.<sup>3</sup>

Impacts on the turfgrass industry were significant, with repercussions that will change weed control strategies. Existing stocks of MSMA with the EPA-approved labeling can be used legally for weed control in the areas impacted by EPA label changes from Sept. 30, 2009 (e.g., residential turf, commercial turf, sports turf, etc.), until exhausted, provided that these uses comply with EPA labeling.

### Residential Turf, Commercial Turf and Sports Turf Maintenance

Distributors of MSMA products labeled for use on residential lawns, commercial lawns and sports turf were prohibited from selling the products to end-users after Dec. 31, 2010. Existing stocks of MSMA could be used legally for weed control in these areas until exhausted, provided that these uses comply with the EPA-approved label and labeling of the affected product. Beyond Dec. 31, 2013, new stock of MSMA will not be labeled for lawn care (both residential and commercial) or athletic field management, making applications of MSMA in these areas prohibited.

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

### Golf Courses

The EPA announcement of 2009 laid out amended use directions for applying MSMA to golf course turf. Newly constructed courses are allowed one broadcast application, while existing courses can use MSMA only as a spot treatment. Spots must be less than 100 square feet and no more than 25 percent of the course can be treated within a given year. These restrictions were made effective on Sept. 30, 2009, and are in place until a National Academy of

Sciences review on risks associated with inorganic arsenic exposure is final. This review was slated to begin in 2013 and is expected to take **nearly 41 months to complete**. Results of the review are essential in determining the future status of MSMA as a turfgrass herbicide.

**To that end, MSMA can be used on golf courses according to the amended use directions of 2009 until a ruling on this review has been made public.** For more information on the status of the ruling, visit the Organic Arsenical Product Task Force website: [www.oaptf.com](http://www.oaptf.com).

## SOD FARMS

The 2009 EPA announcement also developed amended directions for the use of MSMA on sod farms. To that end, sod farms can be treated with two broadcast applications of MSMA per season, and a 25-foot buffer strip is required for farms bordering permanent water bodies.

Similar to golf courses, MSMA can be used on sod farms according to these amended use directions until the National Academy of Sciences review of inorganic arsenic is complete.

## HIGHWAY RIGHTS-OF-WAY

The use of MSMA for weed management along highway rights-of-way is similar to sod farms. According to the 2009 EPA announcement, two broadcast applications of MSMA are allowed per year, and a 100-foot buffer strip will be required when spraying near permanent water bodies. Use can continue in this manner along highway rights-of-way until the National Academy of Sciences' review of inorganic arsenic is complete.

## Dealing With the Restrictions

The loss of MSMA will certainly make managing weeds in warm-season turf more difficult, and, inevitably, more expensive. Research is continually evaluating new compounds, as well as combinations of existing compounds, that will help soften the blow. To follow the latest research being conducted at the University of Tennessee, visit [tennesseeturfgrassweeds.org](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 grassy weeds. This point especially rings true for dallisgrass (*Paspalum dilatatum*), as there are few economical options other than MSMA for selective postemergence control of dallisgrass in 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 containing active ingredients such as prodiamine (trade name: Barricade), oxadiazon (trade name: Ronstar), dithiopyr (trade name: Dimension), indaziflam (trade name: Specticle) 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. See publication, "W 146: Crabgrass Species Control in Turfgrass," for more information on preemergence control.

### 4. **Use alternative postemergence herbicides**

Turf managers have applied MSMA for postemergence control of annual grasses like crabgrass and goosegrass, in addition to perennials such as dallisgrass, purple nutsedge and yellow nutsedge. A list of other 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. This publication contains pesticide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide used.

## References

1. Anonymous. 1997. Acetylsalicylic Acid (Aspirin)- Material Safety Data Sheet. Available at: <http://avogadro.chem.iastate.edu/MSDS/aspirin.htm>. Accessed 15 February 2009.
2. Anonymous. 2001. MSMA 6 Plus- Material Safety Data Sheet. Available at: <http://www.cdms.net/LDat/mp47P000.pdf>. Accessed 15 February 2009.
3. U.S. Environmental Protection Agency. 2009. Pesticide Reregistration – Organic Arsenicals: Web page: <http://www.epa.gov/fedrgstr/EPA-PEST/2009/September/Day-30/p23319.pdf>. Accessed: January 2010.

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

Herbicide	Tolerant Turfgrasses	Application Rates (product/acre)	Use Precautions
Crabgrass ( <i>Digitaria</i> spp.)			
Acclaim Extra (fenoxaprop)	Creeping Bentgrass Fine Fescue Ky. Bluegrass Tall Fescue Zoysiagrass	3.5 to 39 fl oz	<ul style="list-style-type: none"> <li>• Safe to apply to well-established turfgrasses listed.</li> <li>• Do not apply to bermudagrass.</li> <li>• Can be used on creeping bentgrass at 3.5 oz/A (see specific directions in product label).</li> <li>• Can be applied to newly plugged zoysiagrass.</li> </ul>
Drive XLR8 (quinclorac)	Bermudagrass Creeping Bentgrass Fine Fescue Ky. Bluegrass P. Ryegrass Seashore Paspalum Tall Fescue Zoysiagrass	2 quarts	<ul style="list-style-type: none"> <li>• Drive will not interfere with seeding, re-seeding or over-seeding of tall fescue, zoysiagrass or bermudagrass. Delay applications for 28 days after the emergence of perennial ryegrass, Kentucky bluegrass and fine fescue.</li> <li>• When applied prior to seeding (7 days or greater), no time restrictions are required.</li> <li>• Do not use a surfactant with applications to seedling turf.</li> <li>• Do not apply to fine fescue unless part of a blend.</li> <li>• May cause temporary discoloration of fine fescues, hybrid bermudagrass and creeping bentgrass; discoloration can be mitigated with chelated iron or soluble N fertilizer.</li> <li>• May be applied before or after sprigging bermudagrass and zoysiagrass.</li> <li>• Do not use on golf course greens or collars.</li> <li>• Do not mow for 2 days before or after application.</li> <li>• Requires the addition of a methylated seed oil when applied to mature turf.</li> <li>• Allow application to dry for 24 hours.</li> <li>• Reduced rates are required for applications to creeping bentgrass.</li> <li>• Do not apply more than 1.5 lbs ae/acre per year.</li> <li>• Avoid drift to non-target vegetation (especially tomatoes).</li> </ul>
Fusilade II (fluazifop)	Tall Fescue Zoysiagrass Fine Fescue	3 to 16 fl oz	<ul style="list-style-type: none"> <li>• Rates vary for tall fescue and zoysiagrass (see label).</li> <li>• Avoid applications when desirable turf is under stress.</li> <li>• Labeled for use in residential areas but not home lawns.</li> <li>• This product is labeled for use on homelawns under the trade name Ornamec. Refer to the product label for directions on Ornamec use.</li> </ul>
Manuscript (pinoxaden)	Bermudagrass Zoysiagrass St. Augustinegrass (Sod farms only)	9.6 to 19.2 fl oz	<ul style="list-style-type: none"> <li>• Use with Agidor spray adjuvant (0.5 to 1% v/v) to maximize efficacy</li> <li>• Spot treatments (<math>\leq 10,000</math> sq ft) are recommended to control individual weeds or small areas when weed pressure is high.</li> <li>• Spot applications can be made sequentially at 9.6 fl oz/10,000 sq ft (on a 14-day interval) or 19.2 fl oz/10,000 sq ft once annually.</li> <li>• Do not apply more than 19.2 fl oz of Manuscript in a year.</li> <li>• Do not use fresh clippings from treated areas as mulch around trees, shrubs, or in vegetable/flower gardens as some ornamental plants are very sensitive to Manuscript.</li> <li>• Do not make applications to areas where product may accumulate under the drip line of trees and where product may come in contact with roots of desirable plants.</li> <li>• Do not apply to golf course greens.</li> </ul>

Herbicide	Tolerant Turfgrasses	Application Rates (product/acre)	Use Precautions
Crabgrass ( <i>Digitaria</i> spp.)			
Pylex (topramezone)	Centipedegrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue	1 to 1.5 fl oz	<ul style="list-style-type: none"> <li>Effectively controls annual grassy weeds POST with sequential applications.</li> <li>Highly efficacious against goosegrass.</li> <li>Sequential applications suppress bermudagrass infestations in desirable turf. Efficacy is improved with the addition of triclopyr (e.g., Turflon Ultra Ester at 32 fl oz/A).</li> <li>Re-seeding with desirable turf after application also improves bermudagrass suppression.</li> <li>Product can be used to control weeds during the seeded establishment of cool-season turfgrass.</li> <li>Use of an MSO surfactant will improve weed control.</li> <li>This product has no activity on annual bluegrass.</li> <li>Do not apply more than 4 fl oz/A per year.</li> </ul>
Q-4 Plus (quinclorac + sulfentrazone + 2,4-D + dicamba)	Bermudagrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass	5 to 8 pts	<ul style="list-style-type: none"> <li>Will provide POST control of large and smooth crabgrass in addition to several broadleaf weeds.</li> <li>Do not use on golf course greens, tees and/or collars.</li> <li>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.</li> <li>Delay application of this product 3 to 4 weeks after sodding, sprigging or plugging any turfgrass species.</li> <li>Do not apply to turf under stress.</li> <li>Do not apply when temperatures exceed 90 F.</li> <li>Do not apply more than 2 applications per season.</li> <li>Do not irrigate within 24 hours after application.</li> <li>Do not mow for 2 days before or after application.</li> </ul>
Segment (sethoxydim)	Centipedegrass  Fine Fescue (grown for seed)	1.5 to 2.25 pints	<ul style="list-style-type: none"> <li>Can be used only on centipedegrass.</li> <li>In new plantings, do not apply until centipedegrass has 3 inches of new stolon growth.</li> <li>In established centipedegrass, do not apply until at least 3 weeks after spring green-up.</li> <li>Do not mow for 7 days before or after application.</li> <li>Do not apply to turfgrasses other than centipedegrass (other turfgrasses spot treatment only).</li> <li>On newly established, do not apply more than 1.5 pt/A per application and 3 pt/A per season.</li> <li>On mature centipedegrass, do not apply more than 2.25 pt/A per application and 4.5 pt/A per season.</li> <li>Does not control dallisgrass, annual bluegrass or sedges.</li> </ul>

Herbicide	Tolerant Turfgrasses	Application Rates (product/acre)	Use Precautions
Crabgrass ( <i>Digitaria</i> spp.)			
Solitare (quinclorac + sulfentrazone)	Bermudagrass Centipedegrass Ky. Bluegrass P. Ryegrass Seashore Paspalum Tall Fescue Zoysiagrass	16 to 32 oz	<ul style="list-style-type: none"> <li>• Will provide POST control of large and smooth crabgrass in addition to several broadleaf weeds and sedges.</li> <li>• See label for use rates for cool- and warm-season species.</li> <li>• Use of a surfactant is not recommended.</li> <li>• Do not apply to golf course greens, collars or tees.</li> <li>• Do not apply to turf under stressed conditions.</li> <li>• Delay re-seeding, over-seeding or sprigging for one month after application.</li> <li>• Over-seeding 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.</li> <li>• Do not apply to sod within 3 months of harvest.</li> </ul>
Tenacity (mesotrione)	Bermudagrass (DORMANT)  Centipedegrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue  St. Augustinegrass (sod farms only)	4 to 8 fl oz	<ul style="list-style-type: none"> <li>• For best postemergence control, apply to less than 4 tiller crabgrass and goosegrass.</li> <li>• Exhibits POST activity against large and smooth crabgrass.</li> <li>• Efficacy is reduced on mature (&gt;2 tiller) crabgrass.</li> <li>• Mixtures with PSII and PPO inhibiting herbicides widen the spectrum of weed control.</li> <li>• Beginning in 2010, labeled use sites include golf courses, sod production, athletic fields, parks and home lawns (spot treatment only).</li> <li>• Applications result in foliar bleaching (whitening) of sensitive species.</li> <li>• Do not apply more than 5 fl oz/A to perennial ryegrass or fine fescue.</li> <li>• Do not apply more than 16 fl oz/A in one season.</li> <li>• Efficacy can be affected by temperature, humidity, and light.</li> <li>• Sequential applications are required to provide complete control of most species.</li> <li>• 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.</li> <li>• Do not apply an organophosphate or carbamate insecticide within 7 days of application, as turf injury may occur.</li> <li>• Do not use on golf course greens and maintain a 5-foot buffer between treated areas and golf greens.</li> <li>• Do not apply more than 16 fl oz/acre per season.</li> <li>• Safe for use at and soon after seeding most labeled grasses.</li> </ul>

Herbicide	Tolerant Turfgrasses	Application Rates (product/acre)	Use Precautions
Dallisgrass ( <i>Paspalum dilatatum</i> )			
Fusilade II (fluazifop)	Tall Fescue Zoysiagrass Fine Fescue	3 to 16 fl oz	<ul style="list-style-type: none"> <li>• Will only provide dallisgrass suppression, not control.</li> <li>• Start applications in the fall once average daily temperatures fall below 72 F. Continue treatments in April as dallisgrass emerges from winter dormancy.</li> <li>• Rates vary for tall fescue and zoysiagrass (see label).</li> <li>• Avoid applications when desirable turf is under stress.</li> <li>• Labeled for use in residential areas but not home lawns.</li> <li>• This product is labeled for use on homelawns under the trade name Ornamec. Refer to the product label for directions on Ornamec use.</li> </ul>
Manuscript (pinoxaden)	Bermudagrass Zoysiagrass St. Augustinegrass (Sod farms only)	9.6 to 19.2 fl oz	<ul style="list-style-type: none"> <li>• Use with Agidor spray adjuvant (0.5 to 1% v/v) to maximize efficacy.</li> <li>• Spot treatments (<math>\leq 10,000</math> sq ft) are recommended to control individual weeds or small areas when weed pressure is high.</li> <li>• Spot applications can be made sequentially at 9.6 fl oz/10,000 sq ft (on a 14-day interval) or 19.2 fl oz/10,000 sq ft once annually.</li> <li>• Do not apply more than 19.2 fl oz of Manuscript in a year.</li> <li>• Do not use fresh clippings from treated areas as mulch around trees, shrubs, or in vegetable/flower gardens as some ornamental plants are very sensitive to Manuscript.</li> <li>• Do not make applications to areas where product may accumulate under the drip line of trees and where product may come in contact with roots of desirable plants.</li> <li>• Do not apply to golf course greens.</li> </ul>
Monument (trifloxysulfuron)	Bermudagrass Zoysiagrass St. Augustinegrass (Sod farms only)	0.35 to 0.53 oz	<ul style="list-style-type: none"> <li>• Will only provide dallisgrass suppression at broadcast rates. Apply at the spot treatment rate for improved control (see label).</li> <li>• Start applications in the fall once average daily temperatures fall below 72 F. Continue treatments in April as dallisgrass emerges from winter dormancy.</li> <li>• Tracking of applied herbicide onto non-target species by maintenance equipment or human traffic should be considered.</li> <li>• It is recommended that light, frequent irrigation be used to wash the herbicide from the leaf surface and into the soil profile the two mornings after application.</li> <li>• Care should be taken when herbicide could move with surface water onto non-target susceptible species, such as creeping bentgrass or perennial ryegrass.</li> <li>• Repeat applications may be necessary for complete control of difficult-to-control weeds.</li> <li>• Do not apply more than 1.7 oz of product/A each year.</li> <li>• On newly established stands, delay applications for 4 weeks after sprigging, sodding or seedling emergence.</li> <li>• On bermudagrass, this product may be applied up to 3 weeks prior to overseeding with perennial ryegrass.</li> <li>• Do not apply to turfgrass under stress.</li> </ul>

Herbicide	Tolerant Turfgrasses	Application Rates (product/acre)	Use Precautions
Dallisgrass ( <i>Paspalum dilatatum</i> )			
Revolver (foramsulfuron)	Bermudagrass Zoysiagrass	17.4 to 26.2 fl oz	<ul style="list-style-type: none"> <li>• Will only provide dallisgrass suppression at broadcast rates. Apply at the spot treatment rate for improved control (see label).</li> <li>• Start applications in the fall once average daily temperatures fall below 72 F. Continue treatments in April as dallisgrass emerges from winter dormancy.</li> <li>• Do not exceed 1.25 fl oz of product/1,000 sq ft per season.</li> <li>• Allow product to dry for at least 2 hours on foliage.</li> <li>• On bermudagrass, this product may be applied up to 1 week prior to overseeding with perennial ryegrass.</li> <li>• On newly established (seeded and sprigged/stolonized) bermudagrass stands, delay applications for 2 weeks; for zoysiagrass stands, allow 3 weeks.</li> <li>• Care should be taken when herbicide could move with surface water onto non-target susceptible species, such as bentgrass or perennial ryegrass.</li> <li>• Tracking of applied herbicide onto non-target species by maintenance equipment or human traffic should be considered.</li> <li>• It is recommended that light, frequent irrigation be used to wash the herbicide from the leaf surface and into the soil profile the two mornings after application.</li> </ul>
Roundup ProMax (glyphosate)	Bermudagrass (DORMANT)	22 to 44 fl oz	<ul style="list-style-type: none"> <li>• Will injure all desirable turf species.</li> <li>• Spot applications recommended at 2% v/v.</li> <li>• Fall applications to actively growing dallisgrass plants in dormant bermudagrass often provide control.</li> </ul>
Tribute Total (thiencarbazon + foramsulfuron + halosulfuron)	Bermudagrass Zoysiagrass	1 to 3.2 oz	<ul style="list-style-type: none"> <li>• Can provide effective dallisgrass control when applied sequentially at optimal timings over multiple growing seasons. For improved results, apply at the spot treatment rate (see label).</li> <li>• Start applications in the fall once average daily temperatures fall below 72 F. Continue treatments in April as dallisgrass emerges from winter dormancy.</li> <li>• Use of a nonionic surfactant (NIS) at 0.25 to 0.50% v/v will improve efficacy.</li> <li>• Addition of ammonium sulfate (AMS) to the spray solution can improve efficacy.</li> <li>• Do not apply more than 3.2 oz/A per application.</li> <li>• Do not apply more than 6.4 oz/A per year.</li> <li>• Do not apply within 8 weeks of overseeding.</li> <li>• Spot treatments can be applied at 0.073 oz/gallon.</li> <li>• Maintain a 15-foot buffer from sensitive grass areas.</li> </ul>

Herbicide	Tolerant Turfgrasses	Application Rates (product/acre)	Use Precautions
Goosegrass ( <i>Eleusine indica</i> )			
Acclaim Extra (fenoxaprop)	Creeping Bentgrass Fine Fescue Ky. Bluegrass Tall Fescue Zoysiagrass	3.5 to 39 fl oz	<ul style="list-style-type: none"> <li>Safe to apply to well-established turfgrasses listed.</li> <li>Do not apply to bermudagrass.</li> <li>Can be used on creeping bentgrass at 3.5 oz/A (see specific directions in product label).</li> <li>Can be applied to newly plugged zoysiagrass.</li> </ul>
Fusilade II (fluazifop)	Tall Fescue Zoysiagrass Fine Fescue	3 to 16 fl oz	<ul style="list-style-type: none"> <li>Rates vary for tall fescue and zoysiagrass (see label).</li> <li>Avoid applications when desirable turf is under stress.</li> <li>Labeled for use in residential areas but not home lawns.</li> <li>This product is labeled for use on homelawns under the trade name Ornamec. Refer to the product label for directions on Ornamec use.</li> </ul>
Illoxan (diclofop-methyl)	Bermudagrass	33 to 43 fl oz	<ul style="list-style-type: none"> <li>RESTRICTED-USE PESTICIDE.</li> <li>For use on golf courses only. <b>This product will not be produced after Jan. 1, 2014. Existing stocks can be used until they are depleted but will not be able to be replaced.</b></li> <li>Provides postemergence goosegrass control in bermudagrass greens, tees, fairways and closely mowed roughs.</li> <li>Apply only to well-established bermudagrass.</li> <li>Do not re-seed for at least 2 months after application. Thorough spray coverage is essential.</li> <li>Product is most effective on goosegrass under close mowing.</li> <li>Use high rate when goosegrass has 4 leaves or more.</li> </ul>
Pylex (topramezone)	Centipede Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue  Bermudagrass (Spot Treatment Only)  Seashore Paspalum (Spot Treatment Only)	1 to 1.5 fl oz	<ul style="list-style-type: none"> <li>Effectively controls annual grassy weeds POST with sequential applications.</li> <li>Highly efficacious against goosegrass.</li> <li>Sequential applications suppress bermudagrass infestations in desirable turf. Efficacy is improved with the addition of triclopyr (e.g., Turflon Ultra Ester at 32 fl oz/A).</li> <li>Re-seeding with desirable turf after application also improves bermudagrass suppression.</li> <li>Product can be used to control weeds during the seeded.</li> <li>Use of an MSO surfactant will improve weed control.</li> <li>Spot applications in bermudagrass and seashore paspalum limited to a single treatment at 0.75 fl oz/A per year. Turfgrass injury (expressed as whitening) is expected for 14-35 days after application.</li> <li>Do not apply more than 4 fl oz/A per year.</li> </ul>
Revolver (foramsulfuron)	Bermudagrass Zoysiagrass	17.4 to 26.2 fl oz	<ul style="list-style-type: none"> <li>Goosegrass control is optimal when applied to smaller plants with minimal tillering.</li> <li>Do not exceed 1.25 fl oz of product/1,000 sq ft (54.5 fl oz/A) per season.</li> <li>Allow product to dry for at least 2 hours on foliage.</li> <li>On bermudagrass, this product may be applied up to 1 week prior to overseeding with perennial ryegrass.</li> <li>On newly established (seeded and sprigged/stolonized) bermudagrass stands, delay applications for 2 weeks; for zoysiagrass stands, allow 3 weeks.</li> <li>Care should be taken when herbicide could move with surface water onto non-target susceptible species, such as bentgrass or perennial ryegrass.</li> <li>Tracking of applied herbicide onto non-target species by maintenance equipment or human traffic should be considered.</li> <li>It is recommended that light frequent irrigation be used to wash the herbicide from the leaf surface and into the soil profile the two mornings after application.</li> </ul>

Herbicide	Tolerant Turfgrasses	Application Rates (product/acre)	Use Precautions
Goosegrass ( <i>Eleusine indica</i> )			
Speedzone	Creeping Bentgrass Kentucky Bluegrass Fine Fescue Tall Fescue Perennial Ryegrass Bermudagrass Centipedegrass Seashore Paspalum Zoysiagrass	4 to 5 pt	<ul style="list-style-type: none"> <li>Labeled for postemergence goosegrass control when applied sequentially. Ensure adequate soil moisture at application to maximize efficacy.</li> <li>Can be used to control an array of broadleaf weed species postemergence.</li> <li>May temporarily discolor some hybrid bermudagrass species.</li> <li>Do not apply to creeping bentgrass golf greens.</li> <li>Do not apply when air temperatures exceed 90 F, as some turfgrass injury can be expected.</li> <li>Treated areas can be re-seeded 2 weeks after application.</li> <li>Do not apply to turfgrass seedlings until they have been mowed at least twice.</li> <li>Allow 3 to 4 weeks before applying to newly sprigged/stolonized areas.</li> </ul>
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	<ul style="list-style-type: none"> <li>For best postemergence control, apply to less than 4 tiller crabgrass and goosegrass.</li> <li>Mixtures with PSII and PPO inhibiting herbicides widen the spectrum of weed control.</li> <li>Beginning in 2010, labeled use sites include golf courses, sod production, athletic fields, parks and home lawns (spot treatment only).</li> <li>Applications result in foliar bleaching (whitening) of sensitive species.</li> <li>Do not apply more than 5 fl oz/A to perennial ryegrass or fine fescue.</li> <li>Do not apply more than 16 fl oz/A in one season.</li> <li>Efficacy can be affected by temperature, humidity and light.</li> <li>Sequential applications are required to provide complete control of most species.</li> <li>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.</li> <li>Do not apply an organophosphate or carbamate insecticide within 7 days of application, as turf injury may occur.</li> <li>Do not use on golf course greens and maintain a 5-foot buffer between treated areas and golf greens.</li> <li>Do not apply more than 16 fl oz/acre per season.</li> <li>Safe for use at and soon after seeding most labeled grasses.</li> </ul>
Tribute Total (thiencarbazone + foramsulfuron + halosulfuron)	Bermudagrass Zoysiagrass	1 to 3.2 oz	<ul style="list-style-type: none"> <li>Used to provide postemergence control of grasses, sedges (particularly yellow nutsedge) and broadleaf weeds. Species controlled include goosegrass, overseeded perennial ryegrass, annual bluegrass, yellow nutsedge and Virginia buttonweed.</li> <li>Use of a nonionic surfactant (NIS) at 0.25 to 0.50% v/v will improve efficacy.</li> <li>Addition of ammonium sulfate (AMS) to the spray solution can improve efficacy.</li> <li>Do not apply more than 3.2 oz/A per application.</li> <li>Do not apply more than 6.4 oz/A per year.</li> <li>Do not apply within 8 weeks of overseeding.</li> <li>Spot treatments can be applied at 0.073 oz/gallon.</li> <li>Maintain a 15-foot buffer from sensitive grass areas.</li> </ul>

Herbicide	Tolerant Turfgrasses	Application Rates (product/acre)	Use Precautions
Sedges ( <i>Cyperus</i> spp.) and Kyllingias ( <i>Kyllinga</i> spp.)			
Basagran T/O (bentazon)	Bermudagrass Centipedegrass Creeping bentgrass Fine Fescue Ky. Bluegrass P. Ryegrass St. Augustinegrass Tall Fescue Zoysiagrass	2 pts	<ul style="list-style-type: none"> <li>Do not apply to golf greens.</li> <li>For optimum sedge control, do not mow within 3 to 5 days before or after application.</li> <li>Do not apply if rain is anticipated within 48 hours.</li> <li>Make repeat application when sufficient re-growth occurs (approximately 10 to 21 days after initial application).</li> <li>Use a minimum of 1 gallon of water carrier per 1,000 ft<sup>2</sup>.</li> </ul>
Celero (imazosulfuron)	Bermudagrass Zoysiagrass Centipedegrass St. Augustinegrass Creeping Bentgrass Fine Fescue Kentucky Bluegrass Perennial Ryegrass Tall Fescue	8 to 14 oz	<ul style="list-style-type: none"> <li>Do not apply to golf course putting greens.</li> <li>Add non-ionic surfactant at 0.25% to improve efficacy.</li> <li>Do not use when rainfall/irrigation is expected 4 hours before or after treatment.</li> <li>Do not mow within 24 hours after application. Do not apply to moist or wet turfgrass (including dew).</li> <li>Do not apply when daily high temperatures are below 65 F or above 90 F.</li> <li>Allow 4 weeks between application and seeding/sodding of turfgrass.</li> <li>Multiple applications may be needed for control of select species.</li> </ul>
Certainty (sulfosulfuron)	Bermudagrass Centipedegrass Seashore Paspalum St. Augustinegrass Zoysiagrass	0.25 to 2 oz	<ul style="list-style-type: none"> <li>Certain ornamental and native grasses exhibit tolerance to this product (see label).</li> <li>Do not exceed 2.66 oz. of this product per acre per year.</li> <li>Heavy rainfall or irrigation within 2 hours may wash this product off the foliage and a repeat application may be required for adequate control.</li> <li>Repeat applications may be necessary for complete control of difficult-to-control weeds.</li> </ul>
Dismiss (sulfentrazone)	Bermudagrass Centipedegrass Creeping bentgrass Fine Fescue Ky. Bluegrass P. Ryegrass Seashore Paspalum St. Augustinegrass Tall Fescue Zoysiagrass	4 to 12 fl oz	<ul style="list-style-type: none"> <li>See label for use rates for cool- and warm-season species.</li> <li>Do not apply to golf course greens and tees.</li> <li>Delay re-seeding, over-seeding or sprigging for one month after application.</li> <li>Over-seeding of bermudagrass with perennial ryegrass can be done at 2 to 4 weeks after application, if slight perennial ryegrass injury can be tolerated.</li> <li>Do not apply to sod within 3 months of harvest.</li> <li>Use of surfactants is not recommended.</li> </ul>
Dismiss NXT (sulfentrazone + carfentrazone)	Bermudagrass Centipedegrass Creeping Bentgrass Fine Fescue Kentucky Bluegrass Perennial Ryegrass Seashore Paspalum St. Augustinegrass Tall Fescue Zoysiagrass	5.1 to 15.25 fl oz	<ul style="list-style-type: none"> <li>Rates for use on cool-season turfgrass range from 5.1 to 10.2 fl oz/A.</li> <li>Rates for use on warm-season turfgrass range from 10.2 to 15.25 fl oz/A.</li> <li>Do not apply to golf course greens and tees.</li> <li>Delay re-seeding or sprigging for 1 month after application.</li> <li>Over-seeding of bermudagrass with perennial ryegrass can be done at 2 to 4 weeks after application, if slight perennial ryegrass injury can be tolerated.</li> <li>Application may cause temporary discoloration to exposed leaf surfaces on St. Augustinegrass and Zoysiagrass.</li> <li>Do not apply to sod within 3 months of harvest.</li> <li>Use of surfactants is not recommended.</li> <li>Will require sequential applications to control <i>Kyllinga</i> species.</li> </ul>

Herbicide	Tolerant Turfgrasses	Application Rates (product/acre)	Use Precautions
Sedges ( <i>Cyperus</i> spp.) and Kyllingas ( <i>Kyllinga</i> spp.)			
Dismiss South (sulfentrazone + imazethapyr)	Bermudagrass Centipedegrass Zoysiagrass	9.5 to 14.4 fl oz	<ul style="list-style-type: none"> <li>• Exhibits greater efficacy against purple nutsedge (<i>Cyperus rotundus</i>) than Dismiss.</li> <li>• Do not apply to golf course greens or tees.</li> <li>• Delay re-seeding, over-seeding or sprigging for one month after application.</li> <li>• 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.</li> <li>• Do not apply to sod within 3 months of harvest.</li> <li>• Use of surfactants is not recommended.</li> <li>• Mixtures with trinexapac-ethyl (Primo Maxx) are not recommended.</li> </ul>
Image 70DG (imazaquin)	Bermudagrass Centipedegrass St. Augustinegrass Zoysiagrass	8.6 to 11.4 oz	<ul style="list-style-type: none"> <li>• May induce temporary yellowing of tolerant species for 7 to 14 days if applied under stressful conditions.</li> <li>• Do not apply to golf greens.</li> <li>• Do not apply to warm-season grasses over-seeded with perennial ryegrass.</li> <li>• If tall fescue is present and desired, do not apply.</li> <li>• Do not re-seed or over-seed or sprig turfgrasses for at least 45 days after last application.</li> <li>• Do not apply within 6 weeks of initiation of green-up.</li> <li>• Do not apply during spring green-up or fall transition to dormancy.</li> <li>• Apply 0.25-0.5 inches of irrigation or rainfall within 1 to 7 days after application.</li> <li>• Do not apply within 30 days of harvesting sod.</li> </ul>
Katana (flazasulfuron)	Bermudagrass Centipedegrass Seashore Paspalum Zoysiagrass	0.5 to 3.0 oz	<ul style="list-style-type: none"> <li>• Do not apply to new seeded, sodded or sprigged turfgrass until well-established.</li> <li>• Care should be taken when herbicide could move with surface water onto non-target susceptible species, such as creeping bentgrass or perennial ryegrass.</li> <li>• Tracking of applied herbicide onto non-target species by maintenance equipment or human traffic should be considered.</li> <li>• It is recommended that light frequent irrigation be used to wash the herbicide from the leaf surface and into the soil profile the two mornings after application.</li> </ul>
Monument (trifloxysulfuron)	Bermudagrass Zoysiagrass  St. Augustinegrass (sod production only)	0.35 to 0.53 oz	<ul style="list-style-type: none"> <li>• Tracking of applied herbicide onto non-target species by maintenance equipment or human traffic should be considered.</li> <li>• It is recommended that light frequent irrigation be used to wash the herbicide from the leaf surface and into the soil profile the two mornings after application.</li> <li>• Care should be taken when herbicide could move with surface water onto non-target susceptible species, such as creeping bentgrass or perennial ryegrass.</li> <li>• Repeat applications may be necessary for complete control of difficult to control weeds.</li> <li>• Do not apply more than 1.7 oz of product/A each year.</li> <li>• On newly established stands, delay applications for 4 weeks after sprigging, sodding or seedling emergence.</li> <li>• On bermudagrass, this product may be applied up to 3 weeks prior to overseeding with perennial ryegrass.</li> <li>• Do not apply to turfgrass under stress.</li> </ul>

Herbicide	Tolerant Turfgrasses	Application Rates (product/acre)	Use Precautions
Sedges ( <i>Cyperus</i> spp.) and Kyllingas ( <i>Kyllinga</i> spp.)			
Q-4 Plus (quinclorac + sulfentrazone + 2,4-D + dicamba)	Bermudagrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass	5 to 8 pts	<ul style="list-style-type: none"> <li>Do not use on golf course greens, tees and/or collars.</li> <li>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.</li> <li>Delay application of this product 3 to 4 weeks after sodding, sprigging or plugging any turfgrass species.</li> <li>Do not apply to turf under stress.</li> <li>Do not apply when temperatures exceed 90 F.</li> <li>Do not apply more than 2 applications per season.</li> <li>Do not irrigate within 24 hours after application.</li> <li>Do not mow for 2 days before or after application.</li> </ul>
SedgeHammer (halosulfuron)	Bermudagrass Centipedegrass Creeping Bentgrass Fine Fescue Ky. Bluegrass P. Ryegrass Seashore Paspalum St. Augustinegrass Tall Fescue Zoysiagrass	0.67 to 1.33 oz	<ul style="list-style-type: none"> <li>Do not apply to golf greens.</li> <li>May require a repeat application 6 to 10 weeks after the initial application.</li> <li>Do not make more than four applications per year.</li> <li>Do not apply more than 5.33 oz of product per acre per year.</li> <li>Including a nonionic surfactant at 0.25-0.50% v/v will improve control.</li> <li>For optimum control, do not mow within 2 days before or after application.</li> <li>This product is sold with a nonionic surfactant included under the trade name SedgeHammer+.</li> </ul>
Solitare (quinclorac + sulfentrazone)	Bermudagrass Centipedegrass Ky. Bluegrass P. Ryegrass Seashore Paspalum Tall Fescue Zoysiagrass	16 to 32 oz	<ul style="list-style-type: none"> <li>See label for use rates for cool- and warm-season species.</li> <li>Use of a surfactant is not recommended.</li> <li>Do not apply to golf course greens, collars or tees.</li> <li>Do not apply to turf under stressed conditions.</li> <li>Delay re-seeding, over-seeding or sprigging for 1 month after application.</li> <li>Over-seeding 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.</li> <li>Do not apply to sod within 3 months of harvest.</li> </ul>
Surge (sulfentrazone + 2,4-D + MCPP + dicamba)	Bermudagrass Creeping bentgrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue Zoysiagrass	2.75 to 4 pt	<ul style="list-style-type: none"> <li>Do not apply to creeping bentgrass greens or tees.</li> <li>Do not broadcast apply at temperatures above 90 F.</li> <li>Do not apply to turf under stress.</li> <li>Do not apply to warm-season turf transitioning into or out of winter dormancy.</li> <li>The addition of sulfentrazone often allows this herbicide to provide improved efficacy in cooler weather compared to other three-way mixtures.</li> <li>Treated areas may be reseeded 3 weeks after application.</li> <li>Do not make more than 2 applications per season.</li> <li>Allow foliage to dry for at least 6 hours after application.</li> <li>Avoid mowing for 2 days before and after treatment.</li> </ul>

Herbicide	Tolerant Turfgrasses	Application Rates (product/acre)	Use Precautions
Sedges ( <i>Cyperus</i> spp.) and Kyllingas ( <i>Kyllinga</i> spp.)			
Tenacity (mesotrione)	Bermudagrass (DORMANT)  Centipedegrass Fine Fescue Ky. Bluegrass P. Ryegrass Tall Fescue  St. Augustinegrass (sod farms only)	4 to 8 fl oz	<ul style="list-style-type: none"> <li>Mixtures with PSII and PPO inhibiting herbicides widen the spectrum of weed control.</li> <li>Beginning in 2010, labeled use sites include golf courses, sod production, athletic fields, parks and home lawns (spot treatment only).</li> <li>Applications result in foliar bleaching (whitening) of sensitive species.</li> <li>Do not apply more than 5 fl oz/A to perennial ryegrass or fine fescue.</li> <li>Do not apply more than 16 fl oz/A in one season.</li> <li>Efficacy can be affected by temperature, humidity and light.</li> <li>Sequential applications are required to provide complete control of most species.</li> <li>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.</li> <li>Do not apply an organophosphate or carbamate insecticide within 7 days of application, as turf injury may occur.</li> <li>Do not use on golf course greens and maintain a 5-foot buffer between treated areas and golf greens.</li> <li>Do not apply more than 16 fl oz/acre per season.</li> <li>Safe for use at and soon after seeding most labeled grasses.</li> </ul>
Tribute Total (thiencarbazone + foramsulfuron + halosulfuron)	Bermudagrass Zoysiagrass	1 to 3.2 oz	<ul style="list-style-type: none"> <li>Used to provide postemergence control of grasses, sedges (particularly yellow nutsedge) and broadleaf weeds.</li> <li>Use of a nonionic surfactant (NIS) at 0.25 to 0.50% v/v will improve efficacy.</li> <li>Addition of ammonium sulfate (AMS) to the spray solution can improve efficacy.</li> <li>Do not apply more than 3.2 oz/A per application.</li> <li>Do not apply more than 6.4 oz/A per year.</li> <li>Do not apply within 8 weeks of overseeding.</li> <li>Spot treatments can be applied at 0.073 oz/gallon.</li> <li>Maintain a 15-foot buffer from sensitive grass areas.</li> </ul>



Disclaimer

This publication contains herbicide recommendations that are subject to change at any time. The recommendations in this publication are provided only as a guide. It is always the herbicide applicator's responsibility, by law, to read and follow all current label directions for the specific herbicide being used. The label always takes precedence over the recommendations found in this publication.

Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others that may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product. The author(s), the University of Tennessee Institute of Agriculture and University of Tennessee Extension assume no liability resulting from the use of these recommendations.

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