Soil fertility Evaluation: - Approaches – Nutrient deficiency symptoms. Soil testing – Objectives of soil testing –

Literally the word fertile means 'bearing abundantly' and a fertile soil is considered to be one that produces abundant crops under suitable environmental conditions.

Soil fertility: is concerned with the inherent capacity of soil to provide nutrients in adequate amounts and in proper balance for the growth of specified plants when other factors such as light, moisture, temperature and the physical condition of the soil are favourable. Soil fertility is an aspect of the soil plant relationship viz., plant growth with reference to plant nutrients available in soil.

Justus Von Liebig 1840 propounded the 'law of Restitution' which states that in order to maintain soil fertility nutrients removed from the soil by crops must be restored by the application of manures and fertilizers.

The assessment of nutrient supplying capacity of the soil is soil fertility evaluation. It necessitates understanding of certain major concepts having definite bearing on soil fertility.

The law of minimum was put forward by Von Liebig which envisages that if a soil contains optimum / adequate amounts of all but one nutrient element, crop growth is regulated by that single nutrient.

Approaches for soil fertility evaluation: The wide variety of diagnostic techniques used so far can be broadly grouped into

1) Soil Analysis
2) Plant Analysis
3) Biological methods.
4) Visual symptoms of nutrient deficiency or toxicity.

Soil testing and plant analysis are useful tools for making recommendations for application of fertilizers to crops. Soil testing gives a measure of the availability of nutrients to crops, plant

analysis indicates the actual removal of the nutrients from the soil.

Objectives of soil testing

1. Grouping soils into classes relative to the levels of nutrients for suggesting fertilizer practices.
2. Predicting the probability of getting profitable responses.
3. Helping to evaluate soil productivity.
4. Determining specific soil conditions like alkali, salinity and acidity which limits crop yields.

Available nutrients: Plants draw their nutrients from air, water and soil. The bulk of mineral nutrients come from soil. Soil available form of nutrient is that fraction which is distributed in different discrete chemical forms, which often exist in a state of dynamic equilibrium and constitute the pool from which plants draw it. Soil available form of a nutrient is also that fraction whose variation in amount is responsible for significant changes in yield and responses. The nutrient available to biological organisms is termed as bioavailable nutrient.

Chemical methods for estimating nutrients

Soil testing includes measurement of available N, P, K, S, micronutrient, lime and gypsum requirement, besides measuring pH, EC and calcium carbonate, texture by Bouyoucos hydrometer method.

The different extractants for the available nutrients

Nutrient	Extractant
Available P	0.5 M $NaHCO_3$, pH 8.5 Olsen's extractant
	0.03 N NH_4F + 0.025 NHCl Bray's No.1 extratant
Available K	Neutral normal ammonium acetate
Available S	0.15 % $CaCl_2$

Available Zn, Fe, Cu, Mn	0.005 M DTPA, pH 7.3 Diethylene Triamine penta Acetate
Gypsum requirement	Schoonover method
Lime requirement	Shoemaker et al.

Rating limits of soil test values

Nutrient	Low	Medium	High
Organic carbon (%)	Below 0.5	0.5 – 0.75	Above 0.75
Avail. N (kg ha^{-1})	Below 280	280 – 560	Above 560
Avail. P (kg ha^{-1})	Below 10	10 – 24.6	Above 24.6
Avail. K (kg ha^{-1})	Below 108	108 – 280	Above 280

Avail. S (ppm)	Deficient < 10 ppm	Sufficient > 10 ppm
DTPA Zn	Deficient < 0.6 ppm	Sufficient > 0.6 ppm

Visual symptoms of nutrient deficiency or toxicity

Chemical analysis of plants may indicate the presence of more than 90 elements but 16 of them have been established to be essential for their successful growth and development; as per the criteria of essentiality. A constant balanced supply of these nutrients is essential for normal plant growth. Any imbalance among them leads to the emergence of nutritional disorders owing to their deficiencies or toxicities when an essential nutrient is in extremely short / excess supply, the plant suffers from its deficiency which is manifested in the form of specific sign termed as deficiency / toxicity symptom of the nutrient.

Visual deficiency symptoms are generally characteristic enough to permit easy

identification of the deficiency of a nutrient as these appear on particular plant part at specific growth stage. The mobility of nutrients with in a plant differs markedly. Nutrients like N, P and K are readily translocated from old to young leaves under stress condition and are termed as mobile nutrients within the plant and they show up their deficiencies initially on the old leaves. The nutrients such as calcium, sulphur, boron and iron which are not retranslocated are called immobile nutrients and their deficiency symptoms first appear on young leaves. Mobility of other nutrients is intermediate.

Eg: Shortening of internodes due to Zn deficiency results primarily from impaired auxin metabolism.

The visual identification of nutrient deficiencies or toxicities is considered as a simple and inexpensive diagnostic tool in plant nutrition as it does not involve the use of any analytical equipment.

Limitations

Confident diagnosis by this approach requires much experience as the symptoms of some nutrient deficiencies are difficult to differentiate.

By the time the deficiency / toxicity symptoms appear, the crop has undergone marked set back and the ameliorative measures taken at that time may not produce optimum yields. The appearance of deficiency symptoms is an extreme limit of nutrient deficiency but even if the symptoms are not manifest, reduction in the yield of crop may occur. This condition has been termed as hidden hunger.

Plant analysis – Rapid tissue tests – DRIS – Indicator plants Plant analysis

Although plant analysis is an indirect evaluation of soil, it is a valuable supplement to soil testing. Plant analysis is useful in confirming nutrient deficiencies, toxicities or imbalances, identifying hidden hunger, evaluating fertiliser programme and determining the availability of elements. Sometimes adequate nutrients may be present in the soil, but because of other problems like soil moisture and inadequate amounts of some other nutrients, the plant availability of the nutrient in question may be constrained.

Plant analysis is based on the fact that the amount of a given element in plant is an

identification of the supply of that particular nutrient and as such is directly related to the quantity in the soil.

For most diagnostic purposes, plant analyses are interpreted on the basis of critical value approach, which uses tissue nutrient concentration calibrated to coincide 90% or 95% of the maximum yield, below which the plants are considered to be deficient and above that value sufficient.

Two general types of plant analysis are in use.

1. The tissue test which is customarily made on fresh tissue in the field.
2. Total analysis performed in the laboratory with precise analytical techniques.

A. **Tissue Tests**:

Rapid tests for the determination of nutrient elements in the plant sap of fresh tissue. In these tests, the sap from ruptured cells is tested for unassimilated nitrogen, phosphorus and potassium. They are semi quantitative tests mainly intended for verifying or predicting deficiencies of N, P or K. The results are read as low, medium or high. Through the proper application of tissue testing it is possible to anticipate or forecast certain production problems which still in the field. The concentration of the nutrients in the cell sap is usually a good indication of how well the plant is supplied with nutrients at the time of testing.

(1) **Plant Part to be Selected**: In general the conductive tissue of the latest mature leaf is used for testing.

(2) **Time of Testing**: The most critical stage of growth for tissue testing is at the time of bloom or from bloom to early fruiting stage. Nitrates are usually higher in the morning than in the afternoon if the supply is short.

Test for nitrates	€	Diphenylamine
Phosphates	€	Molybdate + Stannous oxalate test
For potassium	€	Sodium cobalti nitrate

B. Total Analysis:

Total analysis is performed on the whole plant / plant parts**.** Precise analytical techniques are used for measurement of the various elements after the plant material is dried, ground and ashed and used for estimating total nutrient content.

Relative and Average Plant Nutrient Concentrations

Plant Nutrient	Average Concentration*
H	6.0%
O	45.0%
C	45.0%
N	1.5%
K	1.0%
Ca	0.5%
Mg	0.2%
P	0.1%
S	0.1%
Cl	100 ppm (0.01%)
Fe	100 ppm
B	20 ppm
Mn	50 ppm
Zn	20 ppm
Cu	6 ppm
Mo	0.1 ppm

*** Concentration expressed by weight on a dry matter basis.**