PLANT ANALYSIS

STATION BULLETIN
UNIVERSITY OF MISSOURI - COLUMBIA
SB 881 1-70-3.5M

Plant Analysis

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In recent years there has been increasing interest in the chemical analysis of growing plants as a tool in the diagnosis of fertility problems. Intensive work with sugarcane and sugarbeets in Hawaii and California has shown that plant analysis can aid the grower in the management of his fertilizer program. When properly used, plant analysis can serve as a monitor of the fertilizer program on a specific crop by indicating insufficiency, sufficiency and excesses of certain plant nutrients.

What is Plant Analysis?

Many Missouri farmers are acquainted with the plant tissue tests as described in UMC Guide 9130. These tests are quick tests made in the field to estimate the levels of nitrogen, phosphorous, and potassium in the fresh plant tissue. While these tests are quite useful they have at least two limitations. The tissue test results can only be evaluated as low, medium, or high i. e. no real quantitative results. Secondly, the usefulness of tissue tests is limited because there are no quick methods of determining in the fields the levels of essential elements other than nitrogen, phosphorous, and potassium.

Plant analysis, on the other hand, is a laboratory determination of as many as sixteen elements at one time on a single plant sample. A plant part is selected which best reflects the nutrient level in the plant. The sample consists of the seleected part (i. e. leaves or petioles) from several plants representative of the field or problem area of interest.

It has only been in recent years that instruments have become available which can fairly rapidly make as many as sixteen determinations simultaneously on a single plant sample and make these determinations on a large volume of samples. These instruments, which are called direct reading emission spectrographs, cost several thousands of dollars; thus, only laboratories which have a large sample volume can afford to purchase such instruments. Fortunately as sample volume increases our ability to make good recommendations improves.

Test results are given in terms of percentage (%) or parts per million (ppm). The spectrographs generally analyze the plant samples for P, K, Ca, Mg, Mn, Fe, B, Cu, Zn, Al, Na, Mo, and other elements depending on the instrument and the laboratory. Nitrogen and sulfur must be determined by other methods but are reported with the above elements.

How are Plant Analyses Results Interpreted?

Experiment stations throughout the country are conducting fertility experiments to gain experience in interpreting plant analyses results. The crop yields and plant analyses are then compared and evaluated. This processing results in guides to use in interpreting plant analysis results from plant samples.

In theory, each species has a critical value (or percentage) of each nutrient. Below this level it will respond to added nutrient. One concept under which plant analyses may be evaluated is that proposed by Macy (Plant Physiology 11:749-764) in 1936. This concept is presented schematically in Fig. 1.

From plant analysis data, the critical percentage and the shape of the percentage nutrient curve in response to increasing nutrient supply may be obtained. Obviously this data would supplement the yield response data developed by soil test correlation.

Plant analysis data are variable even when the nutrient supply is rigidly controlled because:

(1) Weather influences the efficiency of use of nutrients.
(2) The level of elements in the plant (other than the one being studied) influences the magnitude of response to the studied nutrient.
(3) The relative ratios of available nutrients in the soil affect uptake of each nutrient.
(4) Varieties and species differ in their physiological response to nutrients.
(5) The part of the plant used for analysis affects the character of results.
(6) Plant maturity will alter the results.
(7) Other management practices such as herbicides will affect the level of nutrients in a particular plant part.

In spite of the seemingly insurmountable list of factors, research experience has given some fairly good guides to use in interpretation of plant analyses. Tables 1 and 2 give summaries of such experience from Illinois and Ohio, respectively. In general the values given in these tables could be considered "critical values" although many feel there are no such values.

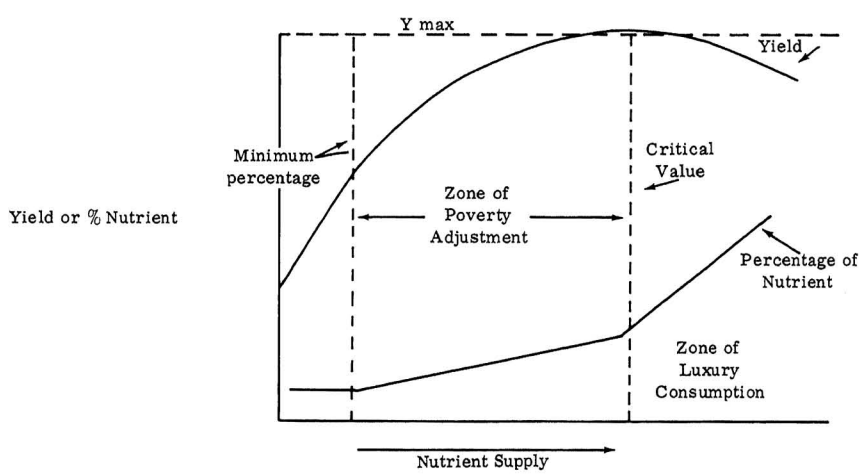

Fig. 1 A schematic illustration of the relationship between yield, percentage of nutrient and nutrient supply (after Macy).

Table 1. Critical composition[1] values for diagnostic interpretations of "total" plant analyses as used in Illinois[2].

Nutrient	Corn	Soybean	Wheat	Alfalfa
	%			
N	3.00		2.60	
P	0.25	0.35	0.30	0.35
K	1.90	2.20	1.80	2.20
Ca	0.40	0.40	0.25	0.80
Mg	0.25	0.30	0.15	0.40
	ppm			
Mn	15	20	30	25
Fe	25	30	25	30
B	10	25	15	30
Cu	5	5	5	7
Zn	15	15	15	15
Mo	0.2	0.5	0.3	0.5

[1]Corn: leaf at or opposite and below ear at tasseling

Soybean: youngest mature leaves and petioles after 1st pod formation

Wheat: whole plant at boot stage

Alfalfa: upper stem cuttings in early flower

[2]Melsted, S. W., H. L. Motto and T. R. Peck. 1969. Critical plant nutrient composition values useful in interpretating plant analysis data. Agronomy Journal 61:17-20.

Table 2. Sufficiency levels used to evaluate plant analysis - Ohio Plant Analysis Laboratory, Wooster, Ohio[1]

Element	Conc.	Crop			
		Corn[2]	Soybeans[3]	Alfalfa[4]	Wheat[5]
N	%	2.76-3.50	4.51-5.50	4.51-5.50	2.46-3.50
P	%	.25- .40	.26- .50	.26- .70	.21- .35
K	%	1.71-2.25	1.71-2.50	2.01-3.50	1.51-3.0
Ca	%	.21- .50	.36-2.00	1.76-3.00	.21- .50
Mg	%	.21- .40	.26-1.00	.31-1.00	.16- .30
Mn	ppm	20-150	21-100	30-100	10-100
Fe	ppm	21-250	51-350	30-250	21-250
B	ppm	6-25	21-55	31-80	6-25
Cu	ppm	6-20	10-30	11-30	6-20
Zn	ppm	20-70	21-50	21-70	21-70
Mo	ppm	Always sufficient	----	----	----

[1]Source: Jones, J. B. Jr. 1967. Interpretation of plant analyses for several Agronomic crops in Soil Testing and Plant Analysis, Part II Plant Analysis, SSSA special publication 2. Soil Science Society of America, Madison, Wisconsin.

[2]Ear leaf at initial silk

[3]Top fully mature leaves at initial bloom

[4]Top 6 inches of plant when plants just begin blooming

[5]Jones, J. B. Jr. and H. Shoemaker. 1967. in Proc. 43d Annual Meetings of Council on Fertilizer Application.

Table 3. Procedures for Taking Samples-
Table of Preferred Plant Parts

Crop	Stage of Growth	Part
Corn	Vegetative	Mature leaf immediately below whorl.
	Tasseling	Main ear leaf.
Sorghum	Vegetative	Same as corn.
	Heading prior to pollination	Second leaf from top of plant.
Cotton	Up to setting of bolls	Petiole or petiole and blade of most recently matured leaf.
Soybeans	Up to pod filling (first bloom best)	Most recently matured leaf.
Alfalfa and Clovers	Up to 1/10 the bloom	Top 1/3 of plant.
Small grain grasses	Before boot	Top leaves (upper 1/3 of plant).
Sugarbeets	All	Fully emerged leaf and petiole.

Care must be exercised in taking plant samples. All precautions must be taken to prevent contamination of the plant sample with soil, perspiration, metal, dust and insects. IN ORDER TO INSURE GOOD RESULTS FOLLOW THE SAMPLING INSTRUCTIONS PROVIDED BY THE LABORATORY THAT WILL MAKE THE ANALYSES.

How Are Plant Samples Taken?

In problem areas with unhealthy plants, only the afflicted plant material should be included in the sample; a sample of healthy plants in the vicinity also should be taken. If sampling is to be used as a monitoring tool, a random sample of uniform plants should be taken. Material from a minimum of 30 to 60 plants should be sampled for forages, small grains, cotton and soybeans. As few as 15 sorghum or corn plants may be sampled unless immature plants are used.

In general plant analyses are of no value if the samples are taken after pollination. Once fertilization of the flower has taken place the physiology of the plant is so altered that the vegetative parts of the plant no longer fully reflect its nutrient status.

Plant analysis is only one tool in the kit of the "plant doctor". The results of a plant analysis can not stand alone; other information is needed to either diagnose a problem or to evaluate fertilizer practices. Therefore, any laboratory which is trying to do a good job for the farmer will insist on three things:

1. A completely filled out information sheet (Fig. 2).
2. A soil test made on soil taken near the location of the plant sample, and
3. A well taken and cared for plant sample.

It is item 3 that may cause the most problems. Table 3 gives the proper growth stage and plant part to sample. The number of plants sampled will depend on the laboratory used, ultimate use of data (diagnostic or monitoring), species and stage of growth.

FIGURE 2

PLANT SAMPLING DATA SHEET

Date_____ Field_____ County_____

Legal Description _____

Soil type_____ Slope_____ Drainage_____

Crop_____ Stage_____ Variety_____

Date planted_____ Seeding rate _____ Previous Crop_____

Weather _____

Fertilizer on present crop:

Kind	Quantity	Application method	Date

Pesticide on the present crop:

Kind	Rate	Application method	Date

Fertilizer and pesticide on the previous crop:

Kind	Rate	Application method	Date

Manure: Tons/acre_____ Date_____ Kind _____

Tillage: Conventional Minimum Zero (Circle)

Lime: Tons/acre_____ Date_____

Observations:

Lodging:

Deficiency symptoms:

Weed Infestation:

Insect Infestation:

Root growth:

Tissue test results:

ANALYSIS RESULTS

	OM	N	P	K	Mg	Ca	Mn	Zn	Fe	Cu	B	Mo	Na	Al	Si
Plant	X														
Soil														X	X

Agronomy Department, University of Missouri:

Where May the Sample be Analyzed?

While the University of Missouri-Columbia does not have the necessary instrumentation to make routine plant analyses, the local University Extension Centers do have an analysis service. They will provide information and sampling kits, process the samples, send them to the laboratory, and make recommendations based upon the analysis.

Plant analysis should be given the same degree of consideration as the purchase of seed or fertilizer; it can be an important tool in the farm production "tool kit".

A grower may want to contact one of the laboratories listed in Table 4. If he chooses one of these laboratories their sampling and processing directions should be followed. Plant analysis results are no better than the sample used.

Table 4. LIST OF PRIVATE LABORATORIES THROUGHOUT THE UNITED STATES THAT ANALYZE PLANT TISSUES

Company	Crops Tested	Area Served	Address
Agrico Chemical Co.	any	East of Rockies	See Agrico sales personnel in area served
Brookside Research Labs.	field & greenhouse	U.S. & Canada	New Knoxville, Ohio 45871
Dr. Wolf's Agr. Labs.	any	U.S. & abroad	6861 S.W. 45 Street Ft. Lauderdale, Fla. 33314
Food Chemicals & Research Labs.	any	U.S.	1201 NE 38, Seattle, Wash. 98704
Harris Labs.	any	U.S. & abroad	Box 520, Lexington, Nebr. 68850
International Agr. Services	commercial	U.S. & abroad	320 Judah St., San Francisco, Calif. 94122
Laucks Testing Labs.	any	U.S.	1008 Western Avenue Seattle, Wash. 98104
Minnesota Valley Testing Labs.	Midwest field crops	Midwest, northern plains	New Ulm, Minn. 56073
National Spec. Lab.	any	U.S. & abroad	6300 Euclid Avenue Cleveland, Ohio 44103
Nu-Ag	any	U.S.	Box 239, Rochelle, Ill. 61068
Pattison's Labs.	citrus, vegetable, grain, cotton	U.S. & Mexico	Box 346, Harlingen, Texas 78550
Saint Louis Testing Labs.	any	U.S.	2810 Clark Avenue St. Louis, Mo. 63103
Southern Testing & Research Labs.	any	U.S. & abroad	Box 350, Wilson, N.C. 27893
U. S. Testing Co.	any	U.S. & abroad	Cotton Exchange Bldg. Memphis, Tenn. 38103

Summary

This bulletin has been written to provide current information on plant analyses. As research data is accumulated new information will be disseminated through Extension channels. Plant analysis is a tool. It will not solve all crop production problems. Plant analysis provides a method for monitoring a fertilizer program and can aid in adjusting this program to a specific growing condition.