Integrated Pest Management
University of Missouri

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Integrated Pest & Crop Management

Diagnosing Nutrient Deficiencies

by Manjula Nathan

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.

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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 maturity, Poor fruit and seed development.	Excess P in the plant can cause iron and zinc deficiencies.
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.	

Nutrient	Deficiency Symptoms	Toxicity Symptoms
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 closed plastic bags 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/

Missouri State Approved Soil Testing Labs

by Manjula Nathan

The Missouri Soil Testing Association (MSTA) Approval Program is designed to assure that results provided by participating public and private labs serving the citizens of Missouri agree with allowable statistical limits. This is accomplished by evaluating the soil testing laboratories in their performance through inter-laboratory sample exchanges and a statistical evaluation of the analytical data. Based on this premise, soil test results from MSTA approved labs will be accepted by the U.S. Department of Agriculture, Farm Service Agency (FSA) and Department of Natural Resources and Conservation Services (NRCS) in federally assisted cost share programs and nutrient management plans in the state of Missouri.

In order to be approved by the Missouri State program, the participating labs should participate in all four quarter exchanges of the NAPT program and submit the MO State data release form each year to the NAPT coordinator. The NAPT coordinator in return sends soil test data from quarterly sample exchanges of the labs participating in MSTA program to the Missouri state coordinator. The MU Soil Testing Lab director serves as the state program coordinator and performs statistical analysis of the data as specified in the MSTA program. If a lab's results fall within the allowable limits, the lab will be placed on the Farm Service Agency's (FSA) list of approved labs. A lab that is not approved may re-apply after a year. An updated listing of Missouri State Approved Soil Testing lab list can be found at: http://soilplantlab.missouri.edu/soil/msta.aspx

List of Missouri State Approved Soil Testing Labs July 2016 to June 2017

MU Soil and Plant Testing Lab
University of Missouri
23 Mumford Hall
Columbia, MO 65211
Telephone: 573-882-3250
Fax: 573-884-4288

MU Delta Soil Testing Lab
Univ. of Missouri, PO Box 160
Portageville, MO 63873
Telephone: 573-379-5431
Fax: 573-379-3383

Custom Laboratory
204 C St.
Golden City, MO 64748
Telephone: 417-537-8337
Fax: 417-537-8337

Perry Agricultural Lab
PO Box 418
State Highway 54 East
Bowling Green, MO 63334
Telephone: 573-324-2931
Fax: 573-324-5558

Ag Source Laboratories
300 Speedway Circle #2
Lincoln NE 68502
Tel: 402-476-0300
Fax: 402-476-0302

American Agricultural Lab
210 East First St, PO Box 370
McCook, NE 69001
Telephone: 308.345.3670
Fax: 308-345-7880

Midwest Laboratories, Inc.
13611 B St.
Omaha, NE 68144-3693
Telephone: 402-334-7770
Fax: 402-334-9121

Ward Laboratories
4007 Cherry Ave.
PO Box 788
Kearney, NE 68848
Telephone: 308-234-2418
Fax: 308-234-1940

Ag Source Laboratories
1532 Dewitt
Ellsworth, IA 50075
Tel: 515-836-4444
Fax: 515-836-4541

Solum Labs Inc.
The Climate Corporation
615 Bell Avenue
Ames, IA 50010
Tel: 515-661-5500

Waypoint Analytical Iowa, Inc.
111 Linn St., PO Box 455
Atlantic, IA 50022
Telephone: 901-213-2400
Fax: 901-213-2440

Ingram's Soil Testing Center
13343 Fitschen Road
Athens, IL 62613
Tel: 217-636-7500
Fax: 217-636-7500

SGS-Toulon Labs
117 East Main St.
Toulon, IL 61483-0518
Telephone: 309-286-2761
Fax: 309-286-6251

SGS-Belleville
1511 East Main St.
Belleville, IL 62221
Telephone: 618-233-0445
Fax: 618-233-2792

A&L Great Lakes Laboratory
3505 Conestoga Drive
Fort Wayne, IN 46808
Telephone: 260-483-4759
Fax: 260-483-5274

MVTL Laboratories-New Ulm
1126 North Front St.
New Ulm, MN 56073-0249
Telephone: 507-354-8517
Fax: 507-359-2890

Brookside Lab Inc.
200 White Mountain Drive,
New Bremen OH 45869
Telephone: 419-977-2766
Fax: 419-977-2767

Spectrum Analytical
1087 Jamison Road, PO Box 639
Washington Court House,
OH 43160
Telephone: 740-335-1562
Fax: 740-335-1104

Waters Agricultural Laboratories
257 Newton Highway
PO Box 382
Camilla, GA 31730
Telephone: 229-336-7216
Fax: 229-336-0977

Waters Agricultural Laboratories
2101 Old Calhoun Road
Owensboro, KY 42301
Telephone: 270-685-4039
Fax: 270-685-3989

Waypoint Analytical Inc.
2790 Whitten Road
Memphis, TN 38133
Telephone: 901-213-2400
Fax: 901-213-2440

Ag Source Cooperative Services
106 N. Cecil St. PO Box 7
Bonduel, WI 54107
Telephone: 715-758-2178
Fax: 715-758-2620

Note: Approval of soil analysis does not imply approval of fertilizer and limestone recommendations by the individual labs. The approval allows the clients to use the University of Missouri soil fertility recommendations as required by the federal and state agencies for cost share and nutrient management planning programs. In order to use the University of Missouri soil fertility recommendations and get meaningful results, it is recommended that the labs use the soil test procedures required by the MSTA program.

Weather Data for the Week Ending July 28, 2016

Station	County	Weekly Temperature (ºF)						Monthly Precipitation (in.)		Growing Degree Days‡	
		Avg. Max.	Avg. Min.	Extreme High	Extreme Low	Mean	Departure from long term avg.	July 1 - 28	Departure from long term avg.	Accumulated Since Apr 1	Departure from long term avg.
Corning	Atchison	90	69	94	64	79	2	4.7	-0.08	2308	360
St. Joseph	Buchanan	88	72	92	66	80	3	6.23	2.04	2204	269
Brunswick	Carroll	90	72	95	65	81	5	6.41	2.55	2327	353
Albany	Gentry	88	69	91	62	78	1	2.99	-1.58	1992	93
Auxvasse	Audrain	90	70	96	68	80	3	7.88	4.28	2193	192
Vandalia	Audrain	90	71	95	69	80	3	7.98	3.95	2180	234
Columbia-Bradford Research and Extension Center	Boone	89	70	94	68	79	1	10.35	6.74	2152	101
Columbia-Capen Park	Boone	94	70	100	67	80	2	10.75	6.66	2198	77
Columbia-Jefferson Farm and Gardens	Boone	92	71	96	69	81	3	9.7	6.09	2259	203
Columbia-Sanborn Field	Boone	90	73	96	70	82	4	10.66	6.91	2380	255
Columbia-South Farms	Boone	90	71	95	69	80	2	10.17	6.5	2228	175
Williamsburg	Callaway	90	70	95	68	79	2	8.17	4.4	2105	157
Novelty	Knox	88	69	92	65	78	2	4.58	0.72	2032	110
Mosow Mills	Lincoln	90	72	96	69	80	3	5.85	2.33	2233	170
Linneus	Linn	89	70	93	64	79	3	3.51	-0.91	2080	191
Monroe City	Monroe	90	70	94	66	80	4	7.89	4.29	2158	188
Versailles	Morgan	92	72	97	69	82	4	4.21	0.47	2339	235
Green Ridge	Pettis	91	71	95	68	81	4	5.93	2.12	2243	222
Unionville	Putnam	88	68	94	62	78	3	2.76	-2.1	1954	188
Lamar	Barton	92	71	97	63	81	2	5.61	1.32	2341	160
Butler	Bates	91	72	97	68	81	2	5.66	1.94	2305	71
Cook Station	Crawford	91	71	96	68	79	1	6.18	3.01	2160	52
Round Spring	Shannon	91	71	97	69	79	2	7.88	4.47	2118	97
Mountain Grove	Wright	92	71	99	66	79	2	5.77	2.19	2094	123
Delta	Cape Girardeau	91	73	94	72	80	1	6.24	3.51	2351	-21
Cardwell	Dunklin	93	74	98	71	81	1	2.63	-0.36	2638	46
Clarkton	Dunklin	93	74	98	73	81	1	6.07	2.91	2597	49
Glennonville	Dunklin	93	75	97	73	82	2	2.21	-0.95	2586	47
Charleston	Mississippi	92	75	94	73	81	2	7.02	3.83	2572	185
Hayward	Pemiscot	91	74	94	72	81	1	3.46	0.36	2538	-18
Portageville	Pemiscot	*	*	*	*	*	*	*	*	*	*
Steele	Pemiscot	93	74	98	73	82	2	3.85	0.93	2650	64

‡Growing degree days are calculated by subtracting a 50 degree (Fahrenheit) base temperature from the average daily temperature. Thus, if the average temperature for the day is 75 degrees, then 25 growing degree days will have been accumulated.

Weather Data provided by Pat Guinan | GuinanP@missouri.edu | (573) 882-5908

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