TURF

by Dr. Ray Dickens and Dr. Robert Shearman

This annual project is continuously updated and expanded to provide turf and landscape managers a comprehensive, up-to-date reference for weed control.

For the 1984 edition, we have added sections on roadside and aquatic weed control. The reviewers for this issue were Dr. Ray Dickens of Auburn University and Dr. Robert Shearman of the University of Nebraska.

The core of the manual was written by Dr. Euel Coats of Mississippi State University and Dr. Elton Smith of Ohio State University. Photos and illustrations were provided by Velsicol Chemical Co., O.M. Scott & Son, the New York State Turfgrass Association and the authors.

Every turf or landscape manager faces weed problems. It is perhaps the most critical part of landscape management.

Weeds are part of the natural landscape. A lawn, garden, or man-made landscape is an unnatural state requiring regular cultural practices to maintain. If these practices aren't followed the landscape will return to its natural state in a few short years.

Once established, a man-made landscape can resist weeds best if the desired plants are healthy and vigorous. As soon as the desired plants are put under stress, weeds will move in.

Stress can come from many sources: poor soil; too much or too little shade, fertilizer, or water; compaction and damage from people and machines; and poor location.

Maintenance practices can also cause stress. Mowing too low, fertilizing too much, applying chemicals which discourage helpful organisms, and compaction and damage caused by maintenance equipment should be corrected as part of a weed control program.

Efficiency and economy in weed control programs are obtained by reducing or eliminating the stress in conjunction with herbicide applications. Rarely do herbicides alone completely eliminate, or maintain at acceptable levels, the weeds in turf or landscape.

Efficiency may also require changing the components or design of a man-made landscape.

If the design is not worth the maintenance level required to keep it in shape, then changes can and should be made. The expense of changing the landscape can be recouped later in lower maintenance costs.

A fairly complex landscape design can be made more efficient by replacing high-maintenance plants with lower-maintenance material. Certain turf cultivars require less care and resist weeds better than others.

Control by location

Location makes a major difference in weed control techniques. Not only does the type of location matter; such as lawn, plant bed, roadside or lake; but so does the geographic location of the landscape involved.

Warm-season weed control varies greatly from cool-season weed control. The weeds, desirable plants, soil, and even herbicides may be different.

Warm-season turf weed control is rather complex primarily because the large number of species and cultivars. There are at least six turfgrasses used in the Southern United States; bahiagrass, bermudagrass, carpetgrass, centipedegrass, St. Augustine, and zoysiagrass. Three of these (bahiagrass, carpetgrass and common bermudagrass) are often weed problems in the other Southern turfgrasses.

Dichondra and kikuyugrass can be added to the list of turf species, however, they are limited primarily to areas of the Southwest that are irrigated. They are also considered weeds in some locations.

A few cool-season turfgrass species are used in the South for winter overseeding to provide color while the warm-season grasses are dormant. These include annual and perennial ryegrass, roughstalk bluegrass, creeping bentgrass and red fescue. As a result, the southern turf manager needs to develop two dif-

ferent weed control programs, one for warm-season turf and one for the overseeded cool-season turf.

Cool-season turf managers must often deal with a mixture of turf species. A mixture of Kentucky bluegrass, perennial ryegrass, and red and chewings fescues is standard. This mixture of species is one hurdle turf growth regulators have not yet cleared since the individual turf species respond differently to present turf growth regulators.

Bentgrass and tall fescue are cool-season grasses planted alone. Tall fescue, long used for utility turf, is growing in popularity as fine-leaved, turf-type varieties are developed, especially in the transition zone. Sheep and hard fescues may gain acceptance as low maintenance turfgrasses in the future. Bentgrasses are used primarily for specialty turf, such as golf greens, and become weeds when they invade standard cool-season turf stands.

Weed control around woody ornamentals and annual and perennial flowers involves a greater variety of plants than turf. Advances in preemergence herbicides for plant beds have given a boost to weed control programs that have been largely mechanical or hand labor.

Roadside weed control is also utilizing herbicides to reduce labor and mechanical control costs. Control of tall-growing plant species is necessary for driving safety.

Control of water weeds is a growing concern as lakes become recreation centers for residential developments. Respect for lakes and rivers has increased dramatically in the past decade. Care of these water areas has grown in importance.

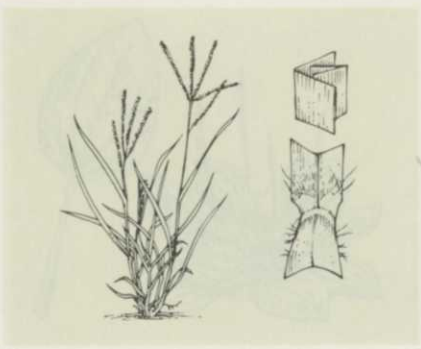
Weed identification

Proper weed species identification and an understanding of life cycles enables landscape managers to correctly and effectively time preemergence and post-emergence herbicide applications.

Poa Annua

Nutsedge

Crabgrass



Goosegrass

Many of the weed problems a landscape manager faces can be solved by knowing the weed history of the areas managed. Records should be kept to show the development of weed problems.

Weed sources are present in all soils in the form of seed, rhizomes, stolons, bulbs and tubers. Effort should be made prior to planting to sterilize the soil where practical.

This reserve of weeds should be understood by the landscape manager and controlled. Disturbing the soil for any reason may trigger a weed problem, including maintenance practices such as aerification, vertical mowing, or seeding. If possible, soil should not be disturbed during key weed germination periods and following application of preemergence herbicides.

If a weed problem doesn't conform to the weed history, then the weed was brought into the area in soil, seed, or another carrier.

Life cycles

All plants can be classified according to life cycle as either annual, biennial, or perennial.

ANNUALS complete their life cycle in one growing season. They are further divided into summer and winter annuals.

SUMMER ANNUALS germinate in the spring and summer and complete their life cycle during the warm growing season. Large crabgrass and goosegrass are examples of summer annuals.

WINTER ANNUALS germinate in the fall and late winter, complete their life cycle during the spring, and die in early summer. Annual bluegrass, henbit, and common chickweed are winter annuals.

BIENNIALS require two years to complete their life cycle. In the first year, biennials form rosettes (radial clusters of leaves close to the soil). The second year they send up flower stalks and produce seed. Musk thistle is a biennial.

PERENNIALS live for three or more years and are especially difficult to control because they reproduce by vegetative means, by seed, or both. Perennials are often well-established before their presence is recognized. Examples are dandelion, yellow nutsedge, quackgrass, wild onion and garlic, torpedograss, and dallisgrass.

Perennials spread vegetatively by structures above and below the ground, called rhizomes, stolons, and tubers. These structures must be killed by postemergence systemic herbicides to effectively control perennials. Postemergence control is generally considered the most effective means of control, although preemergence herbicides can be used to stop perennials from spreading by seed.

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Tall Fescue

Plantain (not Buckhorn plantain)

Ground Ivy

Quackgrass

Grass or broadleaf

A second distinction important to weed control is whether the weed is grassy or broadleaf. Herbicides are often selected by how they disrupt the life processes of either grasses or broadleaf weeds. The effectiveness of these herbicides depends greatly upon this distinction.

Grassy weeds include crabgrass, annual bluegrass, goosegrass, quackgrass and any turfgrass in the wrong place, such as bentgrass, tall fescue, bermudagrass or kikuyugrass.

Broadleaf weeds include dandelion, clover, ground ivy, chickweed, plantain and lambsquarter.

Grassy weeds

Annual bluegrass Persistant seedheads and blotches of heat-killed annual bluegrass make this a weed in the summer in the North and in the winter in the South. It thrives in well-fertilized, irrigated, low-cut turf. Its shallow roots and overdedication to seed production make annual bluegrass very vulnerable to high temperatures and drought. Not all types are annual, despite the name.

Bentgrass can encroach by stolons or seed into cool-season turfs consisting of Kentucky bluegrass, perennial ryegrass, and fine-leaved fescues. It has extremely small seed making it difficult to clean from contaminated lots of seed. Bentgrass is a major target of certified seed producers during production and cleaning. It is difficult to remove from lawns and must be controlled with a non-selective, postemergence herbicide such as Roundup.

Bermudagrass, like bentgrass, encroaches on other desired turfgrasses. A desirable turfgrass for the South, bermudagrass can be undesirable in other turfs. This extremely hardy grass can outperform other warm-season turfgrasses. It spreads by stolons and rhizomes. Bermudagrass goes dormant and turns brown early in the fall in cooler climates, in contrast to cool-season turfgrasses which stay green into the winter.

Crabgrass is the predominant target of most turf weed control programs. It spreads by seed and by rooting at the lower nodes (where stem and leaf join). This pale green grass forms dense patches damaging the appearance of a lawn. Since it is an annual grass it can be controlled with preemergence herbicides.

Goosegrass is an annual grass sometimes called silver crabgrass. It is particularly troublesome in thinned turfs in compacted, wet soils. Preemergence control has been variable, but some of the newer herbicides hold promise for effective control. Goosegrass can be controlled with postemergence herbicides if these materials are applied in the early stages of its development.

Kikuyugrass is a serious problem on golf courses on the Pacific Coast. It spreads by seed and rhizomes at an amazing pace. The only control so far is non-selective postemergence herbicides.

Nutsedge is a major turf and crop weed. It is difficult to control because it is a perennial that spreads by seed and nutlets or tubers. Yellow nutsedge has a light-green to yellow-green color that contrasts with the color of the desired turfgrass. Purple nutsedge is a related species which is a serious problem in the South.

Postemergence herbicides are most effective for nutsedge control. BASF Wyandotte is promoting Basagran specifically for yellow nutsedge control. Repeat herbicide applications are necessary since no systemic herbicides are available for nutsedge in turf.

Quackgrass is a hard-to-control perennial that spreads vigorously by rhizomes. Quackgrass is often introduced during establishment when contaminated topsoil is used. No selective control exists. Quackgrass must be controlled using spot treatment with

a nonselective herbicide.

Tall fescue is a bunch-type grass with short, stubby rhizomes. It does not creep, like red fescue. This grass tolerates poor soils and has a low fertilization requirement making it more able to survive poor locations than Kentucky bluegrass or perennial ryegrass. Tall fescue is often used in low-maintenance sites where drought tolerance is important.

Tall fescue is difficult to remove from other turf stands it encroaches. Small infestations can be eliminated by digging them out. More extensive infestations require spot treatment with a nonselective, postemergence herbicide. Recent research has shown selective control may be possible for tall fescue in Kentucky bluegrass turfs. The products used in the research are not currently labelled for turfgrass use.

Wild garlic is a perennial grasslike weed that spreads by seed and underground bulbets. Some preemergence herbicides prevent its spread by stopping seed germination, but these materials have little or no effect on the bulbets. Postemergence, systemic herbicides are most effective for wild garlic control since they are readily translocated to the bulbets.

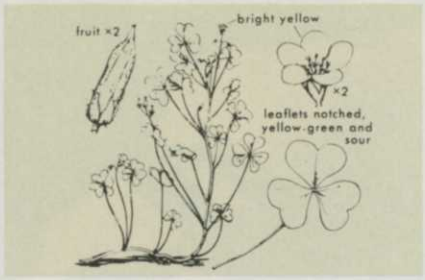
Broadleaf weeds

Black medic is occasionally confused with clover. Black medic is a winter annual. It is common throughout the U.S. and has small yellow flowers.

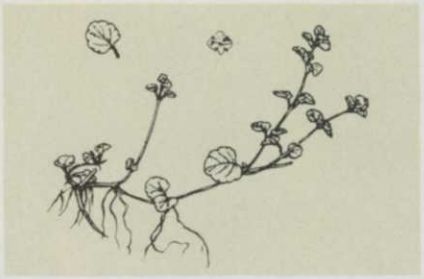
Buckhorn plantain is a perennial present in many low-budget lawns and mow-only areas of parks. Buckhorn has a taproot that defies hand weeding.

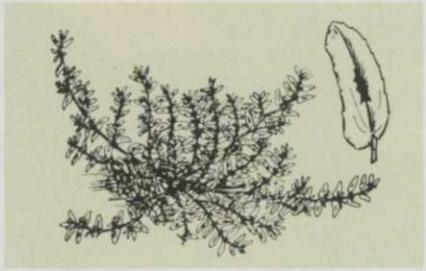
Common chickweed is a winter annual that is common growing in moist, shaded areas. It is succulent in growth, light-green in color and has small white flowers.

Mouse-ear chickweed resembles common chickweed in its spreading growth habit, but it is perennial and has fuzzy leaves.



Yellow Wood Sorrel


Speedwell


Spurge


Heal-all

White clover is a perennial broadleaf weed with white to pink flowers. Its familiar-shaped leaves spread close to the ground.

Dandelion is a perennial famous for its taproot and yellow flower which becomes a puffy seedhead in late spring.

Ground ivy is sometimes called creeping charlie. It is a perennial that persists on poorly-drained, shaded sites. A member of the mint family, ground ivy hugs the ground and produces a purple flower.

Henbit is taller than ground ivy with purple flowers and scallop-shaped leaves. It is a winter annual most noticeable in early spring.

Heal-all is a hairy-leaved perennial common in new and poorly-maintained lawns throughout the U.S. It can spread beneath the level of mower blades.

Lambsquarter is a summer annual with light-green to gray-green foliage. It can be a severe problem in newly-seeded or infrequently-mowed turfs. Mowing helps control lambsquarter.

Plantain has broad leaves which lay flat on the surface of the soil. This perennial sends up tall purple stalks containing seeds.

Red sorrel is a tenacious perennial with arrow-shaped leaves. It spreads by roots and rhizomes and can quickly overtake desirable turf weakened by acid soil or low fertility. Alkaline soils can discourage red sorrel.

Yellow wood sorrel is also known as oxalis. This perennial broadleaf spreads by rooting at the nodes and by seed from pods following flowering. Small yellow flowers mature into long, narrow seedpods. Selective control is difficult.

Speedwell is an example of a plant that was introduced for use in rock gardens and subsequently escaped to become a weed. There are both annual and perennial types of this weed. White to purple flowers bloom above heart-shaped seedpods.

Annual types are controlled with pre- and postemergence herbicides. Perennial types are controlled with spot treatment of postemergence herbicides.

Spurge is a term used by turf managers for both prostrate and spotted spurge. Both contain spots on their upper leaves, milky sap in their branches, and have a spread-

ing growth habit. It is a summer annual and prolific seed producer with a lengthy period of germination throughout the spring and summer. Spurge is best controlled with preemergence herbicides.

Sow thistle is an annual with flowers similar to dandelion but its leaves have spines on the edges and deeper indentations. Selective control is effective.

Herbicides

Herbicides are chemicals used to kill or inhibit the growth of plants. There are many kinds of herbicides for general and specific weed control available in a number of packaged forms. All are subject to the influences of environmental conditions and man's ability to use them to his best advantage.

Herbicides can be mixed, depending upon formulation and chemical compatibility with other herbicides or adjuvants to increase efficiency. Many herbicides are premixed to make your job easier and to provide control of a number of weeds. Use premixed herbicides unless you understand all the complexities and safety considerations.

Mode of action, length of residual, and selectivity are good ways to differentiate herbicides. All herbicides can be categorized by the following outline.

1 FOLIAGE APPLIED
- **A** Contact
  - ☐ Selective
  - ☐ Nonselective
- **B** Translocated (Systemic)
  - ☐ Selective
  - ☐ Nonselective

2 SOIL APPLIED
- **A** Short Residual
  - ☐ Selective
  - ☐ Nonselective
- **B** Long Residual
  - ☐ Selective
  - ☐ Nonselective

Foliage applied—contact—selective herbicides are of little importance in turf or landscape.

Foliage applied—contact—nonselective herbicides for turf and landscape uses include paraquat and cacodylic acid(Phytar 560). These herbicides will kill all green and growing foliage contacted by the spray solution.

Dormant bermudagrass, zoysiagrass, and other warm-season perennial turfgrasses are not usually affected by application of this type of herbicide. To escape injury, foliage must be completely dormant.

Contact type herbicides enter the plant where applied and do not move significantly beyond that point (limited upward or downward translocation). Spray volume and coverage of the leaf surface of the target plants is very critical for maximum control. Extremely low volume applications will often result in inadequate coverage and will kill only

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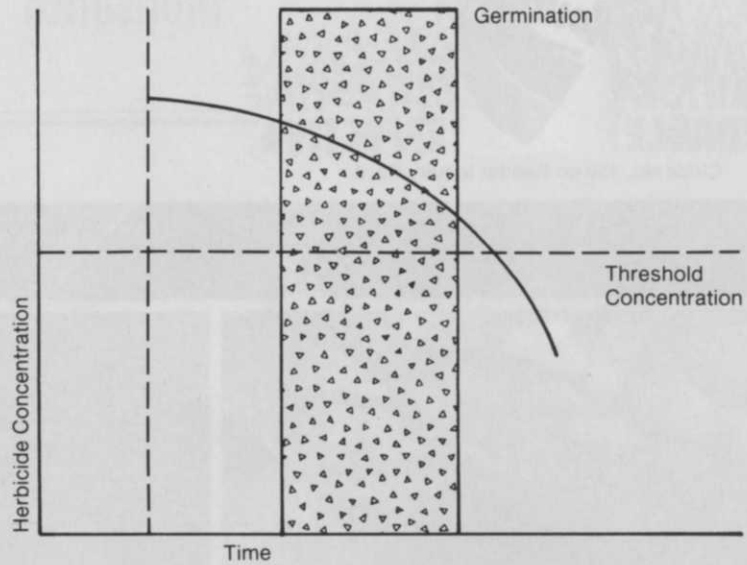
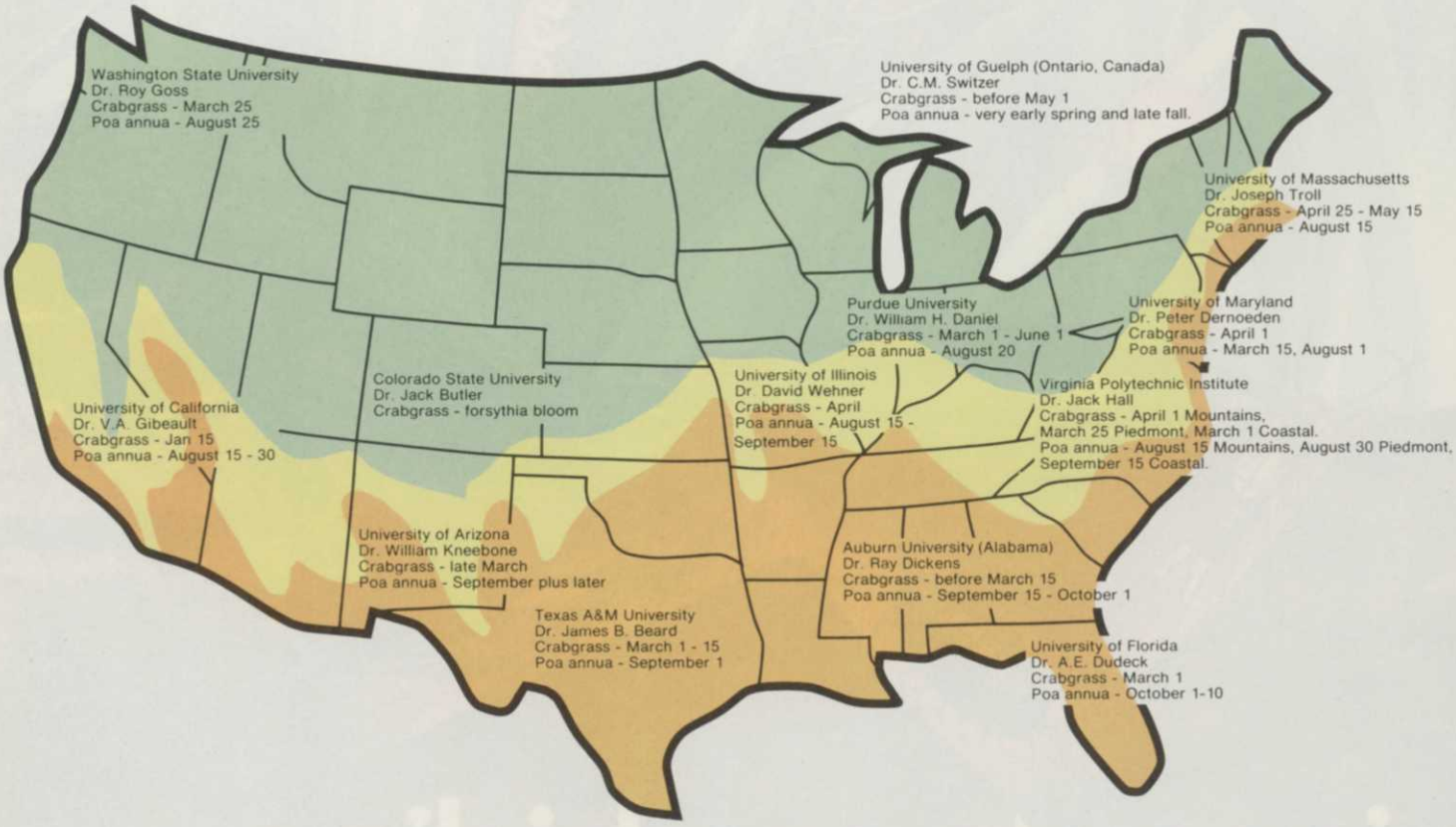
The effect of delaying the application of preemergence herbicides



Suggested Timing for Preemergence Herbicides to Control Crabgrass and Annual Bluegrass



the upper layer of the foliage canopy. Regrowth occurs in a comparatively short period of time.

Increases in control and speed of activity of contact herbicides depends upon the volume of water mixed with them. Increases in activity can be demonstrated up to 50 to 60 gallons per acre of water used. Control is generally poor with less than 20 gallons per acre. A good compromise is 30 to 40 gallons per acre.

Foliage applied—translocated—selective herbicides are absorbed into the plant at point of contact and spread throughout the plant tissues. These herbicides are most effective when applied to actively growing weeds that are storing food reserves in underground structures, such as roots, rhizomes, and tubers. For example, dandelions are most effectively killed by 2,4-D applied in the fall when the plant is storing reserves in its taproot.

The most common foliage applied-translocated-selective herbicides are the phenoxys (2,4-D, mecoprop), dicamba(Banvel), bromoxynil, and the arsenicals (MSMA and DSMA). They are the only group of selective herbicides effective on perennial weeds since they kill the foliage and the reproductive structures.

Spray volume and coverage is not as critical with translocated herbicides as with contacts. However, adequate coverage is essential for maximum weed control (spray volumes from 30 to 40 gallons per acre).

Foliage applied—translocated—nonselective herbicides are used in peripheral areas, such as along fences or structures, and for renovation of turf areas. Examples of foliage applied-translocated-nonselective herbicides are dalapon(Dowpon), amitrole, and glyphosate(Roundup). These materials generally control all weed species sprayed.

Like foliage applied-contact-nonselective herbicides, translocated-nonselective herbicides can be used to control cool-season perennial grasses infesting warm-season turf when applied while

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CHART 1
Growth and treatment periods

Weed	SPRING			SUMMER			FALL			WINTER		
	Early	Mid	Late	Early	Mid	Late	Early	Mid	Late	Early	Mid	Late
Barnyardgrass												
Bedstraw												
Bellflower, creeping												
Bindweed, field												
Bluegrass, annual												
Brome, smooth												
Carpetweed												
Chickweed, common												
Chickweed, mouseear												
Clover, white												
Crabgrass												
Dandelion												
Deadnettle												
Dock												
Fescue, tall												
Foxtail												
Garlic, wild												
Goosegrass												
Henbit												
Ivy, ground												
Knotweed, prostrate												
Kochia												
Mallow												
Medic, black												
Moss												
Nimblewill												
Nutsedge, yellow												
Pigweed, prostrate												
Plantain												
Puncturevine												
Purslane, common												
Quackgrass												
Sanbur												
Shepherdspurse												
Sorrel, red												
Speedwell												
Spurge, prostrate*												
Thistle, Canada												
Thistle, musk												
Vervain, prostrate												
Violets												
Waterleaf (nyctelea)												
Woodsorrel, yellow												
Yarrow												

Active period of plant growth. Varies from year to year and from north to south.
Apply preemergence chemicals.
Apply postemergence treatments. Approximate periods may vary two weeks from season to season.

* Preemergence herbicide applications should be made a second time in late June or early July.

the warm-season grass is dormant.

Soil applied—short residual—selective herbicides include preemergence herbicides such as DCPA(Dacthal), benefin(Balan), bensulide(Betasan), atrazine, simazine, and pronamide. Simazine and pronamide applied to the soil will also control established annual bluegrass as preemergence herbicides.

Maximum residual activity of these herbicides is a matter of weeks to a few months, compared to several months for long residual herbicides. Spray volume is not as critical as with postemergence herbicides, but even distribution in necessary for uniform effective control.

Preemergence herbicides are the best approach to control weeds germinating from seed. They eliminate competition from newly germinated weeds prior to application of postemergence herbicides.

Soil applied—short residual—nonselective herbicides are used as temporary soil sterilants. They are usually referred to as fumigants and include methyl bromide and metham(Vapam). They are active in the vapor forms.

Methyl bromide is a gas at atmospheric pressure while metham is a liquid that converts to a toxic gas in the soil. Because of their volatile nature, both compounds require some kind of sealing to prevent vapor loss to the atmosphere. A plastic or gas-tight cover must be used for methyl bromide fumigation. Water can serve as the seal for metham, although a plastic cover makes control more consistent.

Both herbicides are excellent for killing vegetative structures of perennial plants such as bermudagrass, nutsedge, and torpedograss and are effective on a large number of weed seed, fungi, and insects.

This group of chemicals is the only one that will kill weed seed before germination. All other herbicides work only if applied to germinating or germinated seed.

The effectiveness of fumigants is highly dependent upon soil moisture, temperature, compaction, and texture. They are most effective when applied to friable or well-aerated soils at temperatures above 70 degrees F. Diffusion of vapors can be

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restricted by excess moisture or compacted soils.

Soil applied—long term residual—selective and nonselective herbicides will provide total vegetation control for several months. They are used primarily for rights-of-way and peripheral weed control along fences and buildings. They last too long for turf renovation and may move laterally in the soil to various degrees.

Bromacil(Hyvar) and borate compounds are just a few examples. Several mixtures of these and other compounds for quick foliage kill, such as amitrole, are available.

Extreme care should be taken when applying these herbicides near desirable plants.

Conditions are key to herbicide effectiveness

Most herbicidal failures aren't failures of the herbicide. They are the result of using herbicides without full consideration of the conditions which make them most effective. These conditions include temperature, moisture, timing, application method, and characteristics of the target weed.

To be most effective, herbicides must be applied at the appropriate time in relation to germination or growth of the target weed species and in the right place.

In turf, postemergence herbicides are applied directly on the target weed and preemergence herbicides are applied to the soil.

Since most herbicide applications are made on established turf, it may appear preemergence herbicides are applied to the foliage. In fact, they must be washed off the foliage and down to the soil to be effective, either by supplemental irrigation or rainfall.

With postemergence herbicide applications, irrigation or rainfall is detrimental since the herbicide needs to cling to and be absorbed by the weed foliage.

Preemergence applications should be made before weed seed germinates and should last throughout the germination period to be effective. They do not have any effect on established weeds. Their action is exerted only after the seed germinates and growth commences.

Theoretically, preemergence herbicides form a chemical barrier between the weed seed and the soil surface. Therefore, they must be applied uniformly to the soil prior to germination to be effective. A critical threshold concentration of preemergence herbicide must be maintained in the soil throughout the germination period. Preemergence herbicides with short soil residual may require split applications to maintain the critical concentration.

Dry soil severely reduces the effectiveness of preemergence herbicides unless moisture is added soon after treatment.

Postemergence applications are applied to the weed foliage following germination and emergence. They act either as contact or systemic (absorbed and translocated) herbicides.

Contact herbicides act rapidly while systemic herbicides usually require several days to produce visible results. Systemic herbicides usually kill the entire plant while contact types only kill the foliage contacted by the herbicide.

Postemergence herbicides are most effective when applied to young, actively growing plants when the temperature is above 70 degrees F. Foliar applied herbicides are also less effective if soil is dry.

Surfactants are frequently recommended for use with postemergence herbicides. For consistent results use nonionic agricultural surfactants, sold specifically for use with herbicides.

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Herbicide selection

Since the growth of the professional lawn care industry, the choice of turf herbicides and formulations has increased. Two or more herbicides may be equally effective in a given weed situation. Also, the same chemical may be available in a variety of commercial formulation trade names.

Selection of a herbicide and formulation is determined by:

- the weed species involved
- the availability of the herbicide
- type of equipment at your disposal
- time of application
- your budget for weed control
- precautions needed to limit exposure to desirable plants, humans, and animals, and
- residual of the product.

All recommended rates of application are based on either active ingredient or acid equivalent. Commercial products may have the same herbicides but have different percentages of active ingredients. The label will provide the exact amount of herbicide in the container. It is wise to figure the price of a product on the basis of its active ingredient or acid equivalent.

For example, a herbicide is available in liquid formulations varying from six to less than one pound acid equivalent per gallon. Usually, the more concentrated products are more economical on a per pound basis.

Granular formulations of many herbicides are also available. In comparison to sprays, granular herbicides have both advantages and disadvantages.

The advantages are simpler application—no water or mixing required, less drift, and a tendency toward longer activity in the soil.

Disadvantages of granular herbicides are difficult calibration of application equipment and slightly higher cost.

The range of concentration, particle size of product, and varying rates of application complicate calibration. More concentrated materials are usually more economical but calibration errors are more critical. Calibration charts are supplied by manufacturers of granular applicators. Application equipment should be calibrated prior to intitial use each season and periodically checked during the season. This will ensure safe, effective and economical control.

Weed control strategy for warm season turf

Bermudagrass is the dominant turf species in warmer climates. In general, herbicides that can be used on bermudagrass can be used safely on zoysiagrass.

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Tolerance of turfgrasses to preemergence and postemergence herbicides in Alabama - R. Dickens

	PREEMERGENCE									POSTEMERGENCE									
Established Turf	Oxadiazon	Siduvon	Pronamide	Benefin	DCPA	Napropamide	Bensulide	Atrazine	Simazine	ASU/AM	MSMA, DSMA CAMA	2, 4-D	Dicamba	Glyphosate	Mecoprop	Paraquat	Dichlorprop	Dalapon	Bromoxynil	Benfazonn
Warm Season																				
Bermudagrass	T	S	T	T	T	T	T	I	I	I	T	T	T	D	T	D	T	S	T	T
Zoysiagrass	t	-	I	T	T	-	T	T	T	S	T	T	T	D	T	D	T	S	T	T
Centipedegrass	s	-	I	T	T	T	T	T	T	S	S	I	I	D	I	D	I	S	-	T
St. Augustinegrass	T	-	I	T	T	T	T	T	T	T	S	I	I	D	I	D	I	S	T	T
Bahiagrass	-	-	-	T	T	T	T	O-S	I-S	S	I-S	T	T	D	T	D	T	S	-	T
Cool Season																				
Tall Fescue	t	T	S	T	T	T	T	S	S	-	T	T	T	S	T	S	T	S	T	T
Red Fescue	s	T	S	T	T	-	T	S	S	-	I	I	I	S	T	S	T	S	T	T
Kentucky Bluegrass	t	T	S	T	T	-	T	S	S	-	T	I	I	S	T	S	T	S	T	T

T Tolerant.
I Intermediately tolerant; use herbicide with care.
S Sensitive; do not use this herbicide.
D Dormant grasses tolerant to this herbicide; will kill growing plants.

NOTE: Some of the above combinations show a tolerance rating although such usage is not currently labeled.

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However, special attention should be paid to herbicide labels regarding applications to centipedegrass and St. Augustine, which are similar to each other in their tolerance to herbicides.

Winter grass weeds Annual bluegrass is by far the most severe grassy weed infesting southern turf areas during the late growing season, through the dormancy period, and into the early growing season.

Beside decreasing the aesthetic value of turf, the primary objection to annual bluegrass is its rapid dieback in late spring. Bermudagrass coverage is usually slow following fade out of annual bluegrass leaving large sections of bare ground exposed. Other weeds, such as goosegrass, tend to move into bare areas.

Annual bluegrass control with preemergence herbicides is usually accomplished with either benefin(Balan), bensulide(Betasan), DCPA(Dacthal), Pronamide(Kerb), simazine(Princep) or oxidiazon(Ronstar). Two applications may be necessary during the dormant season for acceptable control except with Pronamide or simazine.

Pronamide and simazine provide either preemergence or postemergence control of annual bluegrass in bermudagrass.

There are two choices for annual bluegrass control on bermudagrass greens overseeded with perennial ryegrasses. Bensulide may be applied prior to overseeding. Ethofumesate(Prograss) may be applied 15 to 30 days after overseeding. Check both labels for timing to avoid delaying spring transition back to bermudagrass.

Broadleaf weed susceptibility to herbicides[1,2]

Weed	2,4-D	Mecoprop	Dicamba
Mustards	S	I	I-R
Nutsedge	I	R	R
Onion, wild	I	R	S-I
Ornamental plants	S-I	S-I	S
Oxalis (woodsorrel)	R	R	I
Pennycress	S	I	S
Pepperweed	S	S-I	S
Pigweed	S	S	S
Plantains	S	I-R	I-R
Poison ivy	I	R	S-I
Ponyfoot (dichondra)	S	I	S-I
Purslane	I	R	S
Red sorrel	R	R	S
Shepherdspurse	S	S-I	S
Speedwell	I-R	I-R	I-R
Spurge, prostrate	I	I	S
Spurge, spotted	I-R	S-I	S-I
Spurweed	S-I	I-R	S
Thistle, musk, curl	S	I	S
Thistle, Canada	I	I	S
Vegetables	S	S	S
Wild carrot	S	S-I	S
Wild strawberry	R	R	S-I
Wild violet	I-R	R	—
Yarrow	I	I-R	S
Yellow rocket	S-I	I	S-I

S = weed susceptible; R = resistant weeds; I = intermediate, good control at time with high rates, sometimes poor, usually require more than one treatment.

Another approach employed particularly on golf courses, is to use a postemergence application of a nonselective herbicide such as paraquat, glyphosate, or cacodylic acid prior to the warm-season turf breaking dormancy. This usually does an excellent job on annual bluegrass as well as annual broadleaf weeds present. Injury is often encountered if application is delayed until the bermudagrass starts breaking dormancy. The degree of injury is dependent on the amount of green foliage at the time of application.

Winter broadleaf weeds Important warm-season winter broadleaf weeds include common chickweed, henbit, clovers, spurweed, mouse-ear chickweed, lawn burweed, common dandelion, wild onion, wild garlic, plantains, and speedwells.

Preemergence control of some species can be obtained with benefin, bensulide, DCPA, simazine and other herbicides.

Henbit, chickweed, and clovers usually require something other than 2,4-D for postemergence control. In dormant bermudagrass and zoysiagrass, dicamba or combinations with dicamba are used often for postemergence control.

The phenoxys are safe on completely dormant turfs. Actively growing turfs vary considerably in tolerance to phenoxy materials.

St. Augustine will usually tolerate a .5 lb/A of 2,4-D with only minimal injury. At rates above .5 lb/A, St. Augustine is usually injured. This may be unimportant when using phenoxys on dormant warm-season turfs, but invariably application is made during spring transition. All turfgrasses are more suceptible to phenoxy injury during this transition period. The combination of mecoprop plus chlorfurecol is often used, especially by the homeowner on St. Augustine.

Summer grass weeds Large

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crabgrass and dallisgrass invade more turf acreage in the southern United States than any other grasses. Germinating seeds of both can be satisfactorily controlled with benefin, bensulide, DCPA, atrazine, and simazine. Certain formulations of atrazine are labeled for use on St. Augustine, zoysia, and centipede for sod production while other commercial products containing atrazine are labeled for homeowner use.

Only asulam is used for postemergence control of crabgrass and dallisgrass in St. Augustine. MSMA and DSMA are effective postemergence herbicides for these weeds in bermudagrass. The arsonates are used almost exclusively for dallisgrass control in bermuda and zoysia.

Goosegrass is the most difficult summer grass to control in the South. Timing of application of preemergence herbicides is of paramount importance if control is to be achieved. We generally think goosegrass starts germinating in significant quantities four to six weeks after crabgrass. However, this can and does vary.

If application of a preemergence herbicide is delayed, large crabgrass will escape because it germinates earlier than goosegrass. In bermuda and zoysia, large crabgrass can be controlled quite effectively with postemergence applications of the arsonates. Use of preemeergence herbicides would appear to be a better approach to goosegrass control than postemergence control with arsonates.

Oxadiazon (Ronstar) gives excellent season-long control of goosegrass, but it is more expensive than other herbicides. Research has shown postemergence applications of MSMA plus metribuzen (Sencor) gives good control of goosegrass.

Sandbur and bahiagrass in bermuda and zoysia can be controlled with arsenicals. There is no selective control of torpedograss

in southern turf at the present time.

Both annual and perennial sedges are problems in the South. Purple nutsedge and, to a lesser extent, yellow nutsedge are the most severe problems. Multiple applications of arsenicals or an arsenical/phenoxy combination are generally recommended for purple nutsedge, only on bermuda or zoysia. Basagran can be used for yellow nutsedge control.

Summer broadleaf weeds Broadleaf weeds are a problem throughout the South in turf, but not to the extent of the grassy weeds, such as dallisgrass, large crabgrass, and goosegrass.

Prostrate spurge and Virginia buttonweed are important and difficult to control broadleaf weeds. Multiple applications of 2,4-D plus dicamba, Trimec or Trex-San are almost always necessary. Researchers suggest the use of a nonionic surfactant with the herbicides.

Highway weed control Herbicides are being used more extensively each year on southern roadsides. Several states, including Alabama, California, Louisiana, Virginia, North Carolina, and Florida have well-developed vegetation management programs.

The primary reasons for the increasing use of herbicides in roadside management are increased safety from more prolonged control of tall growing species and reduced maintenance costs.

Most of the vegetation management programs in the South are designed to convert the turf to monostands of either common bermudagrass or bahiagrass.

Multiple applications of the arsonate herbicide MSMA, in conjunction with 2,4-D, are common. However, sulfometuron-methyl (Oust) has shown very promising results in areas having greater than 50 percent stands of bermuda at the time of application. In bahiagrass areas, diuron and atrazine have given promising results in most states.

Once the roadsides are converted to common bermuda or bahiagrass, cool-season weeds become the major problem. Tall fescue is a real problem in this situation due to its prolific seedhead production in the early spring. Winter application of glyphosate or sulfometuron have shown promise in control of this species in Alabama.

Vegetation management programs necessarily vary from state to state due to the profound differences in environmental conditions and public acceptance. However, there is no doubt that the substitution of herbicide spraying for the slower, more costly, and dangerous mowing will increase as new technology in chemicals and application methods are developed.

Weed control strategy for cool season turf

The primary preemergence her-

bicides for grassy and broadleaf weeds in cool-season turf are benefin(Balan), bensulide(Betasan, Betamec-4, Pre-San, Lescosan), DCPA(Dacthal), oxadiazon(Ronstar), and siduron(Tupersan).

Siduron is the only preemergence herbicide that can be applied near time of seeding. Bensulide and DCPA can be applied in the spring following a fall seeding.

Benefin and oxadiazon should be applied to established turf. Bensulide can affect rooting of existing bermudagrass and caution is advised for use of most preemergence herbicides on bermudagrass greens. Thinning of fine fescue stands from preemergence herbicides has also been reported.

Preemergence herbicides should be watered in to get the chemical to the seed prior to germination. They should be applied two weeks prior to the expected germination time and should last throughout the period. Second applications may be necessary to achieve this. Contact your local extension agent for germination times for primary weeds.

The primary postemergence herbicides for grassy weeds in turf are the arsenates; MSMA, DSMA, CMA, and MAMA. Treated areas should not be reseeded for a month or more after application. See labels for delay period.

Bentgrass and fescue are more sensitive to arsonates than other cool-season grasses. CMA is the safest for bentgrass.

Weed foliage should be sprayed while still young (two to three leaf stage) if possible. The effectiveness of arsonates improves with temperature and rates need to be increased for temperatures below 80 degrees F.

The primary postemergence herbicides for broadleaf weeds are 2,4-D, 2,4-DP, dicamba(Banvel), and MCPP. Garlon(Trychlopyr) has shown promise for control of some of the more difficult-to-control broadleaf weeds, such as knotweed and yellow wood sorrel.

These herbicides should not be applied until a new lawn has had at least three mowings. The target weed weeds should be actively growing for best results. The temperature should be at least 60 degrees F. Applications during extreme heat or drought can cause severe damage to desirable turf.

Two treatments of postemergence herbicides are generally necessary to control broadleaf weeds. See labels for the proper interval between applications.

Winter annuals can be sprayed early in the year, followed by summer annuals and perennials. Fall treatment for perennials is possible.

Postemergence herbicides are often combined to achieve improved control and reduce application time.

Occasionally, a landscape manager chooses to fumigate a seedbed prior to planting to reduce weed seed, control insects and fungi, and eliminate offtype grasses. Methyl bromide(Dowfume), metham(Vapam), dazomet(Mylone) and Vorlex are used for preplant fumigation. See labels for delay period after fumigation for seeding or planting.

Renovation of turf stands is gaining acceptance, especially since the development of glyphosate(Roundup) for turf. During renovation all existing vegetation is killed and the area is reseeded in a matter of weeks. Glyphosate is deactivated within a few days following application, but a delay of two weeks is recommended. Amitrole, cacodylic acid(Phytar), and dalapon can also be used, but the delay period before seeding is longer.

Highway weed control Highway landscape managers have had two reasons to hold back on use of herbicides recently, increased sensitivity by the public to chemicals and tightened budgets. After all, mowing utilized equipment and crew on hand and did discourage tall or woody plants from blocking the view of drivers.

Roadsides are intended to be the lowest maintenance of turf areas. The need is really a groundcover which prevents erosion, does not block driver vision, and requires little to no care.

But, any area left untended for very long will return to a natural state with taller plants blocking drivers' vision. Current standard operating procedures solve these problems with the primary control being mechanical.

Weed control along fences, dividers and signs however, is predominately chemical today. Mechanical control of these areas is impractical. Nonselective, long residual herbicides are standard. A few new herbicides for these areas are on the way. Application equipment for these areas fits the needs.

Part of the problem for larger areas of turf or groundcover may be equipment. Existing chemicals for selective weed control on roadsides are effective, but the application equipment does not adequately consider drift, even distribution, or the feelings of the public regarding chemicals. Boom sprayers or the new wick-type applicators would better meet these considerations but they are impractical for use on steep slopes or embankments.

The solution for steep or difficult-access areas is a groundcover such as crown vetch. However, crown vetch, a legume, should not be sprayed with phenoxys. Drift must be watched when spraying areas where cool-season grasses are adjacent to crown vetch.

Stands of hard or tall fescue have been tried on steep slopes in the Los Angeles area with success. Other native grasses, such as buffalograss, are being used in Western Plains states to eliminate the need for irrigation. Initial selection, or even renovation in some areas, to native grasses can greatly reduce maintenance. **WT&T**