



## POST-EMERGENCE WEED CONTROL IN WARM-SEASON GRASSES

Post-emergence herbicides provide the turfgrass manager with viable options to control weeds during the entire year.

by Tim R. Murphy, Ph.D., University of Georgia

**W**eed control is the process of limiting a weed infestation so that a turfgrass can properly grow, develop and be aesthetically appealing.

A balanced turfgrass weed control program uses a combination of cultural, mechanical and chemical weed control practices. When properly maintained, warm-season turfgrasses are highly competitive with weeds. Adherence to recommended fertility programs, water requirements, mowing heights and schedules and controlling diseases and insects will dramatically improve the success of the chemical weed control program.

The use of herbicides, in the absence of approved cultural and mechanical practices, will not result in a high quality, warm-season turfgrass.

Turfgrass managers can choose from two types of herbicides to control weeds in warm-season turfgrasses. Pre-emergence herbicides form the base of the chemical weed control program. They are primarily used for the control of crabgrass, goosegrass, annual bluegrass and certain annual broadleaf weeds. Post-emergence herbicides are generally used to control weeds that are not controlled by pre-emergence herbicides, or in the event of a pre-emergence weed failure, as a reliable backup.

Post-emergence herbicides offer several advantages over pre-emergents.

### Spot treat, or as needed

Post-emergence herbicides can be applied on a "spot treatment" or "as-

needed" basis, directly to a weed infestation; pre-emergence herbicides are usually applied to the entire turfgrass area.

Spot treatments of post-emergence herbicides are less expensive than blanket applications of pre-emergence herbicides. Post-emergence herbicides will control many problem annual and perennial weeds not controlled by pre-emergence herbicides.

Low rates of most post-emergence herbicides may be used on newly-sprigged or sodded warm-season turfgrasses.

In areas that are scheduled to be overseeded or renovated, the majority of post-emergence herbicides can be used up to one month before renovation. The time interval from application to seeding, sprigging or sodding operations for pre-emer-

**TABLE 1. Common and trade names of warm-season turfgrass postemergence herbicides.**

Common Name	Trade Name(s)	Company(s)
asulam	Asulox	Rhone-Poulenc
atrazine	Aatrex, Others	Ciba-Geigy, Others
bentazon	Basagran	BASF
bromoxynil	Buctril	Rhone-Poulenc
2,4-D	Numerous formulations are available.	Vertac, Lesco, Fermenta, Others
2,4-D + dicamba	Eight-One, Phenaban 801	Lesco, PBI/Gordon
2,4-D + dichlorprop	Weedone DPC Amine, Weedone DPC Ester	Rhone-Poulenc
2,4-D + mecoprop	Lescopar, Phenomec 2+1, 2 Plus 2	Lesco, PBI/Gordon, Fermenta
2,4-D + mecoprop + dicamba	Trimec Classic, Trex-san, Three-Way	PBI/Gordon, Sierra, Lesco
2,4-D + mecoprop + dichlorprop	Weedestroy Triamine, Weedestroy Tri-Ester	Riverdale
dicamba	Banvel, Dicamba 4	Sandoz, PBI/Gordon
diclofop-methyl <sup>1</sup>	Illoxan, Hoelon	Hoechst
diquat <sup>2</sup>	Diquat	Valent
DSMA	Numerous formulations are available.	Vertac, Vineland, Others
ethofumesate	Prograss	Nor-Am
fenoxaprop	Acclaim	Hoechst
glyphosate	Roundup	Monsanto
imazaquin	Image	American Cyanamid
mecoprop	Mecomec, Lescopex	PBI/Gordon, Lesco
mecoprop + 2,4-D + dicamba	Southern Trimec	PBI/Gordon
MCPA + mecoprop + dichlorprop	Weedestroy Triamine II, Weedestroy Tri-Ester II	Riverdale
metribuzin	Sencor Turf	Mobay
metsulfuron	DMC	O. M. Scott
MSMA	Numerous formulations are available.	Fermenta, Platte, Others
MSMA + 2,4-D + mecoprop + dicamba	Trimec Plus	PBI/Gordon
pronamide	Kerb	Rohm-Haas
sethoxydim	Vantage	BASF

<sup>1</sup> Diclofop-methyl currently has a state label for use in Georgia, Florida and South Carolina. Current labels should be consulted as use directions and trade names vary between states.

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

Source: The author

**TABLE 2. Warm-season turfgrass tolerance to postemergence herbicides.**

Herbicide	Turfgrasses					
	Bahia-grass	Bermuda-grass	Centipede-grass	Carpet-grass	St. Augustine-grass	Zoysia-grass
asulam	NR-S	T <sup>1</sup>	NR-S	NR-S	T	NR
atrazine	NR-I	I	T	NR-I	T	I
bentazon	T	T	T	NR-I	T	T
bromoxynil	T	T	T	NR-I	T	T
2,4-D	T	T	I	I	S-I	T
2,4-D + dicamba	T	T	S-I	S-I	S-I	T
2,4-D + dichlorprop	T	T	I	I	I	T
2,4-D + mecoprop	T	T	S-I	I	S-I	T
2,4-D + mecoprop + dicamba	I-T	I-T	S-I	S-I	S-I	T
2,4-D + mecoprop + dichlorprop	T	T	I	I	I	T
dicamba	T	T	I-T	I	S-I	T
diclofop-methyl	NR	T	NR	NR	NR	NR
DSMA,MSMA	NR-S	T	NR-S	NR-S	NR-S	I
fenoxaprop	NR-S	NR-S	NR-S	NR	NR-S	T
glyphosate <sup>2</sup>	S(D)	S(D)	S	S	S	S
imazaquin	NR-S	T	T	NR-I	T	T
MCPA + mecoprop + dichlorprop	T	T	I	I	I	T
mecoprop	T	T	S-I	I	S-I	T
metribuzin	NR-I	T	NR-S	NR-S	NR-S	NR-S
metsulfuron	NR-S	T	NR-T	NR	T	NR-T
pronamide	NR-S	T	NR-I	NR	NR-I	NR-I
sethoxydim	NR-S	NR-S	T	NR-I	NR-S	NR-I

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

<sup>1</sup> Labeled only on 'Tifway' (419) bermudagrass and St. Augustinegrass.

<sup>2</sup> Bahiagrass and bermudagrass are tolerant to glyphosate when completely dormant.

Source: The author

differently to the same herbicide. For example, Meyer zoysiagrass has better tolerance to MSMA than Emerald or Matrella.

The most important factor in selecting a post-emergence herbicide is the tolerance of the turfgrass to the herbicide. Refer to the specific label to determine if the herbicide may be used on a particular turfgrass species.

**Weed species.** Similar to turfgrasses, weed species vary in their susceptibility to herbicides. Correct weed identification is a prerequisite for selecting an appropriate herbicide. Weed identification manuals and identification assistance is available at many county extension service offices. Several chemical companies also distribute excellent weed identification guides.

**Time of application.** The time of year that a herbicide is applied can influence turfgrass tolerance. For example, dormant bahiagrass and bermudagrass have excellent tolerance to Roundup. However, severe injury will occur if this herbicide is applied to semi-dormant or actively-growing bahiagrass or bermudagrass.

The risk of injury from post-emergence herbicides is also greater during the spring green-up process (transition from winter dormancy to active growth) than when the turfgrass is fully dormant or actively growing.

Post-emergence herbicides such as 2,4-D + mecoprop + dicamba (Trex-san, Trimec Classic, Three-Way and others) have been shown to slightly decrease the quality of Tifway bermudagrass when applications were made three weeks before or during spring green-up. Image can also cause slight to moderate delays in green-up if applications are made during spring transition.

Research has shown that the decrease in turfgrass quality that may result from using post-emergence herbicides

gence herbicides varies from 1½ to 4 months.

### Herbicide selection

Many post-emergence herbicides are available to control weeds in warm-season turfgrasses (Table 1). They all have different qualities.

**Turfgrass tolerance.** The warm-season turfgrasses dramatically vary in their tolerance to post-emergence herbicides (Table 2). Bermudagrass has good tolerance to MSMA and DSMA; however, carpetgrass, centipedegrass and St. Augustinegrass are severely injured by these herbicides. With the exception of bahiagrass and carpetgrass, warm-season turfgrasses have excellent tolerance to Image.

Additionally, cultivars within a species may respond

during green-up persists for two to six weeks after application. Also, in turfgrasses that are severely infested with weeds, better turfgrass growth eventually results due to the elimination of the thick cover of weeds.

In the event that a dense weed population necessitates using a post-emergence herbicide during green-up, use only the lowest recommended or one-half the recommended rate. Low or one-half rates will minimize herbicide injury to the turfgrass.

**Application frequency.** For some weed species, a repeat application is necessary to effectively control the weed. For example, two applications of MSMA + Sencor, at a 7- to 10-day interval, are necessary to control goosegrass. In contrast, small crabgrass can often be controlled with a single application of MSMA. However, large, well-tillered crabgrass usually requires two applications of MSMA or DSMA, each at a 7- to 10-day interval.

**Ornamental tolerance.** Turfgrass herbicides are commonly applied to sites containing ornamental plantings. Ornamentals may be injured by spray or vapor drift or by root absorption of the herbicide. Vapor drift is the movement of herbicide vapors from the intended site of application.

Ester formulations of the phenoxy herbicides (2,4-D, dichlorprop) easily volatilize during warm temperatures and can injure sensitive ornamentals by vapor drift. Ester formulations

## Problem weed management

**Bahiagrass:** Repeat applications of MSMA or DSMA at 7- to 10-day intervals will control bahiagrass in MSMA/DSMA tolerant turfgrasses. In bermudagrass and St. Augustinegrass, DMC will effectively control bahiagrass. In centipedegrass, repeat application of Vantage (formerly Poast) at 10- to 14-day intervals will suppress bahiagrass growth and seedhead development.

**Dallisgrass:** It is believed that most pre-emergence herbicides will control dallisgrass that arises from seed.

Established dallisgrass can be controlled in bermudagrass or zoysiagrass with repeat applications of MSMA or DSMA. Applications should be made to actively-growing dallisgrass. Also, a non-ionic surfactant at 0.25 percent v/v is recommended with MSMA or DSMA for dallisgrass control. Staying on the application schedule (2 to 4 applications, each at a 7- to 10-day interval) will be required to control dallisgrass. Shortening the application interval to five days may help on sites where dallisgrass has been difficult to control with MSMA or DSMA.

**Nutsedge:** Basagran will provide good control of yellow nutsedge, but not of the purple variety. Monthly applications of MSMA or DSMA in tolerant turfgrasses during the late spring and summer months can be used to suppress the growth of both species. With the exception of bahiagrass and carpetgrass, Image can be used in warm-season turfgrasses for yellow and purple nutsedge control. The addition of MSMA to Image generally improves nutsedge control in MSMA tolerant turfgrasses. A repeat application, six to eight weeks after the first application, of Image or Image + MSMA will be required to control nutsedge during the summer

months.

**Prostrate spurge:** Control requires repeat applications of two-way or three-way broadleaf herbicides. In bermudagrass, low rates of Sencor (0.125 to 0.25 lb. AI/acre) will effectively control emerged prostrate spurge.

**Virginia buttonweed:** Rapidly becoming the number one problem broadleaf weed in southern

suppress the growth of Virginia buttonweed. Research conducted in Mississippi has shown that applications of Ronstar or Princep at the time of the 2,4-D + dichlorprop application increased the control of Virginia buttonweed.

The increase in control with Ronstar and Princep is believed to be the control of Virginia buttonweed plants that arise from seed. Turfgrass managers should be aware that Princep is not labeled on southern turfgrasses in the months of June, July and August. However, depending upon the geographical location, a mid-April or May application of Princep may assist in the control of Virginia buttonweed.

**Wild garlic:** A perennial that appears in turfgrasses in the mid- to late-fall months. Fall (November) and winter (January-February) applications of 2,4-D or two-way or three-way products that contain a phenoxy herbicide or dicamba will control wild garlic. The fall plus early winter treatment program will need to be repeated for two to three consecutive years to effectively eliminate this weed from turfgrasses. Late fall to early winter applications of Image has provided good to excellent control of emerged wild garlic. Image slowly kills wild garlic and treated plants will remain visible in the turfgrass for an extended time after application. Mowing one to two weeks after the Image application will remove a significant portion of the wild garlic foliage and improve the overall appearance of the turfgrass. Image should be applied to emerged wild garlic in the late fall or early winter after the first killing frost or the onset of winter dormancy of the warm-season turfgrass.

In St. Augustinegrass and bermudagrass, DMC will also effectively control wild garlic.

—Dr. Murphy □



turfgrasses. A warm-season perennial, Virginia buttonweed reproduces by seed, cut plant pieces, and fleshy roots.

Research has shown that 2,4-D + dichlorprop (Weedone DPC amine and ester) has provided better Virginia buttonweed control than other two-way or three-way broadleaf herbicides. Monthly applications of 2,4-D + dichlorprop will be needed during the summer months to

## Suggestions for use

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

### 1. Small, actively-growing weeds.

Perennial and annual weeds that are growing under good soil moisture conditions at moderate air temperatures are easier to control with post-emergence herbicides than weeds that are stressed due to adverse environmental conditions. Target the application to coincide with good soil moisture conditions at air temperatures of 60 to 90°F. Applications on cold, wintery days, or to drought-stressed weeds will result in poor weed control.

### 2. Do not apply post-emergence herbicides to turfgrasses and weeds that are stressed due to high air temperatures or drought.

The tolerance of warm-season turfgrasses to post-emergence herbicides decreases at air temperatures greater than 90°F, and when turfgrasses are drought-stressed. Additionally, turfgrasses growing under high soil moisture, high relative humidity and high air temperatures, (less than 90°F) have a lower level of tolerance to post-emergence herbicides than turfgrasses growing under similar moisture and humidity conditions but at cooler temperatures.

Herbicides that contain 2,4-D; dicamba; mecoprop; dichlorprop; MSMA and DSMA should not be applied at high air temperatures since there is a high risk of increased turfgrass injury.

Follow label guidelines.

### 3. Repeated applications at low rates will generally improve weed control and turfgrass tolerance.

Single applications at high rates generally cause more turfgrass injury than repeat applications at low rates. Additionally, single, high rate applications often do not control the weed, particularly perennial weeds. The repeat application is usually made at intervals of 7

to 14 days after the first application, or when regrowth of the weed is noted. Refer to the label for information regarding repeat treatments.

### 4. Coordinate mowing schedules.

A general recommendation is to delay mowing three to four days before or after a post-emergence herbicide application. The delay prior to application will increase the leaf surface area of the weed and result in better spray coverage and control. The delay after application is necessary to allow adequate time for herbicide absorption and translocation in the target weed species.

### 5. Do not apply post-emergence herbicides immediately before rainfall or irrigation.

The effectiveness of most post-emergence herbicides is better when rainfall or irrigation does not occur for 6 to 24 hours after application. Rainfall or irrigation immediately after application can wash the herbicide from the treated weed foliage and decrease control.

### 6. Use surfactants and crop oil concentrates according to label directions.

The effectiveness of many post-emergence herbicides is enhanced by the addition of a crop oil concentrate or surfactant to the spray mixture, particularly under less than ideal spray conditions. However, indiscriminate use of surfactants or crop oil concentrates can increase the risk of turfgrass injury. Check the label for crop oil guidelines.

### 7. Calibrate spray equipment, train operators.

Weed control failure can be linked to improper calibration of spray equipment.

The tolerance of warm-season turfgrasses rapidly decreases at elevated or higher-than-recommended rates of post-emergence herbicides. Training assistance is available through most county extension service offices and spray equipment company representatives.

—Dr. Murphy □

should not be used during the warm months of the year when environmental conditions are favorable for volatilization. Spray drift damage can be minimized by spraying when the wind velocity is less than 5 mph, and selecting a nozzle tip and spray pressure that produces large spray droplets.

Due to their soil residual characteristics, Aatrex and dicamba (Banvel, Dicamba 4) can injure broadleaf ornamentals via root uptake. Injury to ornamentals is most likely to occur on sandy soils when a heavy rainfall immediately follows application of these herbicides. The potential of these herbicides to injure ornamentals via root uptake can be prevented by avoiding their use over the rootzone of shrubs and small trees.

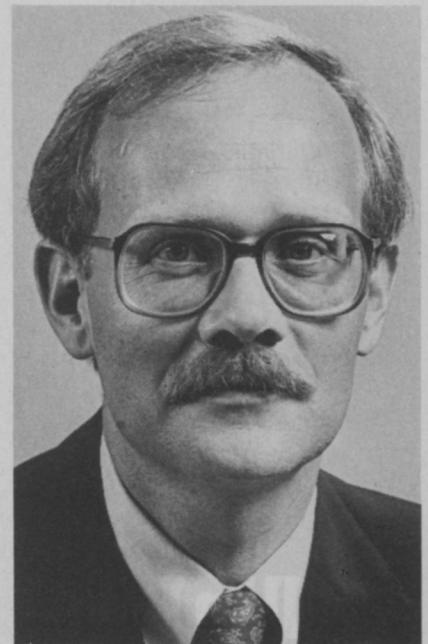
### Spring break important

Post-emergence herbicide use should be avoided during the spring transition of warm-season turfgrasses and during periods of extremely high air temperatures.

winter, late spring and early summer months. The majority of turfgrass post-emergence herbicides are more effective when applied to small weeds than when applied to large weeds. Waiting until weeds are in advanced growth stages will usually require that the highest recommended rate be used, and often, a repeat application.

In the event of a pre-emergence herbicide weed control failure, post-emergence herbicides can be relied upon for a complete chemical weed control program. Due to the necessity of repeat applications and temporary turfgrass injury, most managers prefer to use a combination of pre-emergence and post-emergence herbicides to control turfgrass weeds.

Cultural practices that favor vigorous turfgrass growth, the use of pre-emergence herbicides at recommended times of the year, and timely use of post-emergence herbicides will enable the turfgrass manager to achieve the goal of a high quality, attractive turfgrass that is relatively weed-free. LM



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## POST-EMERGENCE WEED CONTROL IN COOL-SEASON GRASSES

The effectiveness of soon-to-be-released post-emergence control products depends largely on an understanding of the plant's physiology.

by Bruce Branham, Ph.D., Michigan State University

**W**eed control is the cornerstone of most landscape management. In golf course operations, knowledge of weed control is important; however, disease management often requires more time and money for the average golf course superintendent than does weed control.

Regardless of the type of turf you manage, it is important to understand weed control principles, so that the decisions you make are economical, environmentally sound and produce good results.

No new products for post-emergence weed control in cool-season grasses have been introduced in the past year, although we are still waiting on the EPA to approve three turf herbicides. Two of those products are

pre-emergence herbicides (di-thiopyr/Dimension and proflaminate/Blockade) while the other is a post-emergence grass and broadleaf herbicide (quinclorac/Impact) from BASF Ag products.

### Impact of Impact

Impact is an excellent post-emergence grass herbicide with good activity on a number of broadleaf weeds as well. Data in Table 1 shows the effectiveness of this product when compared to other commonly used post-emergence grass herbicides. Impact controls crabgrass effectively at all growth stages and quickly by providing rapid initial burndown of the crabgrass. Impact also has some rapid initial burndown of the crabgrass. Impact also has some pre-

emergence activity as demonstrated by the date from the two- to three-leaf application.

The Impact treatments provided excellent control (99 to 100 percent) at eight weeks after treatment (WAT), while the Acclaim treatment provided good initial control—87 percent at four weeks after treatment, which fell to only 51 percent by eight WAT.

This loss of control with Acclaim indicates that new germination of crabgrass had occurred to reinfest the treated area which occurs because Acclaim does not have pre-emergence activity.

Evidently, Impact had enough pre-emergence activity to provide control for the rest of the growing season. However, applications of Impact applied at the normal time for a pre-

**TABLE 1. Effect of Impact on post-emergence crabgrass control in Kentucky bluegrass turf.**

Treatment	Rate (lbs AI/A)	% Control	
Growth Stage: 2-3 leaf Appl. date: 6-14-90			
		<u>4 WAT</u>	<u>8 WAT</u>
Impact + BAS 090	0.75 + 1qt/A	100 a	99 ab
Impact + BAS 090	1.0 + 1qt/A	100 a	100 a
Dimension	0.38	90 a-d	94 a-c
Acclaim	0.18	87 a-e	51 d-h
Control		0	0
Growth Stage: 2-3 tillers Application Date: 7-10-90			
		<u>4 WAT</u>	<u>9 WAT</u>
Impact + BAS 090	0.75 + 1qt/A	100 a	97 ab
Impact + BAS 090	1.0 + 1qt/A	100 a	100 a
Acclaim	0.18	96 a-d	77 b-d
Daconate 6	2 + 2	93 b-d	88 a-d
Dimension	0.38	72 ef	82 a-d
Control		0	0

emergence herbicide have not given season-long crabgrass control. Impact has also been shown to provide effective control of broadleaf weed species such as white clover, black medic, field bindweed, spurge, and some veronica (speedwell) species.

Currently available herbicides for post-emergence control are shown in Table 2. Impact is not expected to be available until at least 1992.

#### Dimension's residual

Dimension is an excellent pre-emergence herbicide. But as the data in Table 1 shows, it also has excellent early post-emergence crabgrass activity. However, Dimension's ability to control crabgrass falls off rapidly after crabgrass starts producing tillers.

Formulations of MSMA provide effective weed control if two applications spaced 10 to 14 days apart are made. This product has fallen out of favor with lawn care operators because of the necessity to make repeat applications and because the potential for turf injury is high.

#### Acclaim: the standard

Acclaim is still the standard to which other post-emergence crabgrass herbicides are compared.

This product will provide very effective crabgrass control when applied on crabgrass with four tillers or less. As crabgrass grows beyond four tillers, control declines. In addition, crabgrass that is drought stressed is

poor quality turf areas. In this situation, Roundup would be applied to the entire area; a seven-day waiting period should be sufficient to kill all vegetation. The area can then be re-established to a more desirable turf species. Non-selective herbicides are useful for edging around trees to prevent mower damage to the trees and for controlling weeds in the cracks of sidewalks, where it is often combined with a pre-emergence herbicide such as Surflan to provide long-term residual weed control. Non-selective herbicides can also be used to control weeds in mulched planting beds or gardens by directing the spray only on the weeds present.

Paraquat, a non-selective contact post-emergence herbicide, does not translocate. It kills only vegetation that it comes in contact with. Thorough spray coverage is required to achieve good control, but because the herbicide does not translocate, it will only kill the green vegetation of the plant. Some plant species can regenerate from the surviving roots and meristems. In addition, paraquat is moderately toxic, with an LD<sub>50</sub> of 120 mg/kg.

Roundup is translocated throughout the plant. The LD<sub>50</sub> of Roundup is 7200 mg/kg and is classified as almost non-toxic. Both Roundup and paraquat are inactivated once they contact the soil surface, so reseeding operations can begin very shortly after application.

also more difficult to control with Acclaim, although this is generally true of all herbicides.

#### Few non-selectives

The list of herbicides available for non-selective weed control is a short one. Non-selective herbicides are used to control all vegetation and therefore are not normally used in a turf weed control program. These are, however, useful in a variety of situations.

Non-selective herbicides such as Roundup are used to renovate

**TABLE 2. Post-emergence broadleaf weed control herbicides used in turf.**

2,4-D	- 2,4-dichlorophenoxy acetic acid
2,4-DP	- 2-(2,4-dichlorophenoxy) propionic acid
MCPA	- 2-methyl-4-chlorophenoxy propionic acid
MCPP	- 2-(2-methyl-4-chlorophenoxy) peopionic acid
dicamba	- 3,6-dichloro-o-anisic acid
triclopyr	- 3,5,6-trichloro-2-pyridinyloxy acetic acid
clopyralid	- 3,6-dichloro-2-pyridine carboxylic acid

Some commonly used broadleaf herbicide mixtures and the ratio of each product in the mix:

#### 2,4-D + MCPP

2 plus 2 (1/1) Fermenta  
Lescopar (1/2) Lesco  
2,4-D-MCPP (2/1) Cleary's

#### 2,4-D + dicamba

Phenaban 801 (8/1) Gordons  
Eight-one selective herbicide (8/1) Lesco  
Riverdale 81 selective weed killer (8/1) Riverdale  
Riverdale 101 weed killer (10/1) Riverdale

#### 2,4-D + MCPP + dicamba

Three way selective herbicide (1/0.5/0.009) Lesco  
Trimec (1/0.5/0.1) Gordons  
Trimec Bentgrass Formula (0.3/1/0.13) Gordons  
Trexan (1.0/0.53/0.13) (Sierra)  
Trexam Bent (0.3/1.0/0.13) (Sierra)

#### 2,4-D + 2,4-DP

Chipco Weedone DPC ester (1/1) Rhone-Poulenc  
Chipco Weedone DPC Amine (1/1) Rhone-Poulenc  
Turf D + DP (1/1) [ester] Riverdale

#### 2,4-D + 2,4-DP + MCPP

Weedestroy Triamine (1/1/1) Riverdale  
Weedestroy Triester (80.7/1.0/0.7) Riverdale

#### MCPA + MCPP + 2,4-DP

Weedestroy Triamine II (1/1/1) Riverdale

#### MCPA + MCPP + dicamba

Trimec Encore (1.0/0.46/0.1) [amine] Gordons

#### 2,4-D = 2,4-DP = dicamba

Super Trimec (1.0/1.0/0.25) [ester] Gordons

#### 2,4-D = triclopyr

Turfion D (2/1) [ester] Dow  
Turfion II (2.6/1) [amine] Dow

#### triclopyr + clopyralid

Confront (3/1) [amine] Dow

#### Broadleaf options

The list of currently available post-emergence broadleaf herbicide combinations has not changed appreciably from last year. In post-emergence broadleaf weed control, manufacturers tend to sell mixtures of two to three herbicides. Thus, when you are applying an herbicide for post-emergence broadleaf weed control, you are usually using at least two different herbicide products.

The only single herbicide product currently sold is MCPP, which has excellent safety on bentgrass and for that reason is used by many golf courses

**TABLE 3. Post-emergence grass and sedge control herbicides.**

Common Name	Trade Name	Manufacturer
MSMA	Daconate 6	Fermenta
	Drexar 530	Drexel
	MSMA 6.6	Drexel
DSMA	DSMA Liquid	Riverdale
	DSMA Liquid	Drexel
	Methar 30	W. A. Cleary
AMA	Broadside, DSMA 81%	Vertac
	Super Methar	W. A. Cleary
fenoxaprop	Acclaim	Hoechst-Roussel
bentazon (sedges only)	Basagran	BASF

**Esters and amines**

Ester and amine control products have different herbicidal properties which are important to know. Amines are soluble in water; esters are oil-soluble. Esters are generally better herbicides than the corresponding amine product. Esters tend to penetrate into the leaf more effectively than do amines.

The reason that esters are not used exclusively is that they are slightly volatile. This volatility can result in non-target injury to susceptible plants in the landscape. Amines, on the other hand, are non-volatile but not as good as herbicides as the esters.

Thus, you use an amine to avoid the risk of injury that comes when you use an ester. Amines should always be used in the spring when plant material is breaking dormancy, actively growing, and very susceptible to these broadleaf herbicides. Esters can and should be used in the summer when weeds are starting to harden off and are less susceptible to the herbicide, and in the fall when non-target plants are hardening off for the winter and are much less susceptible to injury from volatile broadleaf herbicides.

**Effectiveness principles**

The factors affecting post-emergence weed control are:

- spray deposition;
- absorption;
- translocation.

Spray deposition and retention are very important factors in getting good post-emergence weed control. Several factors are important in deter-

mining spray intention, including spray volume, surface tension of the spray solution, the angle of the leaf and the composition of the cuticle.

Higher sprayer volumes tend to generate larger spray droplets which often may not be retained on leaves. Low spray volumes produce smaller droplets which are more readily retained by plant leaves. However, production of smaller droplets increases the likelihood of the spray drifting onto non-target plants.

Spray solutions with high surface tensions, such as water, may bounce off the leaf surface at impact. Spray solutions that have very low surface tensions may run off the leaf surface and result in little spray retention. Thus, an intermediate surface tension is desirable.

**Leaf movement**

Nyctinasty is the folding movement of leaves with decreasing light intensity and unfolding with increasing light intensity. Nyctinasty could result in decreased weed control from early morning or late evening applications due to a decrease in spray retention by weed species showing this kind of leaf movement.

Another factor which affects spray retention is the composition of the cuticle. The cuticle refers to a layer of wax, cutin and pectin deposited on the leaf surface. The more lipophilic

**TABLE 4. Difficult to Control Broadleaf Weeds**

Weed Problem	Herbicide	Comments
Wild violets (viola spp.)	Turflon	Very difficult to control; usually requires follow-up application 1 to 4 weeks after first application.
	Turflon D	
	Turflon II	
	Weedone DPC Super Trimec	
Creeping speedwell (veronica filliformis)	Dacthal 75 WP	Dacthal is an effective control, as are other products listed. There are 12 other speedwell species and difficulty of control varies. These are beginning to become serious turf weed pests.
	Dacthal 6F	
	Turflon D	
	Super Trimec Weedone DPC	
Ground ivy (Glechoma hederacea)	Turflon D	Very difficult to control in summer.
	Super Trimec	
	Weedone DPC	
Spurge (supina)	Same as above plus Dacthal, PreM, Team	Can control with spring Euphorbia applications of preemergence herbicides.
Oxalis (stricta)	Same as above except Dacthal	Can control with spring Oxalis applications of preemergence herbicides.
Prostrate knotweed (Polygonum aviculare)	Same as ground ivy	Difficult to control in summer.

(i.e. waxier) the leaf surface, the more difficult it is to retain water droplets.

**Caution with surfactants**

Some applicators always add a wetting agent to a herbicide to improve performance. However, this practice is not advised since unexpected results often occur. For starters, most herbicide manufacturers have some kind of wetting agent in their formulation and you don't need to add one.

The label will tell you under what conditions to add a surfactant. For instance, the Acclaim label suggests adding a wetting agent when the crabgrass is under drought stress. Based on the above discussion, one can see that always adding a wetting agent to Acclaim could result in unacceptable injury to the turf by increasing the absorption of the herbicide to phytotoxic levels under non-drought conditions. Thus, always follow label recommendations. **LM**

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