APPLICATION OF NUCLEAR TECHNIQUES IN THE STUDIES OF ROOT (WILT) DISEASE AND NUTRITIONAL PROBLEMS OF COCONUTS

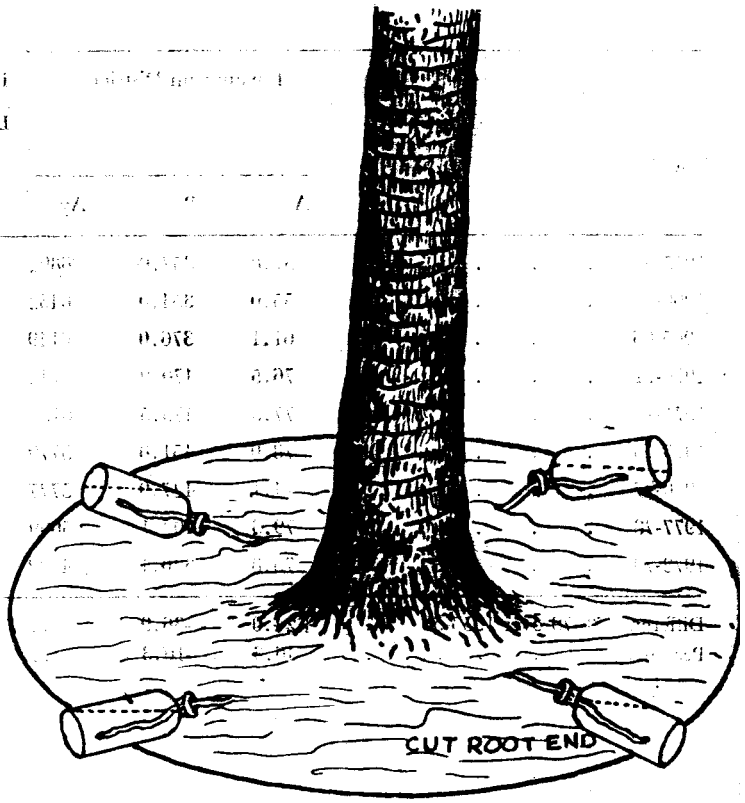
P. K. RAY*

Recent advances in agricultural production are based on efficient management of soil, water and fertilizer resources, evolution of hybrids, plant-protection and disease control measures using improved technology. Nuclear techniques have been made use of as important tools in conducting such studies. The nuclear methods are always rapid, accurate and sensitive and their application in agriculture forms probably the most significant peaceful use of atomic energy.

Root (wilt) disease, etiology of which is still unknown is the most serious malady of coconut in Kerala. It has been found to occur in all soil types under varying ecological conditions from foot hills to coastal sands. The disease is spreading faster in sandy and sandy loam than in laterite soils. Yield in root (wilt) diseased palms gradually decreases and finally the affected palms become unproductive. The annual loss due to this disease has been estimated to be about 50 crores of rupees. The disease is suspected to be the combined effect of pathogen, nutritional imbalance and physiological disorder. In order to tackle nutritional problems on coconut and trace the physiological and biochemical phenomenon associated with nutrient disorder in root (wilt) affected palms, radio-tracer studies were initiated during the year 1975 at Central Plantation Crops Research Institute, Regional Station, Kayangulam, Kerala. The studies were conducted with close collaboration and financial assistance from Bhabha Atomic Research Centre, Trombay, Bombay. Isotopes and radiation techniques have been used extensively under laboratory and field conditions in root (wilt) affected palms and in the nutritional problems of coconut. Some of the important achievements obtained from such studies are briefly reported below:—

(i) *Plant-injection and soil-placement technique*

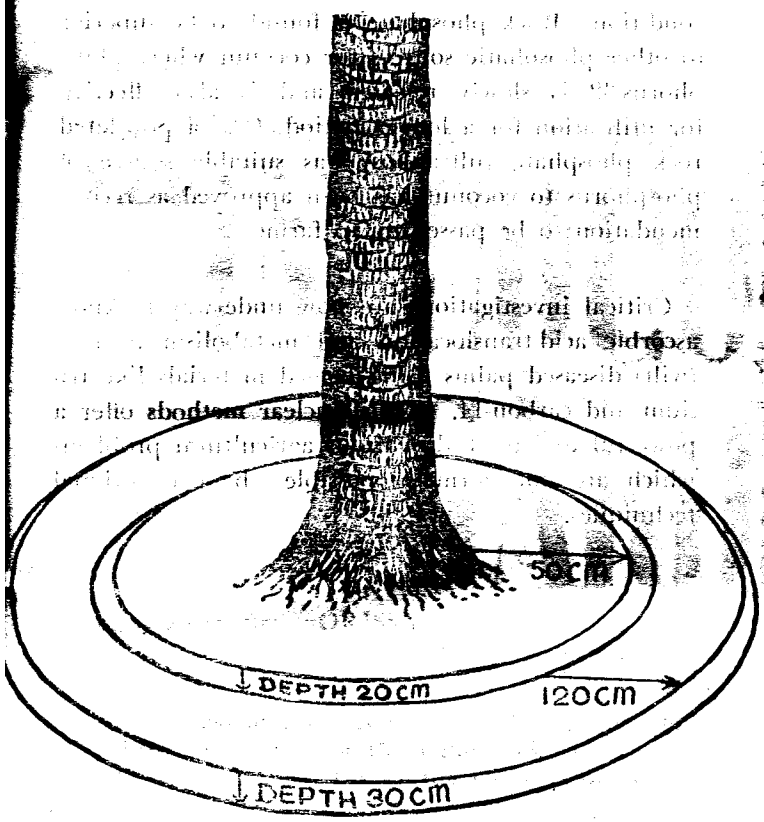
Application of major fertilizers, micronutrients and certain chemical treatments on coconut through efficient methods are considered essential for maximising crop production. Applying nutrients at wrong time and wrong place may be not only wasteful but also harmful. Labelled fertilizers and chemicals are quite useful in determining the most efficient method of application in relation to feeding zone, dose, time of application, placement, source of nutrient etc. By using radioactive phosphorus and rubidium, it has been observed that plant injection technique is superior to soil application method with regard to absorption efficiency. Among plant-injection techniques, feeding of ^{32}P and ^{86}Rb through cut-end of roots (fig. 1) has been found to be most efficient as compared to growing root-tip, leaf-axil and stem injection methods. It can be considered as an intravenous type of injection. Radioactivity in the spindle (topmost unopened leaf) of a 10 m tall coconut palm could be detected after 3 hours of feeding the isotopes through cut-end of roots during dry season and after 4 hours during rainy season. Next efficient



Cut root end injection method.

fig. 1

*Scientist-S2 (Soil Science), Central Plantation Crops Research Institute, Regional Station, Kayangulam, Krishnapuram, Kerala.



Circular trench method.

Fig. 2

method was found to be the leaf-axil application which is often practised by farmers for the application of ash and common salt. The efficiency of different soil-placement methods was also tested. Out of the four soil placement methods tried, application through circular trenches (fig. 2) showed maximum recovery of ^{32}P throughout the experimental period in comparison with hole, basin and strip application methods. An experiment was conducted in a limited scale in the C.P.C.R.I. campus in order to control root (wilt) disease by chemical treatments. Some root (wilt) affected palms were treated with ascorbic acid, phenols and micronutrients alone as well as in combination with NPK as basal application. Ascorbic acid and phenols were fed through cut-root-end injection method and macro and micronutrients were applied through circular trench method. Ascorbic acid (Vitamin C) treatment has shown significant increase in nut yield along with recovery from diseased condition of the palm within 2 years. Fertilizer and chemical treatments are also followed in the same way in an elaborate experiment started in the year, 1978 at farmers field for the control of root (wilt) disease of coconut.

(ii) *Root activity and soil feeding zones of coconut*

Efficiency of fertilizer use will depend upon its placement in the active root zone. The extent of root-system and its pattern of distribution are of considerable importance in bringing about efficient soil-water-fertilizer management. Traditional methods of fertilizer application are based on visual observation on the vast roof system of coconut. Nuclear tools have provided unique methods for tracing active root zone of coconut under the field conditions and the information has been particularly useful for efficient application of fertilizers. Radioisotopic studies were carried out at CPCRI Campus on loamy sand soil using phosphorus-32 and rubidium-86. The results have revealed that the active root zone of coconut is confined to 0.5 to 1.2 m lateral distance and to a slanting depth of 20 to 30 cm reaching upto the top surface of the roots. Placement of fertilizers for coconut to this zone through the circular trench method has been approved as recommendation to be passed on to farmers. What is applicable to phosphorus and rubidium equally holds good for other major nutrients like nitrogen and potash as well as to the micronutrients.

(iii) *Absorption and translocation studies in root (wilt) affected palms*

The disorder in the physiological and biochemical processes are usual phenomena in diseased palms. The coconut palm affected with root (wilt) disease show higher percentage of root decay, flaccidity and yellowing of leaves. These changes result in the slow decline of the vegetative and reproductive growth of the palm. It could not be said as yet whether this disease is due to pathogen or nutritional imbalance or physiological disorder. Double labelling method has revealed higher concentration of ^{32}P and ^{86}Rb in the leaves of the root (wilt) affected coconut palms. From the earlier reports it has been known that accumulation of total, reducing and non-reducing sugars is more in root (wilt) diseased palms as compared to healthy ones. Further studies with ^{32}P have shown that though nucleic acid—p (perchloric acid fraction of phosphorus) is more in healthy palm, sugar phosphate content (trichloroacetic acid-p) is significantly higher in diseased palms. This is a clear indication that phosphate metabolism has been disturbed in diseased palms.

(iv) *Irrigation practices to be followed*

Uncontrolled supply of water can be destructive to man, animals, plants and the land. People are gradually realising that water can be a scarce resource and that steps must be taken to utilize it more efficiently. Controlled irrigation at optimum quantity and optimum time gives better utilization of fertilizer—input that can maximise yield and increase income. With the help of radioactive phosphorus and rubidium, it has been noticed that efficient and economical utilization of nutrients are brought out when the adult palms are irrigated with 250 litres and seedlings with 80 litres of water once in 8 days.

(v) *Selectivity of coconut for a suitable phosphatic source*

Efficient utilization of soil and fertilizer phosphorus depends not only on the characteristics of the soil and fertilizer phosphorus but also on the characteristic of the plant growing in the soil. Since phosphate is a non-renewable source, it is necessary to

maximise its utilization and in this work, labelled radioactive phosphatic fertilizers have given considerable information. Efficient fertilizer utilization particularly of phosphorus is possible by preventing its fixation and following its slow release. Radioisotopic technique using tagged phosphatic fertilizers has been successfully used in coconut for such studies. In Kerala, most of the soil in which coconut is grown are acidic in reaction. The availability of phosphorus in acid soil is reduced to a greater extent. Different phosphatic fertilizers viz. single superphosphate, rock phosphate, nitrophosphate and ammonium dihydrogen orthophosphate in powder form tagged with ^{32}P were applied in loamy sand and laterite soil of Kerala under field and pot culture conditions. Rock phosphate is found to be superior to other phosphatic sources for coconut where phosphorus-32 is slowly released and is also effective for utilization for a longer period. Use of powdered rock phosphate (ultraphos) as suitable source of phosphorus to coconut has been approved as recommendation to be passed on to farmers.

Critical investigations are now underway to know ascorbic acid-translocation and metabolism in root (wilt) diseased palms using tagged materials like tritium and carbon-14. Thus nuclear methods offer a powerful tool to [illegible] agricultural problems which are not [illegible] by conventional techniques.

As the percentage of water to dry matter in a young coconut palm is much greater than in an older palm, the water requirements of a young palm are greater than what is warranted by its size. For this reason young palms are more susceptible to drought conditions.