LAB LESSON PLAN
(Cover Page)

California Agriscience Institute for Agriculture Teachers
California Department of Education

LAB TITLE: PLANT TISSUE TESTING

Ag Model Curriculum Standard(s), Learning Outcomes(s) & Biological Standard(s) Addressed: Plant Science A-1, 3, 8; B-1, 3; C-1, 2, 4, 5 Biological Standard #10, #17.

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Objective(s): Upon completion of the lab activity, the learner will be able to: Conduct a green tissue test. Interpret the results of a tissue test. Compare results of soil to tissue tests.

Teacher Preparation: More than one week.

How many class periods will lab take? More than one week.

Procedures (activities):

Method(s) of Evaluation: Laboratory report

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Time required for experimental effects: 2 days

PLANT TISSUE TESTING

AGRICULTURAL APPLICATIONS AND PRACTICES

Maintaining the nutrient levels of crops is a critical element in plant growth and management. Traditionally, soil nutrient levels have been interpreted as an estimate of actual nutrient uptake by plants. However, scientists know that there is a difference between total soil nutrient levels and nutrients in the soil that are actually available for uptake by plants.

Two methods for determining the amounts of essential nutrients contained in plant tissues have been developed in recent years. Plant tissue analysis is a laboratory procedure now conducted by many soil testing labs which gives an accurate indication of plant nutrition levels. Sophisticated equipment is needed for conducting this analysis, and soil testing labs charge a small fee for the test. Plant tissue testing is another procedure which has been developed for estimating plant nutrition levels. Unlike plant tissue analysis, plant tissue testing can be done in the field or greenhouse using a simple kit which contains nutrient extractants.

Plant tissue testing can be done to monitor plant nutrient levels during the growing season. While the test is a general estimate of plant nutrient levels, it can be used to diagnose nutrient deficiency problems. Plant tissue testing is used in combination with soil tests to strengthen the reliability of the test results. Fertilizers are one of the most critical and expensive inputs into any crop production enterprise. Thus, growers use soil and tissue tests to make certain that their fertility program is sound and cost effective.

INTEREST APPROACH

Show students 3-4 samples of growing plants (greenhouse crops, indoor plants, field crops, or vegetable crops). As a group, the plants should exhibit a variety of plant deficiency or health symptoms, from good condition to obvious nutritional and environmental deficiencies. Ask students to describe the health/condition of each plant. Does the plant show any deficiency symptoms or other problems? If so, what? How can we verify your diagnosis? Be sure to focus on nutrient deficiencies, in addition to other problems students identify.

SCIENCE CONNECTIONS - QUESTIONS FOR INVESTIGATION

1. How do plant nutrients levels vary by stage of growth? Why?

2. Why can sap from plant tissues be used to determine plant nutrient levels?

3. Why are nitrogen, phosphorus, and potassium needed by plants?

4. Why does additional nitrogen enhance the green color of leaves?

5. What factors affect the nutrient levels contained in plant tissues? Why?

PURPOSE OF LAB AND STUDENT PERFORMANCE OBJECTIVES

The purpose of this laboratory is to determine the nutrient levels contained in succulent parts of a plant, using a tissue testing kit. Students will be able to:

1. Conduct a tissue test on a variety of growing plants.

2. Interpret the results of a plant tissue test.

3. Compare the results of tissue tests and soil tests and develop appropriate recommendations. (Note: To be most effective, this lesson should be taught after students have studied soil fertility and tested soils, using kits and commercial tests.)

4. Explain why plant nutrient levels may vary from soil nutrient levels and by stage of plant growth.

MATERIALS AND/OR EQUIPMENT

- Leaf and stem samples from plants to be tested (use representative plants in large growing conditions).

- Tissue testing kit (Urbana NPK Kit) - available from Soil Chem, Box 54, Rossville, IL 60963. Phone: (217) 748-6794 (approximate cost - $15)

  Also available from Simplot and Western Farm Supply.

- Paper towels

PROCEDURES

NOTE: The Urbana NPK Tissue Test Kit is considered the most accurate kit available. Tissue testing provides a general estimate of the nutrient levels contained in plant tissue, which is comparable to the nutrient uptake of the plant. Tissue testing, or sap analysis, measures only soluble forms of N and P, plus all K contained in the plant tissue. Results should not be viewed as the same as total nutrients available in the soil. Tissue testing should be done while plants are alive and growing, as opposed to harvested or frozen samples.

NOTE: This lab will work best when students are arranged in groups of two or three and each group is provided with a tissue testing kit and test plants.

1. Collect plant tissue samples according to directions contained in the tissue testing kit.

2. Conduct nutrient tests, carefully following directions in the kit.

3. Record results for each test.

4. Use the interpretation guide, along with soil test results, to determine if adjustments are needed in fertility and/or pH.

DATA SUMMARY AND ANALYSIS

Have students record the levels of N, P, and K for each of the plants tested. Run tests on more than one part of the same plant to check the consistency of results and interpretations. Combine test results for multiple tests on single plants and determine an average level of major nutrients for each plant. Have students record their test results on poster board or the chalkboard for comparison and summary.

ANTICIPATED FINDINGS

Results of tissue tests depend upon weather conditions, the plant part from which sap is drawn, and other factors. Actual test results will vary according to the general nutrient levels of the test plants.

IDEAS FOR ADDITIONAL EXPERIMENTS

1. Compare test results from various parts of the same plant.

2. Compare results under differing soil conditions.

3. Compare tissue test results with soil test results.

4. Compare results from the same crop at various stages in the growing season.

5. Compare results after the addition of fertilizers and soil amendments. Check nutrient levels at 10 day intervals following applications.

6. Use a hydroponics unit to create specific nutrient deficiencies in plants and verify with plant tissue testing.

UNDERLYING SCIENCE CONCEPTS

A. Relevant Plant Biology Concepts

Fertilization
Nitrogen fixation
Nutrient balance
Macronutrients
Translocation

B. Key Terms

1. Essential element - a chemical element required for the normal growth of plants.

2. Extractant - a solvent used in extracting or separating out the nutrient elements of a compound or substance.

3. Macronutrient - a chemical element necessary in large amounts (usually 50 ppm in the plant) for the growth of plants. Includes C, H, O, N, P, K, Ca, Mg, and S.

4. Plant tissue (sap) test - a simple field procedure for estimating the levels of macronutrients contained in the tissues of a given plant.

C. Relevant Principles of Plant Nutrition

1. In order to be considered essential, an element must meet the following criteria: (a) absence of the element results in abnormal growth, injury, or death; (b) the plant is unable to complete its life cycle without the element; (c) the element is required for plants in general; and (d) no other element can serve as a complete substitute.

2. Nitrogen, phosphorous, and potassium are the three most important elements; large amounts of these elements must be added to the soil for optimum plant growth.

3. Nitrogen is a constituent of amino acids, the building

blocks of protein. All enzymes appear to be protein based. Nitrogen is also a constituent of chlorophyll, with four N atoms in each molecule. Thus, N is required for photosynthesis. Nitrogen stimulates root growth and regulates the uptake of other nutrients by the plant. Nitrogen deficiency is generally characterized by yellowing of lower leaves of plants.

4. Phosphorus is a constituent of nucleoproteins (cell proteins). Cell division is dependent on phosphorus. The transmission of hereditary characteristics also depends on phosphorus. Further, phosphorus is a key element in cell membranes, affecting permeability and retention of substances. Phosphorus effects maturation and fruit development. P deficiency is often characterized by purpling of the stem, leaf, or veins on the underside of leaves.

5. The need for large amounts of potassium by plants is still not well understood. However, potassium appears to be important in the function of basic life processes in plants, such as food manufacture, translocation, and water uptake. K deficiency results in burn or scorch of the margins of leaves, particularly the older or lower leaves.

N, P, & K—Functions and Deficiency Symptoms

	N	P	K
Functions	•Constituent of amino acids (and thus, proteins and enzymes) •Constituent of chlorophyll (four N atoms in each molecule) •Stimulates carbohydrate utilization •Stimulates root growth and development •Regulates uptake and utilization of other nutrients	•Component of ATP (adenosine triphosphate), which implements energy-using processes in plants •Component of DNA and RNA •Affects cell division, root development, maturation, flowering and fruiting, and overall crop quality	•Activates enzymes •Regulates opening and closing of stomates •Regulates water uptake by root cells •Essential for photosynthesis, starch formulation, and translocation of sugars
Deficiency Symptoms	•Stunted growth •Yellowing of lower leaves of plant	•Purpling of the stem, leaf, or veins on the underside of leaves	•Burn or scorch of margins of leaves, particularly older leaves

Data Summary Table for Plant Tissue Testing

Species/plant number or source	Results of tissue test			Results of soil test		
	N	P	K	N	P	K