17. PLANT ANALYSIS — Tool or Tribulation

Plant analysis has been so widely used and there has been so much work done on establishing "critical" levels that the value of plant analysis as a diagnostic tool has gained an exalted state that is perhaps not wholly deserved. There is no question of the value of plant analysis as a **guide** to determining nutrient deficiencies and toxicities and in planning fertilizer programs; the word "guide" should be stressed, however, as basing a recommendation for a particular nutrient solely on the plant level of that nutrient is unwise.

One of the reasons for the popularity of plant analysis is that we all like easy answers to complex questions. What could be easier than plugging an analysis figure for a particular nutrient into a chart for an instant determination of the status of that nutrient - deficient, low, sufficient, high, excessive. The wide scale publication and use of such "critical level" charts gives us confidence that this is the right approach or else why would such charts exist?

The value of plant analysis is currently coming under question in some quarters. The fertilizer industry's R.L. Luckhardt, a promoter of plant analysis through the years, has recently expressed reservations on its value. My own field experience has taught me not to interpret plant analysis data too strictly.

INFLUENCE OF VARIOUS FACTORS ON LEAF LEVELS OF SOME NUTRIENTS

	- - - Nutrients Affected (leaf levels) - - -	
Factor	Increases levels of:	Decreases levels of:
Moisture stress	Na, Cl, B	P, K
Irrigation	P, K	Na, Cl, B, N
Cool, cloudy weather	Nitrate	—
Heavy crop	Ca, Mg	K
Manure application	N, P, K	Zn, Mg
Potassium fertilization	K	Mg, Na
Soil salinity	Na, Cl, B	K
Soil acidity	Mn	—

A new concept called Diagnosis and Recommendation Integrated System (DRIS) is gaining acceptance in some circles. DRIS correlates a number of factors, including N/P, N/K and K/P ratios in plant tissue, to arrive at a picture of the nutrient status of a crop. The DRIS approach is believed by many to be superior to the "critical level" approach.

Some of the many factors that can influence the level of a given nutrient in a crop are given on the preceding page.

The above list is far from complete, but gives an indication of the many factors affecting the level of a particular nutrient in plant tissue. Also, to compensate for a low level of a particular nutrient, the plant can produce smaller leaves; thus the concentration in the leaf might appear normal, but the nutritional status of that element would be below optimum.

Caution should be used when interpreting leaf analysis data rather than plugging analysis results into a handy chart for an instant recommendation. If a grower intends to embark on a leaf analysis program he should know the pitfalls, or hire someone that does. Analysis data should be correlated with on-site observation of field conditions, a knowledge of crop field history and a knowledge of management practices used on the field.

Too often, shotgun analyses for all the essential elements are routinely run in the hope of finding an answer to a problem. Much of such analyses is wasteful; concentrating on the most likely possibilities is a better approach. Knowledge of molybdenum or copper levels in plants is rarely of value. On the other hand, analysis for some non-essential elements is rarely done, even though such analysis could provide useful information in some situations, e.g., aluminum and lithium analysis.

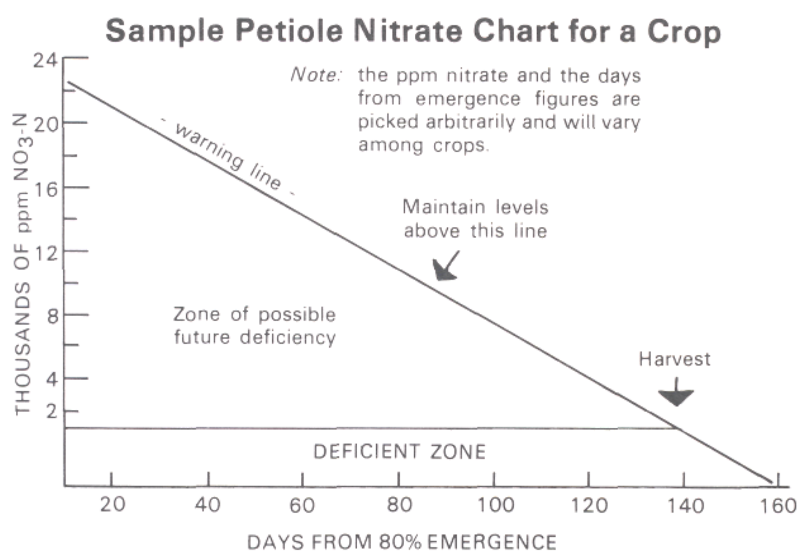
Proper plant sampling, both proper time and proper plant part, is an important part of getting reliable analysis data. Sampling guides for individual crops can be found in publications or are available from extension services. Analysis of plant tissue that has been sprayed with nutrients is of little value for those nutrients since it is difficult to remove sprayed nutrients even if leaves are washed (most labs do not do a thorough job of washing anyway); too much washing can alter results by reducing levels of soluble nutrients such as potassium.

Following is a discussion of plant analysis for three general crop groupings.

Comments on Plant Analysis for Various Crops

Row and field crops

Petiole analysis for nitrate can be very useful in adjusting N fertilizer programs on row crops. Petiole nitrate should be high early in the season then decline as the season progresses (see accompanying diagram). Sampling should be avoided during cloudy or overcast weather because of the possibility of temporary high nitrate accumulation under such conditions. Nitrate can also ac- cumulate during very hot or very cool weather.



At the end of the growing season it is desirable to have nitrate levels at or close to deficiency levels for earlier, more uniform harvest. The slope of the "warning line" for a crop will vary depending on soil type - the slope will be steeper for a sandy soil and gentler for a clay soil.

A petiole sampling program for nitrate must include 2 or more samples during the season - ideally, 4 or more. The nitrate levels on 2 or more samples are plotted on a graph, the points are connected, and the slope of the line is evaluated - it is the slope of the plotted line that is important and that can be used to adjust fertilizer programs during the season; the absolute value of nitrate for any individual petiole sample has much less meaning. Interpretive levels for various crops at different times during the growing season are available in publications or from extension ser- vices. Nitrate levels close to harvest can be used in deciding which of a number of fields to harvest first.

Row crop plant analysis for nutrients other than N is often not definitive because many analysis levels fall in the "gray area" between deficiency and sufficiency. Analysis for other nutrients can be useful, however, when correlated with other data (e.g., soil analysis data).

For alfalfa, P and K analysis of mid-stems can be useful. There is evidence that P/K, P/N and K/N ratios in plant tissue can be important in alfalfa.

Grapes

Growth and nutrient use by cultivated grapes are unique and totally different from any other crop. The reason for this is the severe pruning that is performed on grapes each winter. For virtually all other crops, the top: root ratio does not change significantly. For grapes, the top:root ratio is thrown way out of kilter after a heavy pruning. When starting growth in the spring, grapevines possess a relatively massive root system to supply a relatively small top. The result is vigorous growth and constantly fluctuating nutrient relationships.

Although petiole analysis for nitrate at bloomtime is often done on grapes, the results have too often been erratic and misleading. Analysis of grape **leaves** for total N, 3 or more times a year, will give a better handle on N nutrition of grapes than will petiole nitrate analysis.

Indications are that arginine analysis of canes and/or juice can give a handle on N nutrition of grapes (grapevines accumulate arginine in the fall for use the following growing season) but results have not been consistent and much more work needs to be done in this area.

Compounding the difficulty of establishing a meaningful plant analysis program for grapes is the large number of grape varieties that exist. Critical levels of nutrients are not consistent among varieties. In California, most of the experimental nutritional work has been done on Thompson Seedless; at present it is pretty much up to individual growers of other varieties to develop their own critical level data.

Orchards

Leaf analysis is widely used in orchards and has proven to be an excellent diagnostic tool. Unfortunately, however, many leaf analysis levels fall in the "gray area" between deficiency and sufficiency (this is often the case with zinc), making precise recommendations difficult. Potassium (K) levels can be very low in orchards under stress for water; one should not make a potassium fertilizer recommendation for orchards (or for any crop) based solely on leaf analysis but should get confirming data from other sources. On pecans and grapes, excessive nitrogen fertilization can induce potassium deficiency. Toxic levels of putrescine are associated with this disorder (called "spring fever" in grapes). Caution should also be used with boron leaf levels as good response to boron has been obtained even though leaf levels of B were ample.

Leaf analysis for total calcium is virtually useless when attacking calcium stress disorders (analysis for soluble calcium may have merit in some cases); one shouldn't be lulled into thinking there are no calcium problems just because leaf Ca is high.

Like grapes, much of the spring growth of trees comes from nitrogen that has been stored during the fall and winter. Bark and wood tests during the winter for arginine are being tried for orchards and may prove to be of benefit in the future.

Detecting and Monitoring Toxicities

An excellent use of leaf analysis is in the detection and monitoring of toxicities. Leaf analysis is probably more useful in diagnosing toxicities than it is in diagnosing deficiencies.

Monitoring sodium, chloride and boron in leaves can be helpful in detecting soil salinity build-up. This can be especially valuable in drip irrigation where salts build up on the periphery of the wetted zone. Currently, it is difficult to measure the soil salinity build-up from drip irrigation so that a flushing irrigation can be applied, if needed. Using leaf analysis, the drip irrigated plant can be looked at as a biological salinity sensor giving readouts on soil salinity in terms of sodium, chloride and boron levels in the leaves.

Summary

Plant analysis can be a useful tool, an extremely useful tool, in diagnosing deficiencies or toxicities and in planning fertilizer programs. It is not, however, a definitive tool. Plant analysis data should be correlated with soil analysis data, water analysis data, soil type and irrigation data, crop and field history data, and field observations. Only by doing so will the maximum benefits be obtained from plant analysis.