PLANT ANALYSIS FOR SOIL FERTILITY EVALUATION

Dr. V. K. Venugopal
Former Professor & Head
Department of Soil Science and Agricultural Chemistry
College of Agriculture, Vellayani
Consultant, Digital University, Kerala

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Plant Analysis

- Plant analysis is a technique used to determine the nutrient status of plants by analyzing the tissue composition.
- Tissues samples are analyzed for various nutrient elements such as N, P, K, Ca, Mg, micronutrients like Fe, Mn, Zn, Cu, B.
- Determines the nutrient status of the plant and identify deficiencies or toxicities.
- Also helps in evaluating the effectiveness of fertilizer management practices to optimize plant growth and yield.
- Plant analysis can be done at different stages of plant growth and development, including at planting, mid-season, and post-harvest.
- The timing of plant analysis depends on the crop and the specific nutrient being analyzed. For example, nitrogen analysis is typically done at mid-season when the crop is actively growing and has reached a stage of rapid uptake.

Methods of plant testing

Rapid Tissue and sap Tests

- There are different methods for plant analysis, including tissue testing and sap testing.
- Tissue testing involves collecting plant tissue samples, usually leaves, and analyzing them for nutrient content.
- Sap testing involves collecting plant sap from the stem or petiole and analyzing it for nutrient content.
- Both methods have their advantages and disadvantages, and the choice of method depends on the specific crop and the nutrient being analyzed.

Testing methods for plant samples

- Most common type of rapid plant tissue test is the nitrate quick test, which measures the concentration of nitrate in the plant tissue.
- Nitrate is an important source of nitrogen for plants and is a key indicator of plant health and productivity.
- Nitrate quick test involves crushing a small sample of plant tissue and mixing it with a test solution that reacts with the nitrate in the tissue to produce a color change.
- Intensity of the color is proportional to the nitrate concentration in the tissue, and can be compared to a color chart to determine the nitrate level.
- Plant tissue tests for phosphorus, potassium, and calcium. involve different test solutions and procedures, but the basic principle is the same
- A small sample of plant tissue is extracted and mixed with a test solution that reacts and produce a color change.
- Intensity of the color is then compared to a color chart to determine the nutrient concentration

Advantages and disadvantages

- Quick and easy to perform, require inexpensive, minimal equipment, and provide immediate results.
- Allows growers to make timely management decisions and adjust their fertilization to optimize plant growth and yield.
- They may not be able to detect all nutrient deficiencies or toxicities, and may need to be supplemented with traditional plant analysis methods

Total nutrient analysis of plant part

- Concentration of essential elements found in the index tissue of the plant reflect the nutritional status of the plant.
- Guidelines for interpretation of plant analytical results have been developed through years of research, surveys and experience with various crops.
- In areas where deficiency is suspected, sampling is to be carried out from both affected and normal

Collection, preparation and analysis of plant samples

- Proper sampling is the key to reliable plant analysis results
- Utmost care should be given for the collection and preparation of plant samples.
- The collection of a particular plant part or tissue at the right stage of growth as per technical specification is very important.
- The appropriate part of the plant to sample varies with crop, stage of growth, and purpose of sampling and has been standardized through research
- To monitor plant nutrient status most effectively, sample the specific plant part during the recommended growth stages for the particular crop.
- Take samples weekly or biweekly during critical periods, depending on management intensity and crop value.
- However, to identify a specific plant growth problem, samples to be collected whenever a problem is suspected.
- Collected samples are washed in distilled water , dried in air oven, powdered and used for analysis
- The powdered samples are extracted using acids and the nutrient content estimated using standard analytical procedures

Critical levels of nutrients in plants

- Critical levels in plants indicate the concentration of a nutrient in plant tissue below which deficiency symptoms appear and with yield reduction
- Plant critical level s are governed by soil type, pH, organic matter content, and crop
- Leaf analysis is often used to assess plant nutrient status which vary with nutrient and crop
- Critical levels in plants help diagnose nutrient deficiencies and optimize fertilizer recommendations and efficient fertilizer use
- Soil and plant critical levels are related because plant uptake of nutrients from the soil determines the nutrient concentration within the plant.
- Soil testing and plant tissue analysis are complementary tools used to assess nutrient status and guide fertilizer management.

Determining Critical Levels:

- Critical levels are often determined through field experiments where crop yield is measured at different nutrient levels.
- Statistical methods, such as the Cate-Nelson approach, are used to determine the critical nutrient concentration associated with a specific yield level (e.g., 90% of maximum yield).
- Various software and algorithms, can be used to fit regression equations to the data and determine critical levels and sufficiency ranges of various nutrients
- The Critical Nutrient Concentration (CNC) is the level of the nutrient below which crop yield, quality and performance is unsatisfactory.
- A more realistic approach is to use the concept of critical nutrient range (CNR) which is the range of nutrient concentration at a specified growth stage above which the crop is amply supplied and below which the crop is deficient.
- CNR values have been developed for most of the essential elements for many crops.
- Combination of soil test data and leaf nutrient levels can be used to arrive at a more realistic fertilizer recommendation for crops.

Crop	Leaf Sampling Protocol Index plant part	Stage of sampling
Rice	3rd leaf from apex	Tillering stage
Pulses	Recently matured leaf	Bloom initiation
Groundnut	Recently matured leaflet	Maximum tillering
Cassava	Youngest fully expanded leaf (YFEL) petiole or leaf lade	3-4 months of growth
Sugarcane	3rd leaf from top	3-5 months after planting
Mango	Leaf + petiole	4-7 months old leaves from middle of shoot
Coconut	Pinnate leaf let from each side of 14th leaf	
Coffee	3rd leaf from the tip of growing shoot	
Pepper	Youngest mature leaf from fruiting lateral all round the pepper wine	
cardamom	Youngest mature leaf 5th pair from tillers	Panicle initiation stage
Cocoa	3rd leaf from apex	Bloom initiation
Cashew	4th lead from tip of matured branches	Beginning of flowering
Hibiscus/Ornamentals	Most recent, fully matured leaf	

Other soil fertility evaluation methods

Nutrient deficiency symptoms

- Visual nutrient deficiency symptoms can be a very powerful diagnostic tool for evaluating nutrient status of plants
- A given individual visual symptom is seldom sufficient to make a definite diagnosis of a plant’s nutrient status.
- Classic deficiency symptoms such as tip burn, chlorosis and necrosis are characteristically associated with more than one mineral deficiency and also with other stresses
- Nutrient deficiencies can substantially reduce production without showing any clear symptoms. and is referred to as hidden hunger
- The deficiency has a negative effect without being recognized,
- The principal advantages of visual diagnostic symptoms are that they are readily obtained
- Main drawbacks are that the visual symptoms do not develop until after there has been a major effect on yield, growth and development
- Symptoms may be complicated or suppressed by other factors, such as salinity and non-uniformity of nutrients, weather conditions and pests or disease organisms

Approximate concentration of nutrients in mature leaf tissues of crop plants

Nutrient	Deficient	Sufficient or normal	Average Conc. in plant tissues	Toxicity level
N (%)	-	1-5	1.5	
P (%)	-	0.1-0.4	0.2	-
K (%)	-	1-5	1.0	-
Ca (%)	-	0.2-1	0.5	-
Mg (%)	-	0.1-0.4	0.2	-
S (%)	-	0.1-0.4	0.1	-
Fe(mg/kg)	<50	100-500	100	>500
Mn(mg/kg)	15-25	20-300	20	-
Zn(mg/kg)	10-20	27-150	20	100-400
Cu(mg/kg)	2-5	5-30	6.0	100-200
B(mg/kg)	5-30	10-20	20	50-200
Mo(mg/kg)	0.03-0.15	0.1-2.0	0.1	>100
Cl(mg/kg)	<100	100-500	100	500-1000
Ni(mg/kg)	<0.1	-	0.1	

Diagnosis and Recommendation Integrated System (DRIS)

What is DRIS?

- DRIS is a statistical approach that uses nutrient ratios in plant tissue to diagnose nutrient problems.
- It was developed by Beaufils in the 1970s.
- Instead of focusing on critical nutrient concentrations, DRIS compares the ratios of different nutrients to established norms for high-yielding crops.
- This helps to identify nutrient imbalances and deficiencies that may be limiting crop growth.

How does DRIS work?

- DRIS calculates nutrient ratios (e.g., N/P, N/K, P/K) from plant tissue samples.
- These ratios are then compared to established DRIS norms for high-yielding c:
- DRIS calculates index values for each nutrient, which indicate whether a nutrient is deficient, optimal, or excessive.
- Based on these index values, DRIS identifies the most limiting nutrient or nutrients in the plant

Advantages of DRIS:

- Can identify nutrient imbalances and deficiencies earlier than traditional methods.
- It considers the interactions between nutrients, rather than just individual nutrient concentrations.
- Less affected by variations in plant tissue age compared to traditional methods, allowing for a wider range of tissues to be sampled.
- By identifying the most limiting nutrients, can help to optimize fertilizer applications and improve crop yields.
- Offers a more precise and comprehensive approach to diagnosing nutrient problems compared to traditional methods, leading to more effective fertilizer recommendations and improved crop production.

References

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Thank You