Lesson C8–3

Applying Fertilizers to Field Crops

Unit C. Plant and Soil Science

Problem Area 8. Soil Fertility and Moisture Management

Lesson 3. Applying Fertilizers to Field Crops

New Mexico Content Standard:

Pathway Strand: Plant Systems

Standard: I: Apply principles of anatomy and physiology to produce and manage plants in both a domesticated and natural environment.

Benchmark: I-A. Analyze and evaluate nutritional requirements and environmental conditions to develop and implement a fertilization plan.

Performance Standard: 5. Apply nutrients to plants for economic growth. 6. Describe nutrient application methods and appropriate practices.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Explain the application of fertilizers to field crops.
2. Identify the methods of fertilizer application.
3. Explain the rate of fertilizer application.
List of Resources. The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

- Cooper, Elmer L. and Burton, L. DeVere. *Agriscience Fundamentals & Applications.* Albany, New York: Delmar. 2002 (Unit 9)

Other Resources. The following resources will be useful to students and teachers:

- Waldren, Richard P. *Introductory Crop Science.* Edina, Minnesota: Burgess International Group, Inc. 1992

List of Equipment, Tools, Supplies, and Facilities

- Writing surface
- Overhead projector
- Transparencies from attached masters
- Copies of student lab sheets

Terms. The following terms are presented in this lesson (shown in bold italics):

- Banding
- Broadcasting
- Build up
- Chiseling
- Deep placement
- Fertigation
- Foliar feeding
- Knifing
- Luxury consumption
- Maintenance
- Pop-up fertilizers
- Post-emergence
- Pre-emergence
Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Display examples of crops or grain and ask students to identify the differences. Lead a class discussion concerning what makes one crop or grain better than another. The discussion should move towards healthy plants and how they become or stay healthy.

Summary of Content and Teaching Strategies

Objective 1: Explain the application of fertilizers to field crops.

Anticipated Problem: Why are fertilizers applied to field crops?

I. Fertilizing can increase yields and increased yields add to a growers income.

A. Because fertilizers cost money, a grower must add the amount that is most profitable. The yield of a crop is directly related to the nutrient level of the soil. The nutrient level of a plant can be divided into four levels.

1. Level I: Deficient—The nutrient is clearly deficient; growth and productivity are affected. After the missing mineral is applied, growth response is strong and profitable.

2. Level II: Sufficient—A critical level is reached which satisfies plant needs. More fertilizer may increase yields slightly, but not enough to pay for fertilizer.

3. Level III: High—Nutrient levels are high, yields are maximum. Additional nutrients would be stored in the plant which is referred to as luxury consumption. Fertilization could shift the plant to Level IV or contribute to water pollution.

4. Level IV: Toxic—Nutrient levels in plant tissue are so high as to be toxic. Yields decline.

B. Three methods can be used to find nutrient shortages in plants.

1. Visual inspection of crops for deficiency signs may uncover clear shortages. This method often notes only critical shortages after yield damage has already occurred.
Visual symptoms may be unreliable. Other problems not related to soil nutrient levels may be present that are affecting plant growth.

2. **Tissue testing** measures nutrient levels in plant tissue. This type of testing may uncover problems that soil testing misses.

3. **Soil testing** measures nutrient levels in soil as well as other soil features. Testing laboratories operate on one of two concepts of fertility levels. Fertilize the soil to bring it to an optimum level, then adding yearly maintenance amounts to replace those lost by crop harvest. Frequent soil tests followed by fertilization of the plant to supply needs. Growers depend on these tests to determine the lime and fertilizer needs for crops. Soil tests have limits. Conditions that affect nutrient uptake, such as wet soils, cannot be detected in the laboratory.

Use TM: C8–3A as visual material for lecture and discussion. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Unit 9 in Agriscience Fundamentals and Applications, Chapter 9 in Fundamentals of Soil Science, Chapter 9 in Introduction to Plant and Soil Science, and Chapter 12 in Soil Science and Management are recommended.

**Objective 2:** Identify the methods of fertilizer application.

**Anticipated Problem:** What are the methods of fertilizer application?

II. Producers have a number of options for placement of fertilizer.

A. Selecting the proper application technique for a particular field depends at least in part upon the inherent fertility level, the crop to be grown, the land tenure, and the tillage system.

1. On fields where the fertility level is at or above the desired goal, there is little research evidence to show any significant difference in yield that is associated with the method of application.

2. On low-testing soils placement of the fertilizer within a concentrated band has been shown to result in higher yields.

B. Fertilizers can be applied before a crop is planted, while it is being planted, after it is growing, or in some combination of the three. The time of application has different effects on the crop.

1. Fertilizer applied before a crop is planted is called **preplant**.

2. The simplest way to fertilize before planting is broadcasting. **Broadcasting** is spreading fertilizer evenly on the soil surface.

3. **Soil injection**, also known as **root zone banding**, **deep placement**, **knifing** or **chiseling**, is a process where the fertilizer is placed below the surface in the root zone.

4. Fertilizer applied while planting is called **starter fertilizer**. The most common method of applying starter is called **banding**, where the planter places a band of fertilizer below and to the side of the seeds.
5. **Pop-up fertilizers** are placed in the row with the seeds. Only small amounts are applied to prevent seedling damage.

C. There are several ways to fertilize after planting.

1. **Pre-emergence** is fertilizing after the planting but before the crop emerges from the ground.

2. **Post-emergence** is fertilizing after the crop has emerged from the ground.

3. **Top dressing** is the same as broadcasting, except that the fertilizer is spread over a growing crop and is not mixed into the soil.

4. **Sidedressing** is a way of making a second application of fertilizer part way through the growing season by fertilizing along the crop row.

5. **Fertigation** is a method of injecting fertilizer into irrigation water.

6. **Foliar feeding** is fertilizing by spraying solutions directly on the leaves of the crop. This method offers the quickest response of any fertilizing method.

7. **Site-specific application** also known as **variable rate technology** (VRT) uses computer technology to alter the rate of fertilizer application as the fertilizer applicator passes across the field. This approach offers the potential to improve yield while minimizing the possibility of over fertilization, which results in improved profit.

Use TM: C8–3B, C8–3C, and C8–3D as visual material for lecture and discussion. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation. Use text material to strengthen student understanding of concepts. Unit 9 in Agriscience Fundamentals and Applications, Chapter 9 in Fundamentals of Soil Science, Chapter 9 in Introduction to Plant and Soil Science, and Chapter 13 in Soil Science and Management are recommended.

**Objective 3:** Explain the rate of fertilizer application.

**Anticipated Problem:** What is rate of fertilizer application?

III. Rate of fertilizer application depends upon the soil test level.

A. Soil fertility problems are largely associated with acidity, phosphorus, potassium and nitrogen. Recommended soil tests for making decisions about lime and fertilizer:

1. Water pH test, which shows soil reaction as pH units.

2. Bray P1 test for plant available soil phosphorus which is commonly reported as pounds of phosphorus per acre (elemental basis).

3. Potassium test, which is commonly reported as pounds of potassium per acre (elemental basis).

4. Testing to determine nitrogen fertilizer needs for field crops is not recommended in the same sense as testing for the need for lime, phosphorus, or potassium since nitrogen can change forms or be lost from the soil.
5. Testing soil to predict the need for nitrogen fertilizer is complicated by the fact that nitrogen availability, both the release from soil organic matter and the loss by leaching and denitrification is regulated by unpredictable climatic conditions.

B. The amount of fertilizer recommended may be build up plus maintenance, maintenance or no fertilizer.
   1. **Build up** is the amount of material required to increase the soil test to the desired level.
   2. **Maintenance** is the amount required to replace the amount that will be removed by the crop to be grown.
   3. Build up plus maintenance: when soil test levels are below the desired values, it is suggested that enough fertilizer be added to build the test to the desired goal and to replace what the crop will remove.
   4. At or below the desired values, the yield of the crop will be affected by the amount of fertilizer applied that year.

C. Maintenance: when the soil test levels are between the minimum and 20 pounds above the minimum for phosphorus or between the minimum and 100 pounds above the minimum for potassium, apply enough to replace what the crop to be grown is expected to remove.
   1. The yield of the current crop may not be affected by the fertilizer addition, but the yield of subsequent crops will be adversely affected if the materials are not applied to maintain soil-test levels.
   2. No fertilizer—it is recommended that soil test levels be maintained slightly above the level at which optimum yield would be expected. It would not be economical to attempt to maintain excessively high values.

Use TM: C8–3E as visual material for lecture and discussion. An alternative approach is to transfer the information from the transparency masters to a multimedia presentation.

Use text material to strengthen student understanding of concepts. Unit 9 in Agriscience Fundamentals and Applications, Chapter 9 in Fundamentals of Soil Science, Chapter 9 in Introduction to Plant and Soil Science, and Chapter 13 in Soil Science and Management are recommended.

**Review/Summary.** Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at end of chapters in the textbook may also be used in the review/summary.

**Application.**

TM: C8–3A thru TM: C8–3E
**Evaluation.** Focus the evaluation of student achievement on mastery of the objectives stated in the lesson. Measure student performance on classroom participation, laboratory assignments, and written tests or quizzes.

**Answers to Sample Test:**

**Part One: Matching**

1. k  2. b  3. f  4. h  5. a  6. j  7. e  8. g  9. l  10. c  11. d  12. i

**Part Two: Completion**

1. Maintenance
2. broadcasting
3. banding
4. Side-dressing
5. Foliar feeding

**Part Three: Short Answer**

1. Inherent fertility level, the crop to be grown, the land tenure, and the tillage system.
2. Acidity, phosphorus, potassium, and nitrogen.
Lesson C8–3: Applying Fertilizers to Field Crops

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. Broadcasting  
a. Pop-up  
i. Site-specific application
b. Build up  
f. Post-emergence  
j. Starter fertilizer
c. Fertigation  
g. Pre-emergence  
k. Tissue testing
d. Foliar feeding  
h. Preplant  
l. Top dressing

_______ 1. Measures nutrient levels in plant tissue.
_______ 2. Amount of material required to increase the soil test to the desired level.
_______ 3. Fertilizing after the crop has emerged from the ground.
_______ 4. Fertilizer applied before a crop is planted.
_______ 5. Spreading fertilizer evenly on the soil surface.
_______ 6. Fertilizer applied while planting.
_______ 7. Fertilizer placed in the row with the seeds.
_______ 8. Fertilizing after the planting but before the crop emerges from the ground.
_______ 9. Same as broadcasting, except that the fertilizer is spread over a growing crop and is not mixed into the soil.
_______ 10. Method of injecting fertilizer into irrigation water.
_______ 11. Method offers the quickest response of any fertilizing method.
_______ 12. Also known as variable rate technology (VRT) uses computer technology to alter the rate of fertilizer application as the fertilizer applicator passes across the field.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. ___________________ is the amount of fertilizer required to replace the amount that will be removed by the crop to be grown.

2. The simplest way to fertilize before planting is ___________________.
3. The most common method of applying starter, where the planter places a band of fertilizer below and to the side of the seeds is known as ____________________.
4. ____________________ is a way of making a second application of fertilizer part way through the growing season by fertilizing along the crop row.
5. ____________________ is fertilizing by spraying solutions directly on the leaves of the crop.

**Part Three: Short Answer**

*Instructions.* Provide information to answer the following questions.

1. What does selecting the proper application technique for a particular field depend upon?

2. What are soil fertility problems associated with?
The yield of a crop is directly related to the nutrient level of the soil. Fertilization is most profitable for crops in Level I.
AN AIR APPLICATOR IS USED TO APPLY FERTILIZER
Patriot™ Sprayer Applies Fertilizer to Field

(Courtesy, Case Corporation)
GLOBAL POSITIONING SYSTEM (GPS)
NITROGEN RATE WORKSHEET FOR CORN

1. Determine your average yield for the last 5-year period:

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Sum Across Years</th>
<th>Divided by Number of Years</th>
<th>Average</th>
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2. Multiply average yield by 1.05 to obtain target yield; the increase of 0.05 accounts for increased yield potential due to improved variety and cultural practices.

\[
\text{Average yield} \times 1.05 = \text{Target yield}
\]

3. Multiply target yield by 1.20 lb N/bu to obtain N needed per acre:

\[
\text{Target yield} \times 1.20 = \text{N needed}
\]

4. Reduce N needed by subtracting all N credits (adjust for all of the following that apply):
   a. Previous crop of soybeans (40 lb N/acre).
   b. Previous crop of alfalfa/clover (>5 plants/ft = 100 lb N; 2–4 plants/ft = 50 lb N).
   c. Application of ammoniated phosphate (multiply lb material by percent N). Ex.: 200 lb 18-46-0 = 200 × 0.18 = 36 lb N/acre.
   d. Manure application (total lb N in manure divided by 2).
   e. Weed and feed N (multiply gallons per acre times 3 for 28% N or times 3.5 for 32% N solutions).
   f. Starter (multiply rate by percent N).
   g. N in irrigation water (inches irrigation water × ppm NO₃–N × 0.23).

Total N credits (a + b + c + d + e + f + g)

5. Amount N to apply: (N needed) – (N credit)
Determining the Actual Amount of Dry Fertilizer Applied

To measure the actual amount of dry fertilizer applied, the applicator is driven over a measured distance while the fertilizer is collected using one or more containers. To calculate the amount applied, use the following formula where distance and width are measured in feet:

\[
Pounds/acre = \frac{\text{pounds applied}}{(\text{distance} \times \text{width})/43560}
\]

Tony is calibrating his nitrogen fertilizer applicator that spreads dry fertilizer over a 50 foot width. After traveling 200 feet while collecting the fertilizer, the applicator had applied 80 pounds. How many pounds/acre is his applicator applying?
Lab Sheet

Determining the Actual Amount of Liquid Fertilizer Applied

To measure the actual amount of liquid fertilizer applied, the applicator is driven over a measured distance while the fertilizer is collected using one or more containers. To calculate the amount applied, use the following formula where distance and width are measured in feet:

\[
Pounds/acre = \frac{\text{gallons applied}}{(\text{distance} \times \text{width}/43560)}
\]

Amanda needs to calibrate her 60 foot fertilizer spreader. When she drives 150 feet, 42 gallons are collected. How many gallons/acre did she apply?
Lab Sheet

Nitrogen Worksheet

1. Determine your average yield for the last 5-year period:

<table>
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<tr>
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2. Multiply average yield by 1.05 to obtain target yield; the increase of 0.05 accounts for increased yield potential due to improved variety and cultural practices.

\[
\text{Average yield} \times 1.05 = \text{Target yield}
\]

3. Multiply target yield by 1.20 lb N/bu to obtain N needed per acre:

\[
\text{Target yield} \times 1.20 = \text{N needed}
\]

4. Reduce N needed by subtracting all N credits (adjust for all of the following that apply):
   a. Previous crop of soybeans (40 lb N/acre).
   b. Previous crop of alfalfa/clover (>5 plants/ft = 100 lb N; 2–4 plants/ft = 50 lb N).
   c. Application of ammoniated phosphate (multiply lb material by percent N). Ex.: 200 lb 18-46-0 = 200 \times 0.18 = 36 lb N/acre.
   d. Manure application (total lb N in manure divided by 2).
   e. Weed and feed N (multiply gallons per acre times 3 for 28% N or times 3.5 for 32% N solutions).
   f. Starter (multiply rate by percent N).
   g. N in irrigation water (inches irrigation water \times ppm NO₃ – N \times 0.23).

Total N credits (a + b + c + d + e + f + g)

5. Amount N to apply: \( (\text{N needed}) - (\text{N credit}) \)