

## **Section 5 of 22 (5d - HOW TO COLLECT AND INTERPRET PLANT TISSUE SAMPLES)**

Compiled by Linda Scheffe, 2008, <http://www.nm.nrcs.usda.gov/technical/handbooks/iwm/nmiwm.html>

### **WHY ANALYZE PLANT SAMPLES FOR NUTRIENTS?**

- A plant analysis is often recommended to evaluate fertility status and plant uptake during the growing season.
- It is also used to monitor micronutrient levels and to develop a foliar application spray rate of selected micronutrients.
- Fertilizer efficiencies can be monitored.
- A database for future planning can also be developed based on plant analysis.

### **Sampling Plant Tissue**

- Plant analysis is the laboratory determination of several elements on a single sample of plant tissue. This technique is most commonly used to diagnose nutritional problems related to soil fertility or to monitor the effectiveness of fertilizer practices on growing crops.
- Plant analysis is not a substitute for soil testing, but is most effective when used in conjunction with a regular soil testing program.
- The number of elements that are measured depends on the laboratory to which the samples are sent for analysis. The most common elements analyzed in the sample are nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (M), sulfur (S), sodium (Na), iron (Fe), manganese (Mn), boron (B), copper (Cu), zinc (Zn), and aluminum (Al). Others that may be measured either routinely or upon request include molybdenum (Mo), chloride (Cl), cobalt (Co), silicon (Si), cadmium (Cd), nickel (Ni), lead (Pb), chromium (Cr), arsenic (As), barium (Ba), and selenium (Se). Although some of these are not essential for plant growth, the results may be used to identify elemental toxicities.
- In order for plant analysis to be effective, considerable care must be given to collecting, preparing and sending plant tissue to the laboratory for analysis.

### **What to Sample**

- Proper sampling requires that a specific plant part be taken such as a particular leaf, group of leaves or portion of the plant. Instructions also include number of individual parts, as well as the number of plants to sample. This will ensure that a sufficient quantity of plant tissue is submitted for analysis and that the collected sample is statistically representative of the area under study.
- When sampling mixed stands, particularly forages and pastures, separate plant species. Similarly, the sample should be of only leaves or petioles or whole tops

and not mixtures. The enclosed table provides plant tissue collection guidelines for many of the crops grown in New Mexico.

- When no specific sampling instructions are given for a particular crop, the general rule of thumb is to sample the uppermost recently mature leaves.
- Young emerging leaves, older mature leaves and seed are not usually suitable plant tissues for analysis since they do not ordinarily reflect the general nutrient status of the whole plant.
- The recommended time to sample usually occurs just prior to the beginning of the reproductive stage for many plants. However, sampling earlier or even later than the specified time may be recommended for specific plants or circumstances.
- Sample plants that are showing a suspected nutrient deficiency symptom at the time or shortly after the visual symptoms appear. Do not sample or include in a sample plants under a nutrient stress for an extended period of time, dead plant tissue or plants or tissue mechanically injured, diseased, or insect-damaged.

### Multiple Sampling

- When a nutrient deficiency is suspected at time other than specified for sampling, also collect similar plant parts from normal plants growing in the immediate or adjacent areas. Take care to ensure that the two sets of plants are at approximately the same stage of growth and have been treated the same. Comparative analyses are questionable when the two sets of plants are not at the same stage of growth, have not received the same treatment or are not the same variety or hybrid. If the soil type varies between the two sites, tissue analyses would not be comparable. If all the proper conditions have been met, then a comparison of results between two sets of plant tissue samples can be invaluable to the interpreter. Do not mix or place the collected tissues in the same mailing kit. When soil test data are available, take soil samples from both areas.

### Washing to Remove Contaminants

- Avoid dusty or soil-covered leaves and plants whenever possible. When leaves are dusty, brush or wipe with a damp cloth to remove the contaminants. If this is not effective or when leaves are covered with spray materials, wash in a mild detergent solution (0.30 percent) and rinse in running water to remove attached substances. Do not prolong the washing procedures or allow the plant material to stand in either the washing or rinsing baths. Wash and rinse briskly. Wash leaves which have been sprayed with nutrient solutions while they are still fresh. If iron is of primary interest, wash leaves regardless of their outward appearance. Wash whole plants sampled shortly after emergence to remove soil particles that are frequently attached to the new tissue.

## What Not to Sample

- Do not include diseased or dead plant material in a sample. Do not sample or include plants or leaf tissue that have been damaged by insects or mechanically injured in a sample. When whole plants are sampled, remove the roots and wash the upper portion to remove soil particles. Do not sample plants, which have been stressed extensively by cold, heat, moisture deficiency, or by excess moisture. Examine both the below ground as well as the above ground portion of the plant. The presence of nematodes or roots damaged by other insects or diseases should preclude the need to sample.

## Packaging Plant Tissue

- Air-dry plant tissue samples before shipment to the laboratory. Package samples in clean paper bags or envelopes for mailing to the laboratory. Never place fresh samples in a plastic bag.

## Plant Analysis Interpretation

- The use of plant analysis is an effective management strategy for a sustainable soil fertility program because it provides a direct measure of nutrient concentrations and balance within the plant.
- Principles and procedures used for plant analyses have evolved over many years and changed as knowledge increased about each element that is essential for a plant to complete its life cycle. As such, use of plant analyses has become an integral part of most agronomic research and a tool for crop consultants and fertilizer dealers to monitor production fields.
- The enclosed table provides plant tissue analysis interpretation guidelines for most crops grown in New Mexico.
- The effects of time of sampling, variety or hybrid and environmental factors, such as soil moisture, temperature, light quality and intensity may significantly affect the relationship between nutrient concentration and plant response.
- A defined sufficiency range may not apply to all situations or environments, nutrient uptake and internal mobility, as well as dry matter changes, can affect the nutrient concentrations in plant tissues. Concentration and dilution occur due to the difference between plant growth and nutrient absorption as well as movement of the nutrients within and between plant parts.
- Under normal growing conditions, nutrient absorption, and plant growth closely parallel each other during most of the vegetative growth period. Exceptions occur during the very early growth period shortly after germination, after seed set and at the beginning of senescence. However, if the normal rate of growth is interrupted, nutrient accumulation or dilution can occur.

## PLANT TISSUE ANALYSIS GUIDELINES

<u>Crop</u>	<u>Time of Sampling</u>	<u>Plant Part</u>	<u>No. Plants to Sample</u>	<u>Nutrient</u>	<u>Deficient</u>	<u>Sufficient</u>				
Alfalfa	One-tenth bloom	Whole tops	45-50	Total N-%	-	4.5-5.0				
				Total P-%	0.17	0.25-0.7				
				Total K-%	0.80	1.5-3.5				
				Total S-%	0.17	0.25-0.5				
				B	-	30-80				
Alfalfa	Early growth	Petiole of young, mature leaf	30-35	Cu	-	7-30				
				Mn	-	31-100				
				Zn	-	21-70				
				N	5,000	7,000				
				P	2,000	3,000				
Canola	Before seed set	Recently mature leaf	60-70	K	4	6				
				N (%)	-	4.0-6.4				
				P (%)	-	0.42-0.69				
Chile	Early fruit-set	Petiole of young, mature leaf	30-35	K (%)	-	3.5-5.1				
				N	1,000	2,000				
				P	1,500	2,500				
Chile	First square	The youngest fully mature leaves on the main stem. For "nitrate only" determination, sample only the petioles.	30-35	K-%	3	5-7				
				N	-	35,000-60,000				
				P	-	2,200-7,000				
Corn, Silage	Prior to tasseling	First fully developed leaves from top	25-30	K	-	45,000-45,000				
				N-%	<2.7	2.7-3.5				
				P-%	<0.23	0.25-0.4				
				K-%	<1.7	1.7-2.5				
				B	-	4-25				
				Cu	-	6-20				
				Fe	-	21-250				
				Mn	-	20-150				
				Zn	-	20-70				
				Corn, Grain	Tasseling/ bloom	Collect the leaves below and opposite from the ear of 15-20 plants.	15-20	N-%	-	2.8-4.0
P-%	-	0.25-0.5								
K-%	-	1.8-3.0								
B	-	5-25								
Cu	-	5-25								
Fe	-	30-250								
Mn	-	15-150								
Zn	-	20-70								
Cotton	First bloom		30-35					N	-	12,000-18,000
								P	-	1,500-2,000
				K	-	4.0-5.5				
				N	-	3,000-7,000				
				P	-	1,200-1,500				
	Peak bloom		30-35	K	-	3.0-4.0				
				N	-	1,500-3,500				
				P	-	1,000-1,200				
	First open boll		30-35	K	-	2.0-3.0				
				N	-	1,500-3,500				
Maturity	30-35	P	-	800-1,000						
		K	-	1.0-2.0						
		N	-	> 2,000						

Unless otherwise noted, values are: N = NO<sub>3</sub>-N, ppm; P = acetic acid-soluble PO<sub>4</sub>-P, ppm; K = total K, %; S = SO<sub>4</sub>-S, ppm; B, Cu, Fe, Mn, and Zn = ppm.

## PLANT TISSUE ANALYSIS GUIDELINES

<u>Crop</u>	<u>Time of Sampling</u>	<u>Plant Part</u>	<u>No. Plants to Sample</u>	<u>Nutrient</u>	<u>Deficient</u>	<u>Sufficient</u>
Lettuce	At heading	Mid-rib of wrapper leaf	30-50	N P K	4,000 2,000 2	8,000 4,000 4
	At harvest	Mid-rib of wrapper leaf	30-50	N P K	3,000 1,500 1.5	6,000 2,500 2.5
Onion	Early Season	Tallest leaf	45-50	N-% P-% K-%	3.0 0.10 3.0	4.0 0.20 4.0
	Mid-season	Tallest leaf	45-50	N-% P-% K-%	2.5 0.10 2.5	3.0 0.20 4.0
	Late season	Tallest leaf	45-50	N-% P-% K-%	2.0 0.10 2.0	2.5 0.20 3.0
Peanuts	Before or at bloom	Recently mature leaves	40-50	N-% P-% K-% S-% B Cu Fe Mn Zn	- - - - - - - - -	3.5-4.5 0.2-0.35 1.7-3.0 0.2-0.3 20-50 10-50 100-350 100-350 20-50
Pecans	July or August	2 to 4 paired mid-leaflets on the mid-part of current season's growth taken from each of tree's four quadrants mid-way up the tree	80-100	N-% P-% K-% Ca-% Zn B Na Cl	- - - - - - - -	2.5-2.9 0.12-0.30 0.75-0.95 1.3-2.5 50-100 35-50 Excessive >0.10% Excessive >0.3%
Small grains	Before heading	4 uppermost leaf blades	25-40	N-% P-% K-%	- - -	1.7-3.0 0.20-0.50 1.5-3.0
Sorghum (milo)	Before or at heading	2 <sup>nd</sup> leaf from top of plant	20-30	N-% P-% K-%	- - -	3.3-4.0 0.20-0.35 1.4-2.5

Unless otherwise noted, values are: N = NO<sub>3</sub>-N, ppm; P = acetic acid-soluble PO<sub>4</sub>-P, ppm; K = total K, %; S = SO<sub>4</sub>-S, ppm; B, Cu, Fe, Mn, and Zn = ppm

## Essential Elements for Plant Growth

<http://www.soils.wisc.edu/~barak/soilscience326/listofel.htm>

<b>Essential and Beneficial Elements in Higher Plants</b>																		
H																		He
Li	Be											B	C	N	O	F	Ne	
Na	Mg											Al	Si	P	S	Cl	Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt										
		La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb			
		Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No			

## General Symptoms of Nutrient Deficiency in Plants and Sampling Techniques

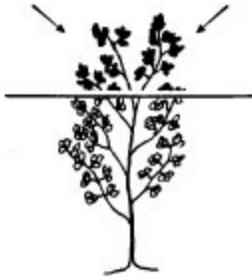
[http://www.cahe.nmsu.edu/pubs/\\_a/a-123.html](http://www.cahe.nmsu.edu/pubs/_a/a-123.html)

<p><b>Nitrogen:</b> Plant light green, lower leaves yellow to light brown, stalks short and slender, plants stunted.</p>	<p><b>Iron:</b> Young leaves are chlorotic, with principal veins typically green; stalks short and slender.</p>
<p><b>Phosphorus:</b> Plants dark green, often developing red and purple pigments; lower leaves sometimes yellow; plants stunted.</p>	<p><b>Zinc:</b> Leaf spots on older leaves, with spots rapidly enlarging and generally involving the area between the veins; thick leaves; stalks with shortened internodes.</p>
<p><b>Potassium:</b> Spots of dead tissue, usually at the tips and between the veins; marked margins of leaves.</p>	<p><b>Boron:</b> Young leaves of the terminal bud are light green at the base; the bud eventually dies.</p>
<p><b>Magnesium:</b> Mottled or chlorotic leaves, which typically redden; leaf tips and margins turned or cupped upward.</p>	<p><b>Copper:</b> Young leaves are permanently wilted, with spotty or marked chlorosis.</p>
<p><b>Calcium:</b> Young leaves of terminal bud hooded; with severe deficiency, dying buds; dying back at the tips and margins of the leaf.</p>	<p><b>Manganese:</b> Spots of dead tissue scattered over the leaf; smallest veins tend to remain green.</p>
<p><b>Sulfur:</b> In young leaves, veins and tissue between veins are light green.</p>	



**Corn...before tasseling**

Collect the first fully developed leaves from the top of 15-20 plants. If the plant is less than 12 inches tall, collect all of the above-ground portion.



**Alfalfa** Collect the top 6 inches or upper third of the plant at early bloom.



**Soybeans** Collect recently mature trifoliate leaves from the top of 20-30 plants before or during bloom. (In the seedling stage, collect all of the above-ground portion of the plant.)



**Corn...from tasseling to silking** Collect the leaves below and opposite from the ear of 15-20 plants.



**Sorghum** Collect the second leaf from the top of 20-30 plants before or at heading.



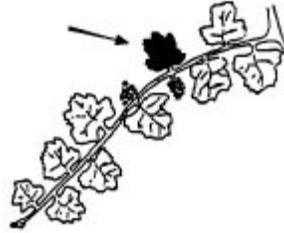
**Pistachios and Walnuts** Collect terminal leaflets/s from nonfruiting shoots at mid- to late season.



**Apples, Pears, Almonds, Apricots, Cherries, Prunes, Plums** Collect the leaves from the current season's nonfruiting, nonexpanding spurs at midseason.



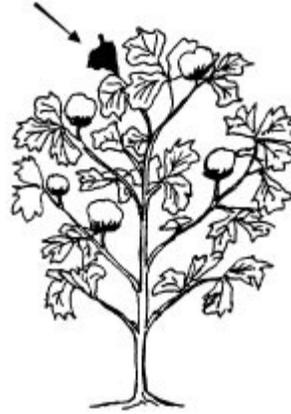
**Pecans, Peaches, and Nectarines** Collect the midshoot leaflets/leaves at midseason.



**Grapes** Collect the petioles or leaves adjacent to basal clusters at bloom.



**Small grains** Collect the four leaf blades from the top of 25-40 plants. Sample should equal 2 cups. (In the seedling stage, collect all of the above-ground portion.)



**Cotton** Collect recent from the main stem on 40 to 50 plants selected at random at full bloom.

**Agronomy Tech Note 76 (<http://www.nm.nrcs.usda.gov/technical/handbooks/iwm/nmiwm.html>)**