This competency-based curriculum unit on soils and fertilizers is one of four developed for classroom use in teaching the turf and lawn services area of horticulture. The four sections are each divided into teaching content (in a question-and-answer format) and student skills that outline taking soil samples, testing samples, preparing soil for turf seedbed, and turf fertility. A list of references precedes a section containing visual aids, student skill checklist, and student activities such as handouts, discussion activities, field trips, crossword puzzles, hands-on experiences, worksheets, tests, and quizzes. Answer keys are provided. (YLB)
Soils And Fertilizers

Competency Based Teaching Materials in Horticulture
Listed below are competency based curriculum units developed for classroom use in teaching horticulture. All units are indexed and include teaching content, references, student activities, a skill check list, and visual aids.

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<th>LANDSCAPE/NURSERY</th>
<th>GREENHOUSE PRODUCTION &amp; MANAGEMENT</th>
</tr>
</thead>
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<td>Tree Identification</td>
<td>Controlling the Greenhouse Environment</td>
</tr>
<tr>
<td>Developing a Landscape Plan</td>
<td>Greenhouse Soils</td>
</tr>
<tr>
<td>Implementing the Landscape Plan</td>
<td>Foliage Plants</td>
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<tr>
<td>Maintaining the Landscape</td>
<td>Propagation</td>
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<td>Cut Flower Production</td>
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<td>Bedding Plants</td>
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<td>TURF AND LAWN SERVICES</td>
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<td>Identification of Turf Grasses</td>
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<td>Planting Turf Grasses</td>
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<td>Insects and Diseases</td>
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<td></td>
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<tr>
<td>FRUIT PRODUCTION</td>
<td></td>
</tr>
<tr>
<td>(In progress)</td>
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</tbody>
</table>

| VEGETABLE PRODUCTION                        |                                                                        |
| Identification of Cool Season Vegetables    |                                                                        |
| Identification of Warm Season Vegetables    |                                                                        |
| Vegetable Production                        |                                                                        |
| Insects, Diseases, and Weeds                |                                                                        |

**ACKNOWLEDGEMENT**

This material was prepared by: Jim Legacy, Fred Reneau, Thomas Stitt, Terry Savko, Amy Swigart, Kathy Cummings, Carole Daesch, Sharon Flanagan, and 42 Illinois teachers of horticulture, in cooperation with the Illinois State Board of Education, Department of Adult, Vocational and Technical Education, and the Department of Agricultural Education and Mechanization, Southern Illinois University.
SOILS AND FERTILIZERS

Contents

TAKE SOIL SAMPLES ................................................................. 1

Problem locations vs. normal locations to be tested, factors to consider when selecting soil test site, soil testing tools, drilling a sample, mix samples, bag samples, label bag, mail the sample, soil treatments, record the sample information.

TEST SOIL SAMPLES ............................................................... 4

Test for pH, quick test phosphorus and potassium tests

PREPARE SOIL FOR TURF SEEDBED ........................................ 5

Influence of soil texture to water movement, tiling and sloping the seedbed, tillage tools, seedbed drainage, seed bed tillage, fertilizer selection, types of spreaders, methods of application

TURF FERTILITY ................................................................. 8

Nutrient levels, interpret soil test results, fertility requirements of turf, calculate maintenance fertilizer

REFERENCES ................................................................. 10

STUDENT ACTIVITIES ............................................................ 11
Soils and Fertilizers

TAKE SOIL SAMPLES

Teaching content: 15 questions; 6 student skills

Question 1: What are the characteristics of a normal site to be tested?
- It would be an average area that has no identifiable problem areas.

Question 2: What is a problem area?
- Wet areas
- Poor producing area
- Any unusual area

Question 3: How many sites per location?
- One per 10,000 sq. ft.
- One per 4 acres if over one acre
- One per problem area

Question 4: What factors should be considered when selecting a site to be tested?
- Sites that will be used for growing purposes should be tested for nutrient deficiencies, etc.

Question 5: What types of tools may be used to test soil?

Alternatives
1. Auger
2. Probe
3. Spade

Factors for Consideration
- Soil moisture
- Equipment available
- Number of samples to be taken

DRILL SAMPLE

Steps
1. Drill auger or spade 3" deep
2. Pull out sample
3. Place sample in bucket

Factors for Consideration

Student Skill 1
Question 6  What is a uniform representative sample?
- A thorough mixture of 5 sample probes per site.

Student Skill 2

MIX SAMPLE

<table>
<thead>
<tr>
<th>Steps</th>
<th>Factors for Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Place 5 sample cores per site in bucket</td>
<td>1. 8 qt. bucket</td>
</tr>
<tr>
<td>2. Stir with a stick</td>
<td>2. Don't use hands to mix</td>
</tr>
</tbody>
</table>

Question 7  What type of bag should be used to store the samples?
- Moisture and temperature resistant
- Double-thick walls
- Bag size dependent upon size of samples taken

Question 8  How much soil is required in the bag?
- One cup
- One-half bag

Student Skill 3

BAG SAMPLE

<table>
<thead>
<tr>
<th>Steps</th>
<th>Factors for Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fill sample bag 1/2 full.</td>
<td>1. Use a cup.</td>
</tr>
<tr>
<td>2. Fold bag closed.</td>
<td></td>
</tr>
</tbody>
</table>

Student Skill 4

LABEL BAG

<table>
<thead>
<tr>
<th>Steps</th>
<th>Factors for Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Write date on bag</td>
<td>1. Use a pencil</td>
</tr>
<tr>
<td>2. Write customer's name</td>
<td></td>
</tr>
<tr>
<td>3. Write customer's address</td>
<td></td>
</tr>
<tr>
<td>4. Record sample number</td>
<td></td>
</tr>
<tr>
<td>5. Record location (field) number</td>
<td></td>
</tr>
<tr>
<td>6. Record location on map</td>
<td></td>
</tr>
</tbody>
</table>
Question 9 What has been done to the soil in the past?
- Farm field
- Garden
- Turf

Question 10 How will the site be used?
- Home lawn
- Park
- Golf course
- Garden

Question 11 When and how much fertilizer and lime was applied in past?
- In records
- Ask owner
- Check old soil test results

Question 12 What type of turf is growing?
- Kentucky bluegrass
- Red fescue
- Best grass
- Others

Question 13 Are there any unusual conditions?
- Low areas
- Wet areas
- Near roads
- Droughtiness
- Eroded areas
- Soil texture
- Soil color

RECORD SAMPLE INFORMATION SHEET

Steps
1. Record past history
2. Record site use
3. Record fertilizer and lime used in past and date
4. Record type of turf growing
5. Record any unusual conditions

Factors for Consideration
1. Ask owner
Question 14 How do you properly package the samples?
- Use a box
- Seal box with tape and string

Question 15 What is the address of the soil lab?
- Secure address from local agricultural extension advisor

<table>
<thead>
<tr>
<th>Student Skill 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MAIL SAMPLE</strong></td>
</tr>
</tbody>
</table>

**Steps**

1. Package samples
2. Address package
3. Mail—after allowing samples to air dry

**Factors for Consideration**

TEST SOIL SAMPLES

Teaching content: 4 questions; 3 student skills

Question 1 How do I use a pH meter?
- Follow directions with pH meter.

Question 2 How do I use the quick test procedure?
- Follow directions with the test kit

| Student Skill 1 |

**TEST FOR pH**

<table>
<thead>
<tr>
<th>Steps</th>
<th>Factors for Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Obtain air dry soil sample</td>
<td>1. Keep hands from touching soil for accurate results</td>
</tr>
<tr>
<td>2. Grind up soil</td>
<td>3. Many pH meters and simple tests are available</td>
</tr>
<tr>
<td>3. Follow pH test directions</td>
<td></td>
</tr>
</tbody>
</table>

Question 3 How do I use the quick test phosphorus procedure?
- Follow test kit directions
**Student Skill 2**

**TEST FOR AVAILABLE PHOSPHORUS**

<table>
<thead>
<tr>
<th>Steps</th>
<th>Factors for Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Obtain air dry soil sample</td>
<td>1. Don't touch soil</td>
</tr>
<tr>
<td>2. Grind soil</td>
<td>2. Use mortar and pestle</td>
</tr>
<tr>
<td>3. Follow test directions</td>
<td>3. Sudbury soil test kits are simple to use, others also</td>
</tr>
<tr>
<td></td>
<td>available</td>
</tr>
</tbody>
</table>

**Question 4** How do I use the quick test potassium procedure?
- Follow test kit directions

**Student Skill 3**

**TEST FOR POTASSIUM**

<table>
<thead>
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<td></td>
<td>available</td>
</tr>
</tbody>
</table>

**PREPARE SOIL FOR TURF SEEDBED**

Teaching content: 11 questions; 4 student skills

**Question 1** How fast does water move into and through the soil?
- Fine, moderately-fine texture--slow movement
- Medium texture--moderate movement
- Moderately-coarse and coarse texture--rapid movement

**Question 2** When is tiling and sloping the seedbed necessary?
- Tile poorly drained soils
- Slope seedbed away from buildings
DRAIN SEEDBED

Steps

1. Place tile in ground if poorly drained
2. Slope soil away from buildings to put in tile

Factors for Consideration

1. Get professional help

Question 3

How does the soil till up to form a seedbed?

- Clays, fine, and moderately-fine textures are difficult to till when wet
- Medium and coarse textures are easy to till

Question 4

How do the tillage tools differ in their ability to till the soil?

- Plow--completely turns over the soil
- Disc--makes a fine seedbed
- Rotary tiller--prepares a fine seedbed, tills deeper than a disc
- Leveling is required for all methods

SELECT TILLAGE TOOLS

Steps

1. Measure soil texture
2. Determine if turning over soil is necessary
3. Select tillage tool suited to soil

Factors for Consideration

Question 5

Which method should be used?

Alternatives

1. Plow
2. Rotary tiller
3. Disc

Factors for Consideration

- Soil texture
- Soil moisture
- Time of year
- Erosion hazard
- Equipment cost
- Necessity of soil to be turned over
Student Skill 3

TILL SEEDBED

Steps
1. Allow soil to become dry
2. Till seedbed
3. Level seedbed
4. Check for fine, loose seedbed
5. Stop before soil becomes pulverized

Factors for Consideration
1. Soil must be moist, not bone dry for best results.

Question 6 Which fertilizer should be used?

Alternatives
1. Slow release fertilizer
2. Blended
3. Liquid
4. Straight grade
5. Bag
6. Bulk

Factors for Consideration
- Cost
- Rate of reaction
- Ease of application
- Availability

Student Skill 4

SELECT FERTILIZER

Steps
1. Determine availability
2. Calculate cost per pound of nutrient
3. Determine ease of application
4. Buy fertilizer

Factors for Consideration

Question 7 How easy are the spreaders to use and maintain?

- Dry spreaders must be cleaned, calibrated, and lubricated
- Liquid sprayers require precise mixing and ground speed
- Liquid sprayers must be cleaned, calibrated, and lubricated

Question 8 Which method of application should & use?

Alternatives
1. Liquid application
2. Dry application

Factors for Consideration
- Cost of equipment
- Ease of application
- Ease of maintenance
Question 9: What steps are necessary to follow when selecting fertilizer equipment?
- Determine time required to fertilize the area
- Match equipment to fertilizer selected
- Estimate the cost of owning and maintaining the equipment
- Rent or buy the equipment

Question 10: Which method should I use?

Alternatives | Factors for Consideration
---|---
1. Spray | - Cost
2. Broadcast | - Rate of application
3. Band | - Speed of application
- Ease of application

Question 11: How do I apply fertilizer to my soil?
- Follow instructions with the spreader
- Avoid skipping and streaking

TURF FERTILITY

Teaching content: 3 questions; 2 student skills

Question 1: What nutrient levels does the soil require?
- pH 6.0 to 6.5
- $P_1$ test optimum 40-50 pounds $P_2O_5$ per acre
- $K$ test optimum 260-300 pounds $K_2O$ per acre

Question 2: How can one determine the present pH level and the $P$ and $K$ levels in soil?
- They can be determined by soil test results.

Student Skill: INTERPRET SOIL TEST RESULTS

<table>
<thead>
<tr>
<th>Steps</th>
<th>Factors for Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Calculate if pH, P, and K are at acceptable levels</td>
<td></td>
</tr>
</tbody>
</table>
Question 3  How much fertility does turf need?

- Ten pounds of 12-12-12 per 1000 ft$^2$ applied in September and April
- Additional nitrogen may be applied at 1#/1000 sq. ft. in November, April, June, and August

<table>
<thead>
<tr>
<th>CALCULATE MAINTENANCE FERTILIZER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steps</strong></td>
</tr>
<tr>
<td>1. Determine type of turf to be grown</td>
</tr>
<tr>
<td>2. Calculate $P_2O_5$, $K_2O$ needed annually by turf species</td>
</tr>
</tbody>
</table>
REFERENCES


Vocational Agriculture Service. Soils Units 4052, 4053. Urbana, IL: Vocational Agriculture Service.


SOILS AND FERTILIZERS
Definitions

Banding - Placing fertilizer in bands beside, above, and below the seed; fertilizer is available to plant's root system a few days after germination.

Fertilizer analysis - The percent of available primary nutrients (N,P,K).

Fertilizer, organic - Fertilizer produced by living plants and animals.

Fertilizer, inorganic - Fertilizer produced from minerals.

Gypsum - Mineral able to supply the essential nutrients of calcium and sulfur to a soil without changing the pH.

Leaching - The loss of dissolved nutrients with the downward movement of water through the soil.

Lime - Mineral supplied to a soil to raise the pH.

Micro-nutrients - Boron, Chlorine, Manganese, Molybdenum, Iron, and Zinc; essential to plant growth in very small amounts - often referred to as trace elements.

Primary nutrients - Nitrogen, Phosphorus, and Potassium (N,P,K); required in large amounts by plants and not usually found in sufficient quantities in the soil.

Plant analysis - Studying the tissue of the plant to identify nutrient deficiencies.

pH - Measures the acidity of a soil with 7.0 being neutral on the scale of 0 to 14. Less than 7 is considered acidic while above 7 is considered basic (alkaline).

Secondary nutrients - Calcium, Magnesium, and Sulfur; not required in as large amounts as primary nutrients but still important to plant growth and development.

Soil structure - The way individual soil particles are grouped together to form clusters of particles (aggregates).

Soil test - Shows the breakdown of the total amount of nutrients available in the soil.

Soil texture - Refers to the size of the various particles that make up the soil.
SKILL EVALUATION FOR TAKING SOIL SAMPLES

1. Is the sample bag 1/2 full?

2. Is the sample bag properly labeled?
   - date
   - name
   - address
   - sample number
   - field or location number

3. Is the sample information sheet properly filled out?
   - past history
   - site use
   - fertilizer and lime used in the past and the date
   - type of turf
   - any unusual conditions.
SOILS AND FERTILIZERS

Tilling the Seedbed and Applying Fertilizer

b. Used in poorly drained soils to improve drainage.

g. Slow water movement.

e. Rapid water movement.

g or h. Soil is difficult to till when wet.

c. Tool that completely turns over the soil.

d. Tool that makes a fine seedbed and is better than a disk.

a. Recommended soil pH.

i. Recommended optimum P₁ test.

i. Recommended optimum K test.

g or h. Moderate water movement.

11. When should fertilizer be applied? Spring or fall

12. How much 12-12-12 should be applied to 1000 sq. ft. of lawn? 10 lbs.

13. What are the three methods of application of fertilizers? spray, broadcast, band
SOILS AND FERTILIZERS

Taking Soil Samples and Testing Soil Samples

1. What is a problem soil area?
   Wet area, poor producing área, any unusual area

2. How many sample probes are required per 10,000 sq. ft.?
   a) 1  b) 2  c) 5  d) 10
   b) 2

3. How much soil is required in the sample bag?
   a) 1 cup  b) 1 quart  c) 1/2 full  d) a and c
   c) 1/2 full

4. To what depth should the soil sample be taken?
   a) 1 inch  b) 2 inches  c) 3 inches  d) 6 inches
   c) 3 inches

5. What information should be listed on the sample bag?
   Date
   Customer name
   Customer address
   Sample number
   Location (field) number
   Location on map

6. Where can you find information on the past history of a lawn?
   Old records; check old soil test results; ask owner

7. Soil samples should be mailed wet to keep the soil moist. True/False
   True

8. Grinding the soil is only necessary when testing for pH. True/False
   False

9. You should take one soil sample per every 40,000 sq. ft. True/False
   False

10. What are three tools you could use to take soil samples?
    Auger
    Probe
    Spade
SOILS AND FERTILIZERS

Worksheet

1. If ammonium nitrate (30-0-0) costs $180 per ton, how much would a 50 lb. bag cost?

\[
4.50 \times \frac{2000 \text{ lbs.}}{50 \text{ lbs. per bag}} = 40 \text{ bags} \\
\frac{180 \text{ ton}}{40 \text{ bags}} = 4.50 \text{ per bag}
\]

2. How much would each actual pound of nitrogen cost?

\[
26¢ \times \frac{2000 \times 34\%}{680 \text{ lbs. actual N}} = 26¢
\]

3. If potash (0-0-60) is selling for $120 per ton, how much does 100 pounds of potash cost? How much does one actual pound of K\(_2\)O cost?

\[
\begin{align*}
$6.00 & \times \frac{2000\text{#}}{10\text{#}} = 20 \\
26¢ & \times \frac{2000\text{#} \times 60\%}{1200\text{#}} = 10¢
\end{align*}
\]

4. Phosphate (0-440) fertilizer sells for $225 per ton. What does one pound of actual P\(_2\)O\(_5\) sell for?

\[
26¢ \times \frac{2000\text{#} \times 44\%}{880\#} = 26¢
\]

5. How many pounds of actual fertilizer nutrients is actually in 100 pounds of 12-12-12?

\[
\begin{align*}
nitrogen & = 12\# \\
P\(_2\)O\(_5\) & = 12\# \\
K\(_2\)O & = 12\#
\end{align*}
\]

6. If the soil test results are pH 6.0, P\(_2\)O\(_5\) 30, and K\(_2\)O 190 how many pounds of each is required to build up the soil per acre?

\[
\begin{align*}
\text{lime} & = \text{none} \\
P\(_2\)O\(_5\) & = 22\# \\
K\(_2\)O & = 110\#
\end{align*}
\]

7. If you need 4 tons of lime per acre, how much lime is that for 1000 sq. ft.?

\[
\begin{align*}
1 \text{ acre} & = 43,560 \text{ sq. ft.} \\
\frac{1000}{43560} \times 8000\# \text{ of lime} & = 183.65\# \text{ of lime per 1000 sq. ft.}
\end{align*}
\]
SOILS AND FERTILIZERS

Student Activities

Activity 1

1. Take soil samples of a new lawn site that will be planted later to grass.

2. Analyze soil samples for pH, P and K.

3. Make fertilizer recommendation.

4. Fertilize and lime the site if needed.

5. Till 1/3 the site with a rotary tiller, 1/3 with a disk and 1/3 with a plow and disk. Compare the methods.

6. Seed the lawn.

Activity 2 - Larry's Lawn and Leisure

Larry is starting up his own business in the lawn care for homeowners. In his business he plans to prepare, fertilize, and seed new lawns or renovate old lawns for homeowners. Along with this he will also do landscaping, trimming, mowing, supply nursery stock, and sodding as part of his business.

Because of Larry's fast-growing business, he has hired several new employees to help him. Jim Jones just purchased a new home and has hired Larry to prepare, fertilize, and plant his new lawn. The lawn has 15,000 square feet in the back and 5000 square feet in the front of the house. Larry took one soil sample in the front yard and the results were pH 6.0, P test 20# P2O5, and K test 200# K2O. Larry's business is located in Springfield, Illinois, and the soil is a black clay loam.

Larry has assigned you to do the job. What, if any, mistakes has Larry made? How much lime and fertilizer will you apply to build up the soil? How many pounds of 12-12-12 will it take to fertilize the lawn after the build-up fertilizer is applied?
Activity 2 Key

1. Larry should have taken at least 2 soil samples—one in the front and one in the back yard.

2. Lime—none

\[
P_2O_5 \quad 56#/acre \quad 56/43560 \text{ sq.ft.} \times 1000 = 1.28# \ P_2O_5/1000 \text{ sq.ft.}
\]

\[
1/28 \times 20 = 25.6# \text{ of } P_2O_5 \text{ for the entire lawn}
\]

\[
K_2O \quad 100#/acre \quad 100/43560 = 2.29# \text{ of } K_2O/1000 \text{ sq.ft.}
\]

\[
2.29 \times 20 = 45.8# \text{ of } K_2O \text{ for the entire lawn}
\]

Extra - He can supply this with 58# of 0-44-0 and 76# of 0-0-60.

\[
25.6/44\% \times 100 = 58 \quad 45.8/60\% \times 100 = 76
\]

3. 10# of 12-12-12 per 1000 sq.ft. \quad 10 \times 20 = 200# of 12-12-12