CURRICULUM FOR TURF WEEDS—OUTLINE

TIME REQUIRED: 4 hours
NUMBER OF SESSIONS: One per year
SUGGESTED CLASS SIZE: Up to 20 participants

Objectives

1) Learn preventive strategies for managing weeds in athletic fields with an emphasis on maintaining healthy turf. Learn appropriate turf grass species for each environmental setting, and proper irrigation, fertilization, drainage, mowing and aeration.

2) Use indoor and outdoor class exercises to (a) identify turf grass species and quality, (b) identify key weed species, (c) monitor weed population levels, (d) practice monitoring techniques and data recording, (e) evaluate site conditions, (f) evaluate soil quality, (g) calculate soil drainage rate, and (h) handle various turf management tools.

Lecture and Discussion

A. Introduction, pages 4–6

Introduce objectives and lesson plan. Distinguish *turf* from *grass*. Review grass anatomy. Discuss characteristics of common turfgrass species planted in California.

B. The Right Turf for Your Field, pages 7–8

1. Field Types, page 7

Explain how to determine the type of turf most suitable for each type of athletic field—baseball, football, or soccer. Discuss other uses of turf on school grounds.

2. Turf Types, page 7

Identify turf samples and discuss qualities of turf types suitable for athletic fields.

C. Key Weeds of Athletic Fields, pages 7–8

Pass around and identify weed specimens.

D. Tools and Methods for Managing Turf Weeds, pages 9–12

1. Soil Type and Quality, page 9

Evaluate soil texture, moisture and compaction. Discuss the importance of texture, structure, and organic matter to compaction and drainage, and how these relate to weed management options. Demonstrate how County Soil Surveys are used to analyze an area, and the importance of available water-holding capacity, drainage, and irrigation.

Writers—Michael Baefsky,[1] Nita Davidson[2] & Sewell Simmons.[2] 2nd printing, October 2004.
Acknowledgments—Thank you to the following DPR staff for reviews and suggestions: Sewell Simmons, Lisa Ross, Tom Babb, Nan Gorder, Belinda Messenger, Chris Geiger, Madeline Brattesani, David Duncan and Veda Federighi.

[1] Baefsky & Associates, P.O. Box 311, Orinda, California 94563 ~ mbaefsky@igc.org
[2] Department of Pesticide Regulation, 1001 I Street, Sacramento, California 95814 ~ school_ipm@cdpr.ca.gov

2. Basic Soil Fertility—What Does Your Turf Need? pages 9–10
Discuss the importance of mineral elements, and fertilization needs and sources.

3. Compaction and Aeration, page 11
Discuss how aeration relates to compaction and healthy turf.

4. Irrigation and Soil Moisture, page 11
Review key points of irrigation efficiency.

5. Mowing to Minimize Weed Problems, page 11
Discuss proper mowing height for each turf species.

6. Overseeding, page 12
Discuss feasibility of overseeding and proper timing.

7. Seasonal Highlights, page 12
Review tools and methods by season.

Exercises

E. Field Exercise 1, page 13
Turf Identification and Quality
Stretch a transect line across a grassy area and identify turf type, color, and density.

F. Field Exercise 2, page 14
Monitoring Weed Population Levels Using A Transect Method
Divide class into groups and guide them through using the transect method to estimate weed population in different areas of the field.

G. Field Exercise 3, page 15
Calculating Drainage Rate
Divide class into groups to measure water infiltration rate.

H. Field Exercise 4, page 16
Soil Quality Evaluation
Take a soil samples, adding water as necessary. Note qualities of moist soil, estimating the sample's texture.

References

Ali, A.D. and Clyde Elmore. 1989. *Turfgrass Pests.* Cooperative Extension. University of California Division of Agriculture and Natural Resources. (Pub. 4053) Oakland, Calif. 121 pp.

Fischer, B. 1989. *The Grower's Weed Identification Handbook.* University of California, Division of Agriculture and Natural Resources. (Pub. 4030) Oakland, Calif. 311 pp.

Flint, M.L. and P. Gouveia. 2001. IPM in Practice: Principles and Methods of Integrated Pest Management. University of California Division of Agriculture and Natural Resources. (Pub. 3418) Oakland, Calif. 296 pp.

LeStrange, M. and C. A. Reynolds. 2004. Weed Management in Lawns. UC IPM Pest Management Guidelines. UC DANR. (Pub. 74113). Oakland, Calif. 8 pp.

Whitson, T. 2000. *Weeds of the West, 9th ed*. Western Society of Weed Science and University of Wyoming. Jackson, Wyo. 630 pp.

Also refer to *Curriculum for Landscape Weeds*.

Visit the Web site for the University of California Statewide Integrated Pest Management Program (UC IPM), particularly the interactive *UC Guide to Healthy Lawns* for home gardeners and managers of parks, school grounds, and other low-maintenance turf, http://www.ipm.ucdavis.edu/TOOLS/TURF/.

Materials

Appendices

1. Turfgrass Species. Excerpted from UC IPM Pest management Guidelines—Turfgrass (December 1997).
2. Turf Fertilization Guidelines.

Books

- ❑ *Turfgrass Pests*, one for each team of two participants. See References above.
- ❑ County Soil Survey: Obtain from Natural Resources Conservation Service

Visual aids

- ❑ Weed poster or photos of weeds
- ❑ Slides of different school turf settings
- ❑ Slides of how to monitor for weeds
- ❑ Slides of management alternatives (cultural, physical, biological, and chemical)

Supplies

- ❑ Quart-size ziplock style baggies (25 for turf, weed, and soil specimens)
- ❑ One-gallon containers of water (one container for each team of two)
- ❑ Clothesline (250 feet)
- ❑ Rulers

Specimens

- ❑ Turf (several types)
- ❑ Turf weeds (several different species collected from training site if possible, one or two specimens for each team of two)
- ❑ Soil types and textures (several samples collected from training site or other area school sites)

Tools and equipment

- ❑ Long-handled bulb planter
- ❑ Soil thermometer
- ❑ Soil moisture meter
- ❑ Aeration spikes
- ❑ Aeration tools (spike, dual plug remover, others)
- ❑ Propane dandelion spike
- ❑ Irriometer
- ❑ Soil compaction meter
- ❑ Evapotranspiration meter

Products

- ❑ Fertilizers in labeled packages (include organic and inorganic products that supply N, P, K, and Ca)
- ❑ Display a variety of herbicide alternatives suitable for the training region and several that may have more limited uses, e.g., herbicides exempt from registration.

CURRICULUM FOR TURF WEEDS—LESSON PLAN

A. Introduction

Turf and grass—What are they?

Turf is another name for a lawn made up of different grass species, all members of the Poaceae (grass family). Grasses have a single seed leaf—a food-digesting and -storing part of an embryonic plant—and so are classified as monocotyledons (monocots), **Figure 1**. They have parallel-veined leaves and bulbets that are dispersed in place of seeds and fruits. Dicotyledons, also known as broad-leafed plants, have two seed leaves and leaves with netted venation.

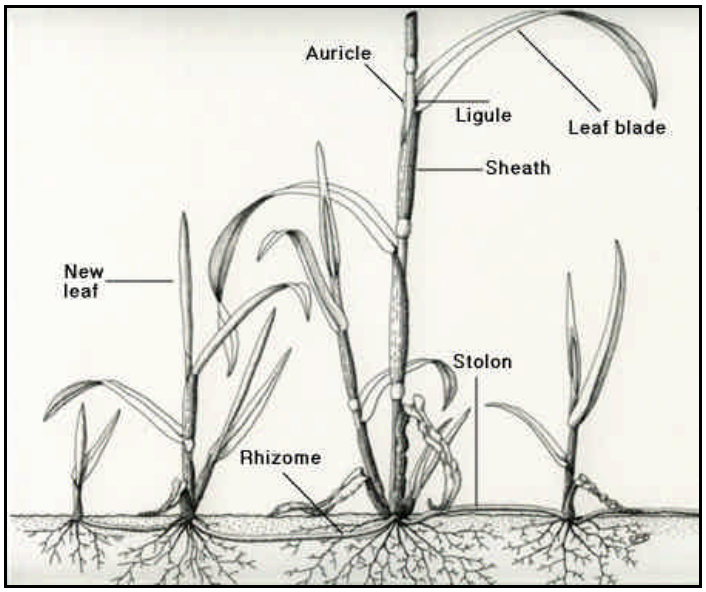


Figure 1. Plant structures useful for identifying grasses from UC Guide to Healthy Lawns, http://www.ipm.ucdavis.edu/TOOLS/TURF/, UC Statewide IPM Project). Used with permission.

If you try using a dichotomous key to identify turfgrass species, refer to the *UC Guide to Healthy Lawns* Web site (**http://www.ipm.ucdavis.edu/TOOLS/TURF/**). You can click on any of the structures pictured in Figure 1 above, and you'll be taken to a pictoral key that illustrates different types of structures described in the key.

For example, clicking on *auricle* will give you examples of auricles that are claw-like, rounded, not fully developed, or absent. If you click on photographs of the various grass species, you'll see a paragraph with identifying tips. For annual ryegrass, auricles are long, narrow and claw-like. There are also accompanying line drawings that show distinctive characters.

See **Figure 2** on the next page for the major turfgrass species in California.

Figure 2. Major turfgrass species in California

<table>
<tr>
<td> 
Perennial ryegrass, Lolium perenne</td>
<td> 
Tall fescue, Festuca arundinacea</td>
</tr>
<tr>
<td> 
Kentucky bluegrass, Poa pratensis</td>
<td> 
Bermudagrass, Cynodon dactylon</td>
</tr>
<tr>
<td> 
Red fescue, Festuca rubra</td>
<td> 
St. Augustinegrass,
Stenotaphrum secundatum</td>
</tr>
</table>

For a more detailed list of species and help with identification, see **Appendix 1**, *Turfgrass species*, and the *UC Guide to Healthy Lawns* Web site, **http://www.ipm.ucdavis.edu/TOOLS/TURF/**. Reprinted with permission.

Table 1. Characteristices of turfgrass species and mixes

	Kentucky bluegrass ***Poa pratensis***	***Tall fescue*** ***Festuca arundinacea***	***Bermudagrass*** ***Cynodon dactylon***
Mixes	Combined with perennial rye	Sometimes combined with bluegrass	Combined with perennial rye
Seasonal characteristics	Cool-season species mixture—slows down during hot weather	Cool season	Warm/cool season mixture—goes dormant in winter
Best growing area	Coastal	Coastal and inland	Inland
Recovery from injury	Best	Worst (tall fescue alone)	Intermediate
High cutting	Best adaptation	Best adaptation	Worst adaptation
Low cutting	Intermediate adaptation	Worst adaptation	Best adaptation
Drainage tolerance (poor for all)	Lowest	Highest	Intermediate
Insect & disease susceptibility	Highest	High	Intermediate
Nitrogen use	Intermediate	Lowest	Highest
Water use	Highest	Lowest	Lower
Maintenance needs	Higher	Lowest	Highest
Looks	Preferred	Some varieties preferred	Not as preferable

Perennial ryegrass, *Lolium perenne*—Often combined with Kentucky bluegrass, tall fescue, or bermudagrass; stays green during winter

Summary: cool-season grasses (spring and fall) = Kentucky bluegrass, fescue, rye; warm-season grasses (summer) = dwarf bermudagrass

See **Appendix 1**, *Turfgrass species.*

B. The Right Turf for Your Field

1. Field Types—Why Turf Type Matters

Of all the uses of turfgrass areas on school campuses, athletic turf tends to be most stressed and problematic, mostly due to human traffic. It's crucial to understand all of the tools available so you can manage these turf areas with a minimal amount of pesticides. Begin by looking at the different types of turf areas you manage, then at the types of turf available. **Select the most appropriate turf species for the region, site and situation**.

Baseball and softball fields, infield vs. outfield

Infield. Usually gravel or turf. Should be kept weed free. Edge of infield near outfield is subject to ongoing invasions of weeds, and therefore requires constant attention and management.

Outfield. Can be higher cut, moderate wear. ➔ Look for turf type that can be cut high and will tolerate moderate traffic. (Examples: Kentucky bluegrass/perennial rye mix, tall fescue)

Soccer

Cut as short as possible to reduce bounce. High wear and tear. ➔ Look for turf type that can be cut short and will tolerate a high amount of wear and tear. (Example: hybrid Bermuda-grass/perennial rye mix)

Football

Intermediate height, bounce not important. High wear and tear. ➔ Look for turf type that can be cut to an intermediate height and will tolerate a high amount of wear and tear. (Example: hybrid bermudagrass/perennial rye mix)

➔ Have class list other uses of turf on school grounds.

Use **Appendix 1**, *Turfgrass species*, as a reference.

2. Turf Types

Match your turf needs with a species and variety that is best for your region and situation (see **Table 1** on page 6 and **Appendix 1**, *Turfgrass species*).

➔ Lead class in hands-on turf identification exercise and discuss specific needs of participants.

C. Key Weeds of Athletic Fields

References

- Flint, M.L. and P. Gouveia. 2001. *IPM in Practice: Principles and Methods of Integrated Pest Management.* UC DANR. (Pub. 3418). See Figure 4–29, page 79: Life cycles of winter annual summer annual and perennial weeds
- *Curriculum for Landscape Weeds*

➔ Show class specimens of key weeds that have been collected from the site. Discuss differences between annuals, biennials, and perennials.

Key weeds summarized in **Table 2**, page 8.

Table 2. Key Weeds of Athletic Fields

PLANT TYPE	*EXAMPLES*	*WHEN GERMINATES*	*GROWTH*	*REPRODUCTION*
Winter annuals	*annual bluegrass, groundsel*	*fall (August through mid-October)*	*winter (mid October through April)*	*Set and disperse seed in winter–spring*
Summer annuals (sometimes biennials)	*California burclover, crabgrass,[1] cheeseweed (Malva)*	*winter*	*spring–summer*	*Set seed and spread during summer–fall*
Perennial broadleaf	*white clover,[2] dandelion,[3] plantains*	*spring–fall*	*spring–fall*	*Set seed and dehisce late summer–fall; clovers also spread by creeping rhizomes*
Perennial grasses[4]	*kikuyugrass, bermudagrass*	*Warm-season vegetative growth*	*Grow throughout year; winter dormant*	*Spread by creeping rhizomes*

[1] Crabgrass is encouraged by frequent, shallow irrigation and poor drainage.

[2] White clover infests low-nitrogen turf sites and makes its own nitrogen. California burclover, lotus (birdseye trefoil) and other clovers infest low-nitrogen turf sites, and outcompete more nitrogen-needing turf types.

[3] Dandelion establishes well in open turf areas, bare spots, less dense areas.

[4] Perennial grasses colonize disturbed and open sites.

D. Tools and Methods for Managing Turf Weeds

1. Soil Type and Quality

What is soil? What kind of soil do you have and how do you find out what it is?

For the management of turf on school sites, we will focus on texture, structure, and organic matter. These soil characteristics influence the overall health of the turf. A healthy turf resists disease and pests better than poorly maintained turf.

Texture	Particle size distribution or amounts of *sand, silt, clay*
Structure	Particle arrangement—unstructured like a sand dune, massively structured like a block of clay, or intermediate in structure
Organic matter	The glue that holds soil together. Provides soil with beneficial qualities such as bioavailable nutrients, water retention, and acid–base buffering

The above three factors affect soil qualities such as fertility, compaction and aeration (which affect how much oxygen is in the soil), and irrigation and soil moisture.

How do you determine what type of soil you have?

It's important to know the specific types of soil around turf-planted areas to understand the soil's physical and chemical properties such as soil infiltration and percolation rates, available water-holding capacity, and soil pH. This information is available in county soil surveys compiled by the Natural Resources Conservation Service (see federal government pages of your local white pages and look for the entry, *Conservation*).

Why does soil texture matter?
The impact of soil texture is indirect and affects moisture, temperature, and oxygen availability of the soil. Depending on the soil texture, you may see an abundance of specific weeds. For example, dandelion and plantains prefer heavy clay soils; these soils have poor drainage and easily get waterlogged.

Each county survey lists soil in series, most named after counties and towns where the soil originates. For example, the Madera series consists of "moderately deep to hardpan, well or moderately well-drained soils that formed in old alluvium derived from granitic rock sources. Madera soils are on undulating low terraces with slopes of 0 to 9 percent." Within the Madera series are five soil types, Ap, Btl, 2Bt2, Bqkm, and 3C, and properties of each are described. Keep in mind that soil adjacent to the school may be a source of soil within the school, which is why it's important to note all surrounding soil types.

2. Basic soil fertility—what does your turf need?

- Plants need minerals that may not be in the soil, or available to them.
- Plants create some of their own nutrients through photosynthesis.
- Too much fertilization may injure plants.
- Don't wait until turf shows symptoms of nutrient deficiencies to figure out what it needs (see **Table 3**).
- Grasscycling and fertilizing the proper amount at the right time will reduce weeds by creating a dense turf that can outcompete weeds. Grasscycling returns minerals to the soil that were taken up by the plant. For information about when and how to fertilize turf, see **Appendix 2**. This appendix also lists nitrogen requirements for different turf species and describes various nitrogen carriers (urea and manures, for example) and their characteristics. See page 11 for information on mowing.

Table 3. Characteristics of some essential plant nutrients

Nutrient	Comments	Amount (lb) to fertilize/ 1,000 ft^2 / yr	Where available?	Sources
nitrogen (N)	***Leaf and stem growth, green color. Extremely mobile in soil water.***	***3***	***Decomposed organic matter***	***Grass clippings, blood meal, cottonseed meal, alfalfa meal, corn gluten, ammonium sulfate (for alkaline soils), calcium nitrate (for acidic soils)***
phosphorus[1/] (P)	***Promotes good root growth, disease resistance. Often becomes tied up in soil.***	***0.5***	***Most undisturbed soils***	***Grass clippings, rock phosphate, bone meal, various phosphate fertilizers Not available at high or low pH***
potassium[2/] (K)	***Increases disease resistance, serves multiple functions. Mobile in sandy soil.***	***1.5***	***Most clay, silt, and loam soils***	***Grass clippings, greensand, potassium sulfate, and potassium nitrate***
calcium (Ca)	***Mobile in sandy soils; limited mobility in plants.***	***1***	***Most clay and loam soils***	***Grass clippings, calcitic limestone, dolomitic limestone, gypsum, oystershells, calcium nitrate***
magnesium (Mg)	***Constituent of chlorophyll molecule. Mobile in sandy soil; very mobile in plants. Must be balanced with calcium.***	***1–6***	***Most soils; excessive in serpentine***	***Grass clippings, dolomitic limestone***

[1/] One application of a complete fertilizer (e.g., 12–12–12, 10–6–4) per year is usually enough to maintain a sufficient level of **phosphorus** in the soil for turfgrass growth. If the recommendation exceeds two pounds of P_2O_5 per 1,000 square feet, split the applications between spring and fall—except when the fertilizer is to be incorporated into the soil.

[2/] **Potassium** may be applied as 0–0–60 (muriate of potash) or as a complete fertilizer. Applications should be split into 1.5-pound increments applied through the growing season since rates of more than 1.5 pounds per 1,000 square feet may cause burning. Apply to dry turf and water immediately if possible.

3. Compaction and Aeration

Most terrestrial plants require oxygen to live and room to discharge carbon dioxide underground. When soil is compacted or flooded, oxygen and room to discharge carbon dioxide is reduced, resulting in plant death unless the plant is specially adapted to live without oxygen. Weeds then move in. Achieving positive drainage off of athletic fields is of paramount importance since these fields are continually in a state of compaction. Thatch builds up on compacted surfaces and prevents movement of oxygen. Creating air holes in the turf is a proven method of managing this problem.

Unless soil moisture is optimum (below field capacity, not wet) the aeration machinery can cause more compaction. Know your soil texture—sands are more tolerant of aeration than clays. Be sure to check soil moisture and compaction level.

Mow, irrigate, wait, decompact, rake up plugs and pile for compost and reuse if plugs are pulled, topdress with compost once a year after aerating, irrigate, topdress with other amendments as needed. Aerate as often as possible!

4. Irrigation and Soil Moisture

Key points for irrigation efficiency: Irrigate deeply and infrequently late night or early morning. Match water application rates to soil infiltration rates. Remove thatch in spring if more than ½-inch thick. Don't overfertilize!

5. Mowing to Minimize Weed Problems

What are the impacts of mowing?

- Increases water needs initially, but reduces irrigation needs when turf is kept shorter.
- Removes proteins and other plant nutrients
- Wounds grass plants, but stimulates damage repair and growth
- Makes it easier to run, see and move balls, reduces the chance of athletes tripping—plus the turf looks groomed

- ***Mowing increases lateral growth (tillering) in Kentucky bluegrass.***
- ***Mowing bluegrass too short (<1½") weakens it and encourages weed growth.***
- ***Mowing bermudagrass too long results in thatch buildup.***

Table 4. Recommended Mowing Heights

Type	Mower setting	Mowing height
Bluegrass/rye blend	*1.5–2"*	*2.25–3.25"*
Tall fescue	*1.5-3"*	*2.25–4.25"*
Bermuda (hybrid)	*1.5–1"*	*0.75–1.5"*
Kikuyugrass	*1–1.5"*	*1.5–2.25"*

Mowing Tricks

- Grasscycling—leave clippings
- **1/3 rule** = no more than 33% of blade removed at one time
- In summer mow cool-season grasses higher

6. Overseeding

As patches develop, or turf has dormant periods, it may be advisable to overseed with either the same or different species. For a cool-season grass that uses a lot of water like Kentucky bluegrass, you may want to overseed with a dwarf fescue during periods of hot weather. Use rye grass for winter-dormant grasses.

Most overseeding programs focus on using either annual rye for a quick fix at any time of the year, or turf-type perennial rye, mostly sown in the fall, to avoid adding weeds at the wrong time of year.

Quality of seeds and timing of seeding are crucial. Purchase high-quality grass seeds—poor quality seeds are often contaminated with weed seeds (read the seed label carefully!). Overseeding in the spring could be a problem if grass seeds contain even 3% weed seeds because a high percentage of weeds may germinate and survive. If you overseed in the fall fewer weeds will germinate.

General Fall Overseeding Program

1. 20–30 days before first killing frost
2. Soil temperature mid-70
3. Dethatch first
4. Cut short
5. Spread seed
6. Work seed in
7. Topdress
8. Irrigate until seeds germinate

7. To Sum Up: Seasonal Highlights

FALL. Fertilize cool-season grasses as soils cool off, irrigate, mow as high as possible. Irrigate again as needed, overseed with rye, apply pre-emergent herbicide/fertilizer such as corn gluten. Solarize new areas before planting. Maintain dense turf when weed seeds should be germinating.

WINTER. Irrigate only if drought, mow, aerate during moist (not wet or saturated) conditions.

SPRING. Aerate, mow, irrigate as needed, fertilize warm-season grasses as soils warm up, apply pre-emergent herbicide/fertilizer such as corn gluten.

SUMMER. Aerate, mow, irrigate, fertilize warm-season grasses. Solarize new areas before planting.

E. Field Exercise 1

Turf Identification and Quality

PURPOSE: To identify the type of turf and its condition in different areas.

PROCEDURE: Each team of four stretches a 15-foot transect line across an athletic field or other grassy area around the school for a total of five different areas. Use this sheet to record the turf type and quality at the beginning, end, and two 5-foot increments of each transect.

BIGGER PICTURE: Remember, to prevent weeds and other pests from becoming unmanageable, select the most appropriate turf species for the site and situation.

Evaluator(s): _____

Location of transect line: _____

Location along transect line: ❒ 0 feet ❒ 5 feet ❒ 10 feet ❒ 15 feet

Turf Type

❒ Bluegrass
❒ Bluegrass/Perennial Rye Blend
❒ Dwarf Fescue
❒ Dwarf Fescue/Bluegrass Blend
❒ Fine Fescue
❒ Fine Fescue/Bluegrass Blend
❒ Heinz 57 (a little of everything)

Turf Color

❒ Green ❒ Dark r❒ Light
❒ Yellow ❒ All r❒ Clumps r❒ Bands r❒ Tips r❒ Whole blade
❒ Brown ❒ All r❒ Clumps r❒ Bands r❒ Tips r❒ Blade

r

Turf Density

❒ Solid carpet (No bald patches or weeds)r❒ More than half turf
❒ Less than half turf

F. Field Exercise 2

Monitoring Weed Population Levels Using A Transect Method

PURPOSE: To practice monitoring turf weeds

PROCEDURE: The class works on this exercise together. Stretch a 15-foot transect line across at least three areas of an athletic field or other grassy area around the school. Sample points every five feet, noting where the line touches the ground. At these 5-foot increments, record plant type (broadleaf or grassy weed, or intentionally planted turf), or bare soil. Also record the top three weeds seen in each transect.

BIGGER PICTURE: Monitoring tells you which weeds grow where at any given time. It's important to anticipate weed problems so you can focus on prevention. If you monitor every few weeks, you can probably figure out problem areas and consider solutions.

Evaluators: _____

Type of Site: _____

Transect 1

Broadleaf weeds	Grassy weeds	Intentional	Bare soil
_____	_____	_____	_____

Dominant weeds: #1 _____, **#2** _____, **#3** _____

Transect 2

Broadleaf weeds	Grassy weeds	Intentional	Bare soil
_____	_____	_____	_____

Dominant weeds: #1 _____, **#2** _____, **#3** _____

Transect 3

Broadleaf weeds	Grassy weeds	Intentional	Bare soil
_____	_____	_____	_____

Dominant weeds: #1 _____, **#2** _____, **#3** _____

G. Field Exercise 3

Calculating Drainage Rate

PURPOSE: To understand how soil type and amount of compaction determine drainage rate.

PROCEDURE: The instructor digs one or more hole to be tested. The class measures and records the depth of each hole, then fills each hole with water. Class measures the depth of the water drop in 15 minutes and 30 minutes.

BIGGER PICTURE: Think about the relationship between drainage rate and irrigation. Proper drainage and irrigation improves turf health and reduces the chance of disease.

For information about irrigation scheduling, see http://www.ipm.ucdavis.edu/TOOLS/TURF/MAINTAIN/irrfreq.html.

Measure the depth of each hole:

A. _____ inches
B. _____ inches
C. _____ inches
D. _____ inches
E. _____ inches

How long does drainage take after you fill each hole with water? Indicate below for the different holes you've tested. See box for interpretation.

A.	15 minutes _____	30 minutes _____	Calculate for one hour _____
B.	15 minutes _____	30 minutes _____	Calculate for one hour _____
C.	15 minutes _____	30 minutes _____	Calculate for one hour _____
D.	15 minutes _____	30 minutes _____	Calculate for one hour _____
E.	15 minutes _____	30 minutes _____	Calculate for one hour _____

Rate of Drainage

If	Then
Less than one inch drainage in one hour	Slow infiltration and/or percolation
More than one inch per hour	Good infiltration and/or percolation
One inch per hour	Generally satisfactory infiltration and/or percolation

H. Field Exercise 4

Soil Quality Evaluation

PURPOSE: To become familiar with major soil textures.

PROCEDURE: Take a soil sample with a probe and extract a small handful, which should be moist enough to knead into a puttylike ball. Add water if necessary. Make a ribbon of soil as long as possible by squeezing the moist soil between your thumb and the side of your forefinger.

BIGGER PICTURE: How does soil texture relate to turf weeds? The impact of soil texture is indirect and affects moisture, temperature, and oxygen availability of the soil. Depending on the soil texture, you may see an abundance of specific weeds. For example, dandelion and plantains prefer heavy clay soils; these soils have poor drainage and easily get waterlogged.

Evaluator(s): _____

Soil texture is determined by the relative proportion of sand, silt, and clay found in the soil. (Think particle size with sand having the largest particles, followed by silt and clay.)

Figuring out what kind of soil you have is not easy considering the number of textural categories, but give it a try using the descriptions below. (Note that there are quantitative ways to classify soils, but we're using the qualitative method here.) Use the Textural Triangle on page 17 and the Guide to Texture by Feel on page 18.

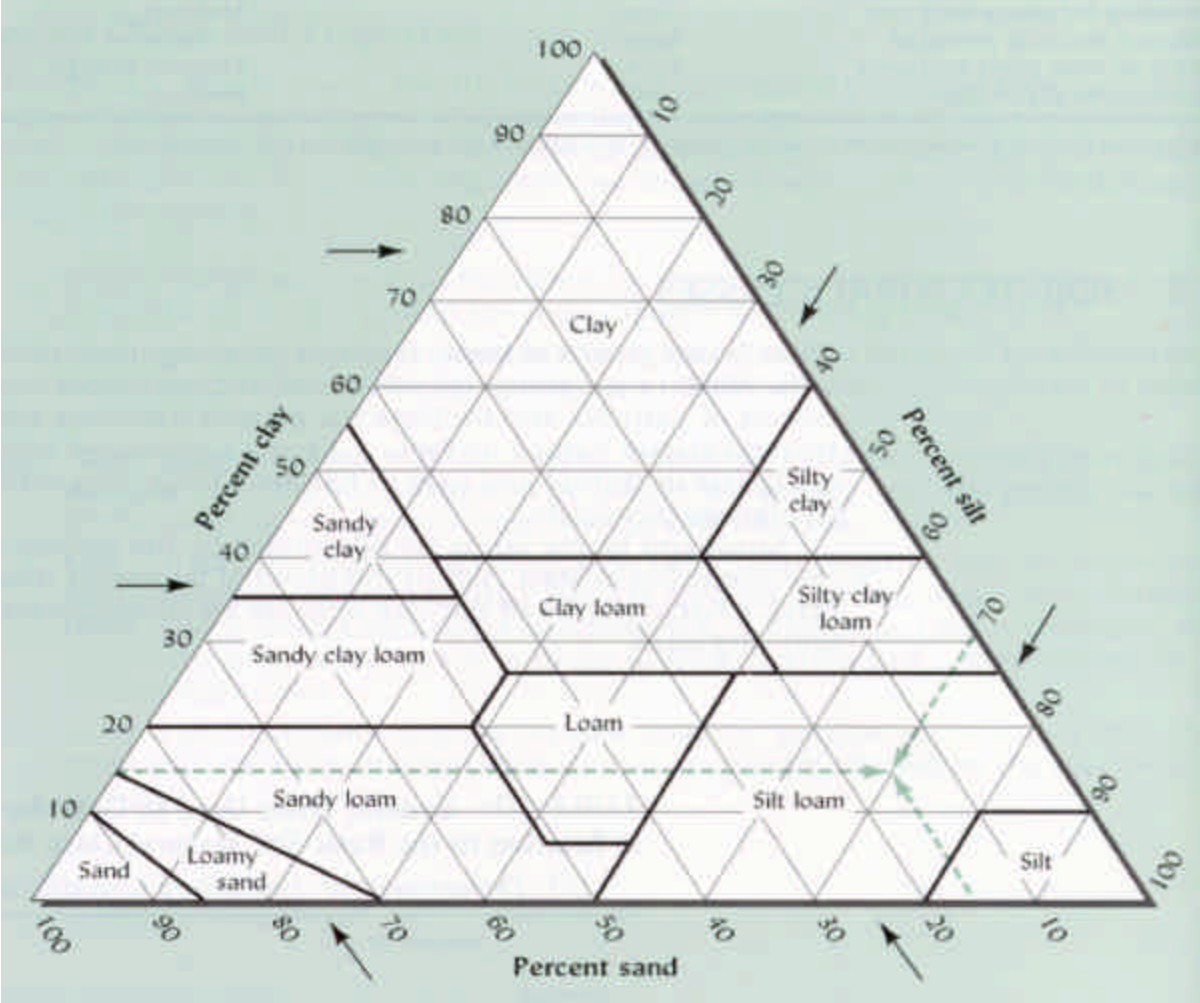
Note qualities and guesstimate the texture of your sample:

- ❑ **Sand** = gritty; will not stay in a ball or form a ribbon; falls apart; has a rough, grainy feel with visible grains; makes a grinding noise when rubbed near ear.
- ❑ **Silt** = smooth, silky feel; little resistance to deformation
- ❑ **Clay** = malleable, sticky, stiff, only slight grittiness and smoothness

Loam = nearly equal parts sand, silt, and clay

- ❑ **Loamy sand = coarse; does not form an inch-long ribbon when moistened**
- ❑ Sandy loam = gritty when moist; dirties fingers; contains silt and clay
- ❑ Silty loam = feels very smooth like flour
- ❑ Sandy clay loam = softer than clay and not as sticky; feels gritty or sandy
- ❑ Silty clay loam = softer than clay and not as sticky; feels smooth like flour
- ❑ Clay loam = does not feel smooth like flour, but has some sand in it

Figure 3. The Textural Triangle for Soil



Coarse soils: sand, loamy sand

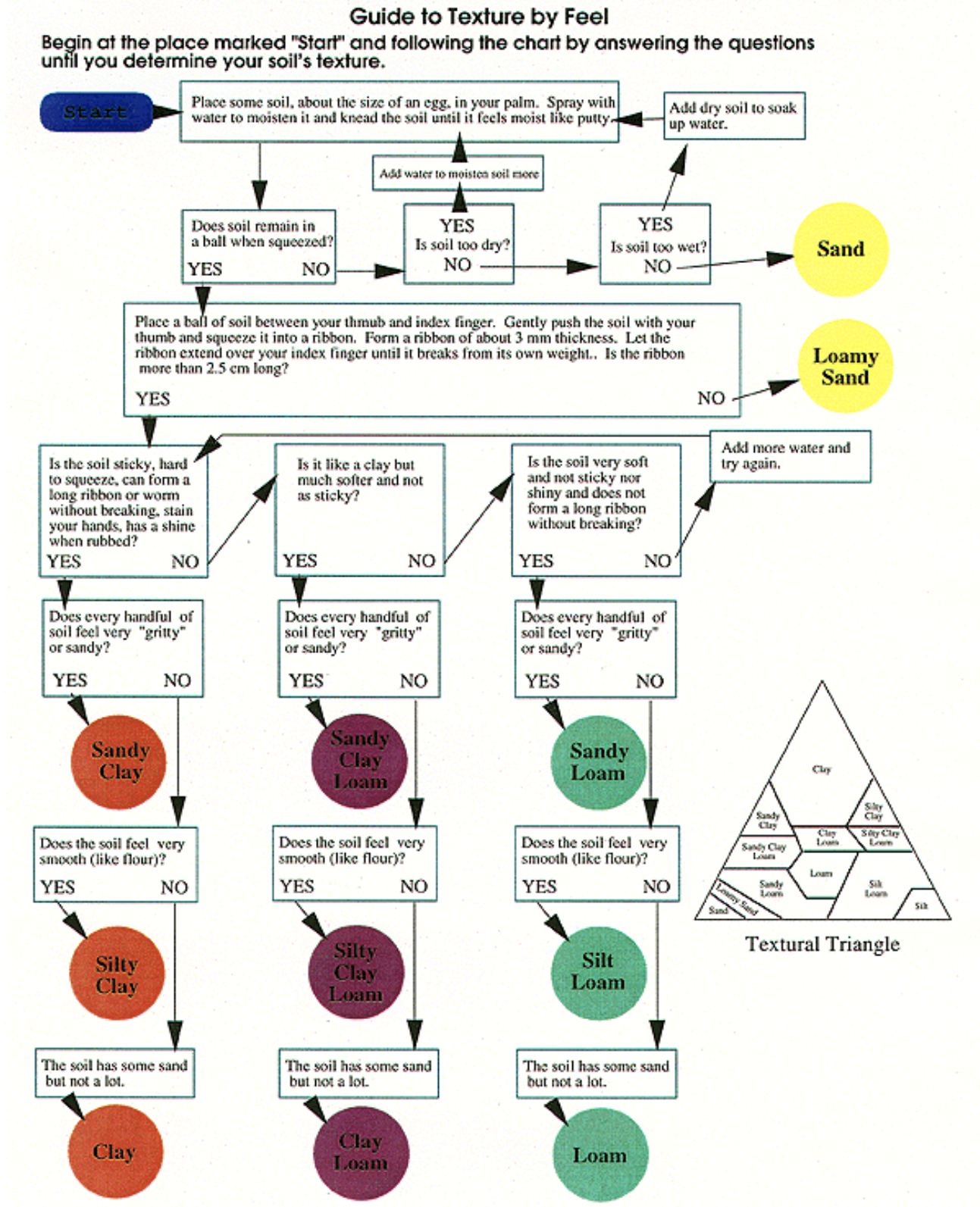
Loamy soils: sandy loam, fine sandy loam

Medium-textured soils: very fine sandy loam, loam, silty loam, silt

Moderately fine textured soils: sandy clay loam, clay loam, silty clay loam

Fine-textured soils: silty clay, clay, sandy clay

Figure 4. Soil Texture Flow Chart



Reprinted from the NASA Goddard Space Flight Center web site, http://ltpwww.gsfc.nasa.gov/globe/tbf/tbfguide.htm

APPENDIX 1. TURFGRASS SPECIES

Excerpted from Elmore, C.L., C. A. Wilen, D. W. Cudney, V. A. Gibeault, & M. A. Harivandi. 2003. UC IPM Pest Management Guidelines—TURFGRASS, UC ANR Publication 3365–T. (http://www.ipm.ucdavis.edu/PMG/r785900111.html)

Proper selection of a turf species is an important component of an integrated pest management program. When turf species are planted in areas where they are not well adapted, they require greater care to grow and maintain and are more susceptible to invasion by pests. The major species used for turfgrass in California are outlined below. Cultivars [also known as varieties] are continually being developed or improved.

BENTGRASS (*Agrostis* spp.). Two species of bentgrass commonly used for turf are colonial and creeping bentgrasses. Colonial bentgrass is best adapted to the coastal region in central and northern California where it is used for general lawn areas. It is a fine-textured grass with upright leaves and dense growth. Colonial bentgrass grows best in cool, humid weather, and can tolerate some shade; it has low tolerance to heat, salinity, water stress, and traffic. Colonial bentgrass requires frequent irrigation because it has a shallow root system. It tends to be susceptible to a wide range of diseases.

Creeping bentgrass is a specialty grass used for golf course putting greens, lawn bowling greens, and lawn tennis facilities. It is capable of withstanding very low cutting heights. Creeping bentgrass is a very finetextured grass with flat, narrow leaves, a bright green color, and a shallow root system. It requires a high level of nitrogen fertilization and needs to be irrigated fairly frequently because of its shallow roots.

KENTUCKY BLUEGRASS (*Poa pratensis*). Kentucky bluegrass produces a dense turf with dark green, medium-textured leaves; it spreads by rhizomes. Kentucky bluegrass grows best in fall, winter, and spring when temperatures are cool; during summer its growth slows. Kentucky bluegrass requires frequent irrigation during the summer months because of its shallow root system.

RYEGRASS (*Lolium* spp.). The species of ryegrass used for turfgrass are annual and perennial ryegrass. Annual ryegrass is used principally for overseeding bermudagrass in winter: it is well adapted to sunny conditions and survives well during the cooler months. Annual ryegrass has low heat tolerance, is coarse textured, and shiny dark green. It dies in late spring to early summer.

Perennial ryegrass is well adapted to sunny or partially shady conditions. It grows best during periods of cool temperatures and is very competitive, rapidly establishing a uniform green cover. Fall seeding is preferred. Perennial ryegrass has a bunchgrass-type growth habit, thus open areas should be reseeded. It is extremely vigorous in its growth, particularly in the seedling stage, thus minimizing weed invasion. Selection of new, improved perennial ryegrass cultivars will decrease invasion of weeds compared to the older pasture-type cultivars such as Linn perennial ryegrass.

KENTUCKY BLUEGRASS AND PERENNIAL RYEGRASS MIX. For general lawns, mixing Kentucky bluegrass and perennial ryegrass is preferred over planting either species singly. The mixture results in a more disease-resistant turfgrass stand offering good color and year round growth. By weight, at least 15 percent perennial ryegrass seed is recommended in the mixture.

TALL FESCUE (*Festuca arundinacea*). Tall fescue is well adapted to sunny or partially shady conditions. It is coarse-textured, although newer cultivars are finer textured, but not as fine as perennial ryegrass. Tall fescue has good disease resistance and excellent tolerance to heat stress. Unlike bermudagrass or Kentucky bluegrass, tall fescue is a bunch-type grass, thus open areas need to be reseeded. The extremely vigorous growth of tall fescue is a deterrent to weed invasion. Selection of new, improved turf-type tall fescue cultivars can improve the competitiveness of the turf over the older pasture-type tall fescue cultivars such as 'Kentucky 31' or 'Fawn.'

FINE FESCUE (*Festuca rubra commutata*). Fine fescue is a fine-textured, cool-season turfgrass that can have either a clumped or creeping type of growth. Fine fescue makes a dense, wear-resistant turf when well established. It is usually mixed with other turf species because it tolerates shade well, thus it will fill in shady areas. It is often mowed at 1 to 1.5 inches to tolerate heat in California. Fine fescues do not like excessive nitrogen.

COMMON BERMUDAGRASS (*Cynodon dactylon*). Common bermudagrass is drought tolerant and well adapted to sunny conditions. It is a medium, coarse-textured grass with a gray green color, but it becomes dormant and loses its color in cold weather. Common bermudagrass establishes a deep root system and produces long rhizomes and stolons. Plant common bermudagrass in spring or summer at a rate of 1 lb seed/1000 sq. ft. Common bermudagrass requires frequent mowing to maintain an attractive quality. It has good wear quality when it is growing, but produces heavy thatch and can produce thatch in light traffic areas. There are new seeded cultivars of common bermudagrass that have improved turfgrass quality characteristics.

HYBRID BERMUDAGRASS. Cultivars of hybrid bermudagrass include 'Tifgreen,' 'Tifway II,' and 'Santa Ana.' All hybrid bermudagrass cultivars form thatch that must be removed periodically by verticutting. Hybrid bermudagrasses are drought tolerant, but good irrigation practices will enhance their competitiveness. 'Tifgreen' is well adapted to sunny conditions. It becomes dormant and loses color during periods of cold temperatures, but less than common bermudagrass. This cultivar is fine textured with dense, prostrate growth. It produces few seed heads and has a deep blue-green color.

'Tifway II' is also well adapted to sunny conditions. It retains its color in winter better than any of the other bermudagrasses. This cultivar has a medium fine texture, a dark green color, and dense growth; it can withstand traffic better than 'Tifgreen.'

Santa Ana has excellent wear characteristics and a dark color. Its requirements are similar to those of the other hybrids, but Santa Ana is more tolerant of smoggy conditions.

KIKUYUGRASS (*Pennisetum clandestinum*). Kikuyugrass is well adapted to coastal regions within fifty miles of the ocean in southern California and central California. It is spreading to some of the inland valleys as well. Kikuyugrass is a coarse-textured, hairy, light green, perennial, warm season grass that spreads aggressively by very thick rhizomes and stolons; its leaves are coarse textured and hairy. Kikuyugrass has good drought, heat, and wear tolerance, but it is difficult to mow and is prone to thatch heavily. It was first considered a weed, but is now also used as a turf.

ST. AUGUSTINEGRASS (*Stenotaphrum secundatum*). St. Augustinegrass is well adapted to areas with full sun or moderate shade; it is the most shade tolerant warm season grass. It is a coarse-textured, creeping grass of medium green color. St. Augustinegrass is propagated by stolons and forms a dense, prostrate turf that is virtually weed free, but thatch is a severe problem. St. Augustinegrass frequently needs iron as a fertilizer supplement. It is relatively drought tolerant.

ZOYSIAGRASS (*Zoysia japonica*). Zoysiagrass grows well in full sun, although it is tolerant of moderate shade. Zoysiagrass is medium textured, dark green in color, and is slow to establish from stolons or rhizomes. It turns brown when it is dormant in winter. Zoysiagrass is an attractive, uniform, dense, lowgrowing, good quality grass that requires less fertilization than bermudagrass. Zoysiagrass is moderately deep rooted and thus requires infrequent irrigation. Vertical mowing is needed periodically to reduce excessive thatch and scalping.

DICHONDRA (*Dichondra micrantha*). Dichondra will grow in partial shade, but it does best in full sun under cool coastal conditions. It is not a turfgrass but a low-growing perennial, broadleaf ground cover. Mowing dichondra is a matter of personal preference; it may either remain unmowed or be mowed. Dichondra has a deep root system when properly irrigated. Frequent irrigation to maintain dichondra increases weed invasion.

APPENDIX 2. TURF FERTILIZATION GUIDELINES

Fertilizer replaces nutrients removed from the soil by growing plants. The amount of fertilizer applied should not exceed established levels, or turfgrass quality can decline. Timing and methods of application should match the turfs' needs and uptake abilities, taking into consideration soil and ambient temperature, wind, rain, and irrigation.

Grasscycle using a special mower, or double mow with a regular mower and leave the clippings on the lawn. Clippings will decompose and eventually provide nutrients to the soil.

When to Fertilize

Table A1. Cool-season turfgrass fertilization schedule to minimize leaching and runoff.

How many N application(s)/yr	*April–May*	*June–July*	*September*
1			*x*
2	*x*		*x*
3	*x*		*x*
4 (with summer irrigation)	*x*	*x*	*x*

Split the annual number of pounds of N to be applied equally into each application. Do not exceed one pound of N in a quick-release form at any one application.

Table A2. Calendar of Fertilizer Application for Northern California

Winter			Spring			Summer			Fall		
D	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*
Kentucky bluegrass											
+	–	+	+	+	+	–	–	–	–	+	+
Kentucky bluegrass and perennial rye											
+	–	–	+	+	+	+	–	–	–	–	–
Tall fescue, dwarf varieties											
+	–	–	+	+	+	+	–	–	–	–	–
Bermuda hybrids											
–	–	–	–	+	+	+	+	+	+	–	–

How to Fertilize

- ***Irrigate the soil before application—it should be moist, not wet. This will prevent dry fertilizer from burning up, and will allow plants to take up available minerals rapidly.***
- ***Aerate the soil before application. This will increase phosphorous availability, since phosphorous applied to the surface will not readily move to the roots.***
- ***Irrigate the soil after application to the point of saturation, but not beyond. It is critical to avoid over saturating the soil, which for sandy soils, will cause the nitrogen and potassium to leach out.***

How Much Fertilizer to Use

Table A3. Pounds of actual nitrogen per 1,000 ft^2/year required by different turf species

	lb N / 1,000 ft^2/yr
Cool-season grasses	
sheep and hard fescue	0–3
red fescue	1–3
tall fescue	2–4
perennial ryegrass	2–4
improved Kentucky bluegrass[a]	2–4
common Kentucky bluegrass[b]	1–2
creeping bent grasses	3–8
Warm-season grasses	
improved bermudagrass	4–8
buffalograss	0–2
St. Augustine grass	2–4
zoysiagrass	2–4

Types of Fertilizer

Table A4. Some nitrogen carriers and relative characteristics.

Carrier	% N	Analysis	Residual response	Low temp. effects	Burn potential	Leaching potential
Quick release						
Urea	45–46	45 or 46–0–0	short	rapid	high	moderate
Ammonium nitrate	33–34	33 or 34–0–0	short	rapid	high	high
Ammonium sulfate	21	21–0–0	short	rapid	high	high
Potassium nitrate	13	13–0–44	short	rapid	high	high
Monoammonium phosphate	11	11–50–0	short	rapid	moderate	moderate
Diammonium phosphate	20	20–50–0	short	rapid	moderate	moderate
Slow release						
IBDU	31	31–0–0	moderate	moderate	mod. low	low
SCU	22–38	22 to 38–0–0	moderate	moderate	low	low
Resin-coated urea	24–35	24 to 35–0–0	moderate to long	moderate	low	low
Methylene ureas & urea formaldehyde	38	38–0–0	moderate to long	very low	low	low
Activated sewage sludge	4–6	4 to 6–4–0	long	very low	very low	very low
Manures	1.5–3	variable	long	very low	very low	very low
Dried blood	3–14	variable	short	moderate	very low	very low