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Soil Physical Properties and Coconut Cultivation

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Introduction

SOIL is the most important natural resource on the earth and it provides the natural medium for the growth of land plants. Scientifically the soil is a living body covering the surface of the earth in a thin layer, which is composed of inorganic materials derived from rocks, organic matter derived mainly from plant residues, moisture, air and

millions of living organisms. The main functions of the soil from the agricultural point of view are to give bracing and anchorage for the roots of plants and to provide water for its transpiration, minerals for its nutrition and oxygen for its metabolism. Only that soil which is in proper physical, chemical and biological condition can perform these functions effectively. A thorough appreciation of this fact is a very necessary

prerequisite for managing a given soil to the maximum advantage.

Soil Fertility

Fertility of a soil is defined as "the quality of a soil that enables it to provide nutrients in adequate amounts and in proper balance for the growth of specific plants when other growth factors and the physical condition of the soil are favourable". Thus productivity of a soil does not depend upon the nutrient status of the soil alone, but also on the physical condition of the soil which affects the proper utilisation of the nutrients by the crops. Thus two soils which may have the same fertility level from the point of view of nutrient contents, may exhibit wide differences in productivity depending upon the physical conditions of the soils. This is only to be expected as the growth of plant roots is affected by soil conditions such as soil moisture, soil air, soil temperature and mechanical impedance which in turn are influenced by physical attributes of the soil such as apparent density, aggregation, porosity, friability, etc. Thanks to the widespread propaganda that is being done by different agencies, the growers by and large are now fertilizer conscious and understand the need to use fertilizers to improve crop yields, but they don't appear to be so well informed about the importance of physical conditions of the soil in relation to soil fertility. This article is intended to draw their attention to this important but little understood aspect of soil productivity.

Soil Physical Properties

The physical properties of soils are determined by the size and arrangement

of the primary particles of which they are composed, i.e., by the texture and structure of soils.

Texture

Texture refers to the size of the particles of which a soil is composed. The international textural classification of soils is based upon the extent of occurrence of the four groups of soil particles, i.e., coarse sand, fine sand, silt and clay. Each group of particles has its own physical properties and the physical condition of a soil will be a reflection of the combined effect of properties of the constituent groups of which the soil is composed.

Coarse sand fraction facilitates aeration and easy movement of water but its capacity to hold moisture and nutrients is very low. Fine sand fraction behaves exactly like coarse sand but in a less pronounced manner. Excess of fine sand tends to compact the soil after rains and to form a surface crust on drying. Silt fraction has to some extent the properties associated with clay soil such as cohesion, water holding capacity and base exchange. Clay is the finest fraction of the soil. It is colloidal in character and is the most reactive fraction and is the seat of all chemical activity. It has enormous surface and exhibits colloidal properties like absorption and ion exchange. Beyond a certain proportion it has undesirable effects on the soil.

Structure

Structure is a very important physical characteristic of the soil. The term structure of a soil refers to the arrangement of soil particles in a soil. A structural unit

may be defined as one or more groups of soil particles held together in such a manner that the resultant physical properties differ from those exhibited by a corresponding mass of individual particles. The structural units or aggregates are more stable and much less mobile than the individual soil particles. A crumbly and granular soil structure is the most desirable structure. In such a soil, lumps of soil will disintegrate and crumble on being gently pressed with the finger and the thumb. On cultivation it will break into small lumps and granules instead of forming into clods or powdery material. Good soil structure is necessary to ensure optimum water relationship for the satisfactory growth of crops growing on it.

Soil Types and Their General Characteristics

As already referred to previously, the distinguishing characters of soils of different kinds depend upon their physical composition. On this basis soils can be broadly classified as gravelly, sandy, loamy or clayey soils. These terms themselves will indicate in a general way the nature and suitability of the soil for agricultural use and the manner in which each class behaves under different conditions or has to be treated under cultivation.

Gravelly soil

This soil will have a large admixture of large fragments of stone, gravel, pebbles, etc. This soil is too open, poor and hard on tillage implements and plough bullocks.

Sandy soils

Soils are classified as sandy when they contain more than 60 per cent of

sand fraction. These soils are highly drained and less retentive of moisture and nutrients. The soils can be easily tilled under a wide range of soil moisture conditions without any adverse effect. Provided water and manures are available in plenty, these soils can be used to raise a variety of crops profitably.

Loamy soils

These soils are intermediate between sandy soils and clayey soils. The sandy component may lie between 30 and 60 per cent. In the matter of physical attributes such as moisture holding capacity, drainage etc., these are intermediate between sandy and clayey soils. These soils are very well adapted for raising a variety of crops.

Clayey soils

In these soils sand component goes below 30 per cent and the clay goes up between 70 to 85 per cent. Clayey soils are difficult to till and require much skill in handling. When moist they are excessively sticky and ploughing will reduce them into a pasty mass. When dry they tend to become very hard and difficult to break. As they dry they shrink in volume resulting in the development of cracks. They possess very high water holding capacity and are very retentive of moisture. Drainage is difficult and imperfect. They are generally very fertile soils in respect of plant food but will require physical improvement before crops can derive their advantage in full.

Factors Influencing Soil Physical Properties

Though soil physical properties are largely influenced by soil texture and

structure they do get, and can be, modified by a variety of factors, some tending to improve them while others having an opposite effect.

Intensive cultivation of soil without taking proper steps to maintain the organic matter content at a satisfactory level will often lead to deterioration in due course. With the loss of the binding material, the soil particles get reduced to separate ultimate particles which get easily carried away by wind and rain. The creation of dust bowl in certain parts of America is a well-known instance in point. Organic matter has, therefore, a lot to do with the improvement of soil physical properties. It helps to open up stiff soils, improving their drainage and aeration aspects. In sandy soils it helps to improve structure, resulting in better retentive capacity for moisture and nutrients.

Lime application is another important matter affecting soil physical properties. It ameliorates clayey soil by its flocculatory effect and overcomes the tendency of the soil to become stiff and pasty. It further prevents the development of acidity which favours the destruction of tilth in farm soils.

Soil cultivation has important effects on soil structure, particularly in the case of soils with high clay content. Working clay soils in wet conditions will spoil soil structure and favour the formation of clods. Clods will also result when the soils are ploughed when they are too dry. Tillage at the correct time will favour the formation of crumb structure. Leaving a land under sod for some time is claimed to improve soil structure.

Occurrence of clay pan, hard pans, etc., in the soil will interfere with the growth of plants by obstructing the movement of water and air and the penetration of roots. This adverse soil physical condition can be improved by growing deep rooted crops as well as by deep tillage.

Another factor that tends to modify soil physical properties is the development of alkaline conditions. In arid regions where irrigation is practised, alkaline conditions are likely to develop. Then the soil becomes saturated with sodium ions which cause dispersion of soil aggregates resulting in a soil that is easily puddled and unfit for agricultural use. The reclamation of such soils will require drainage improvement, copious irrigation to leach out soluble salts and treatment with materials such as gypsum, sulphur, etc., depending upon the type of alkali concerned.

Where drainage is defective, improvement of the conditions will allow roots and air to penetrate to greater depths which with the accompanying biological activity and oxidation processes will result in improved soil structure. Mulching of the soil surface has also been observed to improve the physical condition of the soil by preventing compaction of the surface soil and promoting soil aggregation.

The use of artificial soil conditioners such as kribium for improving soil physical properties has been the subject of considerable research but the possibilities of its successful application on a field scale have not yet been demonstrated.

Soils of different types differ in their response to measures taken to improve their structure and one important contributory factor is the size of the particles of which the soil is naturally composed. Incorporation of fine fractions such as silt and clay to coarse soils and of silt and sand to fine soils such as clays on a long term basis will help to modify the textural composition of the respective soils and bring about improvement in soil physical conditions.

Coconut Soils and Their Requirements

The coconut crop has extensive root system and requires for satisfactory growth soils that possess good retentive capacity for moisture and nutrients, are deep and well drained and free from toxic conditions. The various soils on which the crop is now being raised largely are to be studied from these considerations with a view to see how far they are able to satisfy the palms' requirements and whether and to what extent they need attention for removing the defects that they might be suffering from.

The important soil types on which coconut is being raised in India are the laterite soils, loamy soils, coastal sandy soils and alluvial soils.

Laterite soils are generally open and well drained and possess much better water holding capacity than loams and sandy soils. Where the soil is underlain with soft laterite rock, it may be necessary to dig for planting seedlings, pits of much larger size than the usual one (3' x 3' x 3') and to fill them with loose friable soil to permit easy root development in the earlier stages. Application

of common salt to seedling pits a few months before transplantation has also been found to be beneficial as it has the property to soften the laterite and facilitate easy penetration of roots. In the case of this soil type more attention is required towards improving the nutrient status than to the improvement of soil physical condition.

Gravelly laterite soils are likely to suffer considerably from drought because of its very porous nature. Incorporation of large quantities of organic matter may be necessary to improve the water and moisture holding capacity of the soil. Adequate fertilization to correct nutrient deficiencies is also indicated.

Coarse sandy soils are subject to severe drought during rainless period because of its very poor moisture retaining capacity. The deficient physical properties can be improved by adopting the following methods.

- (1) Incorporation of large quantities of organic matter into the soil.
- (2) Increasing the content of finer soil fractions by carting and incorporating large quantities of clay or silt on a long term basis.
- (3) Providing irrigation at frequent intervals to offset the poor moisture retentive capacity.
- (4) Frequent application of small quantities of fertilizers to avoid loss by leachage.

Alluvial soils are naturally very fertile soils. Where the proportion of finer fraction increases, the soil will tend

to be heavy and will be difficult to till. Free drainage may also be impeded. Under such conditions, in order to open up the soil, coarse sand may have to be incorporated by carting sand from outside on a long term basis. Incorporation of organic matter will also help to open up the soil and improve its physical properties.

Conclusion

It is hoped that the foregoing paragraphs would have brought home to the readers how soil physical conditions are as important as nutrient status in in-

fluencing soil productivity. When we are in the thick of fight to increase crop yields we cannot afford to neglect one important aspect concerning soil fertility viz., soil physical properties without adversely affecting the final outcome. Our motto should be to provide optimum environmental conditions for the crop to grow and to allow the soil to play its full part in supplying besides air and water macro and micro nutrients in sufficient quantities and in proper balance in accordance with its special requirements. To the extent we succeed in this task we can hope for the best results.
