Integrated Pest Management
University of Missouri

Diagnosing Nutrient Deficiencies

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Soil and plant testing lab has been receiving large volume of corn, soybean, and some alfalfa samples with nutrient deficiency problems for diagnosis. Early in the season we found more of phosphorus deficiency (which was mostly observed in fields that has been fallowed during the prior growing season) and some nitrogen deficiency. As the season progressed and with the drought conditions that existed in parts of Missouri, we started seeing more of potassium deficiency along with some nitrogen and phosphorus deficiencies. In most cases the phosphorus deficiency was observed where the soil test P levels were low to medium. In the case of potassium deficiency, some fields had low to medium soil test K, and others had medium to high soil test K and still expressed potassium deficiency. The latter condition was attributed to the drought conditions that prevailed in the field at the time of sampling. Soil test K can become less available in dryer soils due to fixation by 2:1 clay minerals in soil. Also potassium is an element that is taken up by plants by mass flow and diffusion processes. This process can get affected by soil moisture levels. Since nutrient deficiency has been a frequent occurrence in the plant samples received this season, I thought writing an article on diagnosing nutrient deficiencies will be a timely one. In addition to the field crops samples, the lab also received some vegetables, grapevines, and landscaping plants with nitrogen, potassium, iron, and manganese deficiency problems.

Plants need nutrients to grow well and produce. Seventeen elements are considered essential nutrients for plant growth. Plant essential nutrients are grouped into two categories: macronutrients and micros. Macronutrients (carbon, hydrogen, oxygen, nitrogen, potassium, phosphorus, sulfur, calcium and magnesium) are required in large quantities and micros (zinc, iron, copper, boron, manganese, chlorine, molybdenum and nickel) are required in small quantities. Plants need the right balance of nutrients for growth and production. If there is a deficiency of any essential element, plants cannot complete their vegetative or reproductive cycles and as result will express deficiency symptoms.

Lack of an essential nutrient element in plants will result in expression of nutrient deficiencies and can be determined from visual symptoms. The correct diagnosis of the deficiency is important to correct the problem. In general initial symptoms of nutrient deficiency is expressed either in the new or older leaves. For immobile nutrients in plants like zinc, iron, copper, manganese, boron, chlorine, nickel, calcium and sulfur, the deficiency symptoms first show up in the younger leaves. Deficiency symptoms for mobile nutrients in plants like nitrogen, phosphorus, potassium and magnesium are first expressed in older leaves. Molybdenum deficiency symptoms in plants first appear between the old and new leaves.

Excess of any nutrient can be toxic to plants. Too much of fertilizer can result in salt burn symptoms. These symptoms include marginal browning or necrosis of leaves, separated from green leaf tissue by a slender yellow halo. The symptom begins at the tip and proceeds to the base of the leaf along the edges.

There are other factors which can complicate the diagnosis of nutrient deficiency in plants. Excessive top growth beyond the capacity of the root system, damage from excess salts (likely in potting plants and greenhouses), drought conditions, pesticide toxicity, damage to the root system by nematodes, insects or disease, or any other condition that can be detrimental for root growth.

The most commonly found nutrient deficiency and toxicity symptoms are presented in the table below:

Nutrient	Deficiency Symptoms	Toxicity Symptoms
Nitrogen (N)	Stunted growth and restricted growth of lateral shoots. Plants express general chlorosis of the entire plant to light green and yellowing of older leaves which proceeds to younger leaves. Older leaves become necrotic and defoliate early	Plants are stunted, deep green in color, and secondary shoot development is poor. High N causes vegetative bud formation instead of reproductive bud formation. Ammonium toxicity can cause roots to turn brown, with necrotic root tips; reduce plant growth; necrotic lesions occur on stem and leaves; vascular browning occurs in stems and roots.
Phosphorus (P)	Stunted growth. Purplish coloration of older leaves in some plants. Dark green coloration with tips of leaves dying. Delayed	Excess P in the plant can cause iron and zinc deficiencies.

	maturity, Poor fruit and seed development.	
Potassium (K)	Leaf margins turn chlorotic and then necrotic. Tip and marginal burn starting on mature leaves. Lower leaves turn yellow. Weak stalks and plant lodge easily. Slow growth.	High amounts of K can cause calcium (Ca), magnesium (Mg) and N deficiencies.
Magnesium (Mg)	Interveinal chlorosis on older leaves which proceeds to the younger leaves as the deficiency becomes more severe. The chlorotic interveinal yellow patches usually occur toward the center of the leaf with the margins being the last to turn yellow. Curling of leaves upward along margins.	High Mg can cause Ca deficiency.
Calcium (Ca)	Light green color on uneven chlorosis of young leaves. Brown or black scorching of new leaf tips and die-back of growing points. Growing points of stems and roots cease to develop. Poor root growth and roots short and thickened.	High Ca can cause Mg or Boron (B) deficiencies.
Sulfur (S)	Uniform chlorosis first appearing on new leaves.	
Iron (Fe)	Interveinal chlorosis of new leaves followed by complete chlorosis and or bleaching of new leaves. Stunted growth.	
Zinc (Zn)	Interveinal chlorosis of new leaves with some green next to veins. Short internodes and small leaves. Rosetting or whirling of leaves.	
Manganese (Mn)	Interveinal chlorosis of new leaves with some green next to veins and later with grey or tan necrotic spots in chlorotic areas.	
Copper (Cu)	Interveinal chlorosis of new leaves with tips and edges green, followed by veinal chlorosis. Leaves at the top of the plant wilt easily followed by chlorotic and necrotic areas in the leaves. Dieback of terminal shoots in trees.	
Boron (B)	Death of terminal buds, causing lateral buds to develop and producing a 'witches broom' effect.	Symptoms develop as a yellow-tinted band around the leaf margins. The chlorotic zone becomes necrotic and gray, while the major portion of the leaf remains green.
Molybdenum (Mo)	Older leaves show interveinal chlorotic blotches, become cupped and thickened. Chlorosis continues upward to younger leaves as deficiency progresses.	

Plant analysis has proved to be a very effective means of predicting fertilizer needs of plants. It has been used as a diagnostic tool for many years. To determine nutrient deficiencies, most growers rely primarily on visual symptoms, plant tissue analysis and soil analysis. Plant analysis and soil testing go hand in hand. A soil test provides an index of the nutrient that is potentially available for the crop. Plant analysis tells how much of that potentially available nutrient is actually taken up by the plant.

Submitting Plant Samples for Analysis

Do not include plants affected by insects, disease or pesticide damage. Where a deficiency is suspected, take samples from normal plants in an adjacent area as well as from the affected area. It is important to take a representative soil sample from each area. Comparing soil and plant analysis results can greatly assist in the interpretations. Collected plant tissue is very perishable and requires special handling to avoid decomposition. Therefore, fresh plant tissue should be placed in clean paper bags left open; partially air dried if possible or kept in a cool environment during shipment to the laboratory. Wash dusty plants before air-drying. Fresh plant samples should not be placed in clos

unless the tissue is either air-dried or bag and contents are kept cool. Air-drying of fresh plant tissue can be done by placing the plant tissue in an open, dry environment for 12 to 24 hours. Air dried samples can be place in a clean brown bag or envelop and take mailed to the lab. Request a complete analysis of each plant sample including nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), copper, iron, zinc, manganese sulfur, and boron. The University of Missouri soil and plant testing lab offers this service for $30 per sample. Information on submitting samples to the lab and sample information forms can be obtained from the lab's website at: http://soilplantlab.missouri.edu/soil/

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