

SOIL AERATION - A MUST FOR COCONUT ROOT GROWTH

B. Sumathykutty Amma

Scientist-S1, Central Plantation Crops Research Institute, Regional Station, Kayamkulam, Kerala.

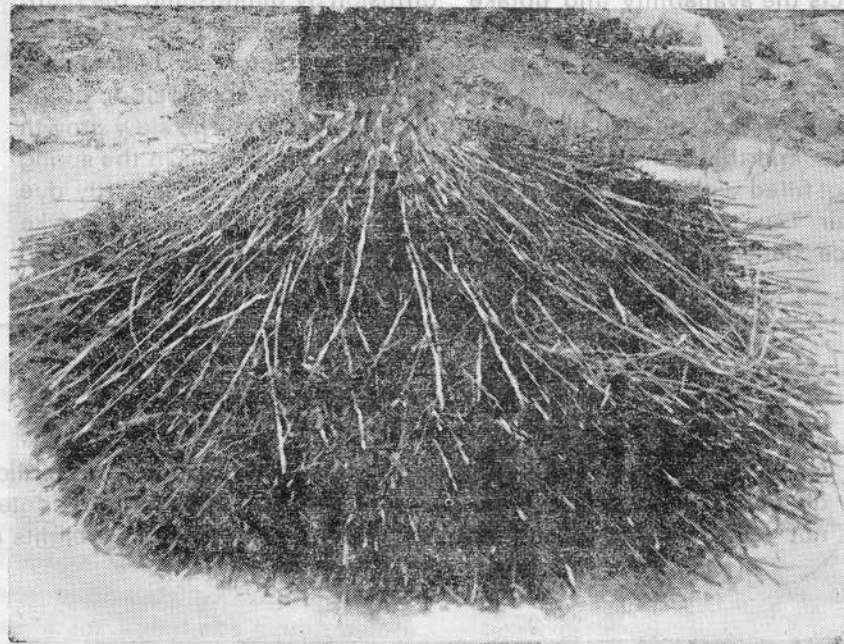
The root system is of great physiological importance for it is the moisture and salt absorbing region of most green plants besides giving anchorage to them. The coconut palm which is designated as essentially a tropical palm possesses an adventitious root system producing numerous fairly uniform roots having 8 to 10 mm diameter. The number of roots produced by an adult coconut palm ranges from 1500 to 8000 depending upon soil conditions. The main roots usually spread horizontally, but some of them penetrate deeper. Coconut palm can adapt itself practically to all soil types and climatic conditions for its growth provided soils are free draining and allow unrestricted root development and aeration.

The manner in which root system develops depends both on its hereditary potentialities and on certain environmental factors. The environmental factors included soil characteristics such as texture, structure, depth, the amount of available water, the kind and concentration of solutes, pH, aeration and competition with roots of other plants.

Of the environmental factors soil aeration is one of the most important one which affects root growth. The aerial surroundings mainly provide light, carbon dioxide and oxygen while the soil usually is the source of water, minerals and minute quantities of soluble organic substances. The root system contacts the soil and utilises

the soil environment. Aeration of the soil is absolutely essential for the absorption of water by roots. Soil air is also useful for the microbial activity in increasing the nutrient availability of the soil by breaking down the insoluble minerals into soluble salts, decomposing plant and animal remains and by bringing about nitrifying and nitrogen fixing processes of bacteria. Besides plant roots require enough supply of oxygen in order to absorb appreciable quantities of mineral salts. This is one reason why the plant growth is slow in water-logged or otherwise poorly aerated soils. It is likely that the accumulation of carbon dioxide or bicarbonate ions in such soils is somewhat toxic to the roots, since it interferes with respiration and ion uptake.

When the soil is poorly aerated carbon dioxide gets accumulated which hinders the water absorption process of the plant. When oxygen concentration in the soil falls beneath the threshold value, the structure/morphology of the root system itself is profoundly altered. The original roots cease growth and may degenerate while newly initiated adventitious roots emerge from the base of the stem with considerable modification to their structure. Lacunae develop in the cortex by the enlargement of the intercellular spaces followed by degeneration of cell walls, leaving only occasional bands of intact cells between cortex and stele. Under poorly aerated conditions, roots show enhanced production of ethylene which is poisonous and harmful to the plant. The



elongation as well as water absorption of the roots are directly dependent upon the production of ATP (Adenosine Triphosphate) which is an energy transfer material in plants. Lack of aeration affects the production of ATP which is required for the normal functioning of roots. In addition to mineral and water absorption, the production of phytohormones like cytokinins represents another major function of root system. Reduced cytokinin production will result in retardation of growth activities leading to early senescence as has been found frequently with root (wilt) diseased coconut palms.

Oxygen is needed for the respiration of roots. On the main roots and also on rootlets of coconut palms are present numerous small whitish outgrowths known as respiratory roots. These facilitate efficient gaseous exchange. In well aerated soils carbon dioxide released by respiration of roots and other microorganisms is freely exchanged with the atmospheric air. One of the reasons for poor growth of coconut after a heavy rainfall is due to lack of aeration which affects the availability and uptake of nutrients.

It has been reported that 30 to 66% of the soil volume is pore space and that pore space which is not filled with water is occupied by air. Thus the non-capillary pore space generally constitutes the

air space of the soil. The occupation of 1/3 pore space in the soil by air and 2/3 by water ordinarily constitutes the most favourable condition for root growth. Like atmospheric air, the soil air is composed largely of nitrogen and oxygen but differs from the former in containing more moisture, more carbon dioxide and a little less oxygen. The oxygen content of the soil-air need not be as high as it is in the atmospheric air (21%). Roughly 2 to 3% oxygen is enough for maximum absorption. Oxygen concentration lower than this will adversely affect the absorption of nutrients. The content of carbon dioxide varies greatly depending on the growth of crop and subsoil biological activity.

There are certain limiting factors which influence soil aeration. Of these soil moisture tension is the most important one. The transport of gases may occur by mass flow related to pressure changes, but generally diffusion is the most important one. Part of the total pore space is filled with a variable amount of water. High water content invariably restricts diffusion by diminishing the pathway for gaseous diffusion. Another important factor is temperature influencing the composition of the soil atmosphere. The slow growth of plants in cold soils in the spring (temperate regions) is partly due to the limited rate of ion uptake under cold temperatures. Increased

rate of diffusion of salts to the roots occurs at high temperatures upto 40°C. Active absorption of salts is also increased because of increased respiration at higher temperatures. Restricted diffusive capacity will be more deleterious as temperature rises.

Poor soil aeration resulting from excessive moisture content can be greatly improved by adequate drainage. Deep ploughing, subsoiling and cracking of soils in summer tend to improve soil aeration. In coconut gardens, tillage helps to improve the aeration of the soil resulting in increased bacterial and chemical activity which in turn increases the available plant food in the soil and also to produce favourable soil structure for the development of roots, thereby increasing the available feeding area for the palm. Growing a cover crop in coconut plantations especially with leguminous crops also helps to improve soil aeration. Shallow cultivation should be preferred in order to avoid damage to the root system. Green manuring helps to maintain the humus content of the soil which improves the physical condition including aeration through increased microbial activity. The health and vigour of the entire plant are conditioned by the distribution and activity of the roots. Adequate nutrition from a favourable root environment will maintain the palm in a healthy state with greater disease resistance.



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—Editor