USING PRE-EMERGENCE HERBICIDES...

All of the 14 pre-emergence herbicides reviewed by the author are effective against annual bluegrass. Choosing the correct one requires a knowledge of the turfgrass and weed species on the site.

... ON WARM-SEASON TURFGRASSES

What do you get when you cross pre-emergence herbicides with proper maintenance practices? Beautiful, weed-free turfgrass, that's what.

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

The effectiveness of pre-emergence herbicides is directly related to cultural practices and insect and disease control programs that promote a dense, vigorous turfgrass cover. Properly maintained warm-season turfgrasses are extremely competitive with weeds.

Prior to using a pre-emergence herbicide, cultural practices such as fertilization, irrigation, cultivation, and clipping height and frequency should be reviewed and matched to the needs of the particular turfgrass species. Insect and disease problems should also be controlled.

Unbeatable combo

When used in combination with approved cultural practices and insect and disease control programs, pre-emergence herbicides will control susceptible weeds for two to four months after application.

Post-emergence herbicides may also be needed on some sites to control problem weeds, such as dandelion, nutsedges and dallisgrass, that are not controlled by pre-emergence herbicides.

The importance of meeting the cultural needs of the turfgrass and controlling insects and diseases cannot be over-emphasized. Herbicides supplement the level of weed control

Common chickweed and henbit are easily controlled with benefin, benefin + oryzalin, oryzalin and pendimethalin. See table 4.

Goosegrass is susceptible to spring-applied, pre-emergence herbicides.

that is obtained from the inherent competitive ability of a properly maintained warm-season turfgrass. Avoid a strict reliance on herbicides without regard for other management practices in the overall weed control program. This will not result in a high quality, aesthetically appealing warm-season turfgrass.

Important tools

Pre-emergence herbicides form the foundation of a chemical weed control program. They are primarily used for the control of crabgrass species, goosegrass and winter annual weeds.

Post-emergence herbicides control these weeds, but usually more than one application is required and often the turfgrass is injured for a short period of time after application.

In the past years there were only four to five pre-emergence herbicides available for warm-season turfgrasses. However, there are now 18 herbicides or herbicide combinations registered for pre-emergence use on warm-season turfgrasses (Table 1).

Isoxaben (Gallery) is the newest registration. It was labeled in 1989 for pre-emergence weed control in both cool-season and warm-season turfgrasses. Isoxaben effectively controls a wide range of summer and winter annual broadleaf weeds, but is not effective for the control of crabgrasses and goosegrass. Additionally, dithiopyr (Dimension) and prodiamine (Barricade) are in the final stages of the registration process and may be available for use in 1990.

Factors to consider

It is extremely difficult to name one pre-emergence herbicide that would be "best" for all turfgrass weed control situations. Several factors must be considered before selecting a pre-emergence herbicide. Selection should be based on turfgrass tolerance and the weed species compostion of the site. Herbicide selection based solely on cost may result in possible turfgrass injury and/or the additional expense of a follow-up post-emergence herbicide application.

There are significant differences in the tolerance of warm-season turfgrasses to pre-emergence herbicides (Table 2). For example, zoysiagrass and bermudagrass have excellent tolerance to atrazine when dormant, but may be discolored or injured if applications are made during the summer months. In contrast, centipedegrass and St. Augustinegrass have excellent tolerance to atrazine at all times of the year, with the possible exception of

TABLE 1.

COMMON AND TRADE NAMES OF WARM-SEASON TURFGRASS PREEMERGENCE HERBICIDES.

Common Name	Company	Trade Name and Formulation[1]
atrazine	Royalgard	Purge 4 lbs./gal.
	Ciba-Geigy	Aatrex 4L, 90DG, 80W
benefin	Elanco	Balan 2.5G, 85DF
	Lesco	2.5 Benefin Granular (2.5G)
benefin + oryzalin	Elanco	XL 2G
benefin + trifluralin		ElancoTeam 2G
bensulide	ICI	Betasan 2.9E, 4E, 3.6G, 7G, 12.5G
	Royalgard	Roysan 4E, 12.5G
	PBI/Gordon	Betamec 4LF
	Lesco	Lescosan 4E, 7G
bensulide + oxadiazon		ScottsGoosegrass/Crabgrass Control 6.5G
DCPA	Fermenta	Dacthal 75W
dithiopyr[2]	Monsanto	Dimension 1EC
ethofumesate	Nor-Am	Prograss 1.5EC
fenarimol	Elanco	Rubigan 1AS
isoxaben	Elanco	Gallery 75DF
napropamide	Lesco	Devrinol 5-G Ornamental
	ICI	Devrinol 50WP, 5G
oryzalin	Elanco	Surflan 4AS
oxadiazon	Rhone-Poulenc	Ronstar 2G, 50W
pendimethalin	Lesco	PRE-M 60DG
	Scotts	Southern Weedgrass Control 2.45G
		Turf Weedgrass Control 1.71G
		Weedgrass Control 60DG
prodiamine[2]	Sandoz	Barricade
pronamide	Rohm-Haas	Kerb 50W
simazine	Ciba-Geigy	Princep 80W, 4L, 90DG, 4G

[1]Numeral refers to percent or pounds of active ingredient.
[2]Registration pending Environmental Protection Agency approval.

TABLE 2.

WARM-SEASON TURFGRASS TOLERANCE TO REGISTERED PREEMERGENCE HERBICIDES.

	Turfgrasses				
Herbicide	Bahia-grass	Bermuda-grass	Centipede-grass	St. Augustine-grass	Zoysiagrass
atrazine[1]	NR	T(D)	T	T	T(D)
benefin	T	T	T	T	T
benefin + oryzalin	T	T	T	T	T
benefin + trifluralin	T	T	T	T	T
bensulide	T	T	T	T	T
bensulide + oxadiazon	NR	T	NR	NR	T
DCPA	T	T	T	T	T
ethofumesate[2]	NR	T(D)	NR	NR	NR
fenarimol	—	T	—	—	—
isoxaben	T	T	T	T	T
napropamide	T	T	T	T	NR
oryzalin	T	T	T	T	T
oxadiazon	NR	T	NR	T	T
pendimethalin	T	T	T	T	T
pronamide	NR	T	NR	NR	NR
simazine	NR	T	T	T	T

[1]When dormant, bermudagrass and zoysiagrass have good tolerance to atrazine.
[2]Ethofumesate is labeled for use on dormant bermudagrass that is overseeded with perennial ryegrass.
T = Tolerant at labeled rates; NR = Not registered for use on this turfgrass.

spring green-up.

Centipedegrass has not exhibited acceptable tolerance to the wettable powder formulation of oxadiazon (Ronstar 60W) in experiments conducted by the University of Georgia. Without a doubt, the herbicide label is the best reference to determine if a pre-emergence herbicide may be used on a particular warm-season turfgrass.

Pre-emergence herbicides should be used only on established warm-season turfgrasses. Newly-seeded and sprigged turfgrasses have a low level of tolerance and can be severely injured by most pre-emergence herbicides. Therefore, pre-emergence herbicide applications should be delayed until complete soil coverage has been achieved.

Post-alternative

An alternative to using pre-emergence herbicides during the "grow-in" of a warm-season turfgrass is to use post-emergence herbicides. Naturally there are exceptions, but many can be used during warm-season turfgrass establishment.

Pre-emergence herbicides persist in the soil for two to four months. The soil persistence characteristics of the these herbicides are advantageous in controlling weeds. However, establishment problems can occur if seeding, sprigging or sodding operations are planned for a particular site. Always consult the herbicide label to determine the length of time required before renovation operations can be safely conducted.

Timing applications

Pre-emergence herbicides are applied to the turfgrass site prior to weed seed germination. This group of herbicides controls susceptible weeds during the weed seed germination process. Pre-emergence herbicides do not affect the viability of dormant weed seeds.

Pre-emergence herbicides are applied in the spring for crabgrass and goosegrass control and in the fall months for winter annual weed control. Since most pre-emergence herbicides are not effective on emerged weeds, applications must be made prior to weed emergence.

Late February to early March applications generally provide better crabgrass control than later applications. However, in the cooler, mountainous regions of the South, the spring application may be delayed until late March or early April. For winter annual weed control, late August to early October applications are used depending upon the geographical location.

Cultural practices

Pre-emergence herbicides require rainfall or irrigation water to move them into the zone of maximum weed seed germination (e.g. the upper one to two inches of the soil profile). Recommendations vary slightly among the different pre-emergence herbicides, but unless one-fourth to one-half inch of rainfall occurs within seven days, the herbicide should be irrigated into the top two inches of the soil profile.

Spring scalping and subsequent mowings of warm-season turfgrasses should be delayed until after either rainfall or irrigation has removed the pre-emergence herbicide from the turfgrass foliage. Unless the herbicide has been washed from the foliage, mowing can remove significant quantities of the herbicide from the site.

Reducing thatch

A thick thatch layer has been shown to decrease the persistence of pre-emergence herbicides. Eliminating heavy thatch by cultivation (core aeration, verticutting, topdressing) increases herbicide contact with the soil and helps to prevent the accelerated breakdown of the herbicide in the thatch layer.

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TABLE 3.
SUMMER ANNUAL GRASS CONTROL RATINGS FOR PREEMERGENCE HERBICIDES.

Herbicides	Crabgrass spp.	Goosegrass
atrazine	P	P
benefin	E	F
benefin + oryzalin	E	F-G
benefin + trifluralin	E	F
bensulite	E	P
bensulide + oxadiazon	E	G
DCPA	E	F
napropamide	E	G
oryzalin	E	F-G
oxadiazon	G	E
pendimethalin	E	F-G
pronamide	F	P
simazine	F	P

E = Excellent, ≥ 90% control. F = Fair, 70 to 79% control.
G = Good, 80 to 89% control. P = Poor, < 70% control.

TABLE 4.
WINTER ANNUAL WEED CONTROL RATINGS FOR PREEMERGENCE HERBICIDES.

Herbicide	Annual Bluegrass	Common Chickweed	Henbit	Parsley-Piert	Lawn Burweed	Corn Speedwell
atrazine	E	E	E	E	E	E
benefin	E	G	G	P	P	E
benefin + oryzalin	E	L	L	—	—	—
benefit + trifluralin	L	—	—	—	—	—
bensulide	F	P	P	E	P	P
DCPA	G	G	F	P	P	G
ethofumesate	G-E	L	—	—	—	—
fenarimol	G	—	—	—	—	—
napropamide	G	E	P	P	E	E
oryzalin	G	G	G	—	—	—
oxadiazon	G	P	P	G	P	G
pendimethalin	G	G	G	—	—	E
pronamide	E	E	P	P	P	E
simazine	E	E	E	G	E	E

E = Excellent, ≥ 90% control. F = Fair, 70 to 79% control.
G = Good, 80 to 89% control. P = Poor, < 70% control.
L = Weed species is listed on the herbicide label, but has not been evaluated by The University of Georgia.
— = Weed response is not known.
Source: Dr. Murphy

Cultivation has not been generally practiced or recommended after a pre-emergence herbicide application. Cultivation was believed to physically disrupt the herbicide barrier in the soil and stimulate weed emergence. Recent studies conducted in Georgia have shown that core aeration at various time intervals after a pre-emergence herbicide application did not stimulate large crabgrass and goosegrass emergence in bermudagrass. Data are not available for other weed species but it appears that core aeration does not influence the level of weed control that is normally achieved with a pre-emergence herbicide.

Summer control

Crabgrass (large, smooth, Southern) and goosegrass are commonly found in Southern turfgrasses. With the exception of atrazine, simazine and pronamide (Kerb), spring applications of pre-emergence herbicides will provide good to excellent control of crabgrasses (Table 3).

Goosegrass tends to germinate later in the spring than crabgrass and is more difficult to control. Single applications of oxadiazon (Ronstar) and bensulide + oxadiazon (goosegrass/crabgrass control) have provided high levels of goosegrass control in experiments conducted in Georgia.

Split applications, each at an interval of 8 to 10 weeks, of benefin + oryzalin (XL), benefin + trifluralin (Team), oryzalin (Surflan), pendimethalin (various trade names) and napropamide (Devrinol) will also give acceptable control of goosegrass.

Winter control

Similar to summer annual weeds, pre-emergence herbicides vary in their effectiveness on winter annual weeds. Bensulide has not generally provided the high level of annual bluegrass control that has been achieved with other pre-emergence herbicides (Table 4).

Common chickweed and henbit are easily controlled with benefin, benefin + oryzalin, oryzalin and pendimethalin. Additionally, DCPA (Dacthal), napropamide, ethofumesate (Prograss) and pronamide will control common chickweed.

Herbicides that have effectively controlled parsley-piert are bensulide and oxadiazon. Napropamide is effective for lawn burweed (spurweed) control. Good to excellent corn speedwell control has been obtained with benefin, DCPA, napropamide, oxadiazon, pendimethalin and pronamide.

Atrazine and simazine effectively control all the winter annual weeds shown in Table 4, either as a pre-emergence or post-emergence application.

Overseeded turfgrasses

On bermudagrass that is overseeded in the fall with perennial ryegrass, fenarimol (Rubigan) and ethofumesate may be used for pre-emergence control of annual bluegrass.

Ethofumesate should only be applied to bermudagrass that is completely dormant, since it can delay the spring green-up of bermudagrass when applications are made to bermudagrass that is not totally dormant. Spring applications of oryzalin, benefin + oryzalin and pendimethalin have been shown to decrease the stand of fall overseeded ryegrass.

These herbicides should not be applied to fall overseeded warm-season turfgrasses unless the goal is to hasten the spring transition by eliminating the perennial ryegrass.

Numerous pre-emergence herbicides are available to control summer and winter annual weeds in warm-season turfgrasses. Choosing the appropriate herbicide requires a knowledge of the tolerance of the various warm-season turfgrass species to the different pre-emergence herbicides and familiarity with the weed species found on a particular site.

Additionally, future renovation plans for the site must be known before a pre-emergence herbicide is used. Attention to the cultural needs of the specific warm-season turfgrass species and the timely use of both pre-emergence and post-emergence herbicides will enable the turfgrass manager to achieve the goal of growing a high quality, weed-free, attractive warm-season turfgrass. **LM**

...ON COOL-SEASON TURFGRASSES

Identification, proper cultural practices and efficient herbicide applications are essential in order to control unwanted plants.

by Tom Fermanian, Ph.D., University of Illinois

Oh the lowly crabgrass plant: there's never enough of it in an area to make a decent turf, but it is the one grass that can be found just about everywhere.

Crabgrass and other annual grass species often represent a major headache to turf managers in cool, humid regions. This group of species, once germinated, seems to out-compete desirable turfgrasses.

Annual grasses generally become a persistent problem only in sparse turfs with open enough cover to allow young seedlings to germinate and grow. The best management of annual grasses is the proper management of desired turf species. Using cultural practices to promote healthy, dense turf minimizes the need for active annual grass controls.

Annual grass control

The first step to select an appropriate control strategy for any weed is identifying the weed. Once the troublesome pests have been identified as an annual grass, a corrective strategy can be developed.

The primary causes of open, sparse turf are a limiting nutrient(s) (generally nitrogen) or injury due to stress or pest invasion. Therefore, the first strategy in annual grass management is to increase density by proper fertilization.

Other soil properties, such as pH level, soil compaction, and salt and moisture levels, should also be checked. Soil pH can be corrected by adding sulphur or lime; soil compaction may be alleviated with aeration; and soil moisture can be controlled with proper irrigation and/or drainage.

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Figure 1.

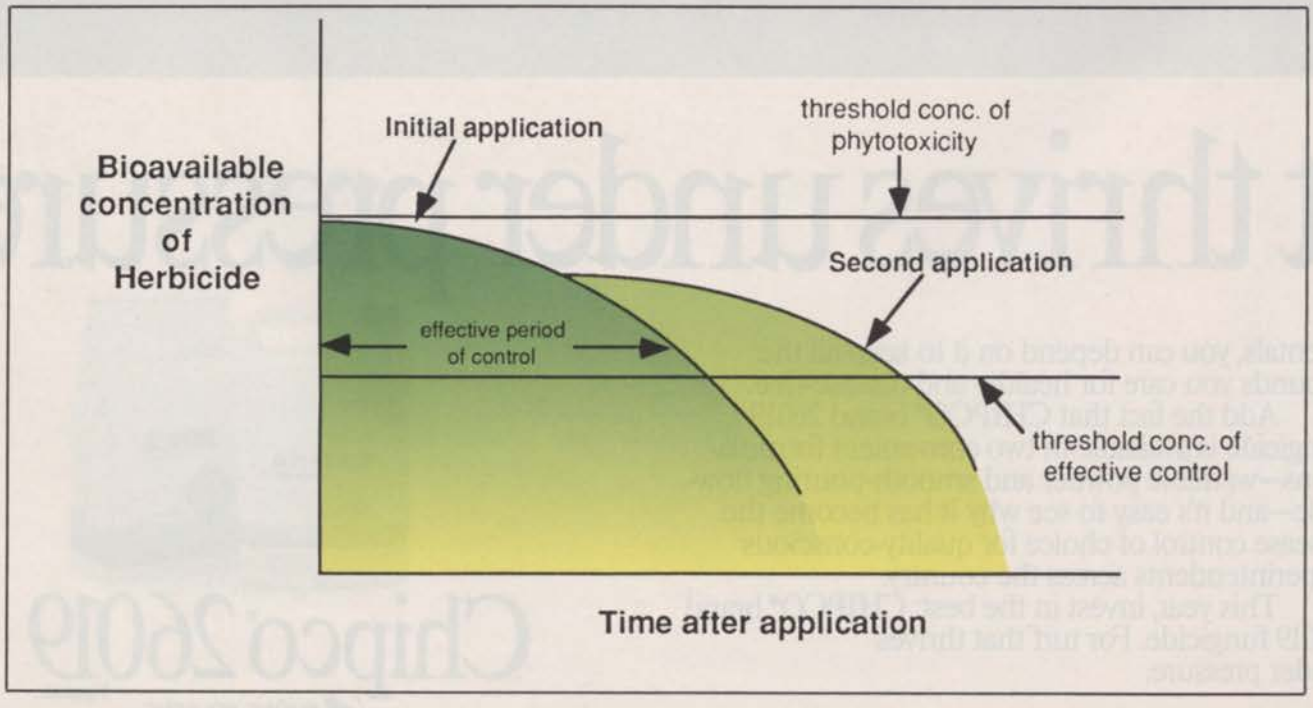


TABLE 1

HERBICIDES FOR CONTROLLING ANNUAL GRASSY WEEDS IN TURF

Always follow the label directions for application rates and proper timing. For extended preemergent control of annual grass weeds, apply a second application 6 weeks after the initial application at ½ the original rate.

Herbicide	Company	Trade Names & Formulations	Weeds controlled: Annual bluegrass	Weeds controlled: Crabgrass, foxtails, barnyard-grass	Weeds controlled: Goosegrass
benefin	Elanco	Balan 2.5G, 85DG	1s	es	..
	Lesco	2.5 Benefin Granular (2.5G)			
bensulide + oxadiazon	Scotts	Goosegrass/Crabgrass Control	1s	es	..
benefin + trifluralin	Elanco	Team 2G	1s	es	..
bensulide	ICI	Betasan 2.9E, 4E, 3.6G, 7G, 12.5G	1s	es	..
	Royalgard	Roysan 4E, 12.5G			
	PBI/Gordon	Betamec 4LF			
	Lesco	Lescosan 4E, 7G			
DCPA	Fermenta	Dacthal 75W	1s	es	es,ej
ethofumesate	Nor-Am	Prograss 1.5 EC	es,1s	..	..
oxadiazon	Rhone-Poulenc	Ronstar 2G, 50WP	1s	es	es
pendimethalin	Scotts	Turfgrass Weed Control 1.71G	1s	es	..
		Weedgrass Control 60DG			
	Lesco	Pre-M 60DG			
siduron	DuPont	Tupersan 50WP		es	..

es—Apply in early spring before weed emergence. 1s—Late Season

Source: Dr. Fermanian

Repairing pest damage as quickly as possible is also necessary to limit annual grass invasion. While these operations will add to your managemant budget, they certainly will help to minimize future pesticide use. While herbicides will still be required, they will be needed less frequently.

Pre-emergence herbicides

With even the best cultural management, annual grasses sometimes present an aesthetic problem.

The seeds of many annual grass species can be viable for many years in the soil. Any herbicide strategy, therefore, must focus on controlling germinating seeds. Pre-emergence herbicides on the market today generally fit this requirement.

(Table 1 lists currently labelled herbicides targeted for annual grass control in cool-season turfs, along with their manufacturing company, trade name and formulations).

Turf managers have a wide range of herbicides available for pre-emergence control of annual grasses. This allows the manager to select a herbicide appropriate for price, longevity and selected turfgrass species. Benefin + trifluralin, bensulide, dacthal, pendimethalin and oxadiazanon are the primary pre-emergence herbicides labelled for use on cool-season turfs.

Determining concentration

All of the herbicides listed are used in a similar manner. An application of the material is made to the targeted turf prior to the generation of the expected annual grass.

The herbicide must develop a chemical barrier within the upper level of the soil. The germinating seedling will then intercept the pesticide and absorb it through the growing shoot and/or root.

For effective control, the concentration of herbicide must be high enough to stop the growth of the intended weed. This minimum concentration is called the threshold of effective control.

If concentrates are too high, they might possibly cause injury to the desirable turf (called the threshold of phytotoxicity). Labelled rates have been developed to provide the maximum concentration that is still safe to use on the listed turf species and therefore provide the longest period of control.

Soil degradation

All pre-emergence herbicides are subject to degradation in the soil, which reduces the concentration of active ingredient available for weed control.

Materials are added to the soil in a concentration that is higher than the threshold of effective control but lower than the threshold of phytotoxicity.

After application, the concentration in the soil slowly dissipates until the level is no longer above the threshold of effective control. At this time, for extended control, a second

TABLE 2

PRE-EMERGENCE CONTROL FOR SELECTED BROADLEAF WEEDS

Apply these herbicides prior to weed seed germination. Read and follow label directions for appropriate turfgrass species, timing, and application rates. The following pre-emergence herbicides are commonly used to control annual grasses in turf. They have also been shown to have some control activity on the broadleaf weeds listed.

Herbicide	Weeds Controlled
DCPA (Dacthal)	spotted and prostrate spurge
pendimethalin (LESCO pre-M, Scotts Turf Weedgrass Control)	prostrate spurge, yellow wood sorrel, knotweed, chickweed, henbit
oxadiazon (Ronstar)	yellow woodsorrel

Source: Dr. Fermanian

application is necessary. For extended control in hot, moist seasons, it is useful to apply a second application of herbicide six to eight weeks after the initial application.

Since some herbicide remains in the soil, the second application can be made at a lower rate which will then boost the total concentration above the threshold for effective control.

This dual application is quite necessary for short residual oversight, such as benefin. Additionally, it allows applications to be made at lower rates, which minimizes the risk of exceeding the threshold of phytotoxicity (see Figure 1). It will help provide equally effective periods of control for all herbicides.

A varied arsenal

The major herbicides used to control crabgrass species and other warm-season annual grasses such as foxtail, barnyardgrass, and others are: benefin, benefin + trifluralin, bensulide, dacthal, pendimethalin and oxadiazon. Siduron is used for controlling crabgrass and other annual grasses during the period of seeding and early turf establishment. Siduron is the only preemergence herbicide that is safe to use in seedling cool-season turfs.

Goosegrass is much tougher to control in cool season turfs and requires higher rates for materials such as dacthal and benefin. Excellent goosegrass control can be obtained with oxadiazon with the same rates used to control crabgrass. As always, the label should be consulted for final instructions on the applications of these materials.

An important consideration in the effectiveness of pre-emergence herbicides is the absorption of the materials to clay particles in the soil. A higher clay content will mean greater absorption, leaving less herbicide available for absorption into emerging plants.

Herbicide labels often instruct the user to apply more material in heavy clay soils to compensate for this process. In lighter, sandy soils, it is necessary to reduce the rate of application to minimize the potential for injury to turf.

Second applications, often at reduced rates, are sometimes necessary to provide season-long weed control.

Secondary benefits

Providing control of annual grasses is the primary use of pre-emergence herbicides. A second benefit is the control of annual broadleaf species. This minimizes the need for post-emergence control of broadleaf annual weeds.

(Table 2 shows the annual broadleaf weeds often controlled with pre-emergence annual grass herbicides).

Spotted and prostrate spurge are often difficult to control once well established, but can be controlled with a pre-emergence application of DCPA or pendimethalin.

The annual broadleaf weed yellow wood sorrel or oxalis is also tough to control. Oxadiazon or pendimethalin can help to minimize or eliminate the germination and development of this troublesome weed.

These are just two examples of annual broadleaf control achieved through the use of an annual grass pre-emergence herbicide. The mechanism for control is similar to that for grasses. However, the timing can be considerably different. It is important to apply the materials prior to the earliest germinating species, grass or broadleaf, and, if necessary, insure thorough season-long control with secondary applications.

Annual/perennial control

Gallery (DowElanco) is a herbicide for controlling a larger group of annual and perennial broadleaf weeds. Gallery can be effective in controlling most broadleaf weeds if applied prior to their germination. Consult the Gallery label for the weeds controlled and the optimum application rate.

Appropriate cultural controls and accurate application of pre-emergence herbicides will minimize annual weeds, minimize herbicide requirements and provide an attractive, weed-free turf. **LM**

Dr. Thomas Walter Fermanian is associate professor of turfgrass science at the University of Illinois department of horticulture. He is currently researching qualitative data analysis for agriculture, crop modelling and simulation, and the development of cost effective turfgrass management systems.

EARLY-SEASON FERTILIZATION

Applying the right fertilizer at the right rate and at the right time is an important step toward growing high quality turf.

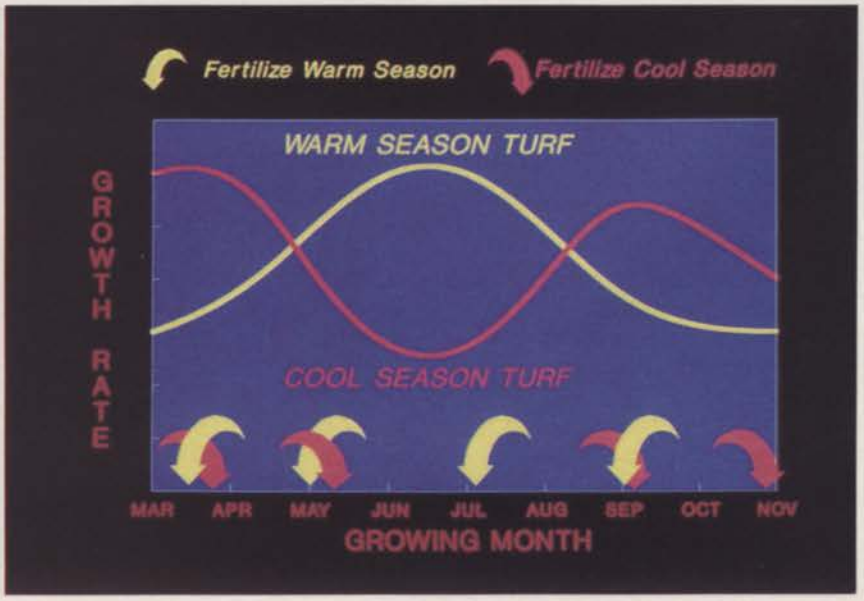
by Roch E. Gaussoin, Ph.D., Kansas State University

To get a high quality turfgrass stand, you need to conscientiously and judiciously implement a number of management factors. Fertilization, one cultural practice, involves several considerations. If it is properly addressed, it can help you maintain quality turfgrass.

Correct choice of fertilizer carrier, laboratory soil analysis to determine fertility needs, and equipment calibration—all need to be completed before the growing season as they are vital to success.

Fertilizer that is poorly applied can result in lost revenue from call-backs or turf loss. Therefore, application equipment should be calibrated regularly.

FIGURE 1.



Nutritional needs

Nutrients required for turfgrass plant growth are divided into two general categories. Nitrogen, phosphorous, potassium, magnesium, sulfur and calcium, required by turfgrass in relatively large quantities, are called macronutrients. Iron, boron, manganese, copper, zinc, chlorine and molybdenum, needed in relatively small amounts, are termed micronutrients.

Supplemental application of magnesium and calcium, as well as boron, manganese, copper and chlorine is not usually necessary because these elements are in abundant supply in the growing environment. So are carbon, hydrogen and oxygen, which also are required for turfgrass growth.

The primary nutrients the turfgrass manager is concerned with are nitrogen, potassium and phosphorous. These elements are used by the growing turf in large quantities and must be replaced in the soil via fertilizers to insure healthy green growth.

In some instances sulfur, iron and zinc may also require supplemental application.

The turf manager's decision of the

product to use depends on the turf's nutritional needs. These needs are best determined by soil testing at a reputable soil testing laboratory.

Most state universities have a soil testing facility. Cost is relatively inexpensive. Commercial testing laboratories are also available. Check with your local county extension office for the availability and cost to analyze your soil samples.

Follow guidelines

Many testing laboratories will provide sample containers as well as guidelines for proper sample collection. Follow these guidelines explicitly; test results can be no better than the sample collected in the field.

A basic fertility test will include pH, available phosphorous and exchangeable potassium. Because nitrogen is very transient in the soil and a sound fertility program will include nitrogen application, nitrogen analysis is not required or recommended. The basic fertility test will, however, indicate the need for supplemental phosphorous or potassium.

In certain regions of the country, especially the western U.S., a soluble salts test is also recommended.

Nitrogen sources

A myriad of nitrogen sources are available on the market, each with characteristics that influence their adaptability to a turf care operation.

Nitrogen sources can be categorized as "slow" or "quick" release, depending on the speed of release in the carrier and its availability for plant growth.

Release of nitrogen from fertilizers is by chemical or biological means, depending on the nitrogen source. Urea, ammonium nitrate and ammonium sulfate are very water soluble and quickly dissolve after a rainfall or when irrigated. Other carriers, such as ureaformaldehyde or natural organic fertilizers, require microbial activity for nutrient release.

Conditions which favor microbial activity with these types of fertilizers, such as moist soil and warm temperatures, also hasten nitrogen availability.

The nitrogen in IBDU becomes available as the product is hydrolyzed, so release depends on soil moisture, as well as fertilizer particle size. Another important facet of nitrogen sources is the salt index, which indicates the burn potential of a particular fertilizer. The higher the index, the greater the potential for fertilizer burn.

Carriers which have a high salt index per unit of N should not be used when conditions are favorable for burn (such as high temperatures and low soil moisture). A summary of some common nitrogen sources and their characteristics is shown in Table 1.

TABLE 1.

N SOURCE CHARACTERISTICS

N-SOURCE	SALT INDEX	RESIDUAL (WEEKS)
QUICK RELEASE		
Urea	1.62	4-6
Ammonium Nitrate	3.18	4-6
Ammonium Sulfate	3.25	4-6
SLOW RELEASE		
IBDU	0.20	6-8
Methylene Urea	0.86	6-8
Ureaformaldehyde	0.20	52+
Sulfur Coated Urea	0.70	Varies
Natural Organics	0.70	Varies

TABLE 2.

MONTHLY N REQUIREMENTS FOR DIFFERENT COOL SEASON TURFGRASS SPECIES AT TWO MANAGEMENT LEVELS

	LBS N/GROWING MONTH/1000 SQ FEET Management Level	
	LOW	MED-HIGH
Chewings Fescue	0.2-0.3	0.4-0.6
Red Fescue	0.2-0.3	0.4-0.6
Italian Ryegrass	0.3-0.4	0.5-0.6
Common Ken. Bluegrass	0.3-0.4	0.5-0.6
Perennial Ryegrass	0.3-0.4	0.5-0.6
Tall Fescue	0.3-0.4	0.6-0.7
Kentucky Bluegrass	0.4-0.5	0.6-0.7
Creeping Bentgrass	0.4-0.5	0.6-0.7

Within each range higher N level should be used if clippings are removed, if soil is sandy and if turf is irrigated frequently or grown in a high rainfall area.

Application timing

Differences in geographic location, soils, climate and species will strongly influence application timing. These general recommendations for timing and rates should only be used as a guideline, making adjustments as necessary.

Application timing is strongly influenced by turfgrass species. Warm-season turfs, like bermudagrass and zoysiagrass, are fertilized at a different time of year than cool-season turfs like tall fescue and Kentucky bluegrass.

This timing difference is closely related to when these turfs are actively growing. Warm-season turfs go off-color in the fall and, depending on location, will not green-up in the spring until as late as April or May. Cool-season turfs, on the other hand, grow actively in the spring and fall, but growth is minimal in the late summer months.

Cool vs. warm

In general, fertilizer is applied to an actively growing turf. There are, however, exceptions to this guideline. Cool-season turfs should be fertilized in the late fall, after the last mowing of the season.

University research and practical experience has shown that cool-season turf fertilized in the late fall has better root growth, fewer weeds, disease and thatch, longer fall color, and earlier spring green-up than turf fertilized in the spring.

A strong disadvantage to spring fertilization is a flush of top growth at the expense of root growth prior to the

TABLE 3.

MONTHLY N REQUIREMENTS FOR DIFFERENT WARM SEASON TURFGRASS SPECIES AT TWO MANAGEMENT LEVELS

	LBS N/GROWING MONTH/1000 SQ FEET Management Level	
	LOW	MED-HIGH
Buffalograss	0.0-0.1	0.2-0.4
Bahiagrass	0.0-0.1	0.2-0.4
Centipedegrass	0.0-0.1	0.2-0.4
Carpetgrass	0.2-0.3	0.4-0.6
St. Augustinegrass	0.3-0.4	0.5-0.7
Zoysiagrass	0.3-0.4	0.5-0.7
Bermudagrass	0.4-0.5	0.5-0.7

Within each range higher N level should be used if clippings are removed. If soil is sandy and if turf is irrigated frequently or grown in a high rainfall area.

Source: Dr. Gaussoin

summer stress period. For this reason, spring fertilization of cool-season grasses is not recommended.

If a spring fertilization is applied for client or owner satisfaction, the rate should not exceed more than ½ lb. N/1000 sq.ft. (see Table 2).

Warm-season grass fertility programs should be started in the early spring, as the turf becomes active, and continue through the active growing season.

Over-stimulation of warm-season grasses in late fall should be avoided because succulent growth may be more susceptible to frost damage or winterkill (see Table 3). A general growth cycle and fertility schedule for warm- and cool-season turfs is shown in Figure 1.

Adjustments for geographic location and attention to previously discussed timing exceptions should be considered before planning application timing.

Proper rates

Application rates of nitrogen fertilizers depend on species, as well as the level of maintenance desired. Turf that is well fertilized will require more frequent mowing and irrigation, but it will be of higher quality.

Management practices will also influence fertility rate. For example, if clippings are removed, higher rates of fertilizer need to be applied to compensate for the loss of nutrients in the removed clippings. Additionally, if the turf is irrigated frequently or grown on sandy soils or in a high rainfall region, higher nitrogen levels should be used (see TABLE 2 for monthly nitrogen requirements for most turfgrass species). **LM**

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