

TURFGRASS MAINTENANCE IN VA NATIONAL CEMETERIES

1. REASON FOR ISSUE: To specify procedures for establishment and maintenance of turfgrass to be followed by National Cemetery Administration (NCA) Office of Field Programs staff involved in operation and maintenance of Department of Veterans Affairs (VA) national cemeteries.

2. SUMMARY OF MAJOR CHANGES: This handbook:

- a. Removes the References entry from Section I;
- b. Revises soil depth information (pages 6 and 7); expands information about herbicide application; and adds a new warm season seed option (page 7);
- c. Updates product, cost, and application information in Appendices A, B, and C (all pages); and
- d. Provides new information about mole control (page D-1) and weed control (page E-1).

NOTE: *New/revised information is noted by a line in the left margin.*

3. RESPONSIBLE OFFICE: National Cemetery Administration, Office of Field Programs, 810 Vermont Avenue, NW, Washington, DC 20420, is responsible for the material contained in this directive. Questions may be directed to the Chief Agronomist in the Office of Field Programs.

4. RELATED PUBLICATIONS:

- a. NCA Directive 3000 – Operational Standards for National Cemeteries (February 5, 2007, as updated)
- b. NCA Directive 3410 and Handbook – Integrated Pest Management at VA National Cemeteries, and Procedures (published simultaneously)

5. RESCISSION: NCA Handbook 3420 – Turfgrass Maintenance in VA National Cemeteries (July 13, 2005)

6. RECERTIFICATION: This publication is scheduled for recertification in September 2011.

/s/
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Under Secretary
for Memorial Affairs

Distribution: Electronic

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SECTION I – INTRODUCTION

1. PURPOSE AND SCOPE

a. This handbook establishes guidelines for the proper establishment and care of turfgrass in all Department of Veterans Affairs (VA) national cemeteries administered by the National Cemetery Administration (NCA) in order to keep the turfgrass healthy, vigorous, and visually attractive.

b. Procedures related to turfgrass establishment and maintenance include: seasonal grounds maintenance; turfgrass establishment and renovation; mowing and trimming; fertilization; irrigation; aerification; thatch removal; and pest control. (Pest control procedures for grubs and weeds in turfgrass stands are included as appendices in this handbook and in the current NCA Handbook 3410 – Integrated Pest Management Procedures for VA National Cemeteries.)

c. Optimum turfgrass appearance will be achieved by performing necessary maintenance operations at the most appropriate times utilizing recommended procedures, equipment, and supplies. The procedures outlined in this handbook will ensure that field operations are consistent with the standards and meet or exceed the goals and objectives for National Shrine appearance set forth in the NCA Operational Standards and Measures, as published in current NCA Directive 3000 – Operational Standards for National Cemeteries. (All cemeteries are required to have a current Cemetery Grounds Management Plan that specifies all required maintenance activities, including those outlined in this handbook. Direct questions to the NCA Chief Agronomist.)

d. Appendices A and B present Operational Flow Charts for both cool season and warm season turfgrass areas, providing complete guides for all potential operations involved in establishment and maintenance of turfgrass stands. The suggested time periods and products will vary according to climate, type of turfgrass, etc.; and cemetery staff will need to adjust the charts to fit the current agronomic needs, and any recommendations by the Chief Agronomist or appropriate MSN Agronomist. Appendix C gives estimated cost information for selected supplies and materials.

e. NCA does not endorse or recommend any commercial products, processes, or services. The use of trade, firm, or commercial product names in this publication is for information only, and does not constitute an official endorsement or approval to the exclusion of other products that may be similar and/or suitable.

2. RESPONSIBILITIES

a. **Under Secretary for Memorial Affairs** ensures that NCA staff develop and implement programs for proper establishment and care of turfgrass in all VA national cemeteries.

b. **Deputy Under Secretary for Memorial Affairs** is responsible for the implementation of appropriate turfgrass programs at VA national cemeteries.

b. **Director, Office of Field Programs**, will ensure that all turfgrass operations at all VA national cemeteries are conducted in accordance with NCA Chief Agronomist guidance, and are designed to achieve the National Shrine standards for cemetery appearance.

c. **NCA Chief Agronomist** will serve as:

(1) NCA subject matter expert for all turfgrass operations, and will periodically update this handbook and any other published guidance;

(2) Primary instructor for turfgrass training activities for cemetery grounds personnel and Memorial Service Network (MSN) agronomists; and

(3) Will respond to requests for advice from NCA State Cemetery Grants Program staff and/or State Cemetery Directors regarding turfgrass operations.

d. **Memorial Service Network (MSN) Directors** will ensure that MSN agronomists, cemetery staff and contractors follow NCA guidance to implement the procedures outlined in this handbook.

e. **Memorial Service Network Agronomists** will:

(1) Provide technical oversight of regional turfgrass operations through annual site visits to all cemeteries within the MSN;

(2) Ensure that the operational procedures outlined in this handbook are properly implemented at all cemeteries; and

(3) Respond to requests for advice from NCA State Cemetery Grants Program staff and/or State Cemetery Directors regarding turfgrass operations.

f. Each **Cemetery Director or designee** will ensure that:

(1) The procedures outlined in this handbook are followed appropriately for the cemetery/ies under his or her jurisdiction;

(2) This handbook is reviewed annually by appropriate employees; and

(3) Updates or revisions are suggested to the Chief Agronomist for inclusion in future revisions of the handbook.

g. All **NCA employees** involved in turfgrass maintenance activities at VA national cemeteries will follow the procedures specified in this handbook.

3. DEFINITIONS

a.i. - Active Ingredient. Refers to the percent by weight of active ingredient content in a pest control product.

Aerification (core or slice) - The process of cultivating an established stand of turfgrass without destroying that stand, using specialized tools to remove small cores of soil, or slice grooves in the soil surface, to relieve soil compaction and improve soil aeration.

Blue Tag-certified seed - Commercially-grown seed that adheres to specific standards of quality and is certified to be true to genetic identity and type by individual State agencies responsible for ensuring seed quality.

Cool Season Turfgrass - A turfgrass species adapted to cool, humid climatic regions. Kentucky bluegrass, fine fescue, perennial ryegrass, tall fescue, and bentgrass are the most widely used examples.

Evapotranspiration - The loss of plant water from the combined forces of surface evaporation and metabolic transpiration.

Generally Free of Bare Areas - The presence of bare ground is very widely scattered and visually insignificant when the total expanse of the cemetery turfgrass is observed. The presence of bare ground in no way distracts from the visual attractiveness of the landscape.

Generally Weed Free - The population of weeds is very widely scattered and visually insignificant when the total expanse of the cemetery turfgrass is observed. The weeds in no way distract from the visual attractiveness of the landscape.

Glyphosate - The common or generic name of the active ingredient contained in the non-selective herbicide known as Roundup.

Low Visual Impact Areas - Includes areas used for soil spoils, not used at all, or viewed at considerable distance.

Medium Visual Impact Areas - Includes non-burial areas adjacent to secondary roads, areas adjoining the memorial path, or areas adjacent to the maintenance building/yard.

Non-selective Herbicide - An herbicide that kills most plants on contact. Glyphosate (tradename Roundup) is the most widely used example.

Over-seeding - Spreading turfgrass seed over the top of an existing stand of turfgrass for the purpose of increasing its density. Usually necessary when turfgrasses have been thinned due to injury from various pests or overuse.

Power Rake - A motorized device used to remove thatch from an established stand of turfgrass. The rake has steel tines that rotate at high speed and rip through the thatch layer.

Sod Quality Seed - An elite grade of certified seed that meets exceptionally rigid standards of purity and quality used to establish turfgrass stands for commercial sod production.

Vertical Mower - A mowing/turfgrass renovation device with rigidly mounted steel blades that slice through the turfgrass canopy perpendicular to the soil surface.

Verticut - The process of slicing through the turfgrass canopy perpendicular to the soil surface.

Visually Prominent Areas - Includes areas near interment sections, committal service shelters, columbaria, flagpole/assembly area, public buildings, and entrance gate; areas adjacent to the main entrance road; and primary roads/routes to committal service shelters.

Warm Season Turfgrass - Turfgrass species adapted to warm, humid climatic regions. Bermudagrass, zoysiagrass, St. Augustinegrass, and bahiagrass are the most commonly used examples.

Windrows - Excessive accumulations of grass clippings deposited in rows during mowing operations (usually when mowing frequency is inadequate).

SECTION II – TURFGRASS ESTABLISHMENT

The soil and site preparation activities required for the establishment of a new stand of turfgrass – whether from seed or from sod – are identical. For most turfgrass establishment situations at NCA facilities, seed is the preferred choice. Where immediate use or a finished appearance of any area is critical, such as in visually prominent areas, sod should be used.

1. SEED SELECTION

Turfgrass species best adapted to the cool season climatic conditions include Kentucky bluegrass, fine-leaf fescue, tall fescue, and perennial ryegrass. Common warm season turfgrasses include Bermudagrass, St. Augustinegrass, bahiagrass, and zoysiagrass.

2. INITIAL SEEDING OR SODDING OF TURFGRASS ON NEWLY-FILLED GRAVES, OR RE-SEEDING OF TURFGRASS ON SUNKEN GRAVESITES

Newly filled graves require establishment of new turfgrass cover. In other cases, individual gravesites may have settled over time, creating an unsatisfactory appearance and maintenance situation that must be corrected by raising the level of the soil and re-establishing turfgrass. Follow steps 1 through 10 below when using seed or sod to establish turfgrass on newly filled graves and sunken graves (when the extent of the sunken grave problem does not warrant the total renovation of an entire burial section):

NOTE: *Hydroseeding uses a mixture of seed, fertilizer, and water applied by a sprayer. Mulch is sometimes added to the mixture. The MSN Agronomist can provide advice on when hydroseeding would be appropriate, and how to do it.*

Step 1: Determine the approximate volume of topsoil required to raise the sunken gravesite(s) or fill the new grave(s) to the desired levels. Use a quality of topsoil similar to that already on the site. Allow sufficient excess material to account for settling and compacting of the filled gravesite(s).

Step 2: Determine if the existing turfgrass on each gravesite to be raised or filled is of sufficient quality (healthy, dense, and weed free) to be kept for re-use.

(a) If not, spray the gravesites with a non-selective herbicide at the maximum label recommended rate for the complete elimination of perennial grasses and weeds. **Follow product label directions for time to elapse for the herbicide to fully affect the plants.**

(b) If the existing turfgrass is to be kept and re-used, set it aside and re-lay it after the grave is properly filled and compacted.

Step 3: Fill bare gravesite(s) to final compacted level that blends with the grade level of adjacent gravesites.

Step 4: Apply a standard turfgrass starter fertilizer at the rate recommended for the chosen species. Spread selected seed mixture at the recommended seeding rate for the turfgrass species being used. On small areas such as individual gravesites, a hand spreader is the most efficient method to use. **NOTE:** *Some turfgrass species, such as St. Augustinegrass or some Bermudagrass cultivars, can only be established through sod or sprigs.*

Step 5: Lightly rake seed into the top 1/4 to 1/2 inch of soil. Firm the soil around the seed by using a roller or tamping. The finished surface should be fine but firm and show a footprint when walked on, but should not be soft enough that an individual would sink into the soil.

Step 6: Mulch by using clean, weed-free straw, or erosion control mats. Straw should be spread so that approximately 25% bare ground is visible through the straw. (Excess straw should be removed following satisfactory growth of turfgrass cover.) Erosion control mats are expensive compared to straw, but they can be reused, are weed-free, and are effective for small projects.

Step 7: Water the area as necessary to ensure satisfactory seed germination and establishment of turfgrass cover on each gravesite. Newly seeded areas should be kept moist at all times.

Step 8: Begin mowing new turfgrass when the leaf blades reach one inch above normal recommended mowing height. Mow at desired maintenance height (see Section III – Mowing and Trimming). **Never remove more than 1/3 of the total foliage length.**

Step 9: Continue watering and mowing until the new turfgrass is well-established. If weeds germinate with the turfgrass, do not treat with herbicides until the seedling turfgrass has been mowed at least three times. Then eliminate the weeds by using appropriate post-emergent herbicides in accordance with procedures specified in the appendices to this handbook (also included in NCA Handbook 3410 – Integrated Pest Management Procedures for VA National Cemeteries).

Step 10: If using sod, only the original sod (removed and saved for re-use) or State-certified sod should be used. (Sod should be harvested with as little soil attached as possible (1/8 to 1/4 inch). The thinner the attached soil layer, the more rapidly the sod will re-root.) Sod should be laid with seams tightly matched, and then tamped lightly or rolled. Sod placement should conform to the existing adjacent grade. On slopes, sod should be laid perpendicular to the direction of the slope. Sod should be kept moist until it is well rooted and able to survive with standard watering.

3. RE-SEEDING OF TURFGRASS IN AREAS DESIGNATED FOR TOTAL RENOVATION

Follow these steps when a burial section requires complete renovation of the existing turfgrass cover due to extensive headstone raising and realignment, a general deterioration of the turfgrass stand over time, extensive sunken gravesites and/or wash boarding appearance over time, or any other circumstance that has rendered the turfgrass stand unsatisfactory:

Step 1: Collect and submit soil samples from the site to a certified soil-testing laboratory two to three weeks prior to the intended re-seeding operation to determine fertility and pH adjustment requirements.

Step 2: Mow target area three times, removing grass clippings each time. The first mowing in this sequence should be at normal maintenance height of 2.5 to 3 inches. Subsequent mowings 2 or 3 days apart should be at lowered height of 1.5 to 2 inches.

Step 3: After the preparatory mowings, the entire vegetated area should be sprayed with a non-selective herbicide (such as glyphosate). Application rate should be at the maximum label recommended rate for the complete elimination of turfgrass species and weeds. **Follow product label directions for time to elapse for the herbicide to fully affect the plants (approximately 10 to 14 days).**

Step 4: Power rake or verticut the entire treated area to loosen residual plant debris. Remove excess quantities of debris that would hinder proper preparation of the seedbed. Spread quantities of starter fertilizer and ground agricultural limestone recommended by the soil testing evenly over the entire area, using any suitable broadcast application method. Roto-till the area to a minimum depth of 3 inches to uniformly mix the fertilizer, lime, and topsoil.

Step 5: Grade the site to desired finished level. If there are low spots, fill with high quality topsoil, similar to the soil already present, to eliminate the depressions and achieve the desired finish grade.

Step 6: Firm the prepared seedbed by rolling in several directions with a standard turfgrass roller filled with water.

Step 7: Use only Blue Tag-certified seed designated as "Sod Quality" with a satisfactory (85% minimum germination) current season germination test. Spread seed uniformly over the entire area by dividing total seed required into two equal quantities, and using a broadcast seeding device such as a Cyclone or Lely to spread in two directions at right angles to each other. Lightly rake seed into the top 1/4 to 1/2 inch of soil. Roll the area with a standard turfgrass roller half full of water to firm the seeded area.

NOTE: Examples of seed mixtures/rates for cool and warm season turfgrass areas are given below. The seed chosen should match the turfgrass composition of the rest of the cemetery grounds. Where total area surface renovation is planned in cool season areas, Kentucky Bluegrass/Perennial Ryegrass mix is usually used. Check with the local cooperative extension service office for recommendations.

COOL SEASON

| <u>Tall Fescue</u> | <u>Kentucky Bluegrass/Perennial Ryegrass</u> |
|---|---|
| 40% Tall Fescue (a blend of 3 regionally adapted cultivars) | 40% Kentucky Bluegrass (a blend of 3 regionally adapted cultivars) |
| 60% Perennial Ryegrass (a blend of 2 regionally adapted cultivars) | 60% Perennial Ryegrass (a blend of 2 regionally adapted cultivars) |
| <u>Seeding Rate</u> | |
| 10 lbs/1,000 sq ft | 6 lbs/1,000 sq ft |

WARM SEASON

Bermudagrass

(Use a blend of 2 or 3 cultivars from the list below)

Sunspart, Princess, Riviera, Southern Star, Blackjack, Savannah, or Primo Blend

Seeding Rate

2 lb/1,000 sq ft

Step 8: For all seeded grasses, apply clean, weed-free straw mulch or hydromulch. (Straw should be spread using 1 to 1.5 bales per 1,000 sq. ft., so that approximately 25% bare ground is visible through the straw. Excess straw should be removed following satisfactory growth of turfgrass cover.)

Step 9: Water the area as necessary to ensure satisfactory seed germination and establishment of turfgrass cover.

Step 10: Begin mowing new turfgrass when the leaf blades reach one inch above normal recommended mowing height. Mow at desired maintenance height (see Section III entry on Mowing and Trimming). **Never remove more than 1/3 of the total blade length.**

Step 11: Continue watering and mowing until the new turfgrass is well-established. If weeds germinate with the turfgrass, do not treat with herbicides until the seedling turfgrass has been mowed at least three times. Then eliminate the weeds by using appropriate post-emergent herbicides in accordance with procedures specified in the appendices to this handbook (also included in NCA Handbook 3410 – Integrated Pest Management Procedures for VA National Cemeteries).

4. WINTER DORMANT OVER-SEEDING TO FILL VOIDS IN COOL SEASON TURFGRASS COVER

The dormant seeding procedure explained below takes advantage of natural activity to create good seed to soil contact, while eliminating any mechanical disturbance of the soil and the existing stand of turf. The procedure requires specific environmental conditions and timing to be successful.

a. The turfgrass area to be over-seeded must be fully exposed to the elements (not covered with snow), and subjected to a heavy frost. A heavy frost creates a honeycomb of raised solid ridges that will capture turfgrass seed as it is broadcast over the surface. Seed broadcasting must be completed while the soil surface is still frosted. As the soil warms, it will cover the seed and create the direct seed to soil contact essential for successful seed germination and survival.

b. Seed will not begin to germinate until soil temperatures have warmed sufficiently. This will likely not occur for a number of weeks following the actual date of seeding. Even with this delay, the seed will generally germinate earlier than if a more traditional approach of mechanically preparing the soil during early spring and then reseeding is used.

c. Although a precise date for using this winter dormant over-seeding technique cannot be specified, in the more northern areas of the United States it will most likely be done during the last half of March or very early April. It is essential that required supplies and equipment are on hand and ready for immediate use when the appropriate environmental conditions occur. If the conditions are not favorable, the more traditional re-seeding techniques discussed in Section II paragraphs 2 and 3 above can be used.

SECTION III – TURFGRASS MAINTENANCE

The following maintenance operations should be performed routinely to achieve a high quality stand of turfgrass: mowing and trimming, fertilization, irrigation, aerification, thatch removal, and pest control.

1. MOWING/TRIMMING/EDGING

a. Mowing:

(1) It is important to remember that mowing turfgrasses stresses the plants. Most common turfgrass species can produce a healthy dense stand of turfgrass when routinely mowed at a height and frequency best suited to the specific growth characteristics of each type. For best results:

- ✓ Keep mower blades sharp at all times. Start each mowing cycle with newly sharpened blades
- ✓ Never remove more than 1/3 of the total leaf surface length in a single mowing
- ✓ Alternate the direction of mowing where possible. When mowing between rows of headstones, begin each mowing cycle at a point that will ensure that each row is mowed in the opposite direction from the previous cycle
- ✓ Remove clippings only if mowing interval has been lengthened due to uncontrollable environmental factors, and excess clippings result
- ✓ Maintain a height of cut recommended for the type of turfgrass (i.e., 2.5 to 3.0 inches for cool season turfgrasses, 1-2 inches for Bermudagrass, 2-3 inches for St. Augustinegrass)

(2) Cemetery areas are normally split into visually prominent areas, medium visual impact areas, and low visual impact areas (see Definitions in Section I). Place special emphasis on mowing the visually prominent areas near front entrance, office, flag pole circle, committal shelters, and interment areas. Mow other areas when ground conditions permit. Mower operators should report any sunken graves or turfgrass area(s) in need of repair and inform the supervisor. The supervisor will give directions for refill or renovation actions.

(3) Mowing equipment should be kept 6 to 12 inches from upright headstones. Mowing equipment can mow over the top of properly set flat markers.

b. Trimming/Edging:

(1) Turfgrass within 6 to 12 inches of upright headstones, monuments, etc., will be trimmed to the recommended mowing height using line-type trimmers. Each trimmer will be fitted with an anti-scalping device and used only with the device properly attached. Flat markers will be edged using appropriate edging equipment.

(2) There should be no windrows; no clippings left on walks, headstones, markers, streets, etc. There should be no damage to headstones or markers, monuments, surrounding vegetation (trees/shrubs), or structures.

(3) A complete trimming and/or edging cycle may take twice as long as a single mowing cycle.

2. FERTILIZATION

a. Applications of fertilizer during the establishment of new turfgrass stands should be based on soil test findings/recommendations. **NOTE:** *Additional soil testing is generally recommended every 5 years (every 3 years for very sandy soils).*

b. Routine maintenance applications of fertilizer should be based on generally recognized nutritional requirements for the essential basic plant nutrients of nitrogen, phosphorus, and potassium. Cemeteries without irrigation systems must carefully time fertilizer application(s).

(1) Established stands of cool season turfgrass use the basic nutrients in a ratio of approximately 4:1:2. Warm season turfgrasses use the ratio of approximately 3:1:3. Follow the directions given for the specific product used.

(2) Because slow release sources of nitrogen feed turfgrass more uniformly over time, the fertilizer products selected for standard maintenance application(s) should contain 30-50% of nitrogen from controlled release sources. These sources include sulfur-coated urea (the most widely used and most cost-effective choice), polymer-coated urea, Isobutylidene Diurea, urea formaldehyde, methylene urea, aminoureaformaldehyde, and stabilized nitrogen.

c. In addition to the three basic nutrients found in all complete fertilizer products, turfgrasses require minute amounts of micronutrients such as iron, manganese, boron, copper, and zinc. Most soils contain adequate levels of these nutrients to meet turfgrass needs, however, an occasional application of a fertilizer product that contains micronutrient materials in addition to the basic nutrients is acceptable. **NOTE:** *To avoid staining, do not use fertilizers containing iron near white or light-colored headstones.*

d. Spring application of fertilizer should not take place until the normal strong growth of spring green-up has subsided. The exact timing of the first seasonal application will vary by location, age of the turfgrass stand, the general health and vigor of the turf, and the regional environmental conditions. Variations in timing will also occur across the north to south latitude range of a region.

(1) Cool Season Fertilizer Program: Cool season turfgrass species will benefit most with late spring and fall applications of fertilizer. (Mid-summer applications would encourage the growth of summer annual weeds and should be avoided.) In the cool season turfgrass areas of the Northeast, Midwest, and Pacific Northwest, the first seasonal fertilizer application should occur when the turfgrass begins to green. Cool season turfgrass species benefit substantially from a late fall application of fertilizer, particularly nitrogen, made following the last mowing of the season.

Application # 1 – June 1 – 24-6-12 at 4 lb per 1,000 sq.ft.

Application # 2 – September 1 – 24-6-12 at 4 lb per 1,000 sq.ft.

Application # 3 – Late Fall – 24-6-12 at 5 lb per 1,000 sq.ft.

(2) Warm Season Fertilizer Program: In the warm season turfgrass areas of the Southeast, Mid-South and Southwest, the first seasonal fertilizer application will likely occur at the end of March or beginning of April.

Application #1 – March/April – 15-5-15 at 5 lb per 1,000 sq.ft.

Application #2 – May – 15-5-15 at 5 lb per 1000 sq.ft.

Application #3 – June – 15-5-15 at 5 lb 1000 sq.ft.

Application #4 – July – 15-5-15 at 5 lb per 1000 sq.ft.

Application #5 – August – 15-5-15 at 7 lb per 1000 sq.ft.

e. Surface applications of lime to established stands of turfgrass are not very effective in correcting a growth-limiting pH problem. If a pH adjustment is necessary, spread a pelletized form of lime after a core aerification (see paragraph 4 below) of the site. Irrigation should then be used to facilitate movement of the lime into the aerification holes.

3. IRRIGATION

a. Deciding when to water, how, and how much, is best determined by close observation of the turfgrass plants. Turfgrass will be healthiest when watered infrequently in a quantity sufficient to wet the entire root zone (usually a minimum 6 inch depth), and then not watered again until it shows signs of wilt. Irrigation should be used to avoid the occurrence of permanent turfgrass injury.

b. When to water: It is best to water turfgrass in the early morning, if it does not interfere with cemetery operations. How often to water depends on the type of turfgrass, the physical properties of the soil, and the local climate conditions (rainfall, humidity, temperature, and wind). In general, moisture should be applied just as the turfgrass begins to wilt (although newly seeded areas must be kept moist during the period the seed is germinating and seedlings are becoming established). Turfgrass areas should be watered deeply, and only when plants show signs of wilting. Frequent, shallow watering encourages shallow rooting and makes turfgrass susceptible to disease and insect attack, as well as damage from foot or vehicle traffic.

c. How to water: Any irrigation method used should deliver a uniform amount of water over the target area.

(1) Many commercially available turfgrass sprinklers may not provide uniform coverage. This can be checked by placing a row of one pound coffee cans (or any cans of equal size) in a line at one to two foot intervals from the sprinkler to the farthest point of water delivery. By allowing the sprinkler to run for a known time (1/2 to 1 hour) the amount of water in each container can be measured and these results plotted on graph paper to show the distribution pattern and application rate of that particular sprinkler.

(2) If a stationary sprinkler is allowed to remain on one area of the turfgrass longer than on another uneven water distribution will result. Stationary sprinklers should be moved when an area has been watered thoroughly. A traveling sprinkler (that moves over the area at a uniform pace) can also be used.

(3) Cemeteries with automated irrigation systems that are programmed to activate based on the measurement of evapotranspiration at the site must maintain the equipment in accordance with manufacturer's instructions. Programming automated system irrigation frequency and quantity based upon the theoretical replacement of total evaporated or transpired moisture leads to significant over-watering of turfgrass areas. Visual observation of turfgrass should be used to set automated systems appropriately.

d. How much to water: Water should not be applied at a rate faster than it can be absorbed by the soil.

(1) The ability of a soil to absorb moisture depends upon a number of factors, including texture (size of soil particles), structure (arrangement of soil particles), and the degree of soil compaction (dense soil). The degree of compaction at or near the surface is important – experiments have shown that a very thin layer of compacted soil will substantially reduce how quickly water is absorbed.

(2) Another factor that influences the ability of a soil to absorb moisture is the rate at which the water is applied. Whenever water is applied at a rate faster than it can be absorbed, the water is wasted as surface runoff.

(3) The amount of water to apply will depend upon the water-holding capacity of the soil, the amount of moisture present when irrigation is started, and drainage. Soil texture and structure influence soil water-holding ability and drainage. Loams and clay loams have desirable water-holding capacity; sandy soils have very little water-holding capacity. Once the soil has been wet throughout the root zone or after contact with subsoil moisture has occurred, any additional water applied will be wasted.

e. Cool season turfgrass species can enter a state of dormancy when prolonged periods of drought occur. Watering to relieve the environmental stress caused by drought is desirable if the cemetery has an irrigation system. At cemeteries that do not have an irrigation capability, the turfgrass will experience a period of dormancy. During such times, all activity on the turfgrass surface should be suspended (if possible) until sufficient moisture has been received for normal growth to resume.

4. AERIFICATION

Aerification is used to relieve soil compacted by heavy foot or vehicle traffic. Aerification allows improved air, water, and nutrient penetration into the turfgrass canopy and root zone. The procedure is generally necessary only once per growing season on national cemetery grounds not subject to continual heavy traffic.

a. *Core aerification* uses specialized equipment to remove numerous soil cores (from 3 to 6 inches long) as it passes across the turfgrass surface. The cores can be removed from the site or left on the turfgrass surface. **NOTE:** *Core aerification should never be done in spring. Spring is the primary germination period of most summer annual broadleaf and grass weeds and would provide an ideal opportunity for seedling weeds to grow in the aerification holes.*

b. Cemeteries with sandy loam soil conditions (where topsoil is only 3-4 inches in depth) can use slice aerification to that depth. This operation should be conducted shortly after Labor Day.

5. THATCH REMOVAL

a. Thatch is an organic layer that develops in turfgrass stands above the soil and below the green tissue of the living canopy. It is composed of a combination of dead organic debris and the living roots, crowns, and stems of the grass. A minimal thatch layer (1/2 inch or less) in turfgrass is a positive attribute. It is a good media for macro- and micro-organisms, serves as a natural filter to reduce pesticide movement into groundwater, and moderates the effects of summer heat stress.

b. If allowed to accumulate for a number of growing seasons, thatch can have a significant negative impact on the health and vigor of the turfgrass. The judicious use of fertilizer, fungicides, irrigation, good mowing practices, and periodic aerification will greatly reduce the rate at which thatch accumulates and the likelihood of thatch becoming a serious detriment to the health and vigor of the turfgrass.

c. If it is necessary to remove a layer of thatch, there are several approaches that can be used, such as vertical mowing or power raking. A vertical mower with steel blades mounted solidly to an axle tends to do a more thorough job of thatch removal, with less ripping of the turfgrass canopy. The blades of the device should be adjusted so that they barely scratch the soil surface.

d. Any thatch removal operation generally produces a significant volume of plant debris that must be removed from the area and added to a composting pile.

e. A de-thatched turfgrass stand will normally exhibit a major growth surge that may require more frequent mowing, and possible clipping removal, for a short period of time.

6. PEST CONTROL

a. Stands of turfgrass are exposed to various types of weeds and pests. The most common pests in VA national cemeteries are broadleaf weeds, annual grass weeds (such as crabgrass and foxtail), and the insect pest known as “white grubs.”

b. Specific protocols discussing the control of these pests using various plant protection products for weed control (both pre- and post-emergence) and common insect problems are included as Appendices in this handbook and in NCA Handbook 3410 – Integrated Pest Management Procedures for VA National Cemeteries.

c. As is always the case when using chemical products, thoroughly read and follow all label instructions regarding proper use, handling, storage, and disposal of the product. All personnel should be equipped with and use the recommended Personal Protective Equipment specified on the product label.

APPENDIX A – OPERATIONAL FLOW CHART**COOL SEASON TURFGRASS AREAS**

| <u>Month(s)</u> | <u>Activity</u> | <u>Recommended Procedure/Product</u> | <u>Estimated Cost*</u> (See Appendix C) |
|-------------------------------------|--|--|---|
| Late March | Dormant seeding | Broadcast turfgrass seed of the same species composition as existing turfgrass onto a frosted soil/turfgrass surface. Surface should be in a frozen honeycombed state. Complete operation before frost goes away. | Variable |
| April thru November/December | Turfgrass mowing | Begin seasonal mowing as turfgrass approaches complete green-up. Continue mowing with rotary equipment with sharp blades at a frequency that will ensure removal of no more than 1/3 of leaf length during any single mowing. Do not remove grass clippings. Alternate direction of cut. Final seasonal mowing as new growth ceases. | Variable |
| April & May/ September & October | Broadleaf weed control for summer & winter annuals * | Spray selective herbicides when weeds are actively growing. Treatment must occur before weeds produce seeds. Dandelion should be in early yellow flower state. Confront – apply @ 2 pints/acre Millennium Ultra – apply @ 3 pints/acre Repeat if necessary to achieve desired level of control. | \$32.00/acre \$19.00/acre |
| May & July | Crabgrass prevention * | Apply pre-emergence herbicide 1 to 2 weeks prior to the expected germination of crabgrass (when soil temperature at 2 inch depth reaches 55° F). For optimum results use split applications: Initial application: Barricade @ 12 oz/acre Second application: Barricade @ 12 oz/acre | \$17.35/acre \$17.35/acre |
| June, September & November | Turfgrass fertilization | Apply complete analysis turfgrass fertilizer after spring growth flush has subsided (usually after Memorial Day). Select fertilizer with 35-60% controlled release nitrogen from sulfur-coated urea or similar product and a 3-1-2 or 4-1-2 ratio of N-P-K. Example of Program: June 1 st : 18-5-9, 30% SCU – 300 lb/acre - \$17.45/50lb bag Sept 1 st : 18-5-9, 30% SCU – 250 lb/acre Nov 30 th : 18-5-9, 30% SCU – 350 lb/acre | \$104.70/acre \$87.25/acre \$122.15/acre |

* See Appendix E for specific protocols regarding weed prevention and control.

| <u>Month(s)</u> | <u>Activity</u> | <u>Recommended Procedure/Product</u> | <u>Estimated Cost</u> (See Appendix C) |
|-------------------------------------|---------------------------|---|---|
| June - September | Turfgrass disease control | Apply a fungicide tank-mix spray containing both curative and systemic products labeled to control the diagnosed disease pathogens. Repeat as required to achieve desired level of control. Example of broad spectrum mixture: Daconil + Banner @ 4 oz + 1 oz/1,000 sq. ft. | \$180.00/ acre |
| August | Grub control ** | Apply soil insecticide in turfgrass areas diagnosed with a grub population above the standard damage threshold of 10 larvae/square foot. For effective performance this insecticide must receive sufficient water ($\frac{1}{4}$ to $\frac{1}{2}$ inch) to move the active ingredient into the root feeding zone at the soil turfgrass interface. Merit @ 0.3 lb a.i./acre Spray – 75 WSP 0.2% on fertilizer (0-0-7) @ 150lb/acre | \$90/acre \$57/acre |
| September | Turfgrass aerification | Remove soil cores to a depth of 3-4 inches with between core spacing of 5-6 inches. Leave cores lying on the turfgrass surface. Where soil compaction is severe (heavy traffic areas) a second pass across the area at right angle to the first pass should occur. | Variable |
| September/ October (variable) | Turfgrass renovation | Prepare turfgrass areas with thin stands of turfgrass or substantial bare ground exposed for reseeding. Various methods can be used to loosen the soil and provide satisfactory seed to soil contact for improved seed germination and survival. | Variable |

** See Appendix D for specific protocols regarding insect and animal prevention and control.

APPENDIX B – OPERATIONAL FLOW CHART**WARM SEASON TURFGRASS AREAS**

| <u>Month(s)</u> | <u>Activity</u> | <u>Recommended Procedure/Product</u> | <u>Estimated Cost</u> (See Appendix C) |
|--|--|--|--|
| February/ March thru November/ December | Turfgrass mowing | Begin seasonal mowing as turfgrass approaches complete green-up. Continue mowing with rotary equipment with sharp blades at a frequency that will ensure removal of no more than 1/3 of leaf length during any single mowing. Do not remove grass clippings. Alternate direction of cut. Final seasonal mowing as new growth ceases. | Variable |
| March & April/ September & October | Broadleaf weed control for summer & winter annuals * | Spray selective herbicides when weeds are actively growing. Treatment must occur before weeds produce seeds. Dandelion should be in early yellow flower state. Confront – apply @ 2 pints/acre Millennium Ultra – apply @ 3 pints/acre Repeat if necessary to achieve desired level of control. | \$32.00/acre \$19.00/acre |
| March & May | Crabgrass prevention * | Apply pre-emergence herbicide 1 to 2 weeks prior to the expected germination of crabgrass (when soil temperature at 2 inch depth reaches 55° F). For optimum results use split applications: Initial application: Barricade @ 12 oz/acre Second application: Barricade @ 12 oz/acre | \$17.35/acre \$17.35/acre |
| March thru August | Turfgrass fertilization | Apply complete analysis turfgrass fertilizer after spring growth flush has subsided (usually after Memorial Day). Select fertilizer with 35-60% controlled release nitrogen from sulfur coated urea or similar product with a 3-1-3 ratio of N-P-K. Example of Program: March/April: 18-0-18, 30% SCU – 185 lb/acre May: 18-0-18, 30% SCU – 185 lb/acre June: 18-0-18, 30% SCU – 185 lb/acre July: 18-0-18, 30% SCU – 185 lb/acre August: 18-0-18, 30% SCU – 245 lb/acre | \$65.50/acre \$65.50/acre \$65.50/acre \$65.50/acre \$86.75/acre |

* See Appendix E for specific protocols regarding weed prevention and control.

| <u>Month(s)</u> | <u>Activity</u> | <u>Recommended Procedure/Product</u> | <u>Estimated Cost</u> (See Appendix C) |
|-----------------|---------------------------|--|---|
| May – September | Turfgrass disease control | Apply a fungicide tank-mix spray containing both curative and systemic products labeled to control the diagnosed disease pathogens. Repeat as required to achieve desired level of control. Example of broad spectrum mixture: Daconil + Banner @ 4 oz + 1 oz/1,000 sq. ft. | \$180.00/ acre |
| August | Grub Control ** | Apply soil insecticide in turfgrass areas diagnosed with a grub population above the standard damage threshold of 10 larvae/square foot. For effective performance, this insecticide must receive sufficient water (¼ to ½ inch) to move the active ingredient into the root feeding zone at the soil turfgrass interface. Merit @ 0.3 lb a.i./acre Spray – 75 WSP 0.2% on fertilizer (0-0-7) @ 150 lb/acre | \$90/acre \$57/acre |
| September | Turfgrass aerification | Remove soil cores to a depth of 3-4 inches with between core spacing of 5-6 inches. Leave cores lying on the turfgrass surface. Where soil compaction is severe (heavy traffic areas) a second pass across the area at right angle to the first pass should occur. | Variable |
| As required | Turfgrass renovation | Prepare turfgrass areas with thin stands of turfgrass or substantial bare ground exposed for reseeding. Various methods can be used to loosen the soil and provide satisfactory seed to soil contact for improved seed germination and survival. | Variable |

** See Appendix D for specific protocols regarding insect and animal prevention and control.

APPENDIX C – ESTIMATED COST INFORMATION

The information provided below may be used as general guidance in preparing budget estimates for turf maintenance operations. Prices will vary throughout the country and local costs should be considered as much as possible when estimating operational costs.

General Rate and Price Guidance

| | <u>Estimated Cost</u> |
|---|--|
| Typical turfgrass seeding rates: | |
| Ky. bluegrass -- 2 to 3 lb./1,000 sq.ft. | \$1.50 to 2.00/lb |
| Per. ryegrass -- 8 to 10 lb./1,000 sq.ft. | \$1.00 to 2.00/lb |
| Tall fescue -- 8 to 10 lb./1000 sq.ft. | \$1.00 to 2.00/lb |
| Fine fescue -- 6 to 8 lb./1000 sq.ft. | \$1.00 to 1.50/lb |
| Bermudagrass -- 2 lb. 1000 sq.ft. | \$3.00 to 5.00/lb |
| Typical cost for cool season turfgrass sod delivered: | \$1.75 – 2.50/yd. Add \$0.75 - 1.25/yd for installation. |
| Roundup Pro: 41% glyphosate | \$45/gallon |
| Barricade 0.38% impregnated on 5-5-25 fertilizer | \$22/bag |
| Heritage fungicide: 50% azoxystrobin | \$315/lb |
| Dursban Pro insecticide: 23.5% chlorpyrifos | \$50/gallon |

Typical Costs for Landscape Supplies and Materials at a 50 acre NCA Facility

Fertilizer: 3 applications of a complete analysis turfgrass fertilizer – Analysis = 18 – 5 – 9, 30% SCU

| | | |
|---------------------------------|-------------------------------------|--------------------|
| Application 1 = 250 lb/Acre | Cost per bag = \$17.45 X 250 bags = | \$4362.50 |
| Application 2 = 250 lb/Acre | Cost per bag = \$17.45X 250 bags = | \$4362.50 |
| Application 3 = 350 lb/Acre | Cost per bag = \$17.45X 250 bags = | \$6107.50 |
| Total Cost of Fertilizer | | \$14,832.50 |

Seed: Assume 10 acres of turfgrass seeded/reseeded each season with a standard seed mixture of 20% Ky. bluegrass + 80% Turf-type perennial ryegrass @ 250 lb/acre X 10 = 2500 lb at a cost per lb = \$1.50

| | |
|---------------------------|-------------------|
| Total Cost of Seed | \$3,750.00 |
|---------------------------|-------------------|

Plant protection products: Primarily herbicides and insecticides – only occasional use of fungicides.

Herbicides: Broadleaf weed control for dandelions and other broadleaf weeds.

| | |
|--|-------------------|
| One total area treatment – Confront, Millennium Ultra, etc. \$32/acre X 50 = | \$1,600.00 |
| Spot treatments periodically (totaling 2 acres maximum) | \$64.00 |

Pre-emergence crabgrass control - Split applications

Barricade @ 12 oz/acre per application $\$17.35/\text{acre} \times 50 \times 2 = \$ 1735.00$

Landscape beds – Spring and fall applications of pre-emergence herbicide

Snapshot granular @ 200 lb/acre X 5 acres maximum X $\$385/\text{acre} = \1925.00

* Insecticides: Grub control – 1 application per season.

Merit insecticide @ 0.3 lb a.i./acre

Merit spray @ $\$ 90/\text{acre}$ **\$ 4500.00**

TOTAL SUPPLY COST (without fungicides)

\$28,500.00

\$ 570.00 per acre

APPENDIX D – INSECT AND ANIMAL TURFGRASS PEST CONTROL

There are many kinds of insects and insect-like pests that can do considerable damage to turfgrass, including Japanese beetles (adult and grub form), June beetles, sod webworms, army worms, cutworms, chinch bugs, leaf hoppers, and ants. Animals such as moles, pocket gophers, skunks, and field mice frequently damage lawns.

1. ANIMALS

Since most animals usually invade turfgrass in search of grubs and other insects, an adequate insect-control program will keep them out. Poison baits will control pocket gophers and mice. Traps in tunnels are a moderately effective means of mole control, as poison baits are not readily taken by moles. A new mole control product called Talpirid has proven effective on NCA properties.

2. INSECTS

a. Turfgrass is primarily subject to damage by insect pests commonly referred to as “grubs.” Grubs are the immature larval stage of several different species of beetles. They cause damage as they feed on the turfgrass roots. This can occur during spring and/or fall and depends on which of the several species of beetle larvae are present.

(1) *Immature larval stages of Japanese beetle, European chafer, northern masked chafer, southern masked chafer, Oriental beetle, and Asiatic garden beetle:* These species generally complete their life cycle in one year. Adults emerge from the soil and lay eggs on or beneath the soil surface. After the eggs hatch the larvae feed on the turfgrass roots and can cause extensive damage.

(2) *The immature stage of the beetles referred to as May beetles or “June” bugs* complete their life cycle in 2 or 3 years.

b. The first step in developing an effective control strategy for these common insect pests is determining whether the number of larvae in the soil is large enough to warrant application of an insecticide. Generally, a grub population in excess of 10 per square foot would trigger a need for treatment.

(1) Periodic population counts should be made in areas with a history of previous grub damage, turfgrass that borders wooded areas where high levels of adult beetle activity have been observed, areas where turfgrass injury symptoms appear, areas where significant mole activity is observed, or where skunks or raccoons are seen or leave evidence of digging up the turfgrass in search of food.

(2) Counts should be made by laying back a section of sod that has been sliced on three sides to expose the soil surface at the root soil interface of the turfgrass. This should be done in late May or September, when beetle larvae are most likely to be actively feeding near the soil surface. To get a more thorough count of all grubs in the area, pour a solution of sudsy water over the entire exposed soil surface. This will drive any grubs not fully visible up to the soil surface.

c. There are several recommended approaches for the control of grubs:

(1) The most common approach uses a moderately residual insecticide applied in a pre-emptive manner during the spring feeding period. This type of treatment controls actively feeding grubs and has sufficient residual action to control any larvae that surface for feeding from late August through September. Imidacloprid (Trade name Merit) and halofenozide (Trade name Mach 2) are both highly effective for controlling grubs when used in this manner. Application of these products can also be made in late summer prior to the heavy fall feeding period of newly hatched grubs.

(2) In situations where grub populations have progressed beyond reasonable expectations of control from Merit or Mach 2 and a 'rescue' treatment is warranted, the choice is trichlorfon (Trade names Dylox and Proxol). Trichlorfon is an organophosphate insecticide and should be handled with care to avoid any exposure to applicators or others.

NOTE: *Proper storage requirements and safe handling and application procedures must be adhered to at all times for all pesticides/insecticides. All chemical pesticides and fungicides must be applied by a State licensed applicator. Records must be kept of the day, time, weather, name of product applied and manufacturer, and quantity used, among other information. See current NCA Handbook 3410 – Integrated Pest Management Procedures for VA National Cemeteries, for details.*

APPENDIX E – WEED CONTROL IN TURFGRASS AREAS

1. BACKGROUND

a. A weed is a plant growing where it is not wanted, or essentially, a plant out of place. Weed encroachment into an established turfgrass usually results when the turfgrass has become weak and thin due to environmental stress, damage by pests and diseases, improper cultural practices, or intense wear from foot or vehicle traffic. Weed control is the process of limiting a weed infestation so that turfgrass can grow properly. Weed control practices are not effective on a long-term basis unless the original cause of weed encroachment is corrected. When properly maintained, warm- and cool-season turfgrasses are highly competitive with weeds. Providing ideal agronomic conditions is the preferred method for managing weeds in turfgrass. When weed populations exceed NCA standards of appearance, chemical weed control can be practiced. There are two types of herbicides to control weeds.

(1) **Pre-emergence herbicides** are applied prior to weed germination and are used for the control of crabgrass, goosegrass, annual bluegrass, and certain annual broadleaf weeds. Pre-emergence herbicides are usually applied to the entire turfgrass area to rid it of broadleaf weeds.

(2) **Post-emergence herbicides** are applied after the weed has germinated and is growing, and are generally used to control weeds not controlled by a pre-emergence herbicide. Post-emergence herbicide can be applied on a "spot-treatment" or "as-needed" basis directly to the weed infestation. Weed species vary in their susceptibility to herbicides. The most important factor in selecting a post-emergence herbicide is the tolerance of the turfgrass to the herbicide.

b. Correct weed identification is necessary to select an appropriate herbicide. The herbicide label should contain information about what weeds can be controlled. Timing of application is important, for example, certain herbicides can only be applied to Bermudagrass when the grass is dormant.

NOTE: *Proper storage requirements and safe handling and application procedures must be adhered to at all times for all pesticides/insecticides. All chemical pesticides and fungicides must be applied by a State licensed applicator. Records must be kept of the day, time, weather, name of product applied and manufacturer, and quantity used, among other information – see current NCA Handbook 3410 – Integrated Pest Management Procedures for VA National Cemeteries, for details.*

2. SELECTIVE BROADLEAF WEED CONTROL

a. **Cultural Practices:** The best way to avoid broadleaf weeds in turfgrass stands is by producing a healthy, vigorous, dense stand of the desired turfgrass species. Using appropriate cultural practices will reduce the need for chemical control measures.

(1) The most common cultural control technique is routine mowing, as only a limited number of broadleaf weed species can tolerate frequent mowing. However, many of the species that can tolerate frequent mowing are difficult to control and quite competitive once established. The most difficult species of broadleaf weeds to deal with in turfgrass are those that have a low, spreading growth and can tolerate the mowing heights commonly employed for turfgrasses. Some of the most troublesome are clover, black medic, wild violet, ground ivy, knotweed, prostrate spurge, veronica, and chickweed.

(2) Other cultural practices that have a significant impact on weed encroachment are fertilization, irrigation, and aerification.

(a) Proper timing, quantity, and nutrient content of fertilizer products can encourage the growth of the desired turfgrass species while discouraging weed species. For example, cool season turfgrass species will benefit most with spring and fall applications of fertilizer. Mid-summer applications would encourage the growth of summer annual weeds.

(b) Established stands of perennial turfgrass should be irrigated infrequently (in sufficient quantity to penetrate to a minimum soil depth of 6 inches), and then allowed to dry before being irrigated again. Water applied in frequent light quantities will encourage the germination of weed seeds located near the soil surface and help them to become established.

(c) Core aerification should never be done in spring. Spring is the primary germination period of most summer annual broadleaf weeds and would provide an ideal opportunity for seedling weeds to emerge in the aerification holes.

b. Mechanical Control: If the number of weeds is small, removal by hand is recommended. It may be necessary to use a broadleaf herbicide to control an infestation of unwanted weed species.

c. Chemical Control:

NOTE: See application/disposal instructions in current NCA Handbook 3410 – Integrated Pest Management Procedures for VA National Cemeteries, for detailed information about application procedures and required notifications. Consult the product label and Material Safety Data Sheet (MSDS) for handling, storage, and safety information.

(1) *Herbicide Selection*: Current practice is to use pyridine-based herbicides (where practical and appropriate) to replace 2,4-D and other earlier products. Triclopyr and clopyralid – sold as Turflon, Confront, and Millennium, and under other trade names – are pyridine products available for use on turfgrasses. These products work well on commonly grown cool season turfgrasses. Warm season turfgrass species' tolerance to these herbicides varies and should be confirmed prior to use.

(2) *Herbicide Application Techniques*:

(a) Scattered small patches of broadleaf weeds should be selectively controlled and removed by spot treating the affected area(s). Small hand-held or backpack style sprayers can hold 2 to 4 gallons of spray solution. The spray solution should be delivered in a single pass over the target area so that the foliage of the weeds is uniformly wet.

(b) If the broadleaf weeds affect a large area, tractor or utility cart-mounted spray equipment should be used to apply the selective herbicide.

(3) *Herbicide Application Timing*: Although selective broadleaf herbicides can be used anytime that the target weeds are growing and the turfgrass is mature and actively growing, applications at certain times will deliver the best results.

(a) Summer annual broadleaf weeds germinate during the spring, grow rapidly into early summer, flower and produce seed during the summer, and usually die as a result of the first killing frost in fall. If herbicide treatment is necessary for summer annual species, it should be completed well before the plants have a chance to produce seed. Common summer annual broadleaf weeds include pigweed, prostrate spurge, black medic, and yellow woodsorrel (this can be perennial in some areas).

(b) Winter annual broadleaf weeds germinate during late summer and early fall, grow rapidly through the fall, overwinter in a semi-dormant state, and resume active growth the following spring; then flower and produce seed and die during the warmer temperatures of summer. Treatment for winter species can be made during the late summer/fall growing period or in the following spring (prior to flowering and seed production). Common winter annual broadleaf weeds include chickweed, henbit, Virginia pepperweed, and corn speedwell.

(c) Perennial broadleaf weeds live two or more seasons and do not need to come back from seed each year. Treatment to control perennials should be made in early fall when plants are moving carbohydrates into their root systems as storage reserves for winter survival. The applied herbicides will move into the root system and facilitate a complete kill of the target weed plant. Common examples of perennial broadleaf weeds include Canada thistle, wild carrot, ground ivy (creeping Charlie), white clover, wild violet, and dandelion.

3. PRE-EMERGENCE CONTROL OF CRABGRASS AND OTHER ANNUAL GRASS WEEDS

Crabgrass is the most common weed in established stands of cool season turfgrass. Several other annual weed grasses are common across the country, including yellow and green foxtail, barnyardgrass, goosegrass, and annual bluegrass (*Poa annua*). Annual bluegrass is a winter annual and germinates around Labor Day; all of the others are summer annuals and germinate during the spring.

a. Herbicide Selection/Performance Factors: There are commercially available herbicide products that will effectively control the germinating seeds of crabgrass and other annual grass weeds. The best choice for each depends upon factors such as cost, formulations available, soil residual properties, turfgrass species tolerance, effectiveness, and user handling and safety.

(1) In order to perform effectively, all pre-emergence herbicides:

- ✓ must be active in the soil in order to kill weed seeds as they germinate;
- ✓ must remain near the soil surface where the weed seeds germinate and not penetrate into the soil where they could affect the turfgrass root mass;
- ✓ must remain effective during the primary germination period of the target weeds – but should not harm reseeding or overseeding operations; and
- ✓ must be tolerated by all commonly grown turfgrass species.

(2) Any pesticide product registered for general use under existing Federal and State guidelines has successfully cleared all environmental, ecological, and human safety test hurdles. All of the products listed below have been in use for some time and have been established as highly effective herbicides when properly used.

NOTE: Available products include benefin (trade name Balan), trifluralin+benefin (trade name Team and Team Pro), pendimethalin (trade name Pendulum and Pre-M), prodiamine (trade name Barricade), dithiopyr (trade name Dimension), and quinclorac (Trade name Drive). The first four products belong to the same chemical family – dinitroanilines – and clearly dominate this category of herbicide usage. Dithiopyr and quinclorac are not members of the dinitroaniline family.

b. Application Timing:

(1) Herbicide application(s) should be made 1 to 2 weeks prior to weed germination, which depends upon soil temperature. Soil temperatures are slow to rise in the spring. If the soil has been more moist than usual the warming process will be even slower, as water is a very poor conductor of heat.

(2) Several inexpensive soil thermometers should be placed at strategic locations around the property at a soil depth of 2 inches. When they record mid-afternoon temperatures of over 50 degrees Fahrenheit for 3 to 4 consecutive days, pre-emergents can be applied.

(3) If the herbicide is applied 4 to 6 weeks before germination, a significant percentage of the active ingredient will be wasted, since the active ingredient begins to degrade as soon as it is applied. Application should not be delayed until after weed germination.

For example, crabgrass begins to germinate in the spring after soil temperatures in the top 1 to 2 inches of soil have reached between 50 and 55 degrees Fahrenheit. The germination process will not begin just because there have been a few unseasonably warm days in March or April. Although all of the herbicides mentioned in the NOTE above will control a young one- to two-leaf stage crabgrass plant, only quinclorac can control relatively mature crabgrass plants.

c. Formulation Options: All of the herbicide products discussed in the NOTE above are commercially available from numerous sources and in several different formulations. They can be purchased in sprayable formulations, true liquids, wettable powders, flowables, or dry flowables.

(1) Uniform application to the target area is essential. Most users will find that a granular product, or fertilizer combination that includes the selected herbicide is easier to apply. Using fertilizer spreading equipment is generally more efficient and accurate than spraying.

(2) In most cases a single, properly timed herbicide application will control over 90% of the annual weed grass seeds that germinate during a normal spring season. **NOTE:** *For areas with consistent crabgrass problems, two sequential crabgrass control applications are recommended to ensure complete full season control.*

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