LECTURE 15

FERTILITY EVALUATION BY PLANT ANALYSIS

Plant analysis is a useful diagnostic tool to ascertain if a nutrient has been or is being assimilated. Plant analysis is also important in ascertaining the nutrient requirements and nutrient status of plants during various stages of growth.

A reasonably simple laboratory test of plant sample provides a measure of nutrient availability in soil or nutrient status of plant at the time the sample was collected. If these tests are to be useful in making fertilizer recommendations, a coordinated laboratory-field research program must be conducted in order to obtain the desired information.

Deficiency symptoms

Careful inspection of growing seedling or plants can help identify specific nutrient stress. If a plant is lacking in a particular nutrient, characteristic symptoms may appear. Nutrient deficiency symptoms must be related to some function of the nutrient in the plant. Visual symptoms may be caused by more than one nutrient. In a set of nutrient omission and addition pot experiments, exact limiting nutrients can be identified.

Tissue tests

The concentration of the nutrients in the cell sap is usually a good indication of how well the plant is supplied at the time of testing. These semi-quantitative tests are intended mainly for verifying or predicting deficiencies of N, P, K, S and several micronutrients.

Method: the plant parts may be chopped up and extracted with reagents. The intensity of color developed is compared with standards and used as a measure of nutrient concentration. Tissue tests are quick, easy to conduct and interpret.

For tissue tests, the time of sampling and plant part to be sampled have already been standardized for many crops. Tissue test can be done 5-6 times in a season and concentration can be monitored in the *farm premises*.

There can be two peak periods of nutrient demand, one during maximum vegetative growth and second during reproductive stage. Fertilization can be done to maintain the peak concentration at critical stages.

Total plant analysis

As in tissue tests, a standardized method for time and method of sampling of plant part are available for total analysis, which is done at *laboratory*. The critical nutrient concentration is commonly used in interpreting plant analysis results and diagnosing nutritional problems.

Diagnosis and Recommendatio ***System (DRIS)***

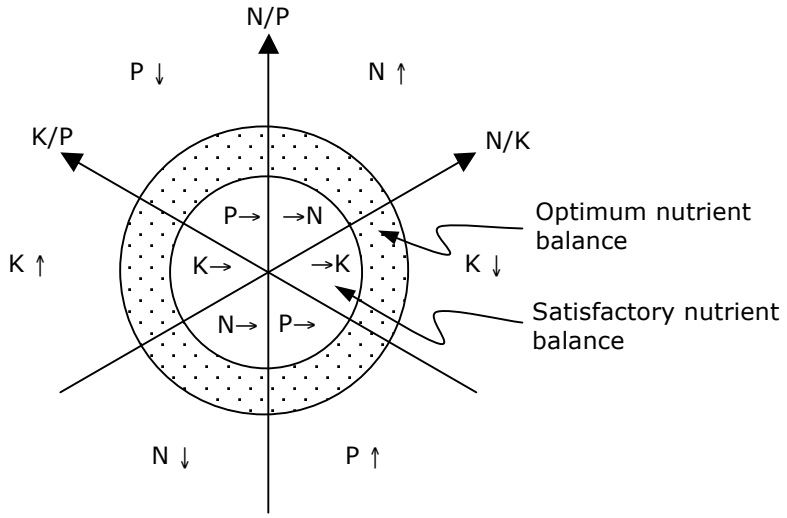
DRIS is a system that identifies all the nutritional factors limiting crop production. Index values measure how far particular nutrients in the leaf or plant are from optimum levels. Index values are used in the calibration to classify yield factors in the order of limiting importance. To develop a DRIS for a given crop, the following criteria are to be well considered.

- All factors having effect on yield
- Relationship among factors
- Calibration norms
- Continually refined recommendations

DRIS was developed based on **nutrient ratios**. When compared to concentration that normally varies with season, nutrient ratio does not vary much. When a nutrient ratio has an optimal value, optimum yield occurs unless some other limiting factor reduces the yield.

$\frac{N \rightarrow}{P \rightarrow}$	$\frac{N \uparrow}{P \uparrow}$	$\frac{N \downarrow}{P \downarrow}$
Both numerator and denominator optimal	Both numerator and denominator excessive	Both numerator and denominator insufficient

When the ratio is too low a response in the numerator will be obtained if it is limiting. If the nutrient in the denominator is excessive, a yield response may or may not occur depending on the level of other yield factors.



General diagram for a DRIS; constructed on nutrient ratios for N-P-K

When the ratio is too high the reverse it true. Usually N/S, K/Mg, K/Ca, Ca + Mg /K, N/P ratios are commonly used. Initially relationship among N-P-K is calibrated.

Thus, DRIS has several advantages to integrate much nutrient concentration at various stages, in different seasons suitable for many cultivars of a crop.

DRIS has been found suitable for several grain crops and perennial fruit trees.

CROP LOGGING

An excellent example of the use of plant analysis in crop production is the crop logging carried out for sugarcane in Hawaii. The crop log, which is a graphic record of the progress of the crop, contains a series of chemical

and physical measurements. Critical nutrient concentration approach is used in the crop log system.

In sugarcane, plant is sampled at 35 days and analyzed for N, sugar, moisture and weight of young sheath tissue. Nutrients like P and K are monitored at critical stages. Based on moisture, irrigation is scheduled. Based on nutrient content, fertilizer application is done. By this record keeping, the productivity of crop is increased.

BIOLOGICAL TESTS

Simpler and rapid laboratory/ green house techniques utilize small quantity of soil to quantify nutrient supplying power of a soil.

Tests using higher plants:

Neubauer seedling method: **The neubauer technique is based on the uptake of nutrients by a large number of plants grown on a small amount soil. The roots thoroughly penetrate the soil, exhausting available nutrient supply within a short time. Usually 100 seedlings of rye or oats made to feed 100 g soil mixed with 50 g sand. Blar** 23 (15/16) **is also run. Total P_2O_5 and K_2O uptake is calculated and blank value is detected to get root soluble P_2O_5 and K_2O. Values designated as Neubauer Nos. (mg/ 100 g soil) are used to determine the deficiency. These tables give the maximum values of available macro and micronutrients for satisfactory yields of various crops.**

Standard and Demont technique: **It is a modified neubauer technique. Round cardboard cartons with bottom removed are nested in a container and filled with sand. Seeds are sown. After 2-3 weeks of growth, a carton containing the plants is nested in a second carton holding 200 g soil or soil + fertilizer. When the mat of roots meets soil, it is allowed to feed for 3-4 days. Then nutrient uptake is estimated.**

Deficiency test of sunflower for Boron

Sunflower is grown in the test soil supplied with nutrient solution with all essential nutrients excepting boron. From the day of appearance of B deficiency symptoms of leaves, the soil is identified as deficient (<28 days), moderately deficient (28-36 days), and not deficient (>36 days).

Microbiological methods:

In the absence of nutrients, certain microorganisms exhibit behavior similar to that of higher plants. For example, growth of *Azotobacter* or *Aspergillus niger* reflects nutrient deficiency in the soil. The soil is grouped from very deficient to not deficient in the respective elements, depending on the amount of colony growth. In comparison with methods that utilize growing of higher plants, microbiological methods are rapid, simple and require little space.

Sacket and Stewart technique

For identifying P and K deficiency test soil is divided in to 4 portions. Solution containing soluble P, K, and P+K are added in 3 portions and one portion was allowed as check. They are inoculated with Azotobacter and incubated for 72 hrs. Based on colony growth deficiency is identified.

Melich Cunninghamella – plaque test:

Cunninghamella is sensitive for P. Test soil is mixed with nutrient solution and a paste is prepared. The paste is spread on a clay dish. *Cunninghamella* is inoculated at the centre and incubated for 5-6 days. Based on the diameter of mycelial growth, the soil is diagnosed as deficient (<10 cm), moderately deficient (11-21 cm), or not deficient (>22 cm).

Mulder *Aspergillus niger* test for Cu and Mg

Colours of mycelial and spores are used to delineate the deficiency of Cu and Mg. This method is used for Mo, Co, Mn, S, Zn also.