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EXTENSION SERVICE

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Nutrient Deficiencies in Plants

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Normal growth and development of a plant depends on the availability of various mineral elements in suitable combination in the soil. Some elements, such as nitrogen, phosphorous, potassium, calcium, magnesium and sulfur, are needed in relatively large amounts and are termed major/macro nutrients. Other elements, such as iron, boron, manganese, molybdenum and zinc, are needed in very small amounts and are termed minor/trace nutrients. Regardless of the amount required, all of them are essential to plants for completing the life cycle. Since major elements are taken up and used by plants in higher amounts, these nutrients need to be replenished more often than the minor elements. When any of these elements are present in concentrations lower than the minimum levels needed, plant growth and development is compromised. Most nutrient deficiencies cause internal or external symptoms that may appear on any or all organs of the plant. Plants that grow in soils with nutritional deficiencies, or in soils where nutrient uptake is hindered, may also be more susceptible to infection. For example, Brown Spot of rice, caused by the fungal pathogen *Cochliobolus miyabeanus*, is much more severe in nutrient-deficient plants.

What causes plants to have nutrient deficiencies?

Nutrient deficiency may occur due to one or more of the following reasons:

1. The soil/growth medium is deficient in the required nutrient.
2. The soil is not sufficiently moist to allow the roots to take up and transport the nutrients.
3. The soil is not deficient in the nutrient, but another factor limits the plant's nutrient uptake ability. Some nutrients, for example, are more available to the plant at certain pH levels.
4. The nutrient is unable to reach the organ where it is needed most (example: blossom end rot of tomato, pepper, and eggplant).
5. A too-high concentration of one nutrient may outcompete the uptake of a similar nutrient. (Example: Calcium uptake can be suppressed by the presence of excess potassium, sodium or magnesium.)

What does a nutrient deficient plant look like?

Plants suffering from nutrient deficiencies present a number of symptoms (Table 1).

Table 1. Symptoms associated with deficiencies of different nutrients

Deficient Nutrient	Function of Nutrient	Symptoms of Deficiency
Nitrogen (N)	Present in most substances of cells	Plants grow poorly and are light green in color. Lower leaves turn yellow or light brown and stems are short and slender. 
Phosphorus (P)	Present in DNA, RNA, phospholipids (membranes), ADP, ATP, etc.	Plants grow poorly and leaves are dark green with purple tints. Lower leaves sometimes turn light bronze with purple or brown spots. Shoots are short and thin, upright, and spindly. 
Potassium (K)	Acts as a catalyst of many reactions	Plants have thin shoots which in severe cases show dieback. Older leaves show chlorosis (loss of the normal green) with browning of tips, scorching of margins, and many brown spots usually near the margins. Fleshy tissues show end necrosis (death of localized tissues). 
Magnesium (Mg)	Present in chlorophyll and is part of many enzymes	First older, then younger leaves become mottled and yellow, then reddish. Sometimes necrotic spots appear. Tips and margins of leaves may turn upward and leaves appear cupped. Leaves may drop off. 

Deficient Nutrient	Function of Nutrient	Symptoms of Deficiency	
Calcium (Ca)	Regulates the permeability of membranes. Forms salts with pectins. Affects activity of many enzymes.	Young leaves become distorted, with tips hooked back and margins curled. Leaves may be irregular in shape and ragged with brown scorching or spotting. Terminal buds finally die. Plants have poor, bare root systems. Causes blossom end rot of many fruits. Increases fruit decay in storage. May be responsible for tip burns in mature detached lettuce heads at high temperatures.	
Boron (B)	Not really known. Affects translocation of sugars and utilization of calcium in cell wall formation.	Bases of young leaves of terminal buds become light green and finally break down. Stems and leaves become distorted. Plants are stunted. Fruit, fleshy roots or stems, etc., may crack on the surface and/or rot in the center. Causes many plant diseases: heart rot of sugar beets, brown heart of turnips, browning or hollow stem of cauliflower, cracked stem of celery, corky spot, dieback and rosette of apples, hard fruit of citrus, and top sickness of tobacco.	
Sulfur (S)	Present in some amino acids and coenzymes.	Young leaves are pale green or light yellow without any spots. Symptoms resemble those of nitrogen deficiency.	

Deficient Nutrient	Function of Nutrient	Symptoms of Deficiency	
Iron (Fe)	Is a catalyst of chlorophyll synthesis. Part of many enzymes.	Young leaves become severely yellowed, but main veins remain characteristically green. Sometimes brown spots develop. Part or entire leaf may dry. Leaves may be shed.	
Zinc (Zn)	Is part of enzymes involved in auxin synthesis and in oxidation of sugars.	Leaves show interveinal yellowing. Later they become necrotic and show purple pigmentation. Leaves are few and small, internodes are short and shoots form rosettes. Fruit production is low. Leaves are shed progressively from base to tip. Causes little leaf of apple, stone fruits, and grape; sickle leaf of cacao; white tip of corn; etc.	
Copper (Cu)	Is part of many oxidative enzymes.	Tips of young leaves of cereals wither and their margins become yellow. Leaves may fail to unroll and tend to appear wilted. Heading is reduced and heads are dwarfed and distorted. Citrus, pome, and stone fruits show dieback of twigs in the summer, burning of leaf margins, yellowing, etc. Vegetable crops fail to grow.	

Deficient Nutrient	Function of Nutrient	Symptoms of Deficiency	
Manganese (Mn)	Is part of many enzymes of respiration, photosynthesis, and nitrogen utilization.	Leaves become yellow but smallest veins remain green and produce a checkered effect. Necrotic spots may appear scattered on leaf. Severely affected leaves turn brown and wither.	
Molybdenum (Mo)	Is essential component of nitrate reductase enzyme.	Melons and probably other plants exhibit severe yellowing and stunting and fail to set fruit.	

How can I tell the difference between a nutrient deficient plant and one with another disease?

Plants may suffer from a wide variety of problems that show similar symptoms. If a grower is unable to identify the cause of a plant's problem, a remedy will be difficult to find. If the problem is biotic (caused by a living organism), some sign of the organism is usually visible, especially upon careful examination. Insects are often present on the plant, or they may leave traces such as webbing, eggs, or cocoons. Fungi may be visible as fuzzy threads or a powdery coating. Bacteria may cause affected areas to appear slimy or water-soaked.

Abiotic problems (those stemming from non-living sources such as environmental stress or nutrition) may cause the plant to appear generally unhealthy. The whole plant may look sickly or be stunted in growth. The foliage may begin to yellow or turn bronze or brown. A simplified diagnostic flow chart (Figure 1) can be used to make a visual diagnosis of a nutrient deficiency disorder.

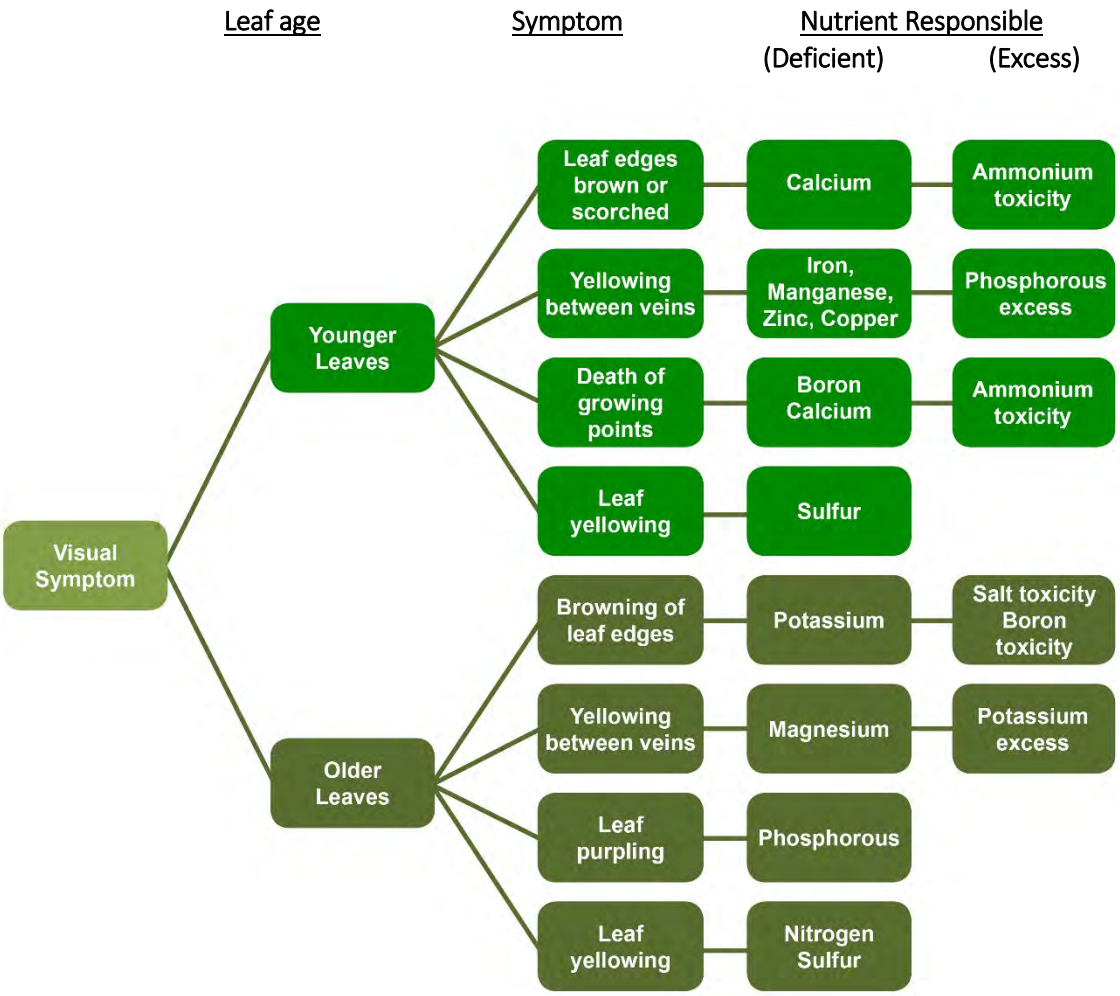

Figure 1. Key to visual diagnosis of nutrient deficiency

The best way to check for a lack of nutrients in the soil is to test a sample of the soil in the laboratory. While there are do-it-yourself kits available, your county's WVU Extension Service agent can provide the necessary supplies and technical assistance for proper sample collection and submission. The resulting soil analysis report will provide information on soil deficiencies and will make recommendations on how to correct them. Table 2 outlines the causes of common nutrient deficiencies of the soil and ways to correct them.

Table 2. Corrective measures for nutrient deficiency

Deficiency	Common Cause	How to Correct
Nitrogen	Excessive watering or waterlogged soil	Water plant less or ensure the area has adequate drainage.
	Soil low in organic matter	Amend soil with a source of organic matter.
	Crop removal	Grow legume crops, fertilize (use manure, blood meal, fish meal, or inorganic fertilizer).
Phosphorous	Cold, wet soil in early spring	Ensure area has adequate drainage.
	pH too high or low	Use soil amendment such as lime to adjust pH.
	Crop removal	Fertilize (use bone meal, rock phosphate, ammonium phosphate, or manure).
	Compacted soil	Till or plow soil.
Potassium	Excessive watering	Water plant less.
	pH too high	Amend soil to adjust pH.
	Crop removal	Fertilize (use wood ash, greensand, potassium sulfate, or potassium chloride).
Magnesium	pH too acidic	Amend soil to adjust pH.
	Crop removal	Fertilize (use dolomitic lime, Epsom salts, or foliar sprays of magnesium sulfate).
Calcium	Excessive or not enough watering	Adjust watering schedule.
	Crop removal	Fertilize (use gypsum, calcitic lime, calcium sulfate, calcium nitrate, calcium carbonate, or dolomitic limestone).
Boron	pH too high or low	Amend soil to adjust pH.
	Sandy soil with low organic matter	Amend soil with a source of organic matter.
	Lack of nitrogen	(see nitrogen above)

Deficiency	Common Cause	How to Correct
	Crop removal	Fertilize (use borax, sodium or calcium borate).
Sulfur	Sandy soil with low organic matter	Amend soil with a source of organic matter.
	Crop removal	Fertilize (use gypsum, ammonium sulfate, calcium sulfate, or elemental sulfur).
Iron	pH too high	Amend soil to adjust pH.
	Soil low in organic matter	Amend soil with a source of organic matter.
	Crop removal	Fertilize (use foliar applications of iron chelates, ferrous sulfate, or ferrous ammonium sulfate).
Zinc	pH too high	Amend soil to adjust pH.
	Soil low in organic matter	Amend soil with a source of organic matter.
	Lack of nitrogen	(see nitrogen above)
	Crop removal	Fertilize (use foliar applications of zinc sulfate).
Copper	Compacted soil	Till or plow soil.
	Lack of nitrogen	(see nitrogen above)
	Excess watering	Water less, ensure area has adequate drainage.
	Crop removal	Fertilize (use copper sulfate or other copper salts).
Manganese	pH too high	Amend soil to adjust pH.
	Lack of nitrogen	(see nitrogen above)
	Crop removal	Fertilize (use manganese sulfate as either a foliar application or soil amendment).
Molybdenum	pH too acidic	Amend soil to adjust pH.
	Crop removal	Fertilize (use sodium molybdate as foliar application or soil amendment).

References

Agrios, G.N. 2005. "Nutrient deficiencies in plants." *Plant Pathology.* 372-373. K.D Sonnack (ed) Elsevier Academic Press, London, UK.

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Bierman, M.P. and Rosen, C.J. 2005. "Diagnosing Nutrient Disorders in Fruit and Vegetable Crops." http://www.extension.umn.edu/distribution/horticulture/M1190.html.

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