EARLY-SEASON FERTILIZATION

Depending on desired turf quality, and amount of spring and early summer activity, many situations call for spring nitrogen fertilization.

by Anthony J. Koski, Ph.D., Colorado State University

Spring time brings daffodils, crocuses, and—hopefully—the greening of grass. Along with the wide acceptance of late-season fertilization, many turf managers seemed to have developed a fear of fertilizing in the spring.

While it is true that improper nitrogen use in the spring can bring about a host of problems, adopting a late-season fertilization philosophy generally does not allow you to eliminate spring nitrogen (N) applications.

Pink patch and red thread can become severe during the spring on N-deficient turf.

Not to excess

Stimulating shoot growth during the spring can detrimentally affect the depth and number of roots. Since this is the time of year when most of the roots for cool-season turfgrass species are being formed (Fig. 1), it is important that root formation not be discouraged.

Large applications (greater than one pound of N/1000 sq. ft.), especially of quickly-available N sources, can substantially reduce root growth of cool-season species. Excessive spring shoot growth shifts carbohydrate use from the roots to the shoots, thus reducing the number and health of new roots. The root and shoot growth patterns of warm-season grasses are different, and spring N applications are less apt to negatively affect root formation (Fig. 2).

Overuse of nitrogen during spring, resulting in high shoot growth, necessitates frequent mowing.

Diseases may increase

The incidence and severity of some diseases may be increased by overfertilization in the spring. The leafspot (Helminthosporium) diseases, patch diseases, and high- and low-temperature pythiums are favored by excessive N applications. Recovery from damage caused by these diseases is more difficult, since exhaustion of carbohydrate reserves is a consequence of N overuse.

Reduced stress tolerance: The zealous use of N in spring may reduce summer drought resistance and heat tolerance. This is partly attributable to effects on the roots, but also because of lowered carbohydrate levels and the formation of excessively hydrated leaves.

Effects on lateral growth: High N rates can diminish the number and vigor of lateral stems (stolons and rhizomes). The ability for a trafficked or divoted turf to recuperate from injury is lowered. Low carbohydrates and hydrated leaves may effect sod strength.

When spring N?

Late-season N doesn't last forever. Even when late-season N fertilization is practiced, the effects of the previous year's application will begin to "wear off" during the following spring. Just *when* the effect begins to wear off depends on a host of factors, including:

- residual activity of the N source used the previous year,
- the amount of N applied at the time,
- the species of grass,
- soil type (sand vs. clay, and leaching potential), and
- level of winter and early spring precipitation.

If a quickly-available source was used in the fall, the effect may begin to dissipate during early to late May, especially if the turf is growing on a sandy soil and winter/spring rain is high. If higher rates of slowly-available products such as IBDU or sulfur-coated urea were used, the residual activity may persist longer into the spring, perhaps into early summer. In either case, some N should be applied in the spring, either to maintain quality during the spring, or to provide an N source that would release slowly during the following summer.

The new customer

When a lawn care company retains a

new customer during the winter, it is probably unwise to depend on the client's memory of "what kind, how much and when" fertilizer was applied the previous season.

You are in the business of growing green grass, and those new customers give you their business because, in many cases, they were unhappy with the last company. A spring N application will insure that the lawn is green and growing in the spring. Don't bet on the possibility that what the other company applied last season will be enough to provide a high quality turf this spring.

Mite, winter damage

Winter-damaged turf may require supplemental spring N to promote recovery, even if late-season applications were made. Where foliage has been killed by desiccation or snow mold (but crowns and roots are still living), fertilization may hasten recuperation. Of course, nitrogen will not resuscitate dead turf, so make sure it is still alive before fertilizing.

In some areas of the country, various species of mites cause turf damage. Quite often the turf is dead by the time the cause has been determined, but in some cases only the foliage has been damaged and a bit of nitrogen can hasten recovery and promote growth that will outpace the injury being caused by the mites. Remind clients that fertilizer applications cannot be expected to "kick in" unless sufficient precipitation occurs, or irrigation is provided, following fertilization.

Athletic applications

Football fields are often used for practice or games late in the fall, long after temperatures have cooled to the point that recuperation is possible. These same fields are often used early the following year for spring games and drills, resulting in even greater damage.

On these fields, spring fertilization is necessary to promote growth and recovery of the damaged turf. Similiarly, spring baseball can be devastating to slow-growing fields, espcially if the same field is used for both practice and games.

Other high-use athletic areas, such as soccer fields and multi-use fields in city parks, can also benefit from springtime fertilization. On such heavy-use fields it is not unusual to fertiilize with as much as 8 to 10 lbs. N/1000 sq. ft. over the course of a growing season.

Averting diseases

Certain disease problems can be averted, or at least be decreased in severity, by wise spring N applications. Turf damaged by snow mold may recover more quickly with spring fertilization, especially if little or no N had been applied the previous fall.

Red thread and pink patch can be especially severe during a cool, moist spring on N-deficient turf. The severity of zoysia patch disease, most common on intensively-managed zoysia in the transition zone, may be reduced by spring and summer nitrogen applications.

Amount and frequency

The goal of any spring fertilization program should be to promote greenup and a pre-determined growth level, without producing a fast-growing, succulent turfgrass plant. This can be difficult for a number of reasons, the main one being that shoot growth is naturally rapid at this time of year. A complicating factor is the unpredictability of spring weather, most importantly temperature and precipitation. Since release of N from all fertilizer sources more or less depends on moisture, with some also being quite temperature dependent, the choice of a fertilizer (and determination of how much to apply) for spring use can be difficult.

Ideally, one would use a quickly-available fertilizer to apply small amounts of N (1/8 to 1/4 lb./1000 sq. ft.) on a frequent basis, perhaps every 7 to 14 days. The amount and frequency could be varied, depending on turf response. Quickly-available nitrogen sources can always be counted on to provide a predictable response, but unless they can be applied at lower rates and more frequently than the slowly-available fertilizers, their use might result in an undesirable rate of shoot growth.

With the exception of some golf course superintendents and a few sports turf managers, there are a few situations where this type of program can be practically implemented. This "spoon-feeding" approach can be approximated, however, via the use of slowly-available nitrogen fertilizers.

This generally works well, but remember: you are depending on Mother Nature to provide conditions conducive to release of N for the turfgrass plant.

Slowly-available nitrogen sources that do not work well (or predictably) during early spring would be ideal for late spring or summer use, since you can count on warmer and moister conditions to prevail at those times. Some natural organic fertilizers and those with a high percentage of their N as longer-chain ureaformaldehyde polymers (Nitroform) must be applied at relatively high rates (1.5 to 2 lbs. N/100 sq. ft.) in order to elicit a noticeable short term response from the turf, even under conditions favoring the release of their nitrogen.

If you are able to make light, frequent spring N applications, using a quickly-available N source (urea, ammonium sulfate) would be ideal. If you are locked into making one or two applications during the spring, consider using a 1/2 or 3/4 rate of a quickly-available source early, and a more slowly-available N source (1 lb. N or

FIGURE 1

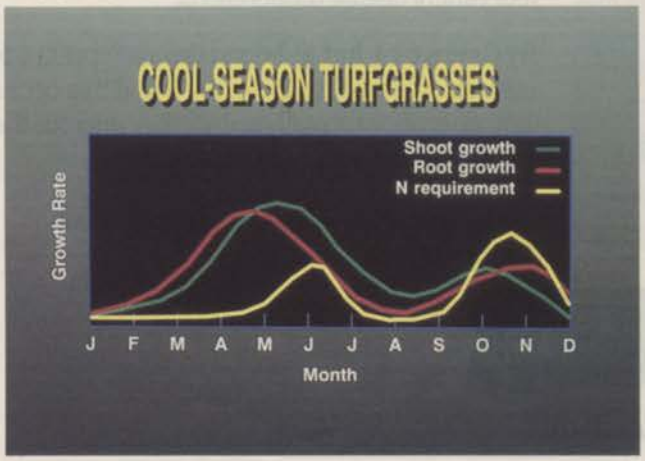
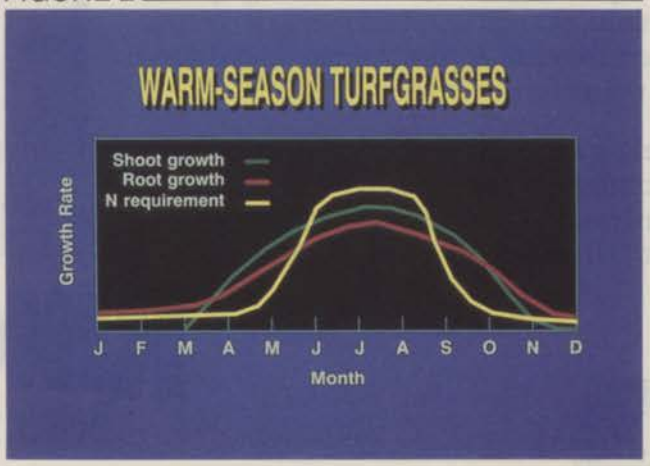


FIGURE 2



Slow and quick release fertilizers

Quickly-available sources: These are water-soluble and not dependent on temperature to release their nitrogen.

Some, such as potassium nitrate, contain N in the form of nitrate (NO_3). Others, such as urea, ammonium sulfate, mono- and diammonium phosphate, have nitrogen in the form of ammonium (NH_4).

Ammonium nitrate contains both forms of nitrogen. Urea is an important N source, since it forms the basis for nearly all of the slowly-available nitrogen fertilzers, with the exception of the natural organic fertilizers.

The quickly-available nitrogen sources are ideal for "spoon feeding" and for use under cold conditions, when many many slowly-available sources do not perform adequately. They are relatively inexpensive, but may result in higher labor costs if they are applied frequently. The potential for "burn" is also greater with the quickly-available sources, mainly due to their higher salt indexes.

Slowly-available sources: It is more difficult to keep up with the types of fertilizers in this category, since changing technologies continue to result in new fertilizers. Within this category are *slow-release (or controlled release) fertilizers* that encapsulate a quickly-available fertilizer (usually urea) with a sulfur or plastic coating that degrades over time, slowly releasing the enclosed nitrogen source. Examples include the sulfur-coated and resin-coated fertilizers. These types of fertilizers generally contain enough free urea, or other soluble N source, to provide adequate short-term response, while providing the benefits of long-term, slow-release fertilization. Sulfur-coated urea has a history of performing well in lawn care and many golf course applications.

A new product from Grace-Sierra, with the trade name Once, can be applied once during the year to provide season-long feeding. In two years of testing at Colorado State University this resin-coated product has performed very well. These coated products require adequate soil moisutre to aid in breakdown of the coating, as well as to allow for solubilization of the enclosed N source and its subsequent movement into the root-zone. They will not perform well under dry conditions. On heavily-trafficked turf (especially if compacted and with little thatch), the coated products are subject to mechanical breakage, thus negating the slow-release characteristics of the fertilizer. On very close-cut turfs, such as tees or putting greens, the particles may be damaged (or picked up) during mowing.

Slowly-soluble: This category would include such fertilizers as IBDU and ureaformaldehyde. The N in these fertilizers is released via the action of hydrolysis (water) and/or microbial activity. Both types are quite moisture dependent. The UF fertilizers are also temperature-dependent, since the level of microbial activity is governed by soil temperature, in addition to the presence of adequate moisture. Thus, IBDU should work effectively under cool, moist conditions, while long-chain UF types will not perform nearly as well. Fertilizers containing UF are better-suited to summer use.

Natural organics popular

Natural organic fertilizers have become quite popular in recent years. Derived from plant or animal by-products, they include products like activated sewage sludge (Milorganite), dehydrated poultry waste (Richlawn products, Sustane), and dried blood, bone and seed meals (the Ringer products). These fertilizers depend on microbial activity to release much of the nitrogen contained in them. Interestingly, the Ringer and Richlawn products have performed very well under cool condintions in Colorado testing, probably because blood meal will release N quite quickly. These products require good levels of soil moisture to work well, and may not perform up to expectations under dry conditions (even if temperatures are warm).

—*Dr. Koski*□

Characteristics of Nitrogen Fertilizers

Fertilizer Source	N Percentage	N Source	Moisture Dependence	Temperature Dependence	Residual Activity	Burn Potential
QUICKLY-AVAILABLE N						
Ammonium nitrate	33	ammonium nitrate	low	low	short	high
Ammonium phosphates	11-21	mono/di-amm. phos.	low	low	short	high
Ammonium sulfate	21	ammonium sulfate	low	low	short	high
Urea	46	urea	low	low	short	high
SLOWLY-AVAILABLE N						
Slow-Release Sources						
Sulfur-coated	14-38	urea, ammoniacal N	moderate	moderate	long	low
Resin-coated (ONCE™)	24-35	ammoniacal N, urea, nitrate	moderate	moderate	long	low
Slowly-Soluble Sources						
IBDU	31	IBDU	high	low	long	low
Ureaform Products						
Nitroform	38	ureaformaldehyde	high	high	long	low
FLUF	18	ureaformaldehyde/urea	moderate	moderate	medium	low
Nutralene	40	methylene urea polymers	moderate	low	medium-long	low
Scotts methylene urea	39	methylene urea polymers	moderate	moderate	medium-long	low
CoRoN	28	methylene urea/urea	low	low	medium	low
Formolene Plus	30	methylene urea/urea	low	low	medium	low
N-Sure	28	triazone/urea	low	low	medium	low
Natural Organic Products						
Ringer fertilizers	6-10	blood, bone, seed meals	high	high	long	low
Sustane	6	composted turkey waste	high	high	long	low
Richlawn fertilizers	6-14	DPW, blood & bone meal	high	high	long	low
Milorganite	6	activated sewage sludge	high	high	long	low

Source: The author

more, depending on the source) later in the spring when it becomes warmer. Alternatively, use a mixture of slowly- and quickly- available N when you cannot make frequent spring applications (see sidebar).

Other nutrients

Most often, other nutrients are applied with (or in addition to) regular nitrogen applications. Potassium (K) applications, even when soil tests say levels are adequate, have been touted in recent years as providing an added degree of drought resistance and/or heat tolerance.

Many turf managers believe that they see this effect in the field, although

In cases of mite damaged turf, recovery can sometimes occur with adequate spring fertilization and watering.

research on the subject has not proven conclusively that supplemental K provides such benefits.

Less has been said about phosphorus (P) in this regard, but many turf managers provide regular supplements of potassium in their programs. It is unlikely that these higher levels of K or P can cause any harm, but one should consider whether any benefit is gained by using high levels of either, especially when one considers the extra cost involved. Routine use of both is encouraged, however, on those sites where grass clippings are regularly removed.

Iron applications can enhance turf color without stimulating excess shoot production. Iron in the spring can be advantageous if it allows you to reduce the amount of N applied. Research by Wehner and Haley at the University of Illinois found that iron can be substituted for a portion of some N fertilizers (urea and Formolene), while still attaining a response equivalent than that obtained from a full rate of nitrogen.

In certain parts of the country where iron chlorosis is prevalent (high pH soils), it may be necessary to apply iron at least once per year. Nitrogen applications to a chlorotic (yellow), iron-deficient turf will worsen the chlorotic condition.

Iron is most effective when applied as a foliar spray. **LM**

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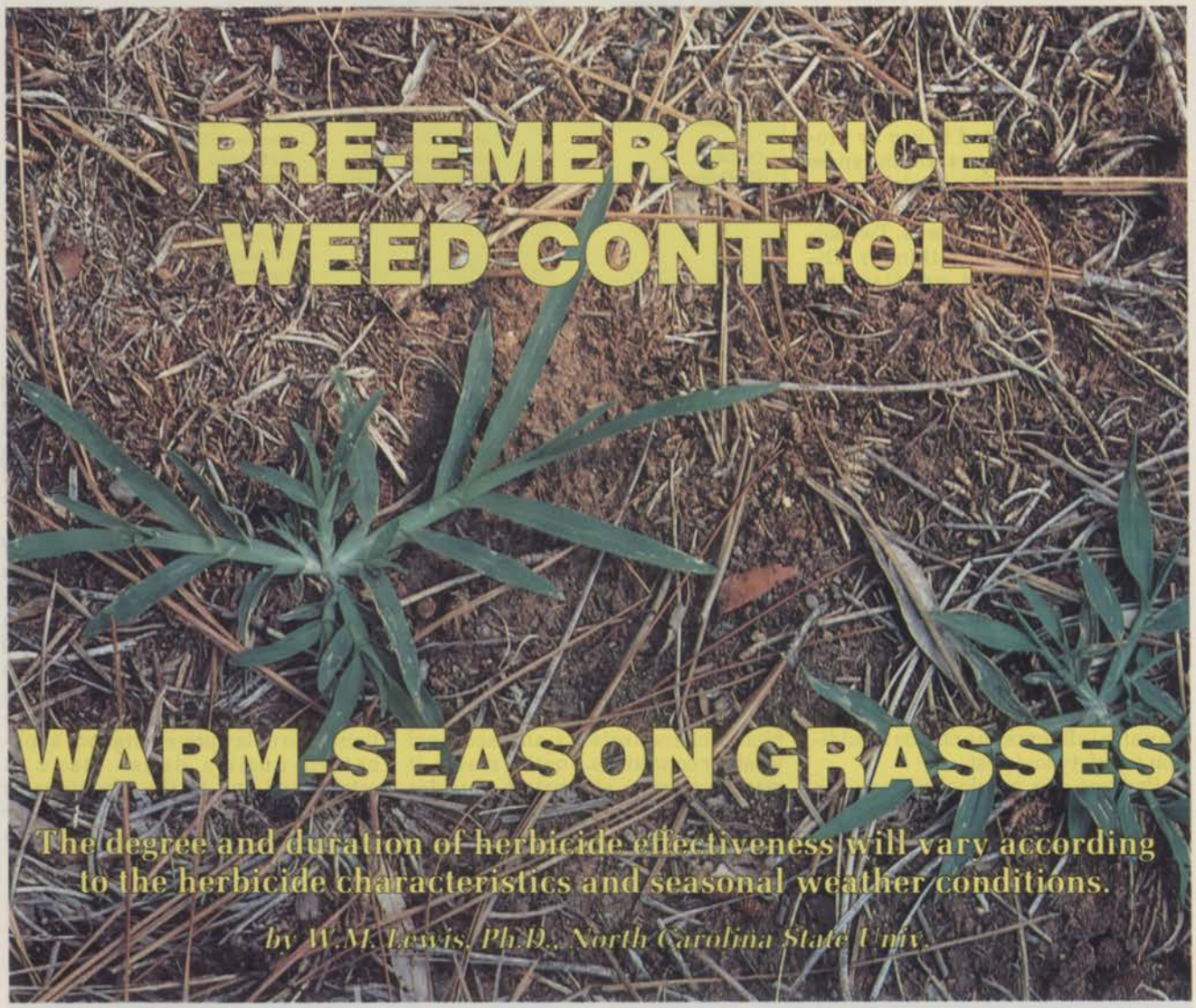


PRE-EMERGENCE WEED CONTROL

WARM-SEASON GRASSES

The degree and duration of herbicide effectiveness will vary according to the herbicide characteristics and seasonal weather conditions.

by W.M. Lewis, Ph.D., North Carolina State Univ.

Goosegrass and smooth crabgrass (shown above) are two of the most common weeds found in warm-season turfgrasses. Specific management practices lead to aesthetically appealing turfgrasses.

The first step in a weed management program is to produce a healthy vigorous turf, one competitive with weeds. This may be done by matching proper warm-season turfgrass species or cultivars with their intended use—whether a home lawn, athletic field, commercial landscape or golf course fairway.

Grass selection may also be related to its intended level of management (amount and frequency of fertilization, needed irrigation and mowing height and frequency).

Insect and disease problems should also be reduced.

Once these practices have been put into action, the turf manager is ready to consider the need for pre-emergence herbicides.

Frequently, the need should be determined by observations made on the site the previous season. Applying pre-emergence herbicides year after year without any consideration to the existing weed problems is not good management. Carefully selecting specific management practices leads to an aesthetically appealing and serviceable warm-season turfgrass.

Available herbicides

Pre-emergence herbicides are the

backbone of a weed management program. They are primarily used for the control of smooth and large crabgrass and goosegrass, though many will control certain other summer annual weedy grasses. Also, they provide pre-emergence control of annual bluegrass when applied in the fall.

A number of herbicides or herbicide combinations are registered for pre-emergence use in established warm-season turfgrasses (Table 1). This listing contains examples of common and trade names of pre-emergence products.

Many herbicides are also formulated on fertilizer carriers. Certain herbicides are limited to use by professional turf managers which can be determined by reading the label.

Oxadiazon (Ronstar) is not registered for use on home lawns. Two additional herbicides, dithiopyr (Dimension 1EC) and prodiamine (Barricade 65 WDG) may be registered for use in the 1991 season.

The emphasis is on application to established turfgrass because none of the herbicides are registered for application at time of sprigging, sodding or seeding warm-season turfgrasses. There is one exception, however: siduron may be used when sprigging zoysiagrass.

Herbicide selection

When selecting a herbicide, first consider turfgrass tolerance (Table 2) and the grassy weeds present on the site. Then consider the effectiveness of the herbicides on those weeds (Table 3). The method or ease of application may also influence the choice in addition to safety and cost.

Perhaps one overlooked factor is the tolerance of trees and ornamentals in the landscape. Most labels list tolerant ornamental species. This opens up another possibility of selecting a single herbicide for pre-emergence grassy weed control in the turf as well as the ornamental plant beds.

With the exception of atrazine, simazine and oxadiazon, the effects of the pre-emergence herbicides are associated with inhibiting root growth in the germinating weed seeds. Root inhibition has also been observed in desired turfgrasses; for example, in the growth of new roots along the stolons of bermudagrass and centipedegrass.

The degree and duration of the effects will vary according to the herbicide characteristics and seasonal weather conditions. For this reason, it may be wise to alternate herbicides from year to year or—maybe even more important—to be very cautious in determining the need for a pre-emergence herbicide in any year.

In heavily-trafficked areas having thin open stands, a pre-emergence herbicide may interfere with the stand filling in and the stolons rooting properly. Post-emergence control would be the best approach for this situation.

Frequent light applications of MSMA may be used in bermudagrass in an effort to control recently germinated crabgrass and goosegrass. In centipedegrass, sethoxydim (Poast) applied as a post-emergence provides control to crabgrass and goosegrass. The other alternative in these situations is to delay pre-emergence application until a dense stand is established and in the meantime to concentrate on starting the proper management practices to encourage that dense stand.

Table 1.

Examples of Common and Trade Names of Pre-emergence Herbicides for Warm-Season Turfgrasses

Common Name	Company	Trade Name and Formulation
Atrazine	Ciba-Geigy	AAtrex 80W, 4L, 90DG
	Security	Purge II 2L
Benefin	Dow/Elanco	Balan 2.5G, 60DF
	Lesco	2.5 Benefin Granular
Benefin + oryzalin	Dow/Elanco	XL 2G
Benefin + trifluralin	Dow/Elanco	Team 2G
Bensulide	ICI	Betasan 4E LF, 3.6G, 7G, 12.5G
	Lesco	Lescosan 4E, 7G
	PBI/Gordon	Bensumex 4LF
Bensulide + oxadiazon	Scotts	Goosegrass/Crabgrass Control 6.5G
DCPA	Fermenta	Dacthal 75W, 6F
Napropamide	ICI	Devrinol 50WP, 2G, 5G
	Lesco	Devrionol 5G Ornamental
Oryzalin	Dow/Elanco	Surflan 4AS
Oxadiazon	Rhone-Poulenc	Ronstar 2G, 50WP
Pendimethalin	Lesco	Pre-M 60 DG
	Scotts	Halts 1.71G
		Southern Weedgrass Control 2.45G
		Turf Weedgrass Control 1.71G
		Weedgrass Control 60WDG
Simazine	Ciba-Geigy	Princep 80W, 4L, 90DG, 4G

Table 2.

Tolerance of Established Warm-Season Turfgrasses to Pre-emergence Herbicides for Control of Annual Weedy Grasses

Herbicide	Bahiagrass	Bermudagrass	Centipedegrass	St. Augustinegrass	Zoysiagrass
Atrazine	NR	T	T	T	T
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
Napropamide	T	T	T	T	NR
Oryzalin	T	T	T	T	T
Oxadiazon	NR	T	NR	T	T
Pendimethalin	T	T	T	T	T
Siduron	NR	NR	NR	NR	T
Simazine	NR	T	T	T	T

T = tolerant when used properly according to the label; NR = not registered for use on this turfgrass.

Application timing

Pre-emergence herbicides are best applied at least two weeks before expected weed seed germination. In areas where there is a crabgrass history, pre-emergence herbicides are applied in the spring when soil temperatures approach 53°F. Goosegrass germination is usually two weeks later than crabgrass.

Crabgrass and goosegrass germinate first in thin open stands of warm-season turfgrasses. Germination is delayed and/or reduced in dense stands, which is another reason for considering all cultural practices as part of a total weed management program. Moving from the southern to the northern portion of the warm-season zone, crabgrass may germinate from late January to early April.

Frequently, application timing is correlated with a biological indicator. For example, in North Carolina, pre-emergence crabgrass herbicides should be applied by the time dogwoods are in full bloom.

Research at North Carolina State University has shown that split applications generally out-perform a single pre-emergence application. An example of a split rate may be 1.5 pounds in early spring and 1.5 pounds eight weeks later, if the usual single spring application rate is 3 pounds active per acre. Split applications of benefin + trifluralin, oryzalin and pendamethalin have given acceptable goosegrass control.

Some turf managers apply one pre-emergence herbicide early in the spring and a second herbicide eight weeks later in an attempt to increase safety to the turf. We have not observed any adverse effects on ryegrass mixtures overseeded in bermudagrass in September or October following a March-to-May pre-emergence herbicide application, though we have observed a reduction in stand density of fall overseeded ryegrass from spring applications of oryzalin and benefin + oryzalin.

Our tests have also shown that applications can begin six to eight weeks before expected crabgrass germination with favorable control, because under cool soil temperatures little if any herbicide degradation occurs during this period. This would not hold true farther south in the warm-season turfgrass area. In fact, in some areas crabgrass can germinate year-round under favorable conditions.

Applications of herbicides for pre-emergence control of annual bluegrass and certain winter annual broadleaf weeds may be from late August to early November, depending on geographical location. Annual bluegrass germination is influenced by adequate moisture and cool temperatures. Time of emergence can be quite variable from year to year.

TABLE 3.

Annual Grassy Weed Control Ratings for Pre-emergence Herbicides

Herbicide	Crabgrass	Goosegrass	Annual Bluegrass
Atrazine	P	P	E
Benefin	G	F	G
Benefin + oryzalin	G	F-G	G
Benefin + trifluralin	G	F	G
Bensulide	G	P	G
Bensulide + oxadiazon	G	G	G
DCPA	G	F	G
Napropamide	G	G	G
Oryzalin	G-E	G	G
Oxadiazon	G	G	G
Pendimethalin	G-E	F-G	G
Siduron	G	F	NR
Simazine	P	P	E

Weed control effectiveness: E = excellent (90-100%), G = good (80-90%). F = fair (70-80%), P = poor (<70%), NR = not registered.

Herbicide effectiveness

Herbicide characteristics, weeds to be controlled, and weather conditions influence the effectiveness and longevity of pre-emergence herbicides. The persistence of herbicides in the soil differs. Benefin does not persist as long as oryzalin or pendimethalin, for example. Split or repeat herbicide applications help to maintain threshold levels for season-long grassy weed control.

Pre-emergence herbicides are best applied at least two weeks before expected weed seed germination.

As indicated in Table 3, with the exception of atrazine and simazine, pre-emergence herbicides provide good to excellent control of crabgrass. However, the ability to control goosegrass varies. For effective goosegrass control, a herbicide rated "good" should be applied. Single applications of oxadiazon and bensulide + oxadiazon have provided favorable goosegrass control in North Carolina tests.

If a pre-emergence herbicide is to be effective, it must be applied prior to weed seed germination. Applications following weed emergence will fail. If applied too early, the herbicide may dissipate or degrade before weed seed germination.

Pre-emergence applications need rainfall or irrigation to move them off the turf foliage into the upper soil layers where the weed seeds germinate. If at least one-half inch of rain doesn't fall within a week following application, irrigation is advisable. On the other hand, excessive seasonal rainfall usually reduces the length of effective control.

Mowings of warm-season turfgrasses should be delayed until the herbicide has been washed off the turfgrass foliage, especially if grass clippings are to be removed.

It has been a common belief that cultivation following pre-emergence appications disrupts the herbicide barrier in the soil and then stimulates weed germination. However, according to test results, coreing (aerification) following pre-emergence herbicide application does not affect herbicide performance, providing the soil cores are returned.

Metolachlor (Pennant 7.8E) has been registered for pre-emergence yellow nutsedge control on golf fairways, sod farms and commercial lawns, but not on residential turf. It may be applied to bahiagrass, bermudagrass, centipedegrass and St. Augustinegrass.

Choosing the appropriate pre-emergence herbicide requires knowing the tolerance of the warm-season turfgrass to the herbicide.This must be matched with the weeds. **LM**

Dr. Lewis is a professor of crop science at North Carolina State University

PRE-EMERGENCE WEED CONTROL

COOL-SEASON GRASSES

Annual weed control requires a sound knowledge of the grasses and weeds in question, and discriminating cultural practices.

by Nick Christians, Ph.D., Iowa State University

Many of the annual weeds we encounter in cool-season turf species are actually warm-season grasses.

Unlike the cool-season turfgrasses that thrive in spring and fall, warm-season grasses such as crabgrass, goosegrass and foxtail thrive during the summer.

Warm-season annuals die early in the fall with the first cool weather. Cool-season grasses thrive in the fall and early spring. Fertilizer applications at this time will help thicken cool-season lawns and make them more resistent to annual weed encroachment in the late spring. Fertilizer applications during mid-June to mid-August to lawns with some annual grasses and broadleaf weeds don't encourage the lawn grasses but do benefit the warm-season weeds.

High-phosphorus diet

The proper fertilizer can also help discourage annual weeds.

When the lawn is established, "starter" fertilizers high in phosphorus (P) are used, such as a 13-25-6 or a 10-20-10. Once the grass plant matures and forms an extensive root system, however, it is able to remove phosphorus from the surrounding soil; then fertilizers with analysis much lower in P are generally sufficient (i.e., 20-3-15 or 18-5-9).

Application timing

Fertilizing mature lawns with high phosphorus fertilizers does little to benefit the turf, unless the area is shown by a soil test to be low in that element. Germinating annual weeds thrive on high P fertilizers just as do germinating perennial grass seedlings.

Although turf deficient in P may benefit from "winterizing" treatments, most lawns have sufficient phosphorus in the soil. So more will not improve the turf's winter survival; however, the resulting high P levels on the soil surface will help germinating weed seeds in the spring.

Importance of mowing

Mowing itself can serve as a weed control. Many of the serious agricultural weeds are of no consequence in turf areas because they cannot tolerate continuous mowing. Excessively low mowing heights, however, will reduce the turf's competitive advantage and allow annual weeds to become established regardless of whether herbicides are used, as oserved at Iowa State University in late summer studies. (Kentucky bluegrass mowed below 1½ inch will often become infested with crabgrass, regardless of the presence of pre-emergence herbicides.)

A good dense stand of turf is one of the best weed controls, and mowing to meet the turf's requirements is one of the best ways to assure a dense stand.

Cultural practices

Cultivation techniques such as core aerification can work both ways on weed infestation.

Compacted soils have a detrimental effect on the turf and often become infested with annual weeds. Using herbicides on compacted areas makes little sense, unless the compaction problem is dealt with first. Aerification reduces compaction and favors the turf, thereby helping to control weeds.

Improperly timed cultivation can potentially aid weed infestation. Any practice that opens the turf and brings annual weed seed to the surface during the peak weed germination period is likely to benefit the weeds more

than it does the turf.

Recent research has shown that spring aerification following pre-emergence herbicide application does not disrupt the barrier established by the herbicide as much as once believed. It makes good sense, though, to avoid this time if possible. Late summer to early fall is still the best time to aerify cool-season lawns.

Irrigation strategies

A sound knowledge of grass species and weeds can also be used to design an irrigation strategy that will help prevent weeds.

In an established, well-rooted lawn it makes little sense to irrigate to keep the surface continuously moist during the germination of annual weeds. Some surface drying will generally have no detrimental effect on perennial lawn grasses, but will have an impact on newly-germinated weed seed that are struggling to survive.

Turf infested with fungal patch diseases may benefit from light, frequent watering before and during disease activity. Proper use and timing of light, frequent watering programs is recommended on lawns where patch diseases have been a problem. On lawns where patch diseases have not historically been a problem, deep, infrequent watering is still the best practice.

Proper irrigation at other times can also help prevent weed problems. Kentucky bluegrass lawns can survive extended drought periods by going into summer dormancy. But spurge and oxalis often infest these lawns in late summer resulting in callbacks and the need for more herbicides. Using irrigation water to keep the lawn growing can help insure against these weed problems.

Watering cool-season lawns during dry fall conditions can also be a sound management practice.

Dry autumns have been a problem in the Midwest during three of the last four years. This is one of the best times for cool-season grasses to become re-established in the absence of competing annual weeds. This time of year is particularly important on lawns damaged by summer drought.

Proper fall fertilization and watering can help make the lawn more resistant to weed infestation in the spring.

Easy on perennials

Using cultural techniques can help prevent a weed problem. However, cultural controls are rarely 100 percent effective.

Insect and disease damage, adverse weather conditions, physical damage to the lawn, and a variety of other factors can injure even the best managed turf and open it to weed establishment. For these situations, herbicides can prevent weed infestation if properly used.

Table 1 lists a variety of pre-emergence herbicides that can be used on cool-season lawns to help prevent annual weeds. The activity of these materials is such that they do little, if any, damage to the perennial grasses in the turf, but are deadly to the germinating annuals.

(For a detailed discussion of these herbicides, see, "Cool-season weed control poses special challenge," *Lawn Care Industry* magazine, Feb., 1990.)

Some of the materials in this group have unique characteristics.

Siduron, for instance, is the only material in the group that can control annual weeds selectively at the time of lawn establishment. This material is particularly useful for spring seedings.

Isoxaben is marketed under the trade name Gallery. It is particularly effective against knotweed, spurge, oxalis and other annual broadleaf weeds. Isoxaben has limited activity at labeled rates against annual grasses and will generally fit into the lawn care program as a supplement to standard pre-emergence herbicides. Where annual broadleaves have been a problem in the past, this material provides a new tool that can be used effectively if properly timed.

Widening the window

Much of the research on annual weed control in the 1980s was aimed at "widening the window" of application (Figure 1).

The pre-emergence herbicides in Table 1 will control annual weeds if applied before weed germination, but most provide little if any post-emergence activity on weeds that have already germinated. These materials are very useful in situations where they can be properly timed before weeds germinate.

A breakthrough

In the early 1980s, MSMA (monosodium methanearsonate) and DSMA (disodium methanearsonate) were the only materials available for post-emergence control of summer annual weeds in turf. The weed control from these materials was quite inconsistent in much of the Northern region and often resulted in phytotoxicity to the turf. Pre-emergence applications were far preferable during this time, and these post-emergence materials were used only as a last resort.

Fenoxaprop-ethyl, marketed under the trade name Acclaim, was released in the mid-1980s. It was the first really effective post-emergence herbicide for controlling annual grasses in cool-season lawns.

This material broadens the window of application by allowing lawn care specialists to effectively treat germinated crabgrass in its early stages. Customers whose lawns could not be treated before crabgrass germination and customers who signed up for the service after the time of pre-emergence application no longer had to go

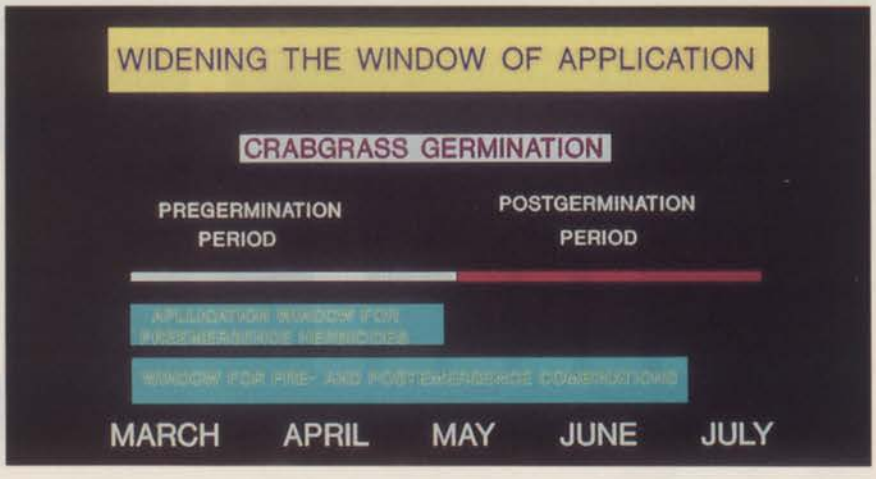
TABLE 1

Pre-emergence herbicides currently in use in cool-season turf

COMMON NAME	TRADE NAME	COMMON NAME	TRADE NAME
DCPA	DACTHAL	OXADIAZON	RONSTAR
BENEFIN	BALAN	PENDIMETHALIN	PRE-M, WEED GRASS CONTROL
BENSULIDE	BETAMEC-4, PRE-SAN, BETASAN	TRIFLURALIN/BENEFIN	TEAM
		SIDURON	TUPERSAN
ISOXABEN	GALLERY		

Source: The author

FIGURE 1



through the entire season with a lawn filled with warm-season annuals.

Fenoxaprop-ethyl has had some limitations. It is incompatable with many broadleaf herbicides such as 2,4-D. It has no pre-emergence activity, and it is not very effective following drought stress of the target species. But it has still been widely used in the cool-season region. **LM**

Dr. Christians is a professor of horticulture at Iowa State University.

New pre-emergence herbicides are becoming available which "widen the window" of time for effective applications.

New control products

DIMENSION: Dithiopyr is a new material that will be marketed on a limited basis in selected states in 1991 under the name Dimension. Research on this product has been under way at various state universities since the mid-1980s under the experimental name MON 15100.

Dithiopyr is a very effective pre-emergence herbicide that provides reasonably good post-emergence control of germinated crabgrass. The extent of the post-emergence activity varies with location, but I have found it to provide excellent post-emergence control in most years at the Iowa State University turfgrass research area.

Dithiopyr has two important advantages over older products:

- it can provide both pre- and post-emergence activity, and
- it does so at a lower rate of application than most herbicides. The recommended application rate will be 0.5 lbs. AI/acre as compared to 1.5 to as high as 10 lbs. AI/acre with earlier materials.

QUINCLORAC: Quinclorac, an experimental product that has been given the potential trade name Impact is another of the new products that may possibly widen the window of application.

This material provides excellent post-emergence control of crabgrass in its early stages and provides excellent control of some broadleaf weeds, particularly white clover. Quinclorac, with little pre-emergence activity, would have to be combined with a pre-emergence material if it is applied at a time when crabgrass is still germinating.

Quinclorac has been found in recent experimental work to provide very good activity in the granular form and may well find a place in the future.

Similar problems during drought

Research at Iowa State University on both dithiopyr and quinclorac indicate that these products are likely to experience problems controlling crabgrass that has been subjected to drought periods. Fenoxaprop-ethyl has similar problems.

Figures 2 and 3 show the results of post-emergence weed control studies following an extended drought period (Fig. 2) and following a period in which no drought stress was observed (Fig. 3). Crabgrass subjected to dry conditions before treatment was much harder to control than the crabgrass that experienced no drought conditions. More work will be needed to understand this reduced control, but this should be considered whenever post-emergence crabgrass control is needed.

Changing standards

With the new tools being developed, the potential exists for a change in the standard lawn care program.

In the past, a standard program included a pre-emergence application in the first round, often followed by an additional application in the second round to assure complete control through the season. With the new post-emergence materials being developed, the possibility exists that the early pre-emergence application could be eliminated and replaced with a single application in the second round that would control annuals both before and after emergence.

The new products will have to prove themselves in the market place, but if this type of program can be used effectively, it could potentially reduce the amount of herbicides that the industry now applies to lawns and could reduce cost. These possibilities will be worth investigating in future seasons as new herbicides reach the market.

—Dr. Christians□

FIGURE 2

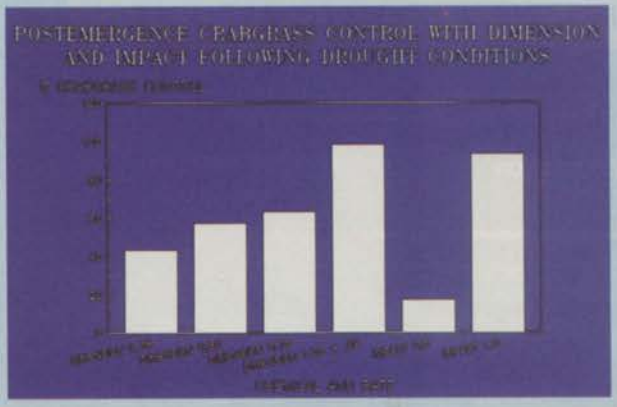


FIGURE 3