THE ROOT SYSTEM OF THE COCONUT PALM

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THE root system is an important part in the structure of a plant. Its importance is manifested in the functions it performs; like the stem or trunk, roots have a form and organization adapted to their mode of life and the conditions in which they live. They are usually buried in the soil and are not exposed to such diversity of influences as stems. Their environment being less complex, they naturally show less variety in form and adaptation. The anchorage of a plant in the soil and the absorption of water and dissolved salts which are the chief functions of a root may be carried out in different ways, according to the nature of the soil and the needs of the plant.

The root system of the coconut palm is typical of the monocotyledons as distinct from the dicotyledons, of which a well-known example is the rubber tree. The root system of the rubber tree is built round a single main or tap root with a system of primary, secondary and tertiary roots. The coconut on the other hand, has a fine, fibrous, branching root system, directly attached to the base of the stem, otherwise known as the " bole." The total number of roots formed on a single tree is very large indeed,—Sampson states a figure of between 1,500 to 2,000 roots for 25-year-old palms and Copeland gives 4,000-7,000.

A feature of the roots of the coconut palm is their uniformity in size and shape throughout their length and a close examination will show that the individual roots are variously coloured,—cream, red, brown or dark brown. These colour differences indicate :—

(1) The extent of the development of the strengthening tissue, situated close to the periphery of the root;

(2) Their efficiency as absorbing organs. Thus the dark brown roots, which have lost their function as absorbing structures, provide extra strength and firmness to the root system for anchoring the plant. The light cream-coloured roots are mainly absorptive in function and have little mechanical strength. The intermediate colours are representative of various stages in between these two extremes.

Unlike most other plants, coconut roots have no root hairs, through which plant food is absorbed. Water and other plant nutrients are taken in through a small area of the root, close to the root cap. Thus although the coconut palm possesses a vast number of roots, its total absorptive area is not very great and the coconut is thus not well adapted to absorb large quantities of water from the soil.

We will now consider how the water in the soil is absorbed into the root system and distributed throughout the plant. Absorption of water takes place by a process called " osmosis " whereby diffusion of a liquid from a less concentrated or very dilute solution to a more concentrated solution

is effected through a semi-permeable membrane. Such a system is unbalanced and water wants to pass from the weaker to the stronger solution. The process of " osmosis " also occurs when the sap passes from cell to cell in a transverse and longitudinal direction within the root, *i.e.*, across and up the root into the stem, feeding the leaves and fruits.

In the plant, the walls of the superficial layer of cells in the roots which are in contact with the soil moisture act as the semi-permeable membrane through which the water passes from the

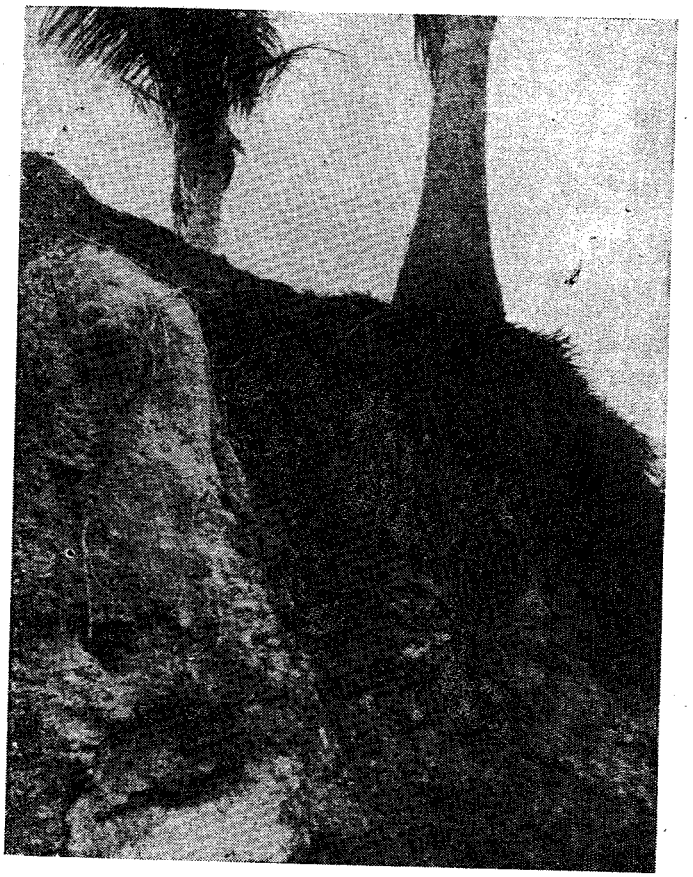
POT-BOUND PALMS AT LUNUWILA

Palms growing in a shallow top soil, less than a foot deep, over 'cabook' (laterite rock).

soil into the cells of the root when the soil water concentration is less than the sap within the cells. If unhappily the concentration of the soil water increases due to the presence of excess salt the reverse, known as " exosmosis " takes place that is the plant loses water into the soil. This occurs whenever coconut lands are inundated with seawater, as sometimes happens in very low lying coconut areas on the coasts of Malaya, and the palms are killed.

As a young root grows older it changes colour because of the thickening and darkening of the outer layer of cells and the core. It is these thick walled cells which give tensile strength to the older roots. A mature root thus consists of a hard cylinder and a hard central rod, which together make it possible to withstand longitudinal and bending strains when the tree is severely disturbed by hurricanes and typhoons; otherwise the roots would snap and the tree would fall, as actually happens with the rubber tree during severe storms.

Between the central core and the outer cylinder, there is a cushion of elastic thin-walled cells and "air pockets." These together protect the root against lateral pressure caused by soil shrinkage during drought. In addition these air pockets allow the diffusion of gases during respiration of the roots.



POT-BOUND PALMS AT KANKESANTURAI
Palms growing in a pocket of clay loam, overlying a hard limestone pan.

In wet weather and under water-logged conditions, respiration is helped by specialized roots with whitish heads called "breathing bodies" or pneumatodes, which are specially formed to meet these conditions.

The root system of the palm is being continuously renewed, and Sampson states that about 30% of the roots are of recent origin. The roots need to be renewed because of death, injury or old age. Roots may die prematurely by disease, or by rotting due to water-logging; roots may be injured by mechanical injury or by pests; roots may harden and become brittle through old age. Thus constant replacement of old roots by new ones on the large scale indicated by Sampson is necessary, and natural, for the plant to maintain a regular and sufficient supply of water and nutrients. The new roots are formed from tissue within the existing roots.

The renewal of roots is also necessary because of the formation of the hard shell of thick tissue which prevents the older roots from acting as absorbing organs. It is therefore essential that a palm should constantly be throwing out fresh and new roots if the plant is to remain in health; when it ceases to produce new roots, the plant is in a declining condition.

According to Sampson, regular root pruning by mechanical means is useful in promoting the formation of active young roots. Thus, surface cultivation by harrowing or ploughing during the wet season is an advantage, but the ploughing must not be deep and it is usually only done in alternate rows, otherwise the set-back is too severe.

The roots of a coconut palm are known to be well distributed in the soil. The direction of root growth is determined by three main factors, *viz.* gravity, moisture and the hardness of the soil. Some roots develop horizontally, some vertically downwards and some obliquely in various directions. It is because of the height of the plant, the great weight of the crown and the tremendous winds which cause movement, that the roots are thus distributed in various directions vertically, obliquely and horizontally in order to anchor the plant securely. Another reason for this wide distribution in various directions is to search for sufficient plant food and water.

The type of root system varies with the nature of the soil. For instance, the roots are longer and more numerous in a sandy soil than they are in clay or a hard lateritic soil; if possible, they will go deeper when the water table is low, than when the land is low-lying and water-logged. A sandy soil being softer and lighter than a clay or lateritic soil affords lesser anchorage and retains a smaller quantity of water volume for volume. Hence the need for longer roots and more roots.

The roots find it more difficult to develop in hard soils and they avoid rock, coral and stones. The root system thus frequently occupies only a limited space and in such circumstances may become pot-bound with the result that the palm becomes unhealthy and unproductive, when the available plant nutrients become exhausted. Hardness of soil is thus one of the factors that determine the favourability of a soil for coconuts. Similarly when there is a hard pan, even a clay pan, below a fertile loam, the roots remain in the favourable medium.

Sampson identified the shallow or surface roots of coconut as "feeding roots," and the deep vertical ones as "water roots." According to him, these water roots continue to grow until they come in contact with the water table when they cease further growth. This is of course true of any ordinary land plant, the roots of which cannot grow in or into water.

In my opinion, this classification of roots cannot be accepted because the structure of the individual roots of the whole system, irrespective of their position in the soil, is the same *i.e.*, if a root section from a surface root is compared with that of a deep root it is the same. It is therefore difficult to believe how roots of the same structure can have different functions and how a root can take in only water and exclude salts, as in the water roots described by Sampson.

During a period of drought, surface roots will not function as absorptive organs owing to the absence of soil moisture ; some may even die. The deeper roots will have to function more effectively or the palm will show signs of withering or desiccation. If this is not possible as in the case of a shallow sandy soil overlying a clay subsoil or hard pan, then the effects of drought may be severe. In such cases, measures to improve soil moisture conservation, such as mulching and husk burying, are absolutely essential.

Conversely, during wet weather, if the water rises and the land becomes water-logged, it is the deeper roots which cease to function as absorbing organs and, if this condition is prolonged, the roots will die back extensively. The plant will then have to depend on the roots which are near the surface and if the supply of plant nutrients in the surface layer of soil is inadequate, the palm will turn yellow and in extreme cases will die. That is why it is so essential to drain low-lying areas and why it is bad practice to fill drains with husks and estate litter which would impede the free movement of the water.