



No turf or landscape will remain weed-free without the intervention of man and his technology. This fact of nature has provided, and will continue to provide, work for the landscape manager.

Manmade landscapes, left alone to heat, drought, poor soil, shade, and traffic, will surrender to weeds.

The landscape manager's job is to shift the balance in favor of the desirable species and keep it that way. He does this by putting stress on the weeds and reducing the stress on the desirable plants.

Stress can come from many sources: poor soil; excessive shade, slope, moisture, wind; improper plant selection; and even maintenance practices such as mowing too low or too much at one time, using unnecessarily heavy machinery on turf areas, overirrigating, and overfertilization. Beneficial practices such as aerification or cultivation at the wrong time increase weed pressure.

Correction of stress factors is an important component of a weed control program. If stress can't be corrected, plants tolerant to the stress should be selected and planted in the area.

In this Guide, weed control is divided into four categories; turf, ornamental, rights-of-way and aquatic. Each area requires a separate approach, even though many of the chemicals and weeds are the same. It's important that a landscape manager approach each in the proper way.

Warm-Season Turf

by Ray Dickens, Auburn University, Auburn, AL., and Euel Coats, Mississippi State University, MS.

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

Summer Grass Weeds. Large 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, pendamethalin, atrazine, and simazine. Certain formulations of atrazine are labelled for use on St. Augustine, zoysia, and centipede for sod production while other commercial products containing atrazine are labeled for homeowner use. A combination of acetamide (Dual) and either atrazine or simazine is currently being tested for effectiveness.



Golf courses present a wide assortment of weed control challenges.

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 pre-emergence 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 is delayed, large crabgrass will escape because it germinates earlier than goosegrass. In bermudagrass 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. 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.

Both annual and perennial sedges are problems in the South. Purple nutsedge and, to a lesser degree, 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.

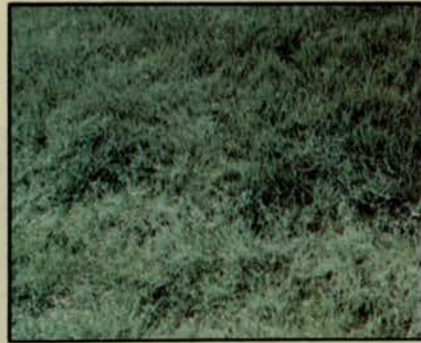
Summer Broadleaf Weeds are a problem throughout the South in turf, but not to the extent of the grassy weeds, such as dallisgrass, large crabgrass, and goosegrass. Prostrate spurge and Virginia buttonweed are important and difficult to control broadleaf weeds. Multiple applications of 2,4-D plus dicamba, Trimec, or Trex-San are almost always necessary. Researchers suggest the use of a nonionic surfactant with the herbicide.

Winter Grass Weeds. Annual bluegrass is by far the most severe grassy weed infesting southern turf

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Grassy Weeds

One of the biggest challenges a landscape manager has is to remove undesirable grass from a desirable one. The following grasses have become notorious for being difficult to control.



**Annual Bluegrass
(Poa Annua)**



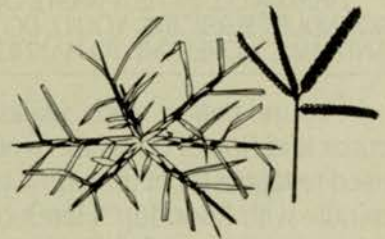
Crabgrass



Nutsedge



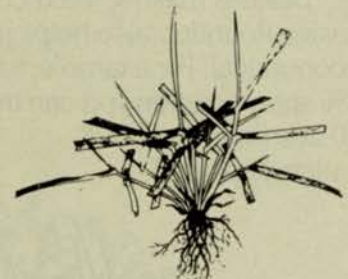
Wild Garlic



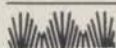
Goosegrass



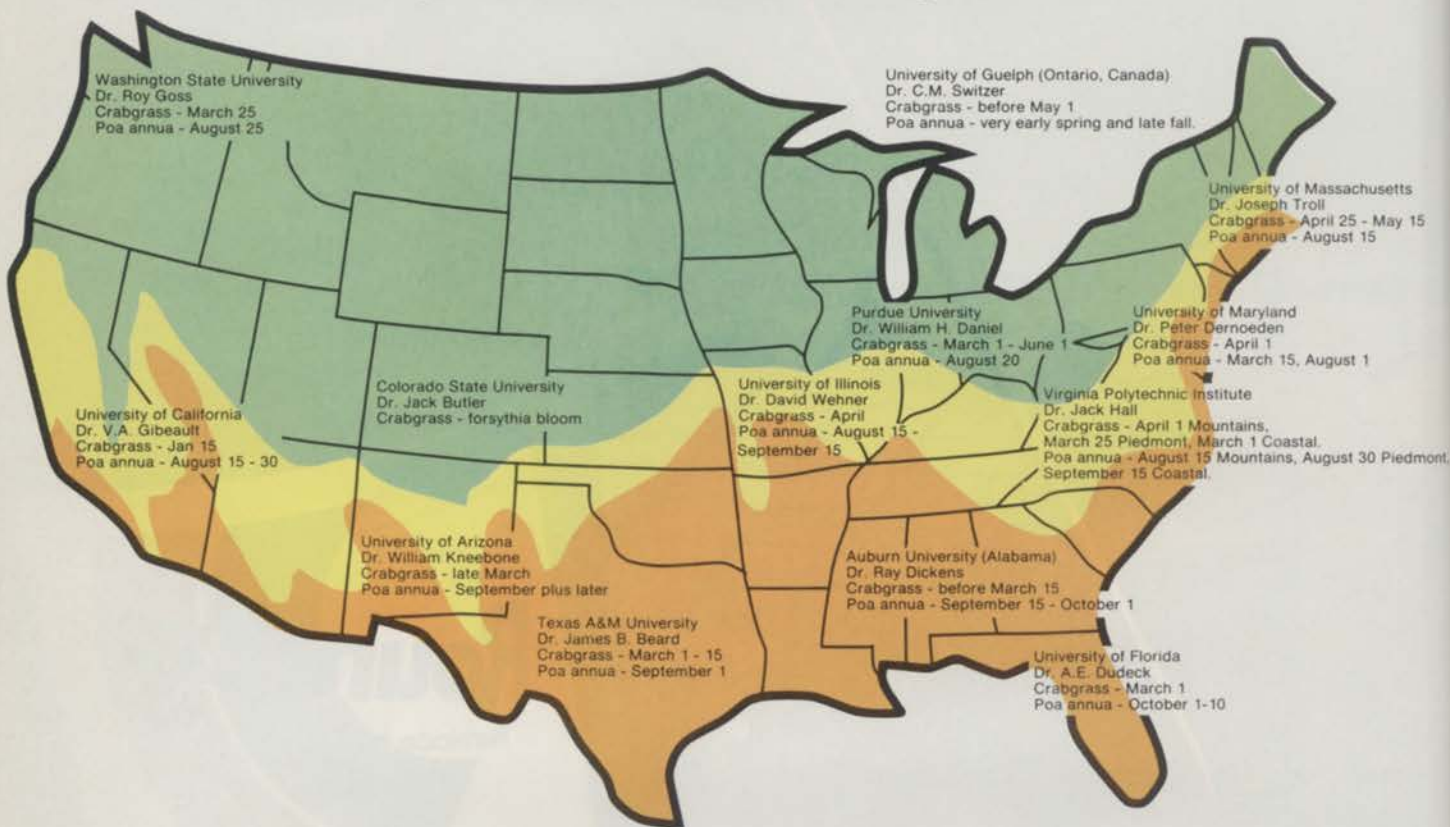
Quackgrass



Tall Fescue



Suggested Timing for Preemergence Herbicides to Control Crabgrass and Annual Bluegrass



during the late growing season, through the dormancy period and into the early growing season.

Beside decreasing the aesthetic value of turf, the primary objective 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 pre-emergence herbicides is usually accomplished with either benefin (Balan), bensulide (Betasan), DCPA (Dacthal), pendamethalin, Pronamide (Kerb), simazine (Princep), or oxadiazon (Ronstar). Two applications may be necessary during the dormant season for acceptable control except with Pronamide or simazine.

Pronamide and simazine provide either pre-emergence or post-emergence control of annual bluegrass in bermudagrass.

There are two choices for annual bluegrass control on bermudagrass greens overseeded with perennial

ryegrass. Bensulide may be applied prior to overseeding as a pre-emergence approach. Ethofumesate (Prograss) may be applied 15 to 30 days after overseeding. Check label for timing to avoid delaying spring transition back to bermudagrass.

Another approach employed particularly on golf courses, is to use a post-emergence 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 bermudagrass starts breaking dormancy. The degree of injury is dependent upon 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.

Pre-emergence control of some spe-

cies can be obtained with benefin, bensulide, DCPA, pendamethalin, simazine, and other herbicides.

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

The phenoxy herbicides are safe on completely dormant turfs. However, actively growing turfs vary considerably in tolerance to phenoxy materials.

St. Augustine will usually tolerate a .5 lbs./acre of 2,4-D with only minimal injury. At rates above .5 lbs./acre St. Augustine is usually injured. This may be unimportant when using phenoxy herbicides 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.



A complete weed control program includes both preemergence and postemergence herbicides, as well as cultural practices.

The primary preemergence herbicides for grassy and broadleaf weeds in cool-season turf are benefin, bensulide, DCPA, pendamethalin, oxadiazon, and siduron.

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

increased effectiveness on hard-to-control species. Turflon-D (triclopyr plus 2,4-D) is effective on 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 been mowed at least three times. The target weeds should be actively growing for best results. The temperature at applications 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 or sod producer chooses to fumigate a seedbed prior to planting to reduce

Cool-Season Turf

by Robert Shearman, University of Nebraska, NE

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. The resulting chemical barrier in the soil should not be disturbed during key weed germination periods.

The herbicides should be applied two weeks prior to the expected germination period. Second applications may be necessary to provide control for the full germination period. Contact your local turf extension specialist for germination times for primary weeds. Also, see the germination map for crabgrass and annual bluegrass in this guide.

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

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 or 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 MCP. Formulations of these products, such as Trimec and Weedone DPC, provide

Progress is being made in selectively killing annual bluegrass in perennial ryegrass, Kentucky bluegrass, and bentgrass fairways.

weed seed, control insects and disease, and eliminate off-type grasses. Methyl bromide (Dowfume), metham (Vapam), dazomet (Mylone), and Vorlex are used for preplant fumigation. See labels for delay period following treatment and before seeding.

Renovation of turf stands is gaining acceptance, especially since the development of glyphosate (Roundup). During renovation all existing vegetation is killed and the area is reseeded in a matter of weeks without major cultivation. Glyphosate is deactivated within a few days following application, but a delay of two weeks is recommended. Amitrole, cacodylic acid, and dalapon can also be used, but the delay period is longer.

Progress is being made in selectively killing annual bluegrass in perennial ryegrass, bentgrass, or Kentucky bluegrass fairways.

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Ornamental Weed Control

by Elton Smith, Ph.D., Ohio State University, Columbus, OH.

Rising labor costs and increased use of ornamentals in commercial and residential landscapes are causing an increase in 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, trees, groundcovers, annual and perennial flowers, bulbs, and ornamental grasses. These plants are located in a wide variety of locations, such as plant beds, containers, greenhouses, atria, and even in sand traps.

Attention to the label is especially important in ornamental weed control due to the varying sensitivity of plants to herbicides. Manufacturers attempt to provide products safe to the largest possible number of species.

Before planting

The most successful approach to a weed-free landscape is to control per-

ennial grasses and broadleaf weeds prior to planting.

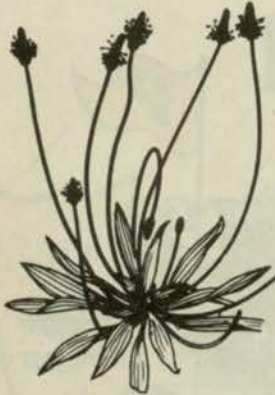
Spraying the weeds in the planting area with postemergence systemic herbicides will kill the root system as well as the topgrowth. Such herbicides include 2,4-D and related products for broadleaf weed control, dalapon for grass control, and amitrole for general weed control. These may have to be applied more than once for complete kill. Each has a specific waiting period prior to planting. Glyphosate is very effective and has no soil residue.

Fumigation of plant beds is another alternative. Vapam is one of the simplest fumigants to use. It is applied and watered into the soil. The water seals the surface, but plastic can also be used to cover the bed after the fumigant is applied and watered in. The fumigant will also kill insects and some fungi detrimental to plants. Planting can take place within days following treatment.



Broadleaf Weeds

Even though selective controls exist to remove broadleaf weeds from grass they exhibit amazing tenacity often requiring multiple treatments.



Buckhorn



Mouse-eared Chickweed



Common Chickweed



Dandelion



Ground Ivy



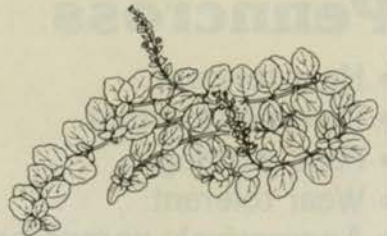
Heal-all



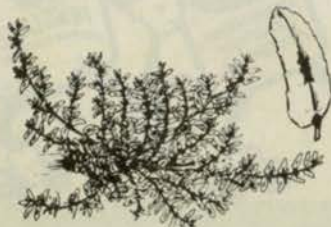
Henbit



Plantain



Speedwell



Spurge



White Clover



Yellow Wood Sorrel

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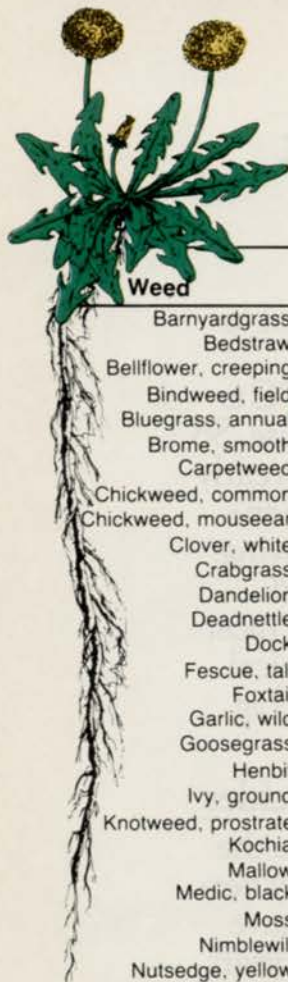


CHART 1
Growth and treatment periods

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.

Fumigants and nonselective herbicides will kill desirable plant material contacted by them. Care must be taken to protect nearby trees and shrubs which cannot be moved.

A number of preemergence herbicides are labelled for ornamentals and two are recommended for use prior to planting. Eptam or Treflan can be incorporated into the soil, follow-

ing 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 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 a planting 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.

Landscape fabrics are growing in use for low maintenance areas. The black plastic cover has been improved to a knitted fabric which allows water and nutrients through but blocks light and growing weeds. These are useful in mulched beds where plants are spaced out. They are impractical for groundcover areas and they do not control germination of weed seeds in the mulch above the fabric.

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

After planting

In recent years, the landscape industry has made extensive use of mulches to prevent weeds in the landscape. Mulches should be applied two-inches deep and renewed to that depth annually. Mulch layers deeper than two inches accomplish little and actually harm shallow-rooted ornamentals which will root into the mulch instead of into the soil.

The most popular mulches are Cypress and pinebark mulches, as well as wood chips, peat moss, and various hulls. Materials which are not composted or inorganic, can rob the soil below of important nitrogen. Composting or sterilization also kills any weed seeds in the mulch.

Preemergence materials can be used in combination with mulches to stop germination of weed seeds in the mulch or those deposited by birds and wind. They control annual weeds for a period of four to eight weeks. Reapplication is usually necessary for season-long control.

Determine the amount of pre-emergence herbicide to be applied by figuring the area of the plant bed, measuring the proper amount for that area, and distributing it evenly in the area.



Agricultural Experiment Station or U.S. Department of Agriculture. Some well illustrated circulars, bulletins, and books are also available.

Mechanical Control. Hand methods of brush control, although effective, are slow, costly, and laborious. They are practical on small areas or in scattered stands.

Hand methods include grubbing, cutting, girdling, and burning.

Grubbing consists of using a grubbing hoe, shovel, or similar tool to dig enough of the root system out of the soil to kill the plants. The operation is difficult and time consuming, but effective if properly done.

Cutting down brush with axes or saws is most effective on woody species that are killed when the top growth is removed, such as eastern redcedar and blueberry juniper. Species that resprout can be treated with herbicides to prevent resprouting.

Girdling is cutting a ring through the bark and cambium layer to prevent movement of water and nutrients to top growth. Girdling is practical in scattered stands of large trees 6-inches in diameter or greater. It is most effective during the summer months. Herbicides can be applied to the cut ring for improved kill.

Portable chain or power saws and girdlers are available for brush control. They reduce labor, time, and cost in brush removal but have limited use in dense stands or large areas.

Dozing is one of the more widely used methods of brush control. Much clearing is done with straight dozer blades; however, many modifications and attachments are available for specialized clearing jobs.

Ideally, dozing removes brush and large trees by pushing or pulling the plants out with as much of the roots intact as possible. Special attachments to the straight blade include teeth or U-shaped "stingers" to allow cutting the plant off below the ground line and lifting out the roots.

Dozing is most commonly practiced in open stands of large trees and brush or on rocky soils where other mechanical control methods are limited. It is not desirable in dense stands of brush that sprout from the roots after top removal.

Dozed trees can be windrowed or stacked so the brush can be burned or left to decay. The equipment and fuel required for dozing are costly. Dozing heavily damages the turf and grounds.

Mowing and shredding are temporary control methods for weeds and small brush in landscape management. *continued on page 68*

Right-of-Way Weed Control

by R. W. Bovey, USDA-ARS, College Station, TX

Many areas around buildings, ditches, billboards, poles, factories, shops, golf courses, parking areas, parks, industrial plant sites, vacant lots, schools, airports, roadsides, fences, lawns, pipelines, and other public or non-cropland areas may harbor unwanted trees and brush.

If these undesirable woody plants resprout after top removal, they may be difficult to kill and remove and cause unsightly appearance or interfere with the intended use of the property. The landscape manager has many options at his disposal to control and remove undesirable woody vegetation and replace it with desirable cover.

Woody plants can be removed by two primary methods or combina-

tions of these methods which include mechanical or chemical means. The selection of the method depends upon

- 1 size of the area to be cleared;
- 2 size of the brush;
- 3 difficulty of control and kind of brush;
- 4 proximity to valuable vegetation, water sources, and population centers; and
- 5 use to be made of the area following brush removal.

Control methods

It is essential that problem plants be accurately identified so the proper control methods can be used. If the species cannot be identified, consult the local county agent, extension specialists, or personnel from the State



ment. Repeated mowing, once or twice a year, is needed for maintenance on most weed-infested areas.

Mower types vary, but most consist of sharp rotary blades. Heavy duty shredders can be used on large brush and small trees, three- to four-inches in diameter.

Disking. Large disk plows or tandem disks will destroy stands of small brush. They may also destroy the grass stand. Disking is limited to tillable soils. Disking prepares a good seedbed, although compaction by a cultipacker, roller, or other implement may be desired. The operation is expensive.

Cost of mechanical treatments is usually closely correlated with degree of soil disturbance and size and density of brush to be removed. Dozing, disking, and grubbing are among the most effective mechanical brush control treatments, but are the most costly to perform, while mowing is less expensive. Hand methods, such as sawing, axing or grubbing, are sometimes effective, but are slow, costly, and laborious.

Chemical Control. Herbicides are an important means of weed and brush control. Compared to mechanical practices, herbicides are usually less expensive, less damaging to the environment, and often more effective.

Herbicide sprays, however, are subject to drift and may damage susceptible crops or valuable vegetation on nearby areas if improperly applied.

A variety of herbicides and herbicide combinations are commercially available. It is necessary to understand the properties and effects of herbicides in order to safely and effectively use them.

Individual herbicides and combinations of herbicides are used for weed and woody plant control. After manufacturing, technical (pure) herbicide must be formulated with other ingredients to prepare usable products for ease of handling and to obtain the desired effects.

Since very small amounts are sometimes required per unit of land, uniform application is essential. Herbicides are formulated as liquid con-

centrates, wettable powders, and granules or pellets. It is important to know the characteristics and precautions to be taken when using herbicides.

Characteristics of Herbicides

Phenoxy herbicides, such as 2,4-D, 2,4-DB, dichlorprop, and MCPA have

grasslands or grass crops. Rates of 0.25 to 2 pounds per acre effectively control many broadleaf plants.

The phenoxy compounds are relatively inexpensive and easy to apply. They are usually marketed as liquid concentrates as salts or esters.

The ester formulations are often more effective as foliar sprays on trees and brush than the salts. Amine formulations commonly available include dimethylamine, triethylamine, diethanolamine, trimethylamines, triethanolamine, and others.

Other inorganic salts of the phenoxy that have been sold include the ammonium, sodium, potassium, and lithium salts. Salts are sprayed in water carriers.

Esters are classified as high volatile or low volatile, depending upon how readily they vaporize. Low volatile esters should be used in areas where sensitive crops or vegetation are grown.

The concentration of the active ingredient, the "acid equivalent," is indicated on the label as pound-per-gallon. If a herbicide concentrate has an acid equivalent of 4 pounds per gallon, then 1 gallon of the concentrate contains 4 pounds by weight of the parent acid, regardless of formulation. Usually the most concentrated formulations cost less per pound and are more economical to use than weaker concentrates.

The phenoxy compounds are readily absorbed by leaves and are translocated throughout the plant along with the products of photosynthesis. Oil soluble formulations, usually esters, applied in kerosene or diesel oil will penetrate the bark of most woody plants, and can be used as basal sprays or foliar sprays to individual plants.

Phenoxy herbicides, however, are more commonly applied broadcast to large areas containing dense stands of brush. These herbicides are sprayed on above-ground parts and foliage since they are not effective at economical rates as soil-applied herbicides.

Organic arsenicals. The organic arsenicals include DSMA, MSMA, and cacodylic acid and are available as liquid concentrates. These compounds

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

been used for over 30 years and are effective for the control of many weed and brush species. They are used to produce changes and shifts in plant cover for crops, pastures, lawns, or wildlife habitat.

The phenoxy herbicides are not toxic to livestock or man at dosages labeled for weed control and disappear rapidly from the soil, vegetation, and water. They do not accumulate in the food chain.

Susceptible vegetation, especially broadleaf plants, may be damaged from spray drift or from volatilization. Following label instructions and making applications during favorable weather should prevent drift and volatilization problems.

The phenoxy herbicides selectively control broadleaf weeds in

have limited use for woody plant control as foliar sprays.

DSMA and MSMA are used for postemergence weed control in tolerant lawn grasses and noncrop areas. Cacodylic acid is used as a general desiccant and defoliant (contact) spray on many crop and non-crop areas.

The organic arsenicals can be used for quick dieback of woody species, but plants tend to recover. They can be injected into the trunk to kill unwanted trees. As foliar sprays, they are applied in water. Complete coverage by spray is required for best results. They are inactivated by soil contact.

Organic arsenicals may injure desirable plants. By directed spraying, desirable plants can be avoided. Organic arsenicals have a moderate to low mammalian toxicity but are highly toxic to insects such as honey bees. They are mildly corrosive to spray equipment.

Bipyridyliums. Diquat and paraquat are desiccant (drying agents) and defoliant herbicides used for general contact activity against weeds and brush. In some situations, they are used as selective herbicides.

Paraquat is water soluble and is inactivated by soil contact. Woody species will usually resprout from foliar sprays of diquat and paraquat. Paraquat may be more effective as an injection treatment against some undesirable trees.

Paraquat is highly toxic when ingested. Extreme care must be taken to avoid breathing the spray mist or getting the concentrate on the skin. Use

of protective clothing and respirators are recommended when making applications.

Get immediate medical care in the event of ingestion. If treated within 12 hours, chances of survival are excellent.

Benzoics. Dicamba is a selective translocated herbicide. It controls many broadleaf weeds in pasture crops and turf and some woody plants.

Dicamba is similar to the phenoxy herbicides in activity and use. It is absorbed through roots, as well as foliage. It may be applied by either ground or aerial sprays or as granules, depending upon the weeds to be controlled and their proximity to susceptible crops.

Dicamba may be applied in mixtures with 2,4-D to broaden the spectrum of weed species controlled. It has a low order of toxicity to wildlife, fish, livestock, and humans. It rapidly degrades and does not accumulate in the environment. Dicamba has a low corrosion hazard to spray equipment.

It is formulated as a liquid as the dimethylamine or sodium salt and is sprayed in water carrier. It is also formulated in granular form as the acid.

Dicamba is highly water soluble. Care must be taken to prevent its movement into water sources. Spray drift of dicamba to sensitive crops, conifers, and certain woody plants should be prevented. Granular formulation may be preferred where drift of sprays would present a hazard to crops.

Dichlobenil is also a benzoic. It is a selective herbicide for control of an-

nual and perennial grasses and weeds in non-crop areas. Dichlobenil inhibits weed seed germination and plant cell division at the growing points.

Because of its relatively high volatility, application when the temperature exceeds 70 F. must be followed by a quarter-inch irrigation or rainfall soon after. Downward movement of active ingredient does not exceed two inches, so deeper-rooted woody ornamentals will not be effected. The control is achieved from a chemical barrier in the top one to two inches of soil.

Ureas and uracils. These compounds include bromacil, diuron, fenuron, fenuron-TCA, monuron, monuron-TCA, tebuthiuron, and hexazinone.

Ureas and uracil-type herbicides can be selective at low rates and non-selective at high rates. They are usually formulated as wettable powders for water sprays or as granules or pellets for dry application.

Bromacil (a uracil) will control a wide variety of woody species. If rates above 5 pounds per acre are used, it will also kill many desirable grasses and forbs on grazing lands.

Fenuron is no longer produced commercially, but a fenuron-TCA combination is available and is used to control certain woody plants and weeds on non-crop areas. Monuron and monuron-TCA combinations are commercially available, but have limited use for brush control since high rates are required for effectiveness. The monuron-TCA or fenuron-TCA combinations are generally used for non-selective, temporary sterilization in non-crop areas.

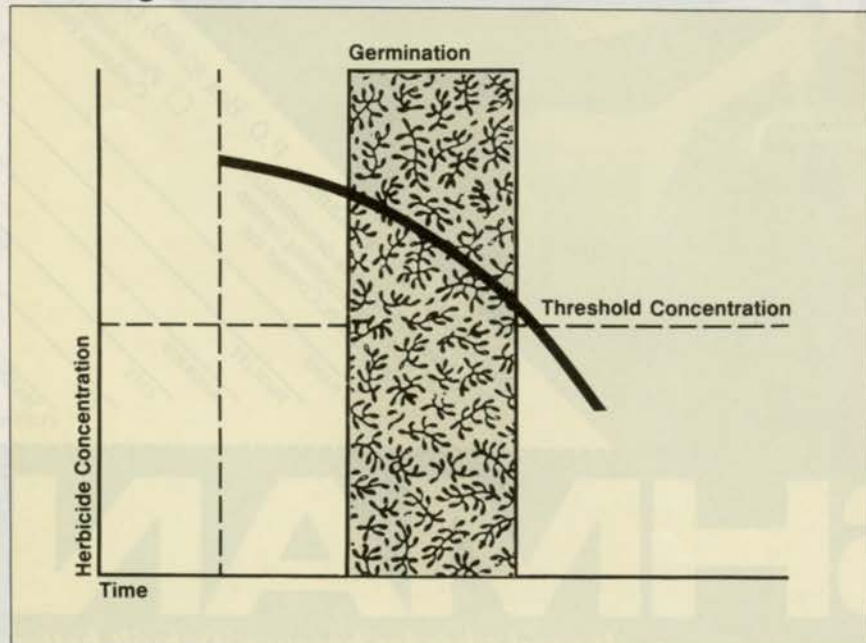
Tebuthiuron provides excellent control of a variety of undesirable woody plants. This herbicide is formulated as pellets and contains 20 or 40 percent active ingredient. A new "brush bullet" containing 13.8% active ingredient is also available. Tebuthiuron is commercially available for grazing lands and weed control on non-crop areas.

Hexazinone is a relatively new compound showing promise for woody plant control and use on non-crop areas. Hexazinone is recommended for forestry site preparation and pine release where loblolly, long leaf and short leaf, slash, and Virginia pines are grown.

The pelletized product can be spread in a grid pattern for hardwood brush control. It also shows promise for total vegetation control including perennial grasses. It is highly water soluble.

The ureas and uracils mentioned

The Effect of Delaying the Application of Preemergence Herbicides





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.
arsenal	Arsenal	American Cyanamid	Non-selective grass and broad leaf control in non-crop areas.
ammonium sulphamate	Ammate	DuPont	Non-selective rights of way herbicide
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	duPont	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	Control 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.

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are absorbed primarily through the roots of plants. They may be applied in spring or fall when weeds and brush are actively growing and when adequate rainfall leaches them into the soil.

Fall, winter, and early spring applications of tebuthiuron and hexazinone can be timed to reduce injury to forage plants and eliminate hazards of drift. These compounds may kill trees at a considerable distance from the point of application, depending upon the size of the root system and whether it extends into the treated areas. Therefore, extreme care should be taken near desirable trees.

Ureas and uracils are non-volatile and do not corrode equipment. Most of the urea and uracil herbicides can be injurious to some forage and turf species when applied broadcast, especially as sprays. Applying herbicides as pellets or balls to confine the herbicide to a few spots in the treated area reduces exposure to desirable forage or turf plants. Also, application of granules, pellets, or sprays to the soil surface or sprays applied subsurface in rows or bands spaced 6 to 10 feet apart may reduce injury to forage or turf and may increase kill of some woody plants.

Most of the ureas and uracils persist in the soil for several months at rates used for brush control. They are low in toxicity to warm-blooded animals.

Other Organic Herbicides

Arsenal (AC 252,925) is a new broad spectrum herbicide with activity against herbaceous and woody plants. It will control sedges, grasses and broadleaved weeds applied either preemergence or postemergence.

Arsenal is readily absorbed through foliage and roots. Complete kill may take several weeks.

Most herbaceous weeds are susceptible to *Arsenal* at rates of 0.4 to 1 pound per acre whereas woody species may require higher rates of 0.75 to 3 pounds per acre depending upon species to be controlled.

Arsenal is being tried experimentally for conifer release and weed control in bermudagrass. *Arsenal* should be applied postemergence to perennial weeds when they are actively growing and the herbicide is readily translocated.

It has a low order of toxicity to warm-blooded animals. It persists for 3 to 12 months in the soil depending upon rate applied and soil moisture content.

Picloram is a selective, translocated herbicide that effectively controls many weed and brush species in

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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	PBI Gordon	Selective weed control in ornamental beds and for total weed control on roadsides, fencerows, etc.
dichloprop	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.
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 dessicant.
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.
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.
floridone	Sonar	Elanco	Broad spectrum herbicide for submersed and emersed aquatic weeds.
Glyphosate	Rodeo	Monsanto	For control of emerged aquatic weeds and broad leaf weeds in or near aquatic sites, such as ditchbanks.
glyphosate	Roundup	Monsanto	Nonselective, short-term herbicide for turf renovation and total weed control along fences and plant beds.

grasslands. It can be applied to the soil or foliage and is effective as injection/cut-surface treatments on many undesirable trees.

Picloram can be applied in liquid sprays and as pellets to brush in the spring and fall, depending upon the species to be controlled. It is absorbed by both foliage and roots. Most perennial grasses are resistant. Its high activity against many woody plants at moderate rates makes it desirable for brush control. Care must be taken to prevent drift of picloram to desirable plants.

Picloram is relatively persistent in soil, especially in cooler climates. Since it is water soluble, care must be taken to prevent its movement into water used for irrigation. It should not be applied where it can be leached or moved to sensitive plants by rainfall.

Picloram has a low mammalian toxicity and is only slightly corrosive to spray equipment.

Triclopyr (Garlon) is a relatively new selective postemergence herbicide for use of rights-of-way, industrial and forestry sites, and experimentally for rangeland brush control. It can also be used to kill trees and brush by injection/cut-surface treatments.

It is readily translocated in plants and is moderately toxic to warm-blooded animals. It degrades rapidly in the soil.

Ester formulations are available.

Glyphosate is a nonselective herbicide effective against both grasses and broadleaf plants.

Glyphosate is readily translocated from leaf and stem tissue to roots, resulting in a high degree of kill on many weeds. It is inactivated by contact with the soil and should not injure newly-seeded plants in treated soil.

Glyphosate is sprayed in water carrier. It is presently registered for use for noncrop and pre-till weed control and as a directed spray for orchards, plantations, Christmas trees, and many other crops. It is corrosive to some equipment.

Broadcast sprays over woody species will damage desirable forage plants. Applications should be made to individual plants on noncrop areas or areas to be renovated.

Glyphosate has a low order of mammalian toxicity.

Amitrole is effective against poison ivy and poison oak. If amitrole is accidentally sprayed on desirable plants, they are less likely to be severely injured than sprays of phenoxy, dicamba, or picloram.

Amitrole is available as a powder

Herbicide Directory *continued*

Herbicide	Brand Name(s)	Company	Uses
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 <i>Poa annua</i> .
methyl bromide	Dowfume	Dow	Fumigant for pre-plant control. Also kills weed seed.
metham	Vepam	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	Devinol	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 fencerows.
pendamethalin	Proturf Weedgrass Control	Scotts	Preemergence turf herbicide for control of grassy and broadleaf weeds.
picloram	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.

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containing 50% active ingredient or as a liquid formulation. Another formulation, Amitrole-T, contains 2 pounds per gallon of ammonium thio-cyanate in addition to 2 pounds per gallon of amitrole.

Amitrole is effective through the roots and tops of plants. Amitrole cannot be used where there is any possibility of residues on food or feed crops.

Fosamine (Krenite) applied as foliar spray will kill or suppress several different woody species on non-crop land. If it is applied to trees or brush in late summer or early fall, susceptible species will fail to leaf out the following spring and subsequently die.

Rates of 1-1/2 to 3 gallons of fosamine are applied per acre during the two month period before fall leaf coloration. If rainfall occurs within 24 hours of application, effectiveness may be decreased. Use only in accordance with recommendations on the label. Fosamine cannot be used on cultivated land or in pastures.

Inorganic Herbicides

Ammonium sulfamate (AMS, Am-mate) is a nonselective herbicide. It is used extensively to kill all plants growing on rights-of-way.

AMS kills trees. It can be used as a foliage spray or in cuts through the bark. When applied to stumps, it prevents sprouting. AMS kills or suppresses herbaceous plants as readily as woody plants.

It is corrosive. Spray equipment should be cleaned immediately and coated with diesel oil or similar light oils after use.

Oils Diesel oil and kerosene are commonly used to control honey mesquite and huisache. One cup to 1 gallon of oil is used per tree, depending upon its size. The oil is applied around the base of the tree during dry weather when the soil is pulled away from the trunk. Application at this time enables the oil to penetrate to the lower buds on the stem.

Oils alone are not very effective herbicides when applied to the foliage of woody plants. However, diesel fuel is commonly used as a diluent and carrier for some oil soluble herbicides.

It is also used as a carrier in aircraft spraying, usually as a 1:4 oil-in-water emulsion. The oil reduces evaporation of the herbicide in arid areas and aids in penetrating stems and foliage of some woody plants. Water carrier, however, is equally as effective as oil carriers in some situations, such as use of 2,4-D on sagebrush.

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Ditchbank, before and after, herbicide treatments and debris removal.



Aquatic Weed Control

Lakes, ponds, and streams are central features for many landscapes. Weeds in water features not only destroy their appearance, they also ruin the impact of the entire landscape.

Lagoons, holding ponds and ditches, although not landscape features, serve useful functions which are inhibited by weeds.

Control measures are limited by local regulations, desirable plants in the water, and uses, such as swimming, irrigation, fish farming, and air conditioning.

If a lake is part of a natural watershed area, there may be restrictions on the use of certain chemicals or weed-eating fish. Check with your local extension agent before treating, diverting, draining, or filling in any lake, even if it is on private property.

Preventative control

Typical conditions causing an aquatic weed problem are shallowness (less than 8 ft. deep), poor circulation of water in the lake and air above the lake, fertilizer runoff into the lake, and presence of dead organic material in the lake (such as fish, plants, or sewage). Concentrate on these faults first.

Bottom-rooted aquatic plants require light to grow. Below eight feet this light is inadequate for many aquatic plants. If a lake cannot be deepened, dyes or bottom liners can be added to shade the lake bottom.

Pond aerators add needed oxygen to water and help avoid temperature stratification of water layers. Without mixing, water tends to form layers of water based upon temperature, the warmest layer on top. Keeping surface

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Herbicide Directory from page 80

Herbicide	Brand Name(s)	Company	Uses
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.
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.
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

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	Broadspectrum, post-emergence turf weed control.

water temperatures down by mixing upper layers with lower, colder ones can discourage algae. Algae does not readily establish until surface water temperature reaches 60 degrees F.

Decaying organic matter removes oxygen from the water. Do not throw debris or clippings into the water. Dead plants should be removed from treated lakes if possible.

In certain states, various weed-eating fish are legal. They are restricted in certain states due to the fear they may reach major rivers and lakes.

Drawdown, or draining to expose aquatic plants to full sun or freezing temperatures, is used where fish or irrigation aren't factors. Dredging and aquatic weed harvestors are expensive and cause a disposal problem, but they may be the only way to get initial control over a serious aquatic weed problem.

Lakes require some vegetation to produce needed oxygen, to provide cover for fish and wildlife, and to appear a natural part of the landscape. Portions of the lake can be kept shallow to provide for aquatic plants. Another method is removable containers of plants submersed close to the water's surface. Desirable water plants, such as water hyacinth, are available from specialized nurseries. These container plants can be removed if necessary during treatment periods.

Certain aquatic herbicides may be absorbed by roots of nearby trees or plants which extend into the water. Read labels carefully for susceptible land plant species.

Curative control

In warmer climates aquatic weed control is an ongoing struggle with nature. In the North it is a seasonal fight beginning when water temperatures get above 60 degrees F.

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.

If a lake has a history of algae problems, start using copper compounds as soon as water temperatures get above 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 can be either free-floating or bottom-rooted plants which have leaves on the surface. They include hyacinths, duckweed, water lettuce, floating fern, water pennywort, and salvinia.

The primary herbicides for floating

2, 4-D plus prometon	Vegemec	PBI Gordon	Selective postemergence control of weeds in turf.
2, 4-D plus triclopyr	Turflon-D	Dow Chemical	Selective postemergence turf herbicide for broadleaf weeds.
Balan plus Ronstar	Regalstar	Regal Chem.	Broad spectrum pre-emergence 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.

weeds are 2,4-D and Diquat. Sonar (Fluridone) is a broad-spectrum aquatic herbicide under experimental use.

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

The primary herbicides for submersed weeds are 2,4-D, endothall (Aquathol K), Diquat, and Sonar (experimental use only). Combinations of endothall and Diquat with copper are often used.

Emersed 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), Rodeo (glyphosate), Sonar (experimental use only) and amitrole.

Products registered for aquatic weeds are also the best to use for ditchbank weed control, since there is always a possibility water containing herbicides in ditches will drift to other locations. Check labels for ditchbank applications.

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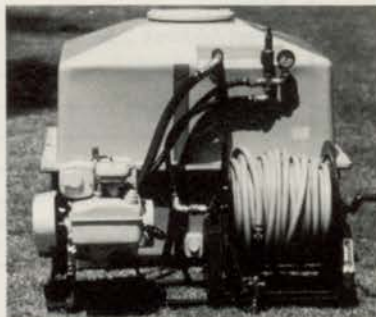
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