

plied soon after emergence of the weeds. A repeat application may be needed to maintain control 30 to 60 days after the initial application. Prograss is also labeled for control of annual bluegrass in established Kentucky bluegrass on golf courses or other commercially-maintained turf. It is not for use on homeowner lawns. Application rates are slightly lower for Kentucky bluegrass than for perennial ryegrass.

### Performance conditions

Environmental conditions, such as temperature, light intensity, rainfall after application, drought stress and relative humidity, can greatly influence the performance of foliar-applied herbicides. These conditions have been mentioned in various places in this article and can be briefly summarized as follows:

- Herbicides are readily absorbed when applied to actively growing weeds.

- Broadleaf herbicides are generally more active if sprayed when daily temperatures are 60 to 80°F. Methanearsonates are more effective from 70 to 85°F. Foliar penetration usually increases within these temperature ranges.

- Soil moisture should be adequate. Under dry conditions, it is advantageous to irrigate prior to herbicide application or wait for a rain. For broadleaf herbicides, there should be a rain-free period of four to six hours following the application. Rainfall or irrigation immediately following application is detrimental to the effectiveness of a post-emergence foliar-applied herbicide.

- Generally, high relative humidity increases herbicide action by increasing absorption and translocation.

- Post-emergence herbicides should be applied before mowing to have maximum leaf surface for absorption. When applying methanearsonates or Acclaim do not mow or water for at least 24 hours after application.

- Post-emergence herbicides are less effective if weeds are under stress conditions, and turfgrass tolerance is frequently also lower.

Understanding these and other factors influencing herbicide performance is helpful to explain results obtained and to maximize weed control.

The use of trade names in this article does not imply endorsement of the products named, nor criticism of similar ones not mentioned.

## WARM-SEASON

by Tim R. Murphy, University of Georgia

**A** chemical weed control program in warm-season turfgrasses uses pre-emergence and post-emergence herbicides. Pre-emergence herbicides form the base of the chemical weed control program; post-emergence herbicides are used to control problem weeds that are not controlled by pre-emergents.

Additionally, in the event of a pre-emergence herbicide weed control failure, post-emergence herbicides can be relied on for a complete chemical weed control program provided multiple applications are used throughout the year.

In newly-established turfgrasses, most pre-emergence herbicides are not recommended. Some post-emergence herbicides may be used at low rates. A general rule is to delay the application until after three to four mowings or until the sprigged turfgrasses have rooted and are actively growing. Delaying the application allows the turfgrass sprigs or seedlings to become established and improves their tolerance to post-emergence herbicides.

### Selection

Many post-emergence herbicides are available to control weeds in  
*continued on page 41*

**Table 1.**

**Common and trade names of turfgrass post-emergence herbicides.**

Common Name	Company	Trade Name and Formulations <sup>1</sup>
asulam	Rhone-Poulenc	Asulox 3.34 lbs./gal.
atrazine	Security	Purge 4 lbs./gal.
	Ciba-Geigy	Aatrex 4L, 90DG, 80W
bentazon	BASF	4 lbs./gal.
bromoxynil	Rhone-Poulenc	Buctril - 2 and 4 lbs./gal., Brominal - 2 and 4 lbs./gal., Brominal 2 lbs./gal.
2,4-D	Lesco Vertac, Lesco, SDS Biotech, Others	Numerous trade names and formulations are available.
2,4-D + dicamba	Rhone-Poulenc Lesco	Weedone SuperDPro Amine Eight-One Selective Herbicide
	PBI/Gordon	Phenaban 801
2,4-D + dichlorprop	Rhone-Poulenc	Weedone DPC Amine, Weedone DPC
2,4-D + MCPP	Lesco Rhone-Poulenc	Lescopar Turf Kleen
	PBI/Gordon	Phenomec 2 + 1
2,4-D + MCPP	PBI/Gordon	Trimec Classic
+ dicamba	Mallinckrodt Lesco	Trex-san Three-Way
dicamba	Sandoz PBI/Gordon	Banvel 4 lbs./gal. Dicamba 4
diquat <sup>2</sup>	Chevron	Diquat 2 lbs./gal.
DSMA	Vertac, Vineland Others	Numerous trade names and formulations are available.
ethofumesate	Nor-Am	Prograss 1.5EC
glyphosate	Monsanto	Roundup 4 lbs./gal.
imazaquin	Lesco	Image 1.5 lbs./gal.
MCPP	Rhone-Poulenc PBI/Gordon	Turf Herbicide MCPP 2 lbs./gal. Mecomec 4 4 lbs./gal.
	Lesco	Lescopex 2.5 lbs./gal.
metribuzin	Mobay	Sencor Turf 75W
MSMA	SDS Biotech, Platte, Others	Numerous trade names and formulations are available.
MSMA + 2,4-D + MCPP + dicamba	PBI/Gordon	Quadmec
MCPP + 2,4-D + dicamba	PBI/Gordon	Southern Trimec
pronamide	Rhom-Haas	Kerb 50W
sethoxydim	BASF	Poast 1.5 lbs./gal.

<sup>1</sup>Numeral refers to percent or pounds of active ingredient.

<sup>2</sup>Diquat has a state label in Arkansas, Louisiana, Mississippi, Oklahoma, Tennessee and Texas for winter annual weed control in dormant bermudagrass.

turfgrasses (Table 1), but not one herbicide is appropriate for all turfgrass weed control situations. The following guidelines should be considered to select a post-emergence herbicide.

● **Turfgrass tolerance**—Turfgrass species vary in their tolerance to herbicides (Table 2). For example, Bermudagrass has excellent tolerance to MSMA and DSMA; however, centipedegrass and St. Augustinegrass will be severely injured or killed by these herbicides.

Additionally, cultivars within a species may respond differently to the same herbicide. For example, Meyer zoysiagrass has better tolerance to MSMA than Emerald and Matrella. Always refer to the label to determine if a herbicide may be used on a specific turfgrass species or cultivar.

● **Time of application**—The time of year that a herbicide is applied can influence turfgrass tolerance. For example, dormant Bermudagrass has excellent tolerance to glyphosate; however, severe injury will occur if glyphosate is applied to semi-dormant or to actively-growing Bermudagrass.

● **Weed species**—No single herbicide will control all weed species. Correct weed identification is a prerequisite in selecting an appropriate herbicide. Weed identification manuals and assistance are available at county extension offices. Several chemical companies also distribute turfgrass weed identification manuals.

● **Application frequency**—Similar to turfgrasses, weed species vary in their susceptibility to herbicides. With some weed species and herbicides, a repeat application is necessary to effectively control the weed. For example, two applications of MSMA + metribuzin, at a seven- to 10-day interval, are necessary to control goosegrass. In contrast, small crabgrass can often be controlled with a single application of MSMA. Large, mature crabgrass, however, may require two applications.

● **Ornamental tolerance**—Turfgrass herbicides are commonly applied to sites that contain ornamental plantings. Ornamentals can be injured through contact of the foliage or green bark by herbicide vapor and spray drift and by ornamental root absorption.

Vapor drift is the movement of herbicide vapors from the area of application. Herbicides vary in their volatility or their potential for vapor drift. Ester formulations of the phenoxy herbicides (2,4-D, 2,4-DP) easily volatilize and can injure sensitive ornamentals by vapor drift. Ester formulations should not be used the

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warm months of the year when conditions are favorable for volatilization. Spray drift damage can be prevented by spraying on calm days when the wind velocity is less than five miles per hour, and selecting a nozzle tip and spray pressure that produces large droplets.

Due to their soil residual characteristics, certain herbicides can injure ornamentals by root uptake. Avoid applications of post-emergence herbicides that contain dicamba or atrazine over the root zone of desirable ornamentals. Injury to ornamentals by root uptake is most likely to



Virginia buttonweed is rapidly becoming the number one problem broadleaf weed in turfgrass.

occur on sandy soils when a heavy rainfall immediately follows a herbicide application.

### Precautions

Post-emergence herbicides are applied after annual weeds emerge or when new growth of perennial weeds appears. Follow these guidelines for better weed control and improved turfgrass tolerance.

- Apply post-emergence herbicides in the fall and late spring months. Air temperatures are cooler at this time of year which results in better turfgrass tolerance to herbicides. Also, perennial weeds and many annual weeds are actively growing and are easier to control with post-emergence herbicides. Target the application to coincide with air temperatures between 60 and 90 °F. Applications below 60 °F can result in poor weed control.

- Do not apply post-emergence herbicides to turfgrasses and weeds that are stressed due to high air temperatures or drought. Turfgrass tolerance to post-emergence herbicides decreases as air temperatures greater than 90 °F and when turfgrasses are drought stressed. Herbicides that contain 2,4-D, MCP, dicamba or MSMA should not be applied at high air temperatures since there is a good possibility of increased turfgrass injury.

Many herbicide labels include warning statements relative to the use of the product at high air temperatures. Always follow the most restrictive warning on the label. Control is also poorer when herbicides are applied to environmentally stressed weeds than when applied to actively growing weeds.

- Do not apply post-emergence herbicides during the green-up process of warm-season turfgrasses. The risk of injury is greater during the spring green-up process (transition from winter dormancy to active growth) than when the turfgrass is fully dormant or actively growing (fully green)

- Repeated applications at low rates will generally improve control and turfgrass tolerance. Single applications at high rates generally cause more turfgrass injury than repeat applications at low rates. Additionally, single applications at high rates often do not control the weed. Refer to the label for information regarding repeat treatments.

- Mowing schedules will need to be coordinated with post-emergence herbicide applications. A general recommendation is to delay mowing three to four days prior to or after a post-emergence herbicide applica-

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**Table 2.**

**Warm-season turfgrass tolerance to post-emergence herbicides.**

Herbicide	Turfgrass			
	Bermuda-grass	Centipede-grass	St. Augustine-grass	Zoysia-grass
asulam	T*	NR-S	T	NR-I
atrazine	T (D)	T	T	I
bentazon	T	T	T	T
bromoxynil	T	T	T	T
2,4-D	T	S-I	S-I	T
2,4-D + dicamba	T	S-I	S-I	T
2,4-D + dichlorprop	T	S-I	S-I	T
2,4-D + mecoprop	T	S-I	S-I	T
+ dicamba	T	S-I	S-I	T
dicamba	T	S-I	S-I	T
diquat	T (D)	NR	NR	NR
DSMA, MSMA	T	S	S	I
glyphosate	T (D)	S	S	S
imazaquin	T	T	T	T
MCP	T	S-I	S-I	T
metribuzin	T	NR-S	NR-S	NR-S
pronamide	T	NR	NR	NR-T
sethoxydim	NR-S	T	NR-S	NR-I

\*Asulam is labelled for use only on 'Tifway' bermudagrass (419).

T = Tolerant at labelled rates; I = Intermediate tolerance, use at reduced label rates; S = Sensitive, do not use this herbicide; NR = Not registered for use on this turfgrass; D = Dormant applications only.

tion. The delay prior to treatment will increase the leaf surface area of the weed and result in better spray coverage and control. The delay after treatment is necessary to allow adequate time for herbicide absorption and translocation in the target weed species.

- Do not apply post-emergence herbicides immediately before rainfall or irrigation. Generally the performance of most post-emergence herbicides is better when rainfall or irrigation does not occur for six to 24 hours after an application. Rainfall or irrigation immediately after treatment can wash the herbicide from the treated foliage and decrease control.

- Use surfactants and crop oil concentrates according to label directions. The effectiveness of many post-emergence herbicides is enhanced by the addition of a surfactant or crop oil concentrate to the spray mixture. However, indiscriminate use of surfactants or crop oil concentrates can increase the risk of turfgrass injury.

### Problem weeds

**Nutsedge**—Two different species of perennial nutsedge occur in warm-season turfgrasses. Purple and yellow nutsedge can be distinguished on the basis of vegetative differences (Table 3). Bentazon will provide control of yellow but not purple nutsedge. Monthly applications of MSMA in labelled turfgrasses can be used to suppress the growth of both species.

Imazaquin can be used in warm-season turfgrasses for yellow and purple nutsedge control. Recent work conducted in Mississippi and Georgia has shown that imazaquin is better than MSMA for nutsedge control.

**Dallisgrass**—Dallisgrass is a difficult-to-control perennial grass weed. It is believed that most pre-emergence herbicides will control dallisgrass that arises from seed. Established dallisgrass can be controlled in Bermudagrass and zoysiagrass with repeat applications of MSMA or DSMA. Applications should be made to actively growing dallisgrass. Also, a nonionic surfactant at 0.25% v/v is recommended with MSMA or DSMA for dallisgrass control. It is very important to stay on the treatment schedule (seven to 10 days between applications) for repeat applications. Shortening the application interval to five days may help in areas where dallisgrass has been difficult to control with MSMA or DSMA.

**Virginia buttonweed**—Virginia buttonweed is rapidly becoming the number one problem broadleaf weed in turfgrass. A perennial, Virginia but-

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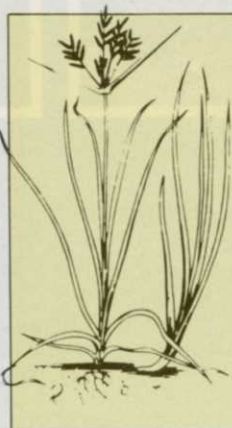
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**Table 3.**

### Vegetative characteristics of purple and yellow nutsedge.



Characteristic	Purple Nutsedge	Yellow Nutsedge
Leaf color	dark green	pale or light green
Leaf surface	flat or corrugated	flat or corrugated
Leaf tip	abruptly tapers to sharp tip	gradually tapers to sharp, needle-like tip
Rhizomes	wiry, scaly	weak, threadlike
Tubers	oblong, coarsely hairy	spherical, smooth
Tuber taste	bitter	sweet
Seed head color	reddish - to purplish-brown	yellow

### HINTS FOR HERBICIDE APPLICATION

1. Read and observe instructions and precautions on the herbicide label.
2. Calibrate sprayers and recheck calibration prior to herbicide application.
3. Apply the proper rate of herbicide. Too much herbicide may damage or kill turfgrass.
4. Apply herbicides in one pint of water per 100 square feet or one gallon of water per 1,000 square feet.

tonweed reproduces by seed, cut plant pieces and fleshy roots. Research conducted in Mississippi has shown that 2,4-D + dichlorprop has provided better Virginia buttonweed control than other two-way or three-way broadleaf herbicide mixtures.

Additionally, applications of oxadiazon or simazine at the time of 2,4-D + dichlorprop application will increase the control of Virginia buttonweed. The increase in control with oxadiazon or simazine is believed to be the control of Virginia buttonweed plants that arise from seed.

**Bahiagrass**—Repeat applications of MSMA or DSMA will control bahiagrass in tolerant turfgrasses. In centipedegrass, repeat applications of sethoxydim will suppress bahiagrass growth and seedhead development.

**Prostrate spurge**—Repeat applications of two-way or three-way broadleaf herbicides will be required to control this summer annual broadleaf weed. In Bermudagrass, low rates of metribuzin (0.125 to 0.25 lb. AI/acre) will effectively control prostrate spurge.

**Wild garlic**—Wild garlic is a perennial that appears in turfgrasses in the mid- to late-fall months. Fall (Novem-



Controlling prostrate spurge requires repeat applications of two- or three-way herbicides.

ber)/winter (January-February) applications of 2,4-D or two-way and three-way broadleaf herbicides that contain 2,4-D or dicamba will control wild garlic.

To effectively eliminate this weed from the turfgrass, the fall and spring treatment program will need to be repeated for two to three consecutive years.

Imazaquin has provided excellent control of wild garlic in experiments conducted in Mississippi. Late fall applications to emerged wild garlic have provided slightly better control than early spring applications.

Post-emergence herbicides enable

the turfgrass manager to control many problem weeds not controlled by pre-emergents. In the event of a pre-emergence weed control failure, post-emergence herbicides can be relied upon for a complete chemical weed control program. However, sole reliance upon post-emergence herbicides for a total weed control program is risky.

Cultural practices that favor good turfgrass growth and development, the use of pre-emergence herbicides and the timely use of post-emergence herbicides will help the turfgrass manager to achieve the goal of a high quality, weed-free turfgrass. **LM**

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