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The Rutgers Turfgrass Proceedings is published yearly by the Rutgers Center for Turfgrass Science, Rutgers Cooperative Extension, and the New Jersey Agricultural Experiment Station, Cook College, Rutgers University in cooperation with the New Jersey Turfgrass Association. The purpose of this document is to provide a forum for the dissemination of information and the exchange of ideas and knowledge. The proceedings provide turfgrass managers, research scientists, extension specialists, and industry personnel with opportunities to communicate with co-workers. Through this forum, these professionals also reach a more general audience, which includes the public. Articles appearing in these proceedings are divided into two sections.

The first section includes lecture notes of papers presented at the 1999 New Jersey Turfgrass Expo. Publication of the New Jersey Turfgrass Expo Notes provides a readily available

source of information covering a wide range of topics. The Expo Notes include technical and popular presentations of importance to the turfgrass industry.

The second section includes research papers containing original research findings and reviews covering selected subjects in turfgrass science. The primary objective of this section is to facilitate the timely dissemination of original turfgrass research for use by the turfgrass industry.

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WEED MANAGEMENT IN LANDSCAPE TURF

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The presence of weeds in a home lawn mars the appearance of turf, but more importantly, weeds compete with the desired turfgrass for water, nutrients, and light. Failure to control these weeds often results in a deterioration of the turfgrass stand as the number of weeds increase. Control of weeds is not by itself enough because a weed problem is often symptomatic of a more basic cultural or soil problem. If these problems persist, weeds will become a continuous problem. Thus, weed control includes not only the removal of existing weeds, but also taking corrective management of the factors causing the poor lawn so that weeds will not become a recurring problem. The following series of lecture notes outlines the management of the two most common weed problems in landscaped turf, broadleaf weeds and summer annual grasses.

BROADLEAF WEEDS

Cultural Control of Broadleaf Weeds

The numbers and types of weeds found in turfgrass are greatly influenced by management and cultural practices. For example, close mowing and too little nitrogen favor white clover. Close mowing also favors weeds such as carpetweed, spurge, plantain, and dandelion. Poorly drained areas favor weeds such as ground ivy and chickweed, whereas compacted sites favor knotweed.

Correcting improper management practices so that a dense, vigorous turf develops is the

best and most lasting method for broadleaf weed control. Of particular importance are proper fertilization, mowing, and watering. Although chemical control of most weeds is possible with the proper use of a labeled herbicide, weeds become a recurring problem if poor management and cultural practices are continued. A few broadleaf weed species cannot be controlled satisfactorily by herbicides, so proper management is necessary to reduce the opportunity for their establishment and spread. **Herbicides should be considered an aid, but not a cure, for broadleaf weed problems in turfgrass.** Once large numbers of weeds have been controlled, vigilant digging or handpulling young weeds as they emerge can effectively keep turfgrass free of broadleaf weeds for long periods.

Chemical Control of Broadleaf Weeds²

In turfgrass where broadleaf weeds have become a problem, an application of an approved herbicide may be necessary for their removal so that the turf can be improved through better management and cultural practices. Several materials are available for broadleaf weed control, but different weeds are susceptible to different products. Thus, proper identification of the weeds is essential before the most economical and effective herbicide can be chosen.

Frequently, two or more different herbicides are sold as pre-packaged mixtures. Most of the materials discussed are sold by several manufacturers, often under different trade names with different formulations and concentrations. READ

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and FOLLOW the label directions on the herbicide container carefully. Applying too low a rate may result in inadequate control, whereas applying too high a rate can also reduce control and injure the turf. The following herbicides are available for the selective removal of broadleaf weeds from turfgrass.

- *2,4-D* (2,4-dichlorophenoxyacetic acid) is the oldest, most widely used turfgrass herbicide and provides broadspectrum weed control. This chemical is particularly effective for control of taprooted weeds such as dandelion, broadleaf plantain, mustard, and shepherd's purse. Amine and salt forms are most commonly used; however, the low volatile ester form of 2,4-D is also available and may be more active on certain weed species such as wild garlic and wild onion. Some notable weeds not controlled well by 2,4-D are white clover, chickweed, purslane, and ground ivy.
- *MCPA* ((4-chloro-2-methylphenoxy)acetic acid) is chemically related to 2,4-D and may be used as a 2,4-D substitute in prepackaged mixtures. MCPA is not as broadspectrum as 2,4-D and is generally used in combination with other herbicides.
- *MCPP* ((±)-2-(4-chloro-2-methylphenoxy)propanoic acid) is most effective in controlling several perennial or winter annual turf weeds. Important weeds controlled include chickweed and clovers.
- *Dicamba* (3,6-dichloro-2-methoxybenzoic acid) controls many different weeds, several of which are not easily controlled with 2,4-D or MCPA. Of particular importance are the summer annual weeds that have a prostrate growth habit, including knotweed, purslane, and spurge. Dicamba is commonly used in combination with other herbicides at low use rates.
- *Dichlorprop* (2,4-DP) ((±)-2-(2,4-dichlorophenoxy)propanoic acid) and *Triclopyr* ([[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid)

are sold in pre-packaged mixtures with 2,4-D and provide broadspectrum weed control.

- *Triclopyr* ([[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid) + *Clopyralid* (3,6-dichloro-2-pyridinecarboxylic acid) is a non-phenoxy, pre-packaged mixture only sold under the trade name of Confront®. This mix also provides broadspectrum control of many common broadleaf weeds including oxalis. Clopyralid is now available alone under the trade name of Lontrel®.
- *Isoxaben* (N-[3-(1-ethyl-1-methylpropyl)-5-isoxazolyl]-2,6-dimethoxybenzamide) is only sold under the trade name of Gallery® and is used primarily in the early fall for preemergence control of numerous winter annuals, especially henbit and common chickweed. It has no postemergence activity against emerged broadleaf weeds.
- *Quinclorac* (3,7-dichloro-8-quinolinecarboxylic acid) is only sold under the trade name of Drive®. It effectively controls only a few broadleaf weed species including white clover and corn speedwell.

Herbicide Combinations. The use of the above mentioned herbicides in combination is very common. Combination products permit the control of a broader range of weed problems than do single herbicides. In addition, some combinations may allow for the control of certain weed species that cannot be controlled easily by the individual components alone. Some commonly used combinations include 2,4-D + MCPA; 2,4-D + dicamba; 2,4-D (or MCPA) + MCPA + dicamba; 2,4-D + dichlorprop; and 2,4-D + triclopyr. The best times of year to control most broadleaf weeds are fall (especially late September) and spring (especially May).

To use these herbicides effectively for broadleaf weed control in turfgrass, several points should be remembered:

1. READ and FOLLOW the label directions CAREFULLY.

2. Spray when the temperature is over 70°F and the weeds are actively growing. Do not spray when the temperature is over 85°F as turfgrass damage may result. Treat only when soil is moist and plants are growing vigorously. Do not apply herbicides during drought periods when soil is dry.
3. Do not mow one day prior to and after spraying.
4. Spray formulations (i.e., liquids) are generally more effective than granular forms of broadleaf herbicides, but granular products are more easy to handle and apply for homeowners.
5. Granular formulations should be applied when the foliage is moist, such as during early morning hours when there is a heavy dew present. Newer formulations of some granular products are just as effective as sprayable materials for weeds such as dandelion, broadleaf plantain, and white clover.
4. The herbicides listed in this publication are safe to use on established tall fescue, Kentucky bluegrass, perennial ryegrass, and fine-leaf fescues (i.e., strong creeping red, hard, Chewings, and blue sheep fescues). All herbicides have the potential to cause some foliar yellowing. Do not use 2,4-D on lawns where bentgrasses or roughstalk bluegrass are considered desirable species.
5. Thoroughly clean sprayer including hose and boom after using these herbicides. It is advised that one sprayer be used for lawns and another for spraying ornamentals. Do not allow spray mixtures to spill or leak onto areas where they can be taken up by foliage or roots of trees or ornamentals.
6. Keep herbicide containers closed, properly labeled, and safely stored.
7. Always keep a pesticide in its original container.

Precautions for Using Broadleaf Herbicides

1. Ornamental plants, trees, shrubs, and vegetables can be highly susceptible to these chemicals. Do not spray around homes and gardens when there is a wind. Even a slight breeze is likely to carry spray droplets to susceptible ornamental and garden plants. Ester formulations (even low volatile-types) are volatile and are, therefore, more likely to injure nearby ornamentals if applied during temperatures exceeding 85°F.
2. Dicamba is included in many herbicide combination products and also in some weed and feed (fertilizer-herbicide) combinations. This and other broadleaf herbicides move readily in some soil types and can be absorbed by plant roots. Therefore, products containing dicamba in particular should not be used near the drip-line of trees or near ornamentals where it can be absorbed by roots.
3. Do not use any of these herbicides on newly seeded turfgrass. Wait until the new turfgrass has been mowed at least three times before treating (usually about 6 to 8 weeks after seedling emergence).

CRABGRASS AND GOOSEGRASS CONTROL IN COOL-SEASON TURFGRASS

Life Cycle

Spring and summer germinating annual grasses such as crabgrass (*Digitaria* spp.) and goosegrass (*Eleusine indica*) are among the most common and troublesome weeds infesting New Jersey turfgrass. Crabgrass seed normally begin germinating after April 10 in Southern New Jersey and by April 20 in Central and Northern New Jersey. Goosegrass seed generally begin germinating after May 30. Most of the crabgrass seed germinate by mid-July, but large numbers of goosegrass seed will continue to germinate throughout summer. As the plants mature, seedheads are produced and mature seed fall to the ground providing next year's crop of crabgrass and goosegrass. Crabgrass and goosegrass plants are then killed by early frosts in the fall.

Cultural Control

Growing a healthy, dense, and vigorous turf is one of the best ways to reduce the potential

infestation of crabgrass and goosegrass in turf. A vigorous, thick turf shades the weed seed and greatly reduces germination. In thin, weak turf, crabgrass is one of the first weeds to invade. There are several management practices that, when followed, will help to reduce weed encroachment. The following six steps can lead to a healthy, dense, and vigorous turf that will resist invasion by weeds:

1. Plant high quality seed of recommended cultivars.
2. Plant seed of cool-season grasses between late August and early October. Avoid spring or summer seedings.
3. Fertilize cool-season turfgrass in fall with mostly slow release (>50%) nitrogen fertilizers. Apply phosphorus and potassium at least one time per year.
4. Reduce soil acidity with lime as recommended by a soil test.
5. Mow lawns at the recommended height (2.5 to 3.5 inches for Kentucky bluegrass, perennial ryegrass, and fescue).
6. When irrigating, apply water when turf begins to wilt (i.e., turf develops a blue-gray color and "footprinting" occurs). Water deeply by wetting the soil to a 4 to 6 inch depth. Frequent, light watering greatly encourages crabgrass and goosegrass encroachment, discourages deeper rooting, and lowers the environmental stress tolerance of turfgrasses.

Chemical Control

Crabgrass and goosegrass can be controlled with herbicides. There are two types of herbicide applications. The first type, "preemergence," prevents crabgrass, goosegrass, foxtail, and many other seeds from emerging. The second type, "postemergence," kills emerged and actively growing plants.

Preemergence herbicides. Preemergence herbicides (Table 1) are generally more effective and easier to apply than postemergence herbicides, but they must be applied in the spring before annual grass weed seed germinate.

Preemergence herbicides must be applied prior to crabgrass germination (April 10 in Southern New Jersey and April 20 in Central and Northern New Jersey) to be effective. If goosegrass, but not crabgrass, is a problem, the preemergence herbicide application may be delayed until early/mid-May.

The majority of preemergence herbicides can be used at a range of application rates as specified on the herbicide label. The rate range depends on a number of factors including tolerance of the turfgrass species to the herbicide, the target weed species (crabgrass or goosegrass), weed infestation level, and whether an additional application of the herbicide is to be made. In general, if high levels of crabgrass/goosegrass control have been obtained in previous years (resulting in a low potential for weed infestation) and the site is well maintained, the lower application rates should provide season-long weed control. However, if crabgrass infestation levels are high or if goosegrass is a significant problem, the herbicide label may recommend a higher application rate. In addition, the herbicide label may recommend an additional application 6 to 8 weeks later to obtain the most consistent levels of season long control of crabgrass and goosegrass.

Table 1. Commonly used preemergence crabgrass and goosegrass herbicides.

Common Name	Trade Name
benefin	Balan
benefin+trifluralin	Team
bensulide	Betasan
dithiopyr	Dimension
pendemethalin	Pendulum, Halts
prodiamine	Barricade
oxidiazon	Ronstar

Most of these herbicides provide good to excellent season-long crabgrass control when used properly. Bensulide may not provide acceptable goosegrass control. Precautions that will help good control are as follows:

1. Consult the label in detail to determine application rates and turfgrass tolerance. If overseeding is a consideration, use herbicides with a short residual.
2. Avoid skips and overdoses. Ensure good, uniform coverage by applying half the recommended rate in two directions (at right angle to each other).
3. Apply at least 1 to 2 weeks before weeds germinate, which is generally early to mid April for most regions in New Jersey.
4. Water-in immediately and thoroughly after chemicals are applied.
5. Do not disturb the soil surface (by aerifying, spiking, or verticutting) after chemicals have been applied until fall.

Postemergence herbicides. Postemergence herbicides are used to kill weeds after they germinate and emerge from the soil. Crab-

grass and goosegrass are easiest to control with postemergence herbicides when they are small and in the 2- to 4-leaf stage of growth. This normally occurs in early July in most areas of New Jersey. The most common postemergence herbicides used for annual grass control in turf are organic arsenicals, dithiopyr (early postemergence only), fenoxaprop, and quinclorac. Only fenoxaprop is effective for control of goosegrass.

A weed control program must be accompanied by a good turf management program. When weeds are removed, large bare areas should be sodded or re-seeded in the fall as these open spaces will be invaded by new weeds. Proper fertilization, irrigation, and mowing greatly reduce and often eliminate significant crabgrass or goosegrass problems in turf.