



# Plant Doctor<sup>®</sup> for a Day

## Purpose

In this lesson, students will learn about nutrient deficiencies in plants. Students will act as plant doctors<sup>®</sup> to explore the important role of agricultural professionals who are trained to accurately diagnose and treat plant diseases to protect our valuable crops.

## Time

*Teacher preparation:*  
20 minutes

*Student activities:*  
50 minutes

## Materials

*For the class:*

- ▶ From the CFAITC website [www.LearnAboutAg.org/402](http://www.LearnAboutAg.org/402) download the “Nutrient Deficient Plants” PowerPoint presentation
- ▶ One water deficient plant (wilted) \*
- ▶ One pest-damaged plant (damaged by insects or mold) \*
- ▶ One over-watered plant \*
- ▶ One rusted or yellowing plant \*

\* *These may be any type of plant*

## Background Information

Plants have certain requirements to grow and be healthy. How do we know, short of plants dying, if they are getting enough sunlight, water, nutrients, and carbon dioxide? Similar to humans, plants show symptoms when they are not healthy. Scientists and farmers are constantly researching methods to efficiently diagnose and treat plant diseases. During this lesson, students will model a systematic approach used by agriculture professionals to diagnose plant nutrient deficiencies. Students will understand that many factors can cause a plant to become diseased and not all diseases can be identified easily. Scientific knowledge and years of practice help farmers identify plant health issues.

Farmers’ livelihoods depend on the food they grow, and people depend on the food the farmers provide, therefore, it is critical that farmers have the ability to quickly and accurately diagnose and remedy plant diseases.

Plants require 17 essential elements for proper nutrition. Carbon, hydrogen, and oxygen are taken in from the air and water and the other 14 elements are absorbed by plant roots.

Primary nutrients are nutrients that plants require in the greatest amounts and they are the most commonly deficient nutrients. These nutrients are nitrogen, phosphorus, and potassium or N, P, K.

- ▶ Plants usually require more nitrogen than any other nutrient. Nitrogen is important in forming plant proteins. Deficiencies in nitrogen first appear when older leaves begin to turn light green to yellow. Deficient plants are spindly, have stunted growth, and fewer leaves.
- ▶ Phosphorus plays an important role in photosynthesis, and root and shoot growth. Symptoms of phosphorus deficiencies include stunted growth, purplish color on lower leaves in corn, and distorted leaf shapes with dark green color. The purplish color is due to accumulation of sugars in the plant, especially when temperatures are low.
- ▶ Potassium regulates many plant processes. Symptoms of potassium deficiency include scorching along edges of leaves beginning with older leaves first, poor root growth, weak stalks, and slow growth.



California Foundation for  
Agriculture in the Classroom

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For each pair of students:

- ▶ *Plant Doctor<sup>®</sup> Reference Manual* handout (page 95)
- ▶ *Plant Doctor<sup>®</sup> to the Rescue* student worksheet (page 98)

## California Standards

### 5th Grade

#### Common Core English Language Arts

RI.5.2  
RI.5.7  
W.5.2e  
SL.5.1

#### Next Generation Science Standards

5-LS1.C  
5-LS2.A  
5-ESS3.C  
5-ETS1.A

### 6th - 8th Grade

#### Common Core English Language Arts

SL.6-8.1  
RST.6-8.2  
RST.6-8.3  
WHST.6-8.1e

#### Next Generation Science Standards

MS-LS2.A  
MS-LS2.C  
MS-ESS3.C  
MS-ETS1.B

Standards alignment is listed in the matrix on page 143.

Secondary nutrients are usually required by plants at slightly lower levels than primary nutrients but are less likely to be deficient than primary nutrients. Secondary nutrients include calcium (Ca), magnesium (Mg), and sulfur (S).

- ▶ Calcium is important in maintaining favorable soil pH and water holding capacity. Calcium deficiency symptoms include browning and die back of growing tips of roots and leaves. Fruit quality is reduced and blossom end rot and fruit decay are common.
- ▶ Magnesium is an important component of chlorophyll. Plants deficient in magnesium exhibit chlorosis, or yellowing between the veins of leaves. Leaves may cup or curve up.
- ▶ Sulfur is important to photosynthesis and protein formation. Sulfur deficient plants are light yellow to light green with yellowing that starts on younger leaves rather than older leaves, as is the case with nitrogen deficiency.

Micronutrients are essential to plant growth but are needed in much smaller amounts than secondary and primary nutrients. Micronutrients include boron (B), chloride (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), zinc (Zn), and nickel (Ni).

## Procedure

1. Gather the variety of sick plants listed in the materials section.
2. Show the sick plants to the students and ask them if they have ideas of what may be wrong with each plant. Discuss possible problems that could lead to a decline in plant health. Plant diseases are caused by many factors including:
  - a. Non-living agents such as air pollutants, nutrient imbalances, and environmental factors such as too much or too little water, frost, or sunburn.
  - b. Living organisms, including bacteria, fungi, viruses, nematodes, protozoa, and parasitic plants.
3. Tell your students that they are going to act as plant doctors<sup>®</sup> and will be diagnosing plant diseases. Today, the Plant Doctors<sup>®</sup> will be specializing in nutrient deficiencies. Explain that professional plant doctors<sup>®</sup> are called plant pathologists. Plant pathologists are plant experts. They know a great deal about the factors that cause

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disease and how plants are affected by diseases. A college degree is required to become a plant pathologist.

4. Have students work in pairs and distribute the *Plant Doctor<sup>®</sup> to the Rescue* worksheet to each student.
5. Complete the introductory section as a class.
6. Discuss the purpose of the lesson and the *Plant Doctor<sup>®</sup> Reference Manual*.
7. Walk through the example of how to use the key. First, determine which chart to start with, A, B, or C. Then work through the chart to reveal which nutrient the plant is deficient in.
8. Show the PowerPoint presentation, *Nutrient Deficient Plants*. Stop on each slide and give student pairs time to key out the deficiency they see in the slide. Do slide one together as an example.
9. After students have completed their worksheet, review as a class. If you want to make the activity a contest, a prize may go to the team of students with the highest score.
10. As a closing discussion, ask students for reasons that a plant may become sick and list these on the board. Note that nutrient deficiencies are only one reason that a plant may become sick. Choose one of your slides from the presentation and ask students what was wrong with that plant. As a class, list three next steps they should take as a Plant Doctor<sup>®</sup> to bring the plant back to good health.

*Examples:*

1. Which types of soil amendments could be added to provide the deficient nutrient?
2. Determine how much of the amendment should be applied.
3. Research the best time of year for the amendment to be applied and if it should be worked into the soil, mixed into irrigation solutions, or another method.

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## Variations

- ▶ Make one print of each nutrient deficiency slide from the PowerPoint presentation. Place each picture at a different station. Have students circulate through the stations and identify plant illnesses.
- ▶ Divide the class into three teams and make up your own “Jeopardy” type game that includes the entire class.

## Extensions

- ▶ Invite a certified Pest Control Advisor (PCA) to speak to your class. Ask the PCA to bring props he or she uses on the job and perhaps some examples of diseased plants to show students how they diagnose and recommend treatment. Contact the California Association of Pest Control Advisers for possible speakers:  
*[www.pathwaytopca.com](http://www.pathwaytopca.com)*  
*[www.plantdoctor.org](http://www.plantdoctor.org)*  
*[www.capca.com](http://www.capca.com)*
- ▶ Have students research one type of pathogen that causes disease in food crops. Have students make a poster about that pathogen, how it affects the plant, and how it is treated. Students should present their poster to the class.
- ▶ To illustrate the impact that some plant diseases can have, look up information about the Irish Potato Famine. Ask students how the potato blight changed history in 1845.

## ELL Adaptations

- ▶ Provide the opportunity for English language learners to partner with a student who is proficient in English. Cooperative learning activities provide opportunities for students to exchange, write, and present ideas.
- ▶ Students can define new terms on a classroom word wall with photos to illustrate definitions.

# Plant Doctor<sup>®</sup> Reference Manual

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When a household plant looks sick, the owner can attempt to make it better by reducing or increasing the amount of water, looking for pests such as aphids or whiteflies, providing more sun or shade, or adjusting the amount of fertilizer, or plant food, that is being applied. If the houseplant dies, the owner can usually replace the plant by purchasing a new one at the garden center.

There is much more at stake for a farmer. With large crops of vegetables or fruit orchards, plant health problems must quickly be identified and treated so the whole crop is not lost. It is very costly if a crop does not make it to harvest. All of the money that went into preparing the fields, fertilizing, pruning, weeding, watering, and more, is lost. Farmers and crop advisors learn to diagnose plant problems quickly so the crop can be treated in the appropriate fashion.

The following pages contain a Nutrient Deficiency Key. Farmers use keys like this one to diagnose real crop problems that occur. You will become familiar with this key while you identify nutrient deficiencies in plants. Flip through the pages of the key to determine which nutrient may be lacking from the soil while observing the sick plant. Remember, there are many other reasons plants may be sick. The plant could have a problem with the amount of water it is getting, or with insect, bacteria, fungi, or viral infestations. People called plant doctors<sup>®</sup>, or plant pathologists, help farmers figure out what is wrong with crops and orchards. Today, you will be a plant doctor<sup>®</sup> and will figure out what is wrong with the sick plants you see in the presentation.

## Vocabulary

**Chlorosis:** leaves look light green, yellow, or white because chlorophyll does not develop.

**Necrosis:** death of plant tissue.

**Terminal bud:** the growing part of the plant.

**Vein:** the tube that carries water and nutrients to all parts to the plant.

**Mottling:** spots on green leaves that indicate a deficiency or disease.

**Midrib:** main vein in the center of the leaf.

## START

- ▶ Plant is discolored on older or larger leaves or entire plant..... Use Chart A
- ▶ Plant is discolored on younger or smaller leaves .....Use Chart B
- ▶ Plant looks sick, but is not discolored ..... Use Chart C

## **Chart A – Symptoms on Older, Lower Leaves of Plant**

Follow the directions of this key to determine in which nutrient the plant is deficient in.

1. If corn or sorghum plant ..... Go to 2  
If legumes (beans, peanuts, etc.) ..... Go to 5  
If citrus (orange, lemon, grapefruit, etc.) ..... Go to 8  
If wheat ..... Go to 5
2. Yellow discoloration ..... Go to 3  
Discoloration other than yellow ..... Go to 4
3. Yellow discoloring makes a V-shape from tip backwards ..... Nitrogen  
Yellowing between veins, edges might be reddish-purple ..... Magnesium  
Light green to yellowish; stunted growth ..... Sulfur  
Pale yellow to white over entire plant ..... Iron
4. Brown discoloration and edges slightly crispy ..... Potassium  
Purple and brown moving from tip backwards ..... Phosphorus
5. Color change over entire plant ..... Go to 6  
Color change in leaf tips ..... Go to 7
6. Plant light green. Older leaves affected first but then entire plant turns  
pale yellow or brown (lacking nitrogen-fixing bacteria) ..... Nitrogen  
Plant is light or dark green. Leaflets tilting upward ..... Phosphorus
7. Yellow mottling around the edges of the leaf that eventually  
dries up and falls off ..... Potassium  
Brown spots with yellowing between main vein: yellow tissue dries  
up and falls off ..... Zinc  
Other appearance ..... Magnesium or Manganese
8. Gradual fading of green throughout leaves ..... Go to 9  
Fading of green except near midrib ..... Go to 10
9. Fade to yellow-green to yellow or possibly white ..... Nitrogen  
Fade to dull green and eventually orange-yellow; fruit may be coarse and  
spongy with hollow center ..... Phosphorus
10. Fading of green, blotchy on outer half of leaf; browning of leaf tips; leaves wilt ..... Potassium  
Other type of fading ..... Magnesium, Calcium, or Molybdenum

## **Chart B – Symptoms on Upper Leaves or New Growth**

1. If corn or sorghum plant ..... Go to 2  
If legumes (beans, peanuts, etc.) ..... Go to 4  
If citrus (orange, lemon, grapefruit, etc.) ..... Go to 6  
If wheat ..... Go to 4

## Plant Doctor® Reference Manual (continued)

2. New leaves are showing chlorosis ..... Go to 3  
New leaves remain green..... Go to 11
3. Yellowing between veins along entire leaf ..... Iron  
White, irregular spots between veins ..... Boron  
Young leaves have yellow to whit bleached bands at lower part of leaf ..... Zinc
4. Growing bud stays alive ..... Go to 5  
Growing bud dies ..... Go to 6
5. Leaves yellow to white but veins are green. Some dead spots may be  
on leaves..... Iron or Manganese  
Leaves and veins turn pale green or yellow ..... Sulfur or Copper
6. Leaves uniformly colored ..... Go to 7  
Leaves have irregular color pattern ..... Go to 8
7. Leaves normal colored ..... Go to 9  
Leaves pale green, yellow, or white ..... Go to 10
8. Green veins, yellow or white leaves..... Iron or Manganese  
Pale green or gray with green background..... Manganese
9. Leaves very dark green; gummy spots ..... Copper  
Other problems..... Go to 11
10. Leaves are pale green or yellow, fruit pale in color..... Nitrogen  
Noticeably yellow ..... Sulfur
11. Leaves are green but parts of leaf are missing ..... Insects  
Leaves green but brown around edges..... High Salinity or Over fertilized

## Chart C

Plants, just as humans, can become “ill” for a variety of reasons. This key cannot assist you in diagnosing all plant illnesses but it gives you an idea of how a home gardener or farmer might uncover the cause of a sick plant.

Your plant may be ill because of pest infestation, over or under watering, too many or too few nutrients, not enough or too much sun, temperature variation, air problems, and more. If you have a sick plant, carefully observe the entire plant to see if you notice the cause of the problem. Take a leaf sample or a photograph of your plant to a local nursery or University Cooperative Extension and find out if their garden experts can assist you in diagnosing your plant’s illness.

Remember, symptoms from one problem may look like symptoms caused by a different problem. Often more than one condition will affect plants at the same time. As plants become weakened from disease, pests, deficiency, or drought they become more susceptible to other problems. If you are interested in plant diseases, take a class that is put on by your local Master Gardener chapter or take botany and plant pathology classes in college.

# Plant Doctor® to the Rescue!

Name: \_\_\_\_\_

## Introduction

The purpose of this activity is for you to learn how to diagnose what is wrong with plants. Plant doctors®, like your family doctor, are licensed by the State of California to doctor plants and prescribe various treatments to help farmers grow healthy crops. Plant doctors® are licensed to help farmers with various plant pests, diseases, parasitic worms, weeds, plant growth regulators and California laws and regulations relating to agriculture.

1. Before beginning the activity, read the introduction in the Plant Doctor Reference Manual. List two key points:
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
2. The object of the activity is for you to correctly identify the disease of the sick plants you see in the presentation. For each slide in the presentation, use the Plant Doctor Reference Manual to determine the nutrient that is deficient in the plant or another problem that may exist. Fill in the chart.

Plant Name	Plant Description	Chart Used (A, B or C)	Nutrient Deficiency or Other Problem



**Conclusion**

Explain at least two reasons why it is important for farmers to keep their crops as healthy as possible.

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Besides nutrient deficiencies, what other factors could cause plants to become sick?

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