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What Next in Soil Science

by T. RAJAGOPALA IYENGAR & P. K. R. MENON,
Agricultural Research Institute, Coimbatore.

Introduction: Soil is the basis of all agriculture. Although it has been shown that vegetables and some other crops can be grown in water cultures it is on the soil that agriculture all over the world depends. Soil not only gives support to the plants and trees growing on it, but it is from the soil that plants take the major part of the nutrients and water required for their growth and reproduction. It is on the produce of plants that men and animals live. Soil is therefore very important and has been studied from time immemorial in order to increase and maintain its productivity.

During the last decade soil science has made tremendous progress in every aspect, physical, chemical and biological, as compared with previous periods. In some cases the change has been almost revolutionary.

According to the modern concept of soil science the colloidal complex is the seat of most of the changes taking place in the soil and is therefore of paramount importance. Emphasis is also laid on the role of biological agencies in the soil. In fact the study of soil science to-day calls for a colloidal-biological approach to the manifold problems confronting the soil scientist. The plants and the colloidal complex in a soil are so intimately connected that they form a part of the soil system. For a proper understanding of this complicated system intensive research has to be carried out in regard to the various components of the soil mineral matter, the process of humus formation and the change it undergoes and the nature and activity of the macro and micro-organisms, with their enzymic inter-relations. All these aspects still remain to be fully understood for arriving at reliable conclusions on soil fertility and crop production.

Factors Influencing the Growth of Higher Plants: The growth and development of plants, as is well known, are dependent on various factors, internal and external. The external factors which are of importance are (1) light; (2) mechanical support; (3) heat;

(4) water; (5) air and (6) nutrients. Except in the case of light, soil is the medium for the supply of these factors for plant growth. The interaction of these factors and their resultant effect on crop growth are still not clear. The problem of balanced manuring for efficient crop production with reference to different soil types, climatic conditions and water resources has to be studied further. We know certain elements must be present in a soil in available form for the plant. Apart from their presence their concentrations in relation to each other must be adjusted properly for ensuring good and healthy crops free from diseases. Physiological balance is one of the important objectives of sound fertilizer practice. Knowledge of this aspect is at present scanty and much work has to be done in this direction. The mechanisum of the release of plant nutrients from soil particles to plants and the relationship between micro-organisms and plants have to be studied further in detail. With regard to plant nutrients the following four factors have to be examined. (1) the quantities of the various primary and minor elements required for maximum crop production, (2) the forms in which they are present in the soil (3) the extent of their availability and (4) pH and soil solution.

A few of the important aspects on which soil research is to be directed and the problems of practical importance to agriculture that have to be tackled on the basis of theoretical knowledge gained so far, are dealt with briefly in the present paper. The study of many of the intricate problems of soil science has become possible on account of the development in recent years of refined methods of attack such as spectrography, X-ray analysis, tracer technique involving the use of radioactive isotopes of manurial elements etc. Chromatography is also being pressed into service in soil analysis.

Soil Colloids and Plant Nutrition: Clays and with them soils, differ widely in their cation exchange capacities. Montmorillonite - Kaolinite, illite - and hydrous oxides groups are the four broad classes in naturally occurring clay. The cation exchange capacity for unit weight of these groups decreases in the order stated. The colloidal complex governs such important factors at soil pH, degree of ionic saturation, ratio of cations, influence of these on the activity of absorbed ions and the effect of these on the metabolic activity of the plant. The colloidal complex brings about a selective absorption of nutrients supplied and partly influences the reaction of the soil.

Plants vary widely in their capacity for producing plant material consequent on the intake of unit doses of nutrients. The amount of dry matter produced by absorption of 318 lb. of N (maximum amount usually taken from 1 acre of soil) is found to be 6 tons for soyabean forage, 13 for corn and 56 for sugarcane. Research on this aspect of production of different amounts of plant material by different plants for unit nutrient doses should yield profitable results.

Micro-Organisms and Soil Fertility: The soil is teeming with life. The innumerable number of different forms of micro-organisms in the soil contribute not a little towards soil fertility. Any condition that adversely effects their growth and activities is bound to bring about undesirable changes in the soil. Again, it is not all organisms that are favourable for plant life. Some are definitely harmful causing diseases to crops. Knowledge of these organisms and their control by proper soil management deserves attention. A few other organisms, while not causing disease, may affect crop growth by competing with plants for availabe plant food.

In addition to the competition for food there is another type of microbial rivalry. Thus certain bacteria, fungi, actinomycetes have the power to produce substances that will inhibit or kill other microbes. The ability of certain micro-organisms to produce antibiotics has brought about revolutionary changes in the treatment of many serious human and animal diseases. Several preparations containing specific ingredients such as penicillin, streptomycin, aureomycin, are now available to cure diseases. Although the soil harbours many disease-producing organisms it is also a source of life-saving drugs.

The activity of microorganisms sometimes help each other. Certain groups of organisms produce metabolic products which serve as a source of food to others. As a striking example of this is the release of ammonia by certain bacteria. This is a source of food and energy to nitrifying bacteria. The series of inorganic transformations taking place in the soil such as ammonification, nitrification, production of sulphate etc., are so complicated that they are still not fully understood. The chemistry of humus formation and compost preparation is also exceedingly difficult to explain. Problems relating to the mechanism of nitrogen fixation by symbiotic and non-symbiotic nitrogen-fixing organisms in the soil are also not fully understood, but great benefit can accrue if the

symbiotic and non-symbiotic nitrogen fixing bacteria are efficiently utilized. The significance of carbon-nitrogen ratios and their bearing on soil fertility has to be studied in detail with reference to crop growth, climate and rainfall. In the biological field, we have little information about the nature and extent of the different forms of micro-organism and their role individually and cumulatively on the numerous physical, chemical and other changes taking place in the soil. Methods for the satisfactory classification of the soil micro-organisms into distinct groups based on their nutritional and other requirements and in relation to their importance in the maintenance of soil fertility have to be worked out.

Plant Nutrients and their Availability in Soils: Among the primary plant nutrients, nitrogen, phosphorus, potassium, phosphorus is by far the most difficult to deal with. The inefficient utilization of phosphorus by plants has long been known, especially in laterite and lateritic soils. The experimental use of radio-active phosphorus has recently emphasized the point even more thoroughly. By adding fertilizers containing tracer phosphorus it is possible to determine the proportion of applied phosphates absorbed during the year of application. This technique will have to be applied to ascertain the fate of phosphates added to the soil and to follow the changes taking place in the phosphorus absorbed by the plant.

Potassium is present in most of the soils of the State in adequate amounts, except in the soils of the West Coast and the Hills, but most of the crops grown in the State do not respond to potash fertilization.

The soils of the State are generally deficient in nitrogen and methods of increasing the content of the soils with regard to this nutrient must be explored.

The placement of phosphatic and nitrogenous manures should be studied to obtain the maximum return from the nutrients. A proper balance of the three essential plant food materials nitrogen, phosphorus and potassium has to be worked out for different crops in the various soil-climatic zones of the State.

Trace Elements: Numerous trace elements in minute amounts have been found to be essentiol for optimum plant growth. Of these, the more important are iron, manganese, copper, zinc, boron and molybdenum. Except for iron, trace elements are found sparingly

in most soils. Every year the crop removes small quantities of this natural reserve and crop production over a long period depletes the soil to such an extent that many areas in the world suffer from trace element deficiency. The roles specific of trace elements in plant nutrition and our knowledge on these with reference to our soils and crops is very little.

Work that has to be taken up in the Chemistry Section : Some of the major items of work of great significance that has to be undertaken in the State are the following:—

(1) The reclamation of saline and alkali soils.

(2) Soil survey and efficient land utilization.

(3) Efficient use of fertilizers with reference to water supply, soil types and crops.

(4) Application of latest methods and techniques in the elucidation of problems in soil science such as rapid soil tests, tissue tests, sprectrography, chromatography, and the use of radio-active isotopes.

(5) Systematic field experiments with major and minor plant nutrients to evolve suitable fertiliizer mixtures for different crops in the soil-climatic zones of the State.

(6) Cultivation of inoculated legumes in rotation with cereals for the enrichment of the soil in respect of nitrogen and organic matter and for structural improvement (tilth).

(7) Prevention of soil erosion.

(8) Conservation of soil moisture for plant growth in regions of scanty rainfall.

(9) Study of the clay fraction of the soil types.

All these items are important for the advancement of agriculture in the State. The first item, namely the reclamation of saline and alkaline soils is easy of attainment and if the large areas of such soils present in the State can be improved and put to crops agricultural production can be considerably enhanced. Our knowledge of base exchange can be utilised for the purpose. It has been shown at Mettumarudur in Trichinopoly district that even the worst type of alkali soil, where not even grass will grow, can be made to produce over 3000 lb. of paddy per acre and that the method of reclamation must depend on the nature of the soil. So a survey of the extent

and nature of the saline and alkali soils in the State is imperative. After this, suitable blocks of alkali land with good water resources can be taken up and reclamation experiments carried out with different soil amendments. A separate technical staff with sound knowledge of soil science should be appointed for this important work to enlarge the cultivable area in the State.

As soil is very important in agriculture, it is necessary that an inventory of the soils of our country should be made. The purpose of such an inventory is to classify, and study the soil types so that they can be put to best use. There are several other purposes served by soil surveys. The soil survey of some parts of the State have been made twenty five-years ago and earlier. These surveys had as their object the manurial requirements of paddy tracts. So the soil and sub-soil to the depths 0-9" and 9"-18" only were studied. As is well known, the unit of study of the soil at the present time is the soil profile i. e. the succession of soil horizons from the surface down to the parent rock. So the earlier soil surveys are not useful now to understand the soil fully. It is therefore necessary to carry out soil surveys of at least the important tracts of the State. For this purpose, there should be a permanent organization attached to the Agricultural Chemistry section. The organisation or soil survey party should undertake detailed soil surveys and map out the soils in each of the soil climatic zones. The party should be given the necessary equipment and transport facilities.