

WEED CONTROL GUIDE

Prepared by the staff of
Weeds, Trees & Turf



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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-



Poa Annua



Crabgrass

emergence herbicide applications.

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 aeration, 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

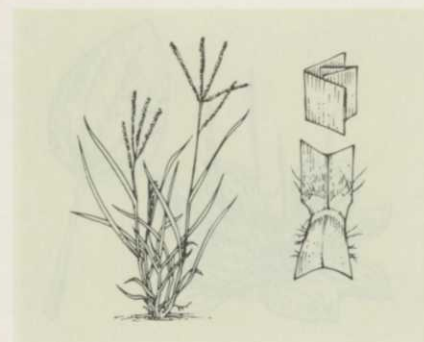
All plants can be classified according to life cycle as either annual, biennial, or perennial.

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



Nutsedge



Goosegrass

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.

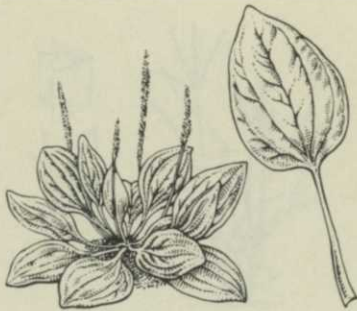
PERENNIALS live for three or more years and are especially difficult to control because they reproduce by vegetative means, by seed, or both. Perennials are often well-established before their presence is recognized. Examples are dandelion, yellow nutsedge, quackgrass, wild onion and garlic, torpedograss,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

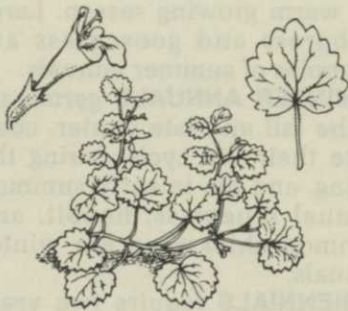
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Tall Fescue



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 Persistent 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 pre-emergence 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 non-selective, 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 grass-like 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.

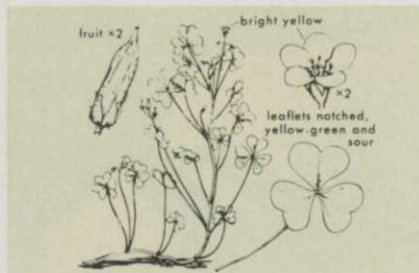
Broadleaf weeds

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.

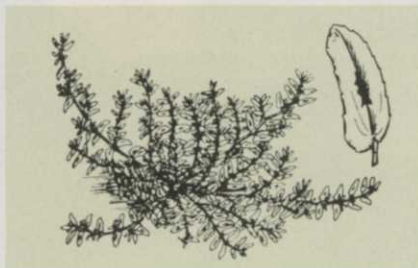
Mouse-ear chickweed resembles common chickweed in its spreading growth habit, but it is



Yellow Wood Sorrel



Speedwell



Spurge



Heal-all

perennial and has fuzzy leaves.

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 her-

bicides 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.

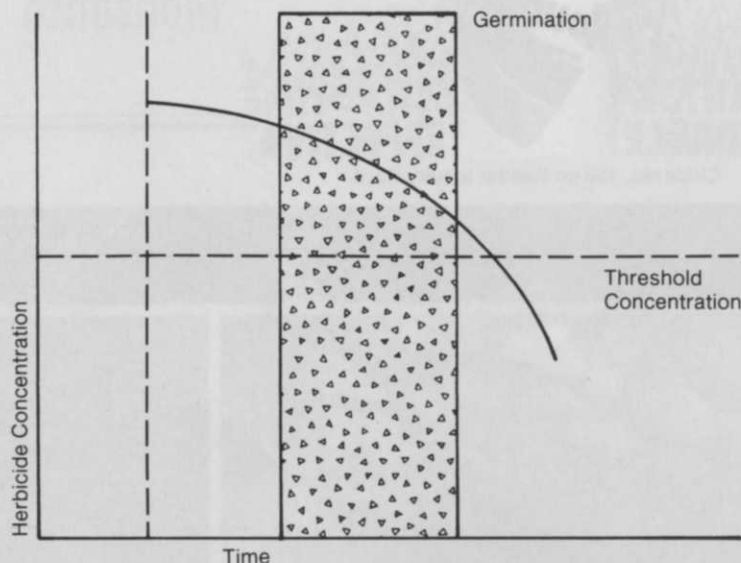
Foliage applied—contact—nonselective herbicides for turf and landscape uses include paraquat and cacodylic acid (Phytar 560). These herbicides will kill all green and growing foliage contacted by the spray solution.

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.

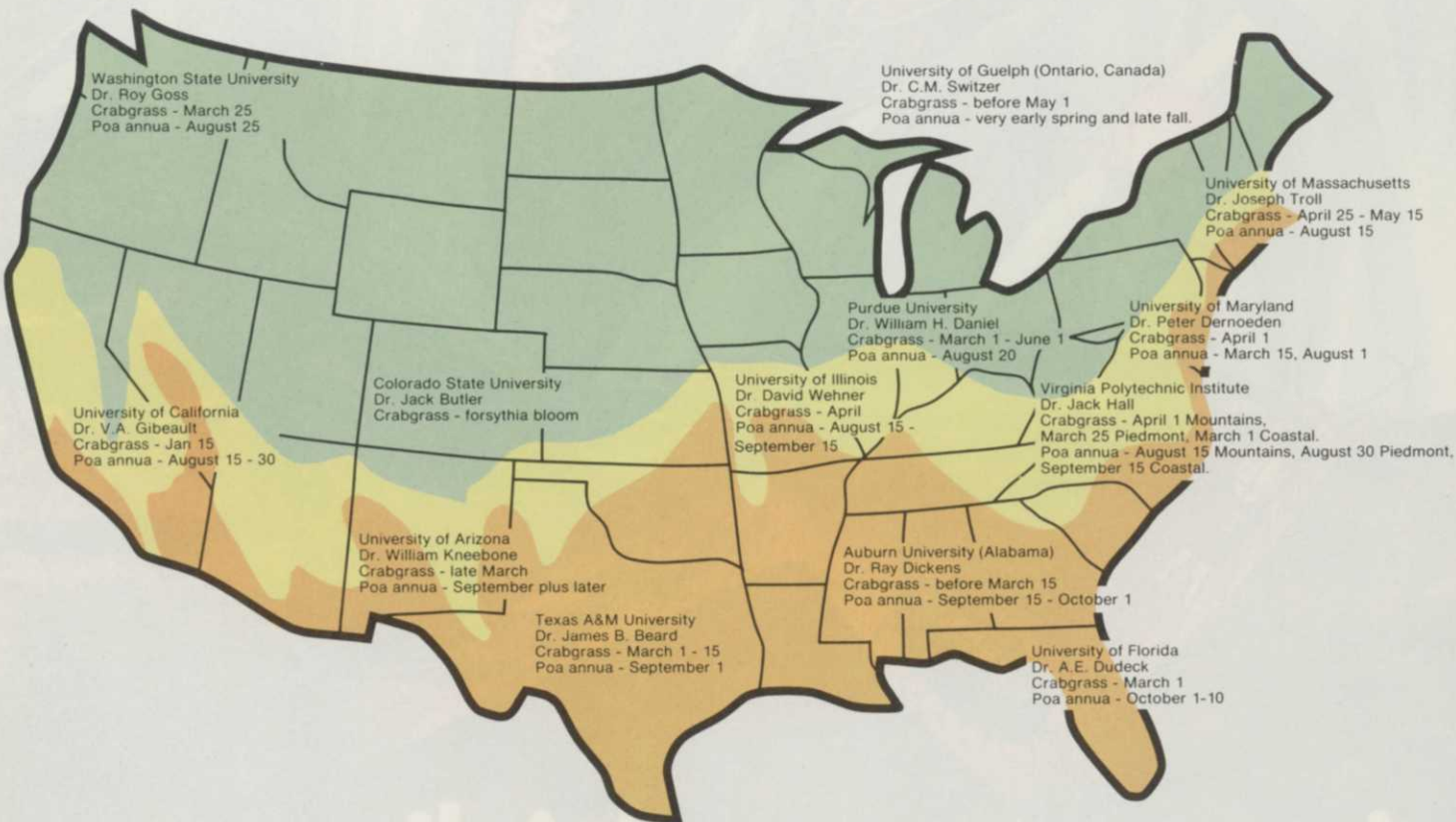
Contact type herbicides enter the plant where applied and do not move significantly beyond that point (limited upward or downward translocation). Spray volume and coverage of the leaf surface of the target plants is very critical for maximum control. Extremely low volume applications will often result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

continued on page 46

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 phenoxy (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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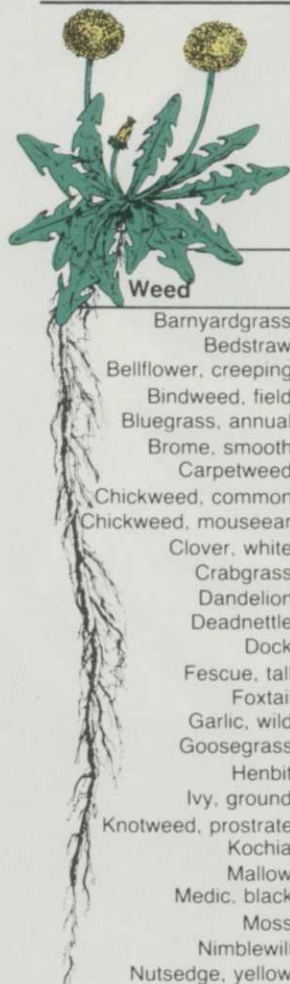


CHART 1
Growth and treatment periods

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 pre-emergence 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 pre-emergence 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 is 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 her-

bicides 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 initial 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

Established Turf	PREEMERGENCE								POSTEMERGENCE											
	Oxadiazon	Siduvon	Pronamide	Benflin	DCPA	Napropamide	Bensulfide	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.

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.

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 phenoxy 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 phenoxy on dormant warm-season turfs, but invariably application is made during spring transition. All turfgrasses are more susceptible to phenoxy injury during this transition period. The combination of mecoprop plus chlorfurecol is often used, especially by the homeowner on St. Augustine.

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.

Summer grass weeds Large
continued on page 62

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 preemergence 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 seed-head 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-

TURF

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 pre-emergence 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 pre-emergence herbicides on bermudagrass greens. Thinning of fine fescue stands from pre-emergence herbicides has also been reported.

Pre-emergence 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 post-emergence 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 arsenates 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 arsenates improves with temperature and rates need to be increased for temperatures below 80 degrees F.

The primary post-emergence 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 post-emergence 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.

Post-emergence 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 off-type grasses. Methyl bromide (Dowfume), metham (Vapam), dazomet (Mylone) and Vorlex are used for pre-plant 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

LANDSCAPE

by Dr. Elton Smith

Rising labor costs have caused an increase in the use of both preemergence and postemergence herbicides in landscape maintenance.

The landscape manager has to control weeds around a variety of desirable plant material, including deciduous and evergreen shrubs, bulbs, annual and perennial flowers, and ornamental grasses. He uses herbicides to control weeds under trees, in sand traps, around grave markers, in patios, along fences, in plant beds and groundcover, and in containers.

The effectiveness of a weed control program depends on proper selection, calibration, calculation, and application of herbicides. Reading the label is critical to see what desirable plants may be intolerant to certain

herbicides.

The weeds involved are much the same as in turf. Annual weeds, such as crabgrass, foxtail and purslane are relatively easy to control by a combination of mulching, cultivation, hand pulling, and preemergence weed control. Perennial weeds, such as bindweed, thistle, quackgrass and nutsedge, are more difficult to control because of extensive root systems.

It is important, especially with perennial weeds, to eliminate them prior to planting. There are virtually no selective postemergence herbicides to help you out when weeds take over. The variety of plant material makes it impossible for herbicides to distinguish between weeds and desirable plants. Non-selective foliage-applied postemergence



herbicides can be used only with extreme care if they do not leave residue in the soil. For example, Roundup can be applied to the foliage of weeds with a wick applicator or glove.

Prior to planting

The most successful approach to a weed-free landscape is to control perennial grasses and broadleaf weeds prior to preparing the area for planting.

Spraying the weeds in an area with one of several postemergence systemic herbicides, which will be translocated to the root system for total plant control, is one of the most effective methods of control. Examples of such herbicides are 2,4-D and related products for broadleaf weed control, dalapon for grass control, and amitrole for general weed control. Each of these normally has to be applied more than once and most have a specific waiting period prior to planting. Glyphosate (Roundup), a very effective product for perennial grass and broadleaf weed control, has no soil residue.

A number of preemergence herbicides are labelled for landscape plants and two are recommended for use prior to planting. Eptam or Treflan can be incorporated into the soil, following tillage, to control annual and some perennial weeds for a period of four to six weeks. Following incorporation to a depth specified on the label, ornamentals can be

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planted. This method has been used extensively by commercial nurserymen and is now being used by landscape contractors to a large extent, especially where maintenance for a specified period of time is in the contract.

Tillage as a method of weed control prior to planting is a successful practice for the control of annual weeds but not perennial weeds. In some cases, tillage only cuts up the root systems of perennials into smaller pieces and distributes them.

Following planting

In recent years the landscape industry has made extensive use of mulches to prevent weeds in the landscape.

Mulches should be applied about two-inches deep and renewed to that depth annually. Mulch layers much deeper than two inches accomplish little and may actually harm shallow-rooted ornamentals according to new research at the University of Maryland.

Many types of mulches are available, however, the most popular include hardwood, Cypress and pinebark mulches along with wood chips, peat moss, and an assortment of hulls and inorganic materials. Barks and inorganic materials will not rob nitrogen from the soil as raw organic material will. When using compost, make sure it has had enough time to fully break down during composting and weed seed in it is sterile.

Some weeds will come through the mulches. These must be hand pulled or sprayed. Seeds will be carried into planting beds by wind and birds and will often germinate in the mulch. Again, hand pulling is the most satisfactory control measure in small areas, however, landscape personnel are using more and more herbicides, such as glyphosate.

Several preemergence herbicides can be used as an alternative to, or in combination with

mulches. They control annual weeds for a period of four to eight weeks. Reapplications are usually necessary to achieve season-long control depending on selection of herbicide, soil, and climatic conditions.

Typically the first application of preemergence herbicides should be made prior to weed seed germination. Subsequent treatments can be made as needed, based upon regrowth of annual weeds. The soil should be weed-free and moist prior to application or the treatment should be followed by irrigation or rain.

It is important to know how much area is included in the beds to be treated. Once the area is calculated, determine the amount of herbicide needed for that area based upon the label recommendations. Apply the herbicides with equipment that is properly cali-

brated and in good working order.

Postemergence herbicides for landscape weed control

Postemergence herbicides are used for general weed cleanup around buildings, waterways, ditchbanks, fence rows, etc. Used with extreme care, these materials may be used in tree plantings. However, avoid herbicide contact with foliage and green, yellow or immature bark.

Pre- and postemergence herbicide combinations

Preemergence and postemergence herbicides can be combined to kill existing weeds and prevent emergence of others. Combinations of paraquat or Roundup with Princep, Phytar 560, or Surflan have been used extensively in trees with excellent success. **WT&T**

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Calculating rates and quantities

Granular Materials

Example—A landscaper needs to treat 4,000 sq. ft. of Juniper with 4% RONSTAR granules at 4 lbs. aia. How much RONSTAR is required?

Formula

$$\text{lbs. aia} \times \frac{\text{sq. ft. to be treated}}{44,000 \text{ sq. ft./acre}} \times \frac{100}{\% \text{ granular}} = \text{lbs. required to treat area}$$

Calculation

$$4 \text{ lbs. aia} \times \frac{4,000}{44,000} \times \frac{100}{4} = 9.1 \text{ lbs. 4\% granular RONSTAR}$$

Wettable Powders

Example—A landscape firm needs to treat 4,000 sq. ft. with 50% DEVRINOL wettable powder at the rate of 10 lbs. aia.

Formula

$$\text{lbs. aia} \times \frac{\text{sq. ft. to be treated}}{44,000 \text{ sq. ft./acre}} \times \frac{100}{\% \text{ powder}} = \text{lbs. required to treat area}$$

Calculation

$$10 \text{ lbs. aia} \times \frac{4,000}{44,000} \times \frac{100}{50} = 1.8 \text{ lbs. 50\% DEVRINOL W.P. to be mixed in enough water to cover 4,000 sq. ft.}$$

Liquid Concentrate

Formula

$$\text{lbs. aia} \times \frac{\text{sq. ft. to be treated}}{44,000} \times \frac{1}{\text{lbs. active ingredient/gallon}} = \text{gallons required to treat area}$$

Calculation

$$2 \text{ lbs. aia} \times \frac{22,000}{44,000} \times \frac{1}{4} = .25 \text{ or } \frac{1}{4} \text{ gal. TREFLAN to be mixed in enough water to cover } \frac{1}{2} \text{ acre}$$

AQUATIC

Lakes, ponds, and streams are central features to many landscapes. The best maintained landscape around a weed-infested lake is a failure. Both land and water must work together for a complete landscape.

A water feature without plants is not the objective either. Plants produce oxygen needed for a healthy, balanced water environment. The lake should be designed as you would any landscape and maintained to preserve the design.

Whereas some water plants are usually a nuisance, such as hydrilla, watermilfoil, algae, and spinyleaf naiad, others can be managed to provide an attention-getting display. These include water lily, lotus, arrowhead, cattail and others.

Control measures are limited by the desirable plants in the lake and the use of the lake water for irrigation, fish farming, air conditioning, etc. If the lake is part of a watershed area, there may be restrictions on the use of certain

chemicals or weed-eating fish. Check with the extension service in your area before instituting an aquatic weed control program.

Preventative control

Aquatic weeds have the same needs as other plants; light, nutrition, and certain growing conditions. As on land, you want to encourage the desirable plants and discourage the weeds.

Typical conditions causing an aquatic weed problem are shallowness (less than eight feet deep), water in the lake does not circulate by currents or flow, and heavily-fertilized watershed drains into the lake. Concentrate first on these faults.

Weeds won't get established if sunlight can't reach the lake bottom in amounts satisfactory for growth. Banks should drop quickly so that very little of the lake is less than eight to ten feet deep. Areas where plants are desired can be kept shallow. An option to this is to plant aquatic displays in pots raised from the



lake bottom.

If this is impractical, dyes or *Chlorella sp.* algae can be used to shade out the sunlight at the surface. Another method gaining acceptance is Aquascreen, a fiberglass cloth which is placed over the lake bottom where weeds are not wanted. Bottom-rooted aquatic plants will not grow through the material. It can even be placed over growing vegetation if necessary.

Algae likes stagnant, warm
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AQUATIC



Mechanical aquatic weed harvester.



water. A pond aerator or recirculator can be used to mix the layers of water together, keeping temperatures down and adding oxygen to the water.

Plants produce oxygen needed for a healthy lake. Decaying plants or effluent rob water of valuable oxygen. Do not throw grass clippings into lakes. If possible, remove dead plants after chemical treatments.

In certain states, various weed-eating fish are legal. These and other fish feed on lake vegetation. They are restricted from certain states for fear they might reach major rivers and lakes.

Drawdown, or lowering the water level to expose aquatic weeds to full sun or freezing temperatures is used where fish or irrigation uses are not important. Dredging can also be tried to remove plants and deepen lakes. Mechanical weed harvesters are available for purchase or rent. They cut the bottom-rooted weeds below the surface for removal.

Remember, once you decide to use chemical controls, you must protect the desired aquatic plants. Also trees with roots extending into lakes may be effected by aquatic herbicides. Preventative measures should be tried before resorting to a chemical program.

Curative control

In certain areas it is impossible to defeat all the conditions favoring aquatic weeds. In warm climates, landscape managers fight a constant battle with aquatic weeds.

In cooler climates, summer provides better conditions for aquatic weeds and seasonal control may be needed.

Algae If preventative measures aren't enough to stop algae, then copper compounds (Cutrine) are effective. Used at correct rates, these compounds do not restrict water use for swimming, irrigation, watering stock or fish farming.

If the lake has a history of algae problems, start using copper compounds as soon as water temperatures reach 60 degrees F. Periodic retreatment may be necessary for season-long control.

Copper compounds are often mixed with other aquatic herbicides for control of a variety of weeds.

Floating weeds Floating weeds are either free-floating or bottom-rooted plants which have leaves that float on the water's surface. They include hyacinths, duckweed, water lettuce, floating fern, water pennywort, and salvinia.

The primary herbicides for floating weeds are 2,4-D and Diquat.

Submersed weeds Weeds which are bottom-rooted and totally under water are called submersed. They include hydrilla, pondweed, watermilfoil, and coontail.

The primary herbicides for submersed weeds are 2,4-D, endo-thall (Aquathol K), Diquat and combinations of Diquat and endo-thall with copper.

Emerged weeds These are weeds growing in shallow areas with stems and leaves above the water surface. They include cattails, duckweed, hyacinths, alligatorweed, torpedograss and arrowhead.

Primary herbicides for these are Banvel, 2,4-D, dalapon (Dowpon), diuron (Karmex) and amitrole.

Ditchbank weeds Emergent weeds and grasses are often problems on ditchbanks. Use herbicides listed for emergent weed. If the ditches are dry, glyphosate (Roundup) may be used. Caution should be taken to keep the glyphosate away from nearby bodies of water.

Herbicide precautions

Use of water following applications of aquatic herbicides may be restricted. Generally, copper compounds cause no delay in use. Wait 24 hours before swimming and seven days before irrigation when using endo-thall. Diquat requires certain delays up to ten days and should not be used in muddy water. Always check product labels for delays and precautions.

Proper calculation of the amount of herbicide is important. Rates are based on acre square feet. To calculate this figure you need to know both the area of the lake surface and the depth. Measurements should be taken rather than estimating. Multiply the area of the surface in acres by the average depth in feet. Your chemical supplier or extension agent can help you if you are uncertain of your calculations.

WT&T

DIRECTORY

Herbicide Directory

Herbicide	Brand Name(s)	Company	Uses
amitrole	Amitrole-T	Union Carbide	Non-selective grass and broadleaf control in non-crop areas including ditches, roadsides, industrial areas and marshes.
asulam	Asulox	Rhone Poulenc	Postemergence grassy weed control for turf and ornamentals
atrazine	atrazine	Ciba Geigy	Non-selective control in non-crop areas.
benefin	Balan	Elanco	Preemergence control of annual grasses and broadleaf weeds in established turf.
bensulide	Betasan Pre-San Lescosan Betamec-4	Stauffer Mallinckrodt Lesco PBI Gordon	Preemergence control of annual grasses and broadleaf weeds in established turf and established flower gardens. Safe near tulip and daffodil bulbs.
bentazon	Basagran	BASF	Selective postemergence control of nutsedge in warm-season turf.
bromacil	Hyvar	du Pont	Nonselective control of weeds and grasses in non-crop areas. Usually mixed with diuron for roadsides and rights-of-way.
bromoxynil	Brominal Buctril	Union Carbide Rhone Poulenc	Postemergence control of broadleaf weeds in seedling turf, established turf and non-crop areas.
cacodylic acid	Phytar Rad-E-Cate	Vertac Vineland	Nonselective control for turf renovation, edging and in plant beds.
chloramben	Amiben	Union Carbide	Preemergence control in ornamentals.
chlorfurecol	Maintain	Uniroyal	Growth regulator. Also controls broadleaf weeds and vines.
copper	Citrine-Plus	Applied Biochemists	Controls algae, chara and hydrilla in potable water.
dalapon	Dalapon 85 Dowpon M	SDS Biotech Dow	Selective control of perennial and annual grasses in non-crop areas and ditchbanks.
dazomet	Mylone	Hopkins Ag.	Preplant sterilant for turf and ornamental beds.

DIRECTORY

Herbicide Directory *continued*

Herbicide	Brand Name(s)	Company	Uses
DCPA	Dacthal	SDS Biotech	Preemergence control of annual grasses and broadleaf weeds in turf and ornamental beds.
dicamba	Banvel	Velsicol	Selective postemergence control of broadleaf weeds in turf and for noncrop control of brush.
dichlobenil	Dyclomec Casoron	PBI Gordon Thompson-Hayward	Selective weed control in ornamental beds and for total weed control on roadsides, fencerows, etc.
dichlorprop	2,4-DP	SDS Biotech	Brush control and aquatic weed control.
diphenamid	Enide	TUCO, Upjohn	Selective control of annual grasses and broadleaf weeds in bermudagrass, dichondra and around ornamentals.

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DIRECTORY

Herbicide Directory *continued*

DSMA	Methar 30 Ansar DSMA Liquid DSMA 81% Weed-E-Rad	W.A. Cleary SDS Biotech Drexel Vertac Vineland	Selective postemergence control of sedges and grasses in turf and ditchbanks and storage yard.
diuron	Karmex Dynex Diuron 80WP Urox	du Pont Vertac Drexel Hopkins	Generally used at high rates for nonselective total weed control in industrial sites.
diquat	Diquat	Ortho, Chevron	Aquatic weed control.
endothall	Aquathol K Endothall	Pennwalt Pennwalt	Aquatic weed control and turf herbicide and desiccant.
EPTC	Eptam	Stauffer	Selective control of annual grassy weeds, nutgrass, and perennial weeds.
Ethofumesate	Prograss	Nor-Am	For control of <i>Poa annua</i> and white clover in fairways.

What makes a Cushman turf vehicle worth the investment:

Turn your crew's walking time into working time.
It's the fastest way to increase productivity.

If you stop to figure how much time your crew spends every week —just walking—you'd probably be shocked.

You'd also understand the economics of taking your crew off their feet and putting them into one of our tough turf vehicles.

Take the Cushman Runabout®, for instance. It carries two workers and up to a half ton of fertilizer, sand, sod or supplies.

The Runabout's 18-hp engine features a 4-stroke cycle for extra torque and longer life (a 12-hp model is also available).

For smaller needs, and budgets, consider the Cushman Turfcart™. It too can transport a pair of workers at up to 14 mph. And there's cargo space for rakes, hose, trimmers or up to 250 pounds of other supplies. The sturdy 7-hp engine can run all day on just a little gas. And a sealed-beam head-

light lets the work continue into the night.

A free demonstration.

Of course the best way for you to learn about the Cushman Runabout and Turfcart is to see them in action. Right on your own grounds.

To do that, contact your Cushman dealer or call toll free **1-800-228-4444**.

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CUT4-2045

fenac	Fenac	Union Carbide	Preemergence long-term control of weeds, usually mixed with other herbicides.
fosamine	Krenite	du Pont	Brush control.
fluazifop-butyl	Fusilade	ICI Americas	Selective postemergence control of grassy weeds in ornamentals.
glyphosate	Roundup	Monsanto	Nonselective, short-term herbicide for turf renovation and total weed control along fences and plant beds.
imidazoline	Arsenal	American Cyanamid	Broad spectrum systemic industrial herbicide.
linuron	Lorox	du Pont	Short-term control of annual weeds in roadsides and fence rows.
mefluidide	Embark	3M	Growth regulator that suppresses Poa annua.
methyl bromide	Dowfume	Dow	Fumigant for pre-plant control. Also kills weed seed.



CUSHMAN®

5063 Cushman, P.O. Box 82409, Lincoln, NE 68501

It works harder because it's built better.

DIRECTORY

Herbicide Directory *continued*

Herbicide	Brand Name(s)	Company	Uses
metham	Vapam	Stauffer	Preplant soil fumigant killing weeds, weed seed, insects and fungi.
metribuzen	Sencor	MoBay	Postemergence control of goosegrass in warm-season turf.
MCPP	MCPP Mecomec MCPP Chipco Turf Herbicide	SDS Biotech PBI Gordon WA Cleary Rhone Poulenc	Selective broadleaf weed control in turf. Often combined with other herbicides.
MSMA	Ansar Broadside Ansar Weed-Hoe	SDS Biotech Vertac Drexel Vineland	Postemergence selective control of crabgrass and broadleaf weeds in turf. Also, grassy weed control in ditchbanks, roadsides, industrial areas.
napropamide	Devrinol	Stauffer	Selective control of weeds in ornamental beds and containers. Experimental combination with Betasan for season-long crabgrass control in turf.
oryzalin	Surflan	Elanco	Preemergence control of weeds in established ornamentals.
oxadiazon	Ronstar	Rhone Poulenc	Preemergence control of weeds in ornamentals and turf.
oxyfluofen	Goal	Rohm & Haas	Selective control of weeds in ornamentals.
paraquat	Paraquat	Ortho, Chevron	Nonselective control of weeds in rights-of-way, industrial areas and fence rows.
pichloram	Tordon	Dow	Systemic, long-term killer of woody plants and broadleaf weeds.
prometon	Pramitol	Ciba Geigy	Nonselective herbicide with long residual for industrial weed control.
pronamide	Kerb	Rohm & Haas	Poa annua control in warm-season grasses. Also weed and grass control around woody ornamentals and Christmas trees.
sethoxydim	Poast	BASF	Postemergence control of grassy weeds around broadleaf ornamentals.
siduron	Tupersan	du Pont	Preemergence control of annual grasses in newly seeded turf areas.

continued on page 86

DIRECTORY

Herbicide Directory *continued*

Herbicide	Brand Name(s)	Company	Uses
simazine	Princep	Ciba Geigy	Selective control of annual grasses and broadleaf weeds in established bermudagrass. Also, used in industrial and aquatic weed control.
sulfometuron	Oust	du Pont	Non-selective industrial and selective in bermudagrass
tebuthiuron	Spike	Elanco	Total vegetation control in non-crop areas
trifluralin	Treflan	Elanco	Selective preemergence weed control in established ornamentals.
trichlopyr	Garlon	Dow	Systemic control of woody plants in rights-of-way and industrial sites. Current experiment use pending for selective turf weed control.
2, 4-D	2, 4-D	Dow, SDS Biotech, Rhone Poulenc, Vertac	Selective control of weeds in turf and numerous other areas. Usually mixed with other herbicides.
Vorlex	Vorlex	Nor-Am	Preplant fumigant Broadleaf weed control in established turf.

Herbicide Combinations

Active Ingredients	Brand Name	Company	Uses
2, 4-D plus MCPP	Chipco Turf Kleen Cleary Scotts II SDS Tee Time Lescopar	Rhone Poulenc WA Cleary OM Scott SDS Biotech Andersons LESCO	Broadleaf weed control in established turf.
2, 4-D plus dicamba	Scotts I Banvel Plus Lesco Selective Herbicide	OM Scott Velsicol Lesco	Selective postemergence control of weeds in turf.
2, 4-D plus MCPP plus dicamba	Trimec Trexan	PBI Gordon Mallinckrodt	Selective, broad spectrum control of weeds in turf.
2, 4-D plus dichlorprop	Weedone DPC	Union Carbide	Selective postemergence control of weeds in turf.
2, 4-D plus 2, 4-D plus dicamba	Trimec Ester	Bulkem	Selective, broad spectrum control of weeds in turf.
2, 4-D plus dicamba plus dalapon	Banvel Plus	Velsicol	Broad spectrum, post-emergence turf weed control.

Herbicide Combinations *continued*

2, 4-D plus prometon	Vegemec	PBI Gordon	Selective postemergence control of weeds in turf.
Balan plus Ronstar	Regalstar	Regal Chem.	Broad spectrum preemergence control of weeds in turf.
amitrol plus simazine	Amizine	Union Carbide	Season-long control of weeds and grasses around ornamentals.
MSMA plus cacodylic acid	Broadside	Crystal	Nonselective, broad spectrum weed control.
diuron plus sodium chlorate plus sodium metaborate	Chlorea	Rhone Poulenc	Nonselective weed and grass killer.
amitrole plus fenac plus atrazine	Fenamime	Union Carbide	Pre- and postemergence control of weeds for industrial sites and rights-of-way.
bromacil plus diuron	Rout Krovar	Hopkins du Pont	Wide range control of weeds in industrial sites and rights-of-way.
MSMA plus dicamba	Mondak	Velsicol	Noncropland general weed control.
prometon, simazine and chlorate	Pramitol	Ciba Geigy	Full-season weed control in industrial sites.

Nitrogen costs money. So does water for that matter. And bluegrasses need them both.

Well, most bluegrasses.

Tests have shown that Rugby tolerates heat and drought better than most bluegrass cultivars. Rugby held its medium dark-green color and overall vigor on restricted moisture conditions. That makes *less watering* highly feasible.

A similar result happened in tests measuring the

The Way Some Bluegrasses You Wonder What



TABLE 1.
Woody plants tolerant to pre-emergence herbicides

The following evergreen and deciduous plants are labeled for use with the pre-emergence herbicides across the top of the chart. An (X) in the column indicates the herbicide can be safely used for that plant listed. The list includes only those plants with company label registration.

	BETASAN	CASORON	DACTHAL	DEVIRINOL	ENIDE	EPTAM	FURLOE CHLORO IPC	ORNAMENTAL WEEDER	PRINCEP	RONSTAR	SURFLAN	TREFLAN
Narrowleaf Evergreens												
Arborvitae	X	X	X	X	X		X	X	X	X	X	X
Chamaecyparis					X	X						
Eastern Red Cedar	X		X	X					X			X
Fir		X	X		X	X						
Fir, Balsam							X			X		X
Fir, Douglas				X					X	X		X
Fir, Fraser									X			
Hemlock			X	X	X	X	X	X	X	X		X
Juniper	X	X	X	X	X	X	X	X	X	X	X	X
Pine			X	X		X	X	X		X		
Pine, Austrian									X	X		X
Pine, Japanese Black									X	X	X	
Pine, Mugo									X		X	
Pine, Red									X			X
Pine, Scotch									X	X		X
Pine, White									X	X	X	X
Spruce			X	X		X	X			X		
Spruce, Blue											X	X
Spruce, Norway										X	X	X
Spruce, White										X		X
Yew	X	X	X	X	X	X	X	X	X	X	X	X
Broadleaf Evergreens												
Boxwood	X	X	X	X		X					X	X
Cherry Laurel					X							X
Euonymus				X	X		X	X			X	X
Firethorn	X	X	X	X					X	X	X	X
Holly	X	X	X	X	X					X	X	X
Holly, Japanese						X					X	X
Japanese Pieris			X			X		X			X	X
Leucothoe		X				X					X	X
Magnolia grandifolia											X	X
Mahonia					X		X		X	X	X	X
Mountain Laurel	X	X		X		X					X	X
Rhododendron	X	X	X	X	X	X	X	X	X	X	X	X

continued

need for nitrogen. Rugby scored well at low to moderate nitrogen fertility levels. And maintained good turf quality and density under no-nitrogen conditions.

In short, Rugby needs *some* nitrogen, but it doesn't need to wallow in it. So you can spend your time and money where it does more good.

But not on extra fungicide. Rugby resists Fusarium blight, leaf spot, dollar spot, stem rust, and powdery mildew.

Rugby also offers you the benefits of a low growth habit. And only the *blades* grow vertically. So mowers clip the leaf ends only, not the crucial growth-sustaining lower stems.

With Rugby, you can have rich, dense Kentucky bluegrass. For less nitrogen. Less water. And less time.

That's nothing to snort at.



Circle No. 161 on Reader Inquiry Card

Devour Nitrogen, You're Raising.



DIRECTORY

TABLE 1.

Woody plants tolerant to pre-emergence herbicides

	BETASAN	CASORON	DACTHAL	DEVIRINOL	ENIDE	EPTAM	FURLOE CHLORO IPC	ORNAMENTAL WEEDER	PRINCEP	RONSTAR	SURFLAN	TREFLAN
Deciduous Trees												
Ash	X	X	X	X						X		
Ash, White					X			X				X
Bald Cypress					X							X
Beech					X							
Birch	X	X		X			X			X		
Birch, European												X
Chinese Chestnut			X		X							X
Corktree, Amur	X											
Crabapple	X	X	X	X					X	X		X
Dogwood	X	X		X	X		X	X	X	X		X
Dogwood, Kousa												X
Elm	X	X										
Elm, American								X				
Elm, Siberian								X				
Ginkgo										X	X	
Goldenchaintree	X			X								
Goldenraintree	X										X	
Hackberry	X											
Hawthorn			X	X								
Honeylocust				X					X			X
Linden	X					X						
London Planetree												X

	BETASAN	CASORON	DACTHAL	DEVIRINOL	ENIDE	EPTAM	FURLOE CHLORO IPC	ORNAMENTAL WEEDER	PRINCEP	RONSTAR	SURFLAN	TREFLAN
Magnolia	X	X				X	X	X		X		
Maple	X	X	X	X	X	X	X					
Maple, Amur											X	
Maple, Norway												X
Maple, Red								X				X
Maple, Silver												X
Maple, Sugar					X							X
Mountain Ash	X											
Oak	X	X			X	X				X		
Oak, Pin												X
Oak, Red								X	X	X		X
Oak, Scarlet												X
Poplar	X	X	X	X			X					
Redbud			X	X	X							X
Russian Olive	X	X	X	X					X	X		
Sassafras								X				
Sweetgum			X	X	X						X	X
Sycamore			X	X	X							X
Tuliptree			X	X	X							X
Tupelo												X
Walnut	X	X	X	X	X							X
Willow	X	X			X							X

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A New Generation

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DIRECTORY

TABLE 2. Ground covers tolerant to pre-emergence herbicides

Ground covers	BETASAN	DACTHAL	DEVINOL	ENIDE	EPTAM	ORNAMENTAL WEEDER	PRINCEP	RONSTAR	SURFLAN	TREFLAN
Ajuga	X		X		X			X		
Boston Ivy		X								
Cotoneaster		X		X		X	X	X	X	X
English Ivy	X	X	X	X	X	X		X	X	
Euonymus		X		X		X		X	X	X
Honeysuckle		X		X						X
Juniper	X	X		X		X	X	X	X	X
Liriope			X						X	
Myrtle	X		X	X	X			X	X	
Pachistima		X								
Pachysandra	X		X		X			X		
Potentilla										X
Sedum	X				X			X		
Stoncrop									X	
St. John's Wort	X		X	X	X					

TABLE 3. Deciduous shrubs tolerant to pre-emergence herbicides

Deciduous Shrubs	BETASAN	CASORON	DACTHAL	DEVINOL	ENIDE	EPTAM	FURLOE CHLORO IPC	ORNAMENTAL WEEDER	PRINCEP	RONSTAR	SURFLAN	TREFLAN
Abelia	X		X	X								X
Azalea	X	X	X	X	X	X		X		X	X	X
Azalea, Mollis		X										
Barberry		X	X		X	X	X		X	X	X	X
Beautybush		X			X							
Cinquefoil												X
Cotoneaster		X	X		X			X	X	X	X	X
Currant			X		X							
Deutzia		X										X
Dogwood, Red Osier										X		
Euonymus, Winged		X	X	X	X	X				X	X	X
Flowering Almond		X										
Flowering Quince		X										
Forsythia		X	X		X		X			X	X	X
Hibiscus				X	X							X
Honeysuckle		X	X		X		X		X	X	X	X

What makes Ryan® big aerators worth the investment:

Large area cultivation plus five choices of tines to get to the root of your problem fast.

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Every time you cut grass, it gets harder for water and fertilizer to seep down through the thatch build-up.

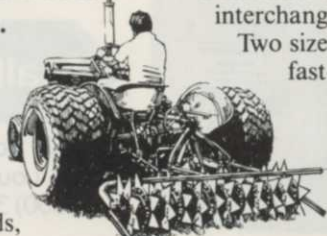
And every time your soil is walked on, or dried out by hot weather, it gets harder for the grass to breathe.

And for new grass to take root.

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Ryan solves your turf problems with an aerator specifically built for your type of turf.

On fairways, parks and other uneven grounds,



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To aerate flat expanses of turf (like athletic fields), choose the Ryan Tracaire®.

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Two sizes of **deep-slicing** tines to open up dry soil in the summer.

And **open-spoon** tines to prepare the turf for new seed and fertilizer in the fall.

No other equipment gives you such thorough aeration, season after season.

A free demonstration.

Of course, the best way for you to learn about the Ryan Tracaire and Renovaire aerators is to see them in action.

On your own grounds.

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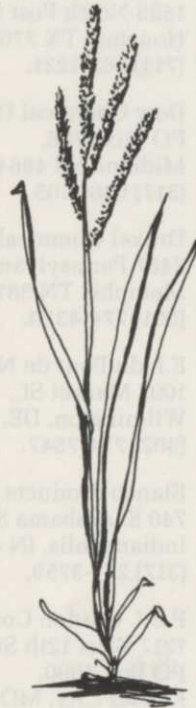
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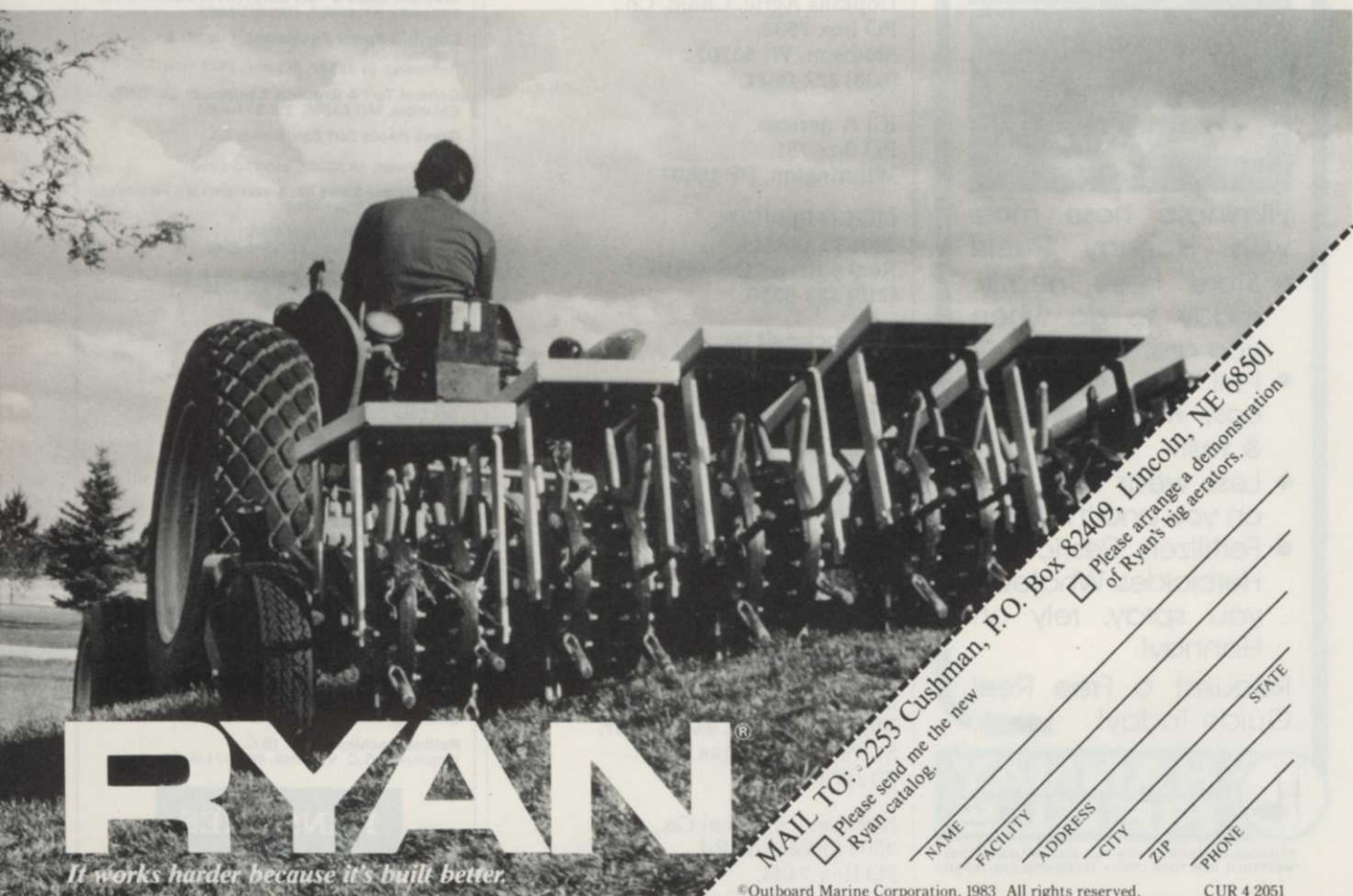
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	BETASAN	CASORON	DACTHAL	DEVRIKOL	ENIDE	EPTAM	FURLOE CHLORO IPC	ORNAMENTAL WEEDER	PRINCEP	RONSTAR	SURFLAN	TREFLAN
<i>Continued</i>												
Hydrangea		X			X		X					
Hypericum			X	X								
Lilac	X	X	X	X	X	X	X			X	X	X
Mockorange	X	X		X			X				X	
Mockorange, Lemoine												X
Nandina	X		X						X			
Peashrub	X											
Photinia	X		X								X	
Privet	X	X	X	X	X	X	X			X	X	X
Rose	X	X	X	X	X	X	X	X		X	X	X
Spirea	X	X		X			X	X				
Spirea, Vanhoutte												X
Viburnum			X		X	X	X	X		X		X
Viburnum, Doublefile											X	
Wiegela	X	X		X								



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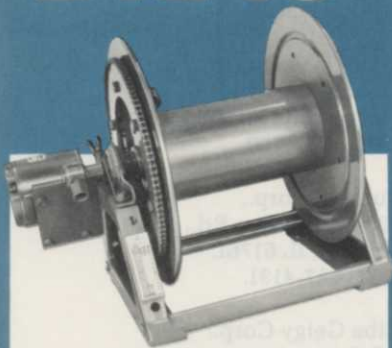
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