Dept. of Soil Science and Agril. Chemistry

Course SS-523

Advances in Soil Fertility

TOPIC:

Evaluation of Soil Fertility

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Soil Fertility Evaluation

The estimation nutrient supplying power for plant growth is known as Evaluation of Soil fertility. The soil fertility evaluation refers to the estimation of nutrient supplying power of the soil for crop production. When the soil doesn't supply requires quantity of nutrients for optimum productivity, crop yields suffer resulting in low production. The proper rate of plant nutrients needed for optimum productivity is determined by knowing the nutrient requirement of the crop and nutrient supplying power of the soil.

1. Nutrient deficiency symptoms

2. Leaf spray, painting and trunk injection techniques

3. Plant analysis

    a, Total plant analysis

    b, Plant part analysis

    c, Plant tissue test

    d, Cell sap test

4. Biological test

5. Soil Test

1. **Nutrient deficiency Symptoms** – Plants exhibit characteristics symptoms when one or more nutrient elements are not available in sufficient quantities for their growth. By careful examination of these symptom the deficient nutrient/s in the soil can be identified. However, it requires learning to identify nutrient deficiency. In applying this technique, one must develop diagnostic proficiency through practice and close observation. It may be pointed out that deficiency symptoms in many cases are not always clearly defined an in some cases, the symptoms can be common to other causes or may be masked by other nutrients. Nutrients-deficiency symptoms may be classified as follows:

    A, Complete crop failure at the seedling stage.

    B, Severe stunting of plants.

    C, Specific leaf symptoms appearing at varying times during the season.

        -Yellowing of leaf.

        - Mossaic pattern

        -Chlorosis

        -Coloration

        -Die back , etc.

    D, internal abnormalities such as clogged conductive tissues.

    E, Delayed or abnormal maturity.

    F, Obvious yield differences, with or without leaf symptoms.

G, Poor quality of crops, including differences in protein, oil, or starch content and storage quality.

ADVANTAGES-

1. This method is fast and does not require any apparatus
2. Useful for orchards because we can't test the all sorts of root zone.
3. Also useful where we are introducing new farming techniques.
4. Very economic.

DISADVANTAGES-

A. The visual symptom may be caused by more than one nutrient. For example, N-deficiency symptoms may be identified, although S may also be accompanied by a red coloration of the leaves near the growing point when the plant is well supplied with K. on the other hand, when the K content is low, yellowing of alfalfa leaves occurs.
B. Deficiencies are actually relative and a deficiency of one nutrient may be related to an excessive quantity of another. For example, Mn deficiency may be induced by adding large quantities of Fe, provided that soil Mn is marginally deficient. Also, at a low level of P supply, the plant may not require as much N compared to normal or adequate P. In other words, once the first limiting factor is eliminated, the second limiting factor will appear (Liebig's law of the minimum).
C. It is often difficult to distinguish among the deficiency symptoms in the field, as disease or insect damage can resemble certain micronutrient deficiencies. For example, leaf hopper damage can be confused with B deficiency in alfalfa.
D. A visual symptom may be caused by more than one factor. For example, sugars in corn combine with flavones to form anthocyanins (purple, red and yellow pigments) and their accumulation may be caused by an insufficient supply of P, low soil temperature, insect damage to the roots, or N deficiency.

Nutrient-deficiency symptoms appear only after the nutrient supply is so low that the plant can no longer function properly. In such cases, it would have been profitable to have applied fertilizer long before the symptoms appeared. If the symptom is observed early, it might be corrected during the growing season. Since the objective is to get limiting nutrient into the plant as quickly as possible, with some nutrients and under some conditions this may be accomplished with foliar applications or side dressings. Usually, the yield is reduced below the quantity that would have been obtained if adequate nutrients had been available at the beginning. However, if the problem is properly diagnosed, the deficiency can be corrected the following year.

E. Hidden hunger refers to a situation in which a crop needs more of a given nutrient yet has shown no deficiency symptoms. The nutrient content is above the deficiency symptom zone but still considerably below that needed for optimum crop production. With most nutrients on most crops, significant responses can be obtained even though no recognizable symptoms have appeared.

The question, then is, how best to eliminate hidden hunger. Testing of plants and soils is helpful for planning or modifying plant-nutrient programs to avoid this problem in subsequent crops. In both approaches, careful consideration must be given to past management practices.

F. **Seasonal Effects**- Nutrient shortages in the soil may be caused by abnormal weather conditions. Nutrients may be present in sufficient quantities when conditions are ideal.

G. **Late Symptoms**- After observing the symptoms crop has been lost set is difficult to support crop particularly in short duration crop.

H. It is qualitative test not quantitative and amount of nutrient to be applied could not be observed.

2. **Leaf Spray, Painting and Truck Injection Technique** – This method is used for forestry and orchard (very tall plants). To confirm of nutrient deficiency we list some elements which could be deficient and spray all the elements separately in separate leaf and see by which element the deficiency in was recovered.

PAINTING- Half of the deficient leaf paint with certain concentration and after sometime check by which element concentration recovered.

TRUNK INJECTION TECHNIQUE- This method may be adopted at places where deficiency symptoms is to be diagnosed in very tall plants where leaf were not reachable. Certain concentration of carbon element which could be deficient should directly inject in the trunk of the tree and observed after some time.

3. **Plant Analysis**-

a, **Plant Tissue Tests**- The nutrients absorbed by plant roots and later they are transported to other parts of the plant body where they are needed. In these tests the sap from ruptured cells of tissues is tested for un assimilated N, P, K, Mg, Mn, etc, which gives an indication of how well the plant is indicate the range of supply and can be read as very low, medium or high.

The nutrient composition varies from part to part of the plant, from one growth stage and also from one time to another time of the day when sampling is done. Thus it is essential to take the sample in view of these points.

b, **Part of the plants to be tested**- To get correct nutritional status of the growing plants it is essential to test that part which can give right indication. It has been observed that the blooming or the period between bloom and early setting is the most critical stage for tissue testing because during this early period the utilization of the nutrients is at its peak and low level of nutrient supply can be easily detected. In corn the tests made at this stage of crop can not help in correction of the nutrient deficiency.

The samples must be collected from 10-15 places and average values should be considered. It is also advisable that the tests should neither be made so early in the morning nor so late in the evening because nitrate content is usually higher at both the times. The uptake of all the essential elements is not always at a constant rate which results into concentration or dilution according to plant growth and nutrient absorption pattern. Thus plant tissue tests are no more a scientific and real assessment of soil fertility status.

c, **Total Plant Analysis**- The plant part selected for analysis is of greater importance and recently matured material is being preferred. It has been suggested that in some cases the difference in K content between lower and upper leaves is lesser than for detecting the deficiency *viz*, if the K content of lower leaves is lesser than that of upper leaves the plant is deficient in K. But if the K content of the lower leaves is equal or greater than that of upper eaves, the plant is not deficient. The tissue tests or quick tests are carried out on green plant tissues and are used less and

less in the recent part. The visual symptomology of mineral deficiencies made the tissue test unnecessary to confirm the diagnosis.

Moreover hidden hunger can be recognised by total plant analysis than quick tests. Further, availability of quick and accurate analytical instruments like atomic absorption, flame photometer, spectrograph, etc. has made it more practical, quick and economical to make a complete plant analysis than laboratory techniques.

4. **Biological Tests**-

Biological Method of Soil Fertility Evaluation

Besides plant analysis there are some biological tests also which may be used to evaluate soil fertility:

1. **The Mitscherlich pot-culture method**- In this method pots containg 2.72 kg soil taken for growing oats as test crop. N, P and K are added in different combinations in these pots (N_0 one pot, P_0 three pots, K_0 three pots and NPK three pots). The crop is grown till maturity and percentage increase in yield is calculated by using Mitscherlich tables from addition of given quantity of fertilizers over native fertility status (control).

2. **The Jenny's pot-culture test**- Smallller pots containing 1.81 kg soils are used for growing romaine lettuce (*Lactuca sativa longifolia*) as test crop for 6 weeks. Following treatments are used in four replications:

Control ..... $N_0 P_0 K_0$

Full fertilizer ..... $N_{150} P_{150} K_{100}$

No nitrogen ..... $N_0 P_{150} K_{100}$

No phosphorus ..... $N_{150} P_0 K_{100}$

No potash ..... $N_{150} P_{150} K_0$

3. **The Neubauer seedling method**- Rye or oats are taken as test crop to feed exhaustively on 100g of soil mixed with 50g of sand which is filled in dishes of 11cm diameter and 7cm depth. 100 healthy seedlings are taken and grown for 17 days and compared with blank having no soil. The total P_2O_5 and K_2O uptake is calculated and the blank value is deducted to obtain the 'root soluble' P_2O_5 and K_2O in 100g of air dry soil. The values are represented as Neubauer numbers which are expressed as mg/100 g of dry soil having certain limits to determine the deficiency.

4. **The Stanford and DeMent technique**- This is similar to Neubauer technique with certain modifications to determine all those nutrients studied by Neubauer technique. In this case round waxed cardboard cartons of about 100g capacity with bottom removes which are nested in similar containers having intact bottom filled with 680g of sand. The seeds of the test crop are shown about 1.25cm deep. After growing the seedlings for 2-3 weeks a carton containing the plants are nested I second carton holding 200g of soil or soil mixed with fertilizers. The plant roots enter the second carton where these plants are allowed to feed for 3-5 days. Four plants of maize and 30 plants of wheat and oats are maintained for studies. After 5 days the plant samples are taken to determine the nutrient status in them.

5. **Sunflower pot-culture technique for Boron**- The technique was adopted by Ghose *et al.,* for determining B deficiency in Delhi soils. In this method 500g of soil is taken in small pot and 5

sunflower seedlings are allowed to grow. The soil is fertilised with a solution containing all the nutrients except B and deficiency is notices and ranked.

6. **Sackett and Stewarts technique**- This technique is used to find out P_2O_5 and K_2O status in the soil judged by the coloration of Azotobacter in culture prepared from soil. Three containers having soil culture are used of which one portion is supplied with P_2O_5 another with K_2O and rest with both of P_2O_5 and K_2O. these cultures are now inoculated with Azotobacter and incubated for 72 hours for the growth of colony which may be classified as under:

Class I- **Very deficient**- None or few extremely small pin-head sized colonies on the unfertilized plaque.

Class II- **Moderately deficient**- Few to numerous but small and weak colonies with little or no pigment on the unfertilized plaque.

Class III- **Slightly deficient**- The colonies on unfertilized plaques are equal in number and development.

Class IV- **Not deficient**- Colonies on both fertilized and unfertilized plaques are equal in number and development.

Thus a qualitative assessment can be made from the growth and development of the Azotobacter colonies.

7. **Mehlich technique for available K_2O**- This method is adopted to determine available K_2O content in the soil. A small amount of soil is taken in conical flasks in which appropriate nutrient solution is added and then it is inoculated with *Aspergillus niger* and incubated for 4 days. Weight of mycelial pad and it K_2O content are taken into account for determination.

8. **Mehlich's Cunninghamella-plaque method for phosphorus determination**- This test is adopted to determine P_2O_5 deficiency in the media in which Cunninghamella is grown which is very sensitive to P_2O_5 status. The soil (to be tested) is mixed with nutrient solution and paste is prepared which is spread in clay dish. Now it is inoculated on the surface (in the centre) with Cunninghamella and allowed to incubate for 4-5 days. After incubation the diameter of mycelial growth is measured to find out P deficiency range.

9. **Mulder's *Aspergillus Niger* test for Cu and Mg**- In this method the color of the mycelia and spores give an indication of either deficiency or enough quantity of both Cu and Mg. Known standards are prepared in weighed quantity of soil to compare the color of mycelia and spores with those growing on unknown soils.

The method may be used for determining Mo, Co, Mn, S and Zn contents in the soil.

Use of Indicator plants-

Certain plants are very similar to deficiency of specific plant nutrient and they produce special symptoms which are different from other deficiency symptoms. These symptoms give a definite clue for deficiency of that element. Thus the deficiency of that element can be easily be detected.