helping to increase tree crops

Tree crops such as coffee, coconuts, palm oil, citrus fruits and cocoa are of major importance to the economies of countries in Africa, Asia and Latin America, and may be a prime source of foreign exchange earnings. The search for ways to improve efficiently the yields of crops like these — now being aided by the Division of Atomic Energy in Food and Agriculture operated jointly with the Food and Agriculture Organization — thus has a clearly defined practical goal. D. Nethsinghe deals here with some of the work.

In general the use of fertilizer improves the yield of crops, sometimes dramatically. But unless the fertilizer is properly applied much of its value may be lost. Traditional lines of research into the efficiency of fertilizer use on tree crops — evaluating yield after harvest for each of a variety of techniques of application — can take as long as ten years for a single series of experiments, and the results may not be conclusive even then. A research team under the central direction and with the active help of the joint Division therefore began three years ago a study using radioisotope tracer techniques to provide more data, more quickly. The information gained will not only assist in increasing production, but could also help to lower overall production costs.

In advanced countries, where fertilizer is relatively cheap, agricultural practice is largely directed towards labour saving. But in developing countries the situation is reversed; the main consideration is that the minimum amount of fertilizer should be used for maximum crop benefit. The potential value of research into ways of improving the efficiency of fertilizer use is indicated by the fact that Kenya depends on coffee for about 30 per cent of the gross national income, Ghana derives about 60 per cent of the national income from cocoa, and Ceylon depends on coconuts for about 15 per cent of foreign exchange earnings — and

half the coconut crop is consumed within the country. In the Philippines, in Kerala State on the west coast of India and in Ceylon the coconut industry provides employment for about a third of the population. Philippine coconut production currently supplies about 40 per cent of world trade in this crop.

The genesis of the research programme of the joint Division was the meeting of a panel of experts in Vienna, headquarters of the Agency, in 1965. At that time little was known about the root systems of tree crops as a function of age, time of year (for example, in relation to wet and dry seasons), management and soil type. The panel recommended that before beginning a systematic study of the efficiency of fertilizers using commercially available products these basic factors should be studied. It suggested that the first approach should be made simultaneously in a fairly wide variety of crops.

Encouraging results

The programme got under way in 1966, and first reports are encouraging. The research team, assisted by contractors in the field, have studied cocoa in Ghana, coffee in Kenya and Colombia, citrus fruits in Spain and in Taiwan, coconuts in Ceylon and in the Philippines, oil palm on the Ivory Coast and in Malaysia and olives in Tunisia, and some work is still going on. Results which have been obtained so far were discussed at a coordinating meeting in Vienna early this year.

A relatively simple soil injection technique, using primarily a phosphorus solution containing the radioactive isotope P—32, proved effective in the study of patterns of root activity. The solution was injected at various distances away from the tree bole and at various depths, and its uptake by the tree was detected by counter measurements in defined parts of the crop. The research workers took into account environmental factors which are known or thought to affect root distribution — soil moisture gradients, specific soil properties like texture, structure and chemical makeup, and weather patterns.

It was found that an injection of five millicuries of P—32 for each tree, distributed equally in 16 holes at different distances and depths of placement, was adequate for the tree crops studied. The uptake of the radioisotope was gauged by examining samples of the foliage at regular intervals. The Agency's Seibersdorf laboratories near Vienna prepare ampoules of the radioisotope solution for shipment to research contractors in the field; in most cases analyses of samples from the crop are made locally, but where contractors' facilities are limited the samples are sent back to Seibersdorf for analysis. The results are collated and reviewed at the central laboratories, and at regular coordinating meetings the research workers taking part in the programme discuss the results and plan future work.

It has now been shown conclusively that the basic experimental technique works for a variety of tree crops. The general picture is that root activity is greater both in extent and in intensity during the wet seasons for cocoa, coffee, coconut and oil palm trees. Root activity of orange trees is less intense but more widespread in winter and early spring, when the weather is cooler and dryer. For all tree crops studied so far the highest root activity has been seen in the upper layers of the soil. The roots of coconut and coffee are most active close to the tree, in contrast to cocoa and citrus trees, whose greatest activity is seen generally two to three metres from the bole. The roots of the oil palm show little variation in activity from one to four metres away from the stem.

Oranges, coconuts and coffee

Eight-year-old sweet orange trees in Taiwan, grown in sandy loam high above sea level, were found to have their most active functional root system within a radius of one to two metres from the trunk, and about ten centimetres under the surface. Results from a Spanish project

Examination of foliage content gives information on fertilizer efficiency. Photo: IAEA/Nethsinghe

Experiment in Ceylon, Placement of radioactive isotopes in solution to ascertain uptake of fertilizer at varying distances from a coconut palm. Photo: IAEA/Nethsinghe

however showed that for the navel orange studied there the most favourable depth for fertilizer placement was about 30 cm, two to three metres away from the bole.

In the Philippines coconut palms showed wide variation in activity between wet and dry seasons. During a dry period in April/June 1967 the uptake of P—32 was very small, and no proper conclusions could be drawn, but highly significant differences were shown in comparable experiments during the wet season. Ten-year old palms absorbed most fertilizer from between one and two metres from the bole, and between 15 and 30 cm from the surface. Similar results from Ceylon are a pointer to what this programme might achieve: there, fertilizer has commonly been applied in a ring around the tree about a metre from the stem, whereas it was found that the greatest uptake ocurred from 50 to 100 cm from the tree. The different placement suggested by the experimental results could increase efficiency of use significantly.

Cocoa trees have a well-defined tap root, with lateral sworls at intervals, though the character of the root system is influenced to some extent by the physical system of the soil — in particular, by its permeability. Root studies of four varieties of mature trees in Ghana showed that root activity was about ten times greater in the top few centimetres of soil than at greater depths. There was also a marked variation in uptake between varieties.

During the January/February dry season in Kenya the roots of coffee appear to be virtually inactive, but in April/May experiments indicated that the majority of active roots are concentrated near the stem — again a pointer to increased efficiency, for in the past fertilizer has been applied some distance away. Again, placement in the upper layers of the soil proved most effective.

Future experiments

For the future, experiments are already planned to determine the influence of soil type and tree age on the distribution of root activity. Work will be done on very young trees, using both a radioisotope of nitrogen (N—15) and P—32 to determine whether the pattern of root activity observed for phosphorus is applicable for nitrogen as well. As a further step towards the ultimate objective of the programme, the research workers will experiment with commercially available phosphate fertilizers tagged with P—32, and possibly with nitrogenous fertilizers tagged with N—15, to check that their earlier results may be extrapolated in practice to the conditions under which a farmer or grower will use fertilizer in the field.

Yield changes as a result of fertilizer frequently do not occur for three years or more, and large acreages are commonly required to reduce experimental error in the more "traditional" forms of research to an acceptable level. This cooperative project of the joint Division illustrates one of the ways a new tool is being used to illuminate an ancient problem, a tool which enables the research worker virtually to see the pattern of adsorbing roots. The information the research team has gained so far will be a sound basis for the next stage of their work.

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course on radiation processing

A six-week training course on industrial radiation processing is to be held in Tokyo and Takasaki during October and November this year. Intended for countries in Asia and the Far East, it is being organized by the Agency but the cost will be met from funds of the United Nations Development Programme.

The syllabus will include lectures, demonstrations, laboratory and pilot plant work, covering topics such as the technology of radiation processing, the application of radiation techniques to the plastics industry and economic evaluations. Places are necessarily limited and Governments of countries in the area have been invited to nominate suitable participants.