

His Excellency then called upon Mr. M. Park to read his paper entitled "Investigation of root diseases of coconuts."

Investigation of Root Diseases of Coconuts.

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General.

ROOT diseases of coconut have received comparatively little attention from mycologists. The coconut palm does not appear to succumb readily to the attacks of root fungi and it is unusual to find what may be termed spectacular instances of death by root disease. The coconut is a monocotyledon and perhaps a brief statement of the essential differences between the root systems of monocotyledonous and dicotyledonous plants will render clear the possible reasons for the apparent resistance of palms to root disease.

A dicotyledonous tree has a tap root and a few stout main lateral roots which are firmly embedded in the soil and which are immovably connected with the stem which they hold erect by their own rigidity. The main lateral roots branch irregularly and from these in succession arise smaller roots until finally are found the feeding rootlets which take up water and dissolved salts from the soil through root-hairs. All the roots of a dicotyledon are capable of increasing in size with age by secondary thickening.

The coconut palm, being monocotyledonous, does not form a tap root. It produces, and continues to produce throughout its life, roots from the base or bole of the stem. These are the main roots of the tree and they are very uniform in size. They radiate in all directions from the base of the tree and tend to keep more or less in the direction in which they start; they branch occasionally to form straight-growing roots of much the same size as themselves. From these main roots arise small branching roots which are the feeding roots of the palm and which are short-lived and replaced frequently by fresh rootlets.

The root system of the coconut thus differs from that of a dicotyledonous tree in the absence of a tap-root, the development of all the main roots in succession from a definite root-bearing area at the base of the stem, and the uniformity of size and flexibility of the roots. If a root of a palm is damaged so that the tip or growing point dies, it either forms a fresh branch root behind the

point of injury to replace the original root or else another dormant root in the bole commences to grow and take its place. This faculty for replacing injured or diseased roots is of importance in disease of coconuts since, so long as a pathogen confines itself to the roots, it is possible for the palm to go on replacing affected roots, provided that environmental conditions are favourable for its growth. In addition to this factor, it has been stated that the number of roots formed by a coconut palm is considerably in excess of the number required at any one time. It is obvious therefore that in normal healthy palms a root fungus may be established for a considerable time before the gradual reduction in vitality becomes apparent in symptoms of deterioration and ultimate death. In this connection it has been recorded that root disease sometimes takes ten years to kill a palm. On the other hand, if the organism attacking the roots penetrates into and kills the tissue of butt or bole of the palm, more rapid death follows owing to the stoppage of the supply of water and dissolved salts from the soil.

It is convenient to consider the two forms of disease separately and they may be differentiated by the terms "root disease" and "butt disease;" the distinction is arbitrary since a root disease may also become a butt disease and, again, the presence of a condition of root disease may be the predisposing factor for the development of butt disease. Root disease is slow in action, whereas butt disease may be rapid.

Root Disease.—The external symptoms of root disease are those of slow degeneration. The outer leaves wither and droop and often remain for a long time suspended round the stem. The yield drops owing to the suppression of the flowering branches and the fall of immature nuts. New leaves become successively smaller and smaller and the stem tapers at the top, with the result that the crown eventually consists of a few small, erect and yellowish leaves on a tapered stem. In extreme cases the leaves all wither and the bud decays. This final decay of the bud must not be confused with bud-rot caused by a species of *Phytophthora* in which the bud decays first. The main characteristic of root disease is its slow action and the symptoms described are typical of what is known as tapering or wasting disease of coconuts. In this connection it may be stated that through the kind agency of the superintendent of an estate in the Negombo district records of the yields, etc. of a number of trees affected with tapering disease are being kept in order to obtain definite data on the rate of progress of the disease.

There are a number of conditions besides fungus infection of the roots which may induce the symptoms described. Unfavourable soil conditions or conditions which tend to cut down the

supply of water from the soil may result in the display of one or more of the symptoms enumerated above. A brief review of some of these conditions will not be out of place here.

Drought.—The results of drought are well known; wilting and hanging down of the outer leaves and the fall of immature nuts are common effects. Recovery usually occurs with the resumption of suitable weather conditions.

Flooding.—Constant flooding or planting in badly drained or swampy soil may cause typical tapering symptoms. Roots of the coconut are unable to take up water in the absence of air and the water-logging of soil sets up anaerobic conditions which render the soil unfavourable for growth. Tapering of the stems is common among palms planted under such conditions and it is illuminating to see such areas after draining and to observe the increase in girth and the general improvement in the appearance of the palms.

Old Age.—It is well known that coconuts lose productivity and display symptoms of degeneration after a certain age, probably as the cumulative result of a number of conditions, including the decrease of resistance to disease.

Soil Conditions.—This heading includes a number of factors which may induce tapering, and for convenience it may be considered in two sub-sections, conditions which are rendered unfavourable by

- (a) the presence of an inhibiting factor, and
- (b) the absence or insufficiency of a soil constituent essential for normal growth.

(a) Inhibiting factors are of two kinds, physical and chemical. Under the former may be included the "hard pan" formation in some of the soils in Ceylon. The presence of a hard pan at a certain depth below the surface renders the palms more susceptible to drought and results in symptoms of tapering; this problem is cultural and need not be considered here. Land which is liable to be inundated by sea-water may become impregnated with salt with the result that the palms fail to develop normally, and may therefore be classed in the group in which a chemical inhibiting factor is present. Another example is to be found when a definitely toxic substance occurs naturally in the soil, but fortunately this appears to be rare in Ceylon. In addition to these, excessive acidity or alkalinity of the soil may induce conditions resulting in tapering.

(b) Tapering symptoms induced by the absence or insufficiency of essential soil constituents rarely occur on well-cultivated land. In the Eastern Province, a very sandy soil markedly deficient in humus, which deficiency is sometimes aggravated by

excessive ploughing, has been observed to give rise to tapering symptoms in a considerable area of coconuts. A deficiency of mineral constituents such as lime, phosphorus, nitrogen or potash (which will be mentioned again later) may cause a similar degeneration.

The conditions briefly reviewed above are of such a nature that they cause a number of trees to be affected in a given area, but it should be borne in mind that such conditions, if present in a small degree only, may cause a decrease of resistance to disease, which may be confined to certain trees only and therefore appear only sporadically through such an area.

Fungus Disease.—*Rhizoctonia bataticola* has been found on dead roots of palms which displayed symptoms of tapering in a number of districts in Ceylon and it is probable that further investigation will reveal its presence everywhere. It has been found on dead roots in a variety of soils and under a variety of conditions. There has been some discussion as to its significance in roots of woody plants, particularly of tea and rubber, and the recent discovery of its presence in apparently healthy roots of tea (reported in the *T.A.*, *March*) has indicated the possibility of its almost ubiquitous presence in tea as a common mycorrhizal fungus, i.e., a fungus living as a symbiont in normal healthy tea roots in a manner somewhat analogous to the root-nodule bacteria of legumes. It is possible that the possession of mycorrhiza by plants may be of mutual benefit in that the plant supplies the fungus with carbohydrates while the fungus, being able to utilise sources of nitrogen in the soil which are not available to the host plant, supplies the host with combined nitrogen. The condition, however, is essentially one of suppressed parasitism, and the fungus is broken down and absorbed by the host plant in the inner cells of the cortex. So long as the host cells retain this power of resisting the fungus and of keeping it under control it is conceivable that the absorption of the fungus material will be of value to the host plant by supplying readily available combined nitrogen. If the resisting power of the plant be reduced, a different set of conditions arises enabling the fungus to proceed in the manner of a normal parasite, killing the cells in its advance.

A mycorrhizal fungus has been seen in the small roots of the coconut; it has been shown that normal coconut roots may contain a mycorrhizal fungus and it is but a short stage to infer that the hyphae present in healthy roots may be those of *Rhizoctonia bataticola* which hyphae produce sclerotia when some condition arises to cause the death of the root. In other words, it is suggested that *Rhizoctonia bataticola* is a mycorrhizal fungus of coconut as well as of tea. If this assumption is correct then it is obvious that conditions which upset the balance between root

and fungus are of primary importance and an investigation of these conditions essential. Potash deficiency has been proved to be a predisposing factor in the incidence of a disease of jute caused by *Rhizoctonia bataticola* in India and an experiment has been started on a coconut estate in the Negombo district to test if the addition of (a) potash, (b) lime, or (c) potash and lime will have an ameliorating influence on the progress of tapering disease. An experiment of this kind is speculative and serves to indicate how little we know of the physiology of the coconut palm and to emphasise the need of a full study of the conditions which affect its growth favourably or unfavourably.

At the same time, it is possible that *Rhizoctonia bataticola* is a parasite of the normal type and preliminary inoculation experiments have been set up to determine this point. No positive results have been obtained as yet and it will be necessary to carry out inoculations under varying conditions before a definite statement can be made as to the pathogenicity of the fungus towards coconut.

In addition to *Rhizoctonia bataticola*, other fungi have been isolated from the roots of palms which displayed the symptoms of tapering. Pure cultures of these fungi have been grown and inoculation experiments are in hand to determine if they are parasitic or whether they merely live saprophytically on dead roots. It is probable that *Fomes lucidus* and *Poria Ravenalae*, fructifications of which are common on decaying coconut wood, are among the fungi isolated. Fungi of this type, if parasitic, are likely to pass into the bole of the palm, since they are essentially wood-rotting fungi, and to cause what has been termed butt-disease which probably brings on a more rapid death of the palm than root disease alone. Further investigation is necessary to determine the conditions, if any, which enable these fungi to attack the palm and to deduce therefrom satisfactory methods of control.

A general review of root disease, to use the term in its narrow sense, tends to indicate that external conditions play a large part in the appearance of the symptoms of slow degeneration which characterise the disease and may themselves be the only operating factor. In Ceylon we have but touched the fringe of the problem, but it would appear that, if in the case of the coconut palm, the external conditions are favourable, the danger of root disease is minimised. This is amply borne out by the relatively small amount of disease that occurs on estates that are well and wisely cultivated.

Butt Disease.—This form of disease is comparatively rare in Ceylon and, during the time in which special attention has been given to the study of root disease of coconuts, no cases definitely attributable to this type of disease have been encountered. Petch

has recorded the occurrence of this form of root disease caused by *Fomes lucidus*. Death follows rapidly after the entry of a parasite into the bole or butt of the palm, since the hyphae enter and fill the conducting vessels of the vascular strands and cause what is known in herbaceous plants as a wilt, and eventually rot the tissues. Under certain conditions it may be possible for fungi of this type to spread from tree to tree, and the removal and burning of diseased tissue is advocated. We know very little of the conditions, if any, which enable the fungus to attack the palm, but it would appear that certain conditions are necessary since the fungus *Fomes lucidus* is common in coconut land whereas disease caused by this fungus appears to be of rare occurrence. This emphasises the point mentioned before which is that the preliminary investigations into the problem of root disease of coconuts have indicated the need for a full investigation into the conditions, particularly those of the soil, which affect the coconut palm favourably or unfavourably.

Discussion.

HIS EXCELLENCY THE GOVERNOR.—We are very much obliged to Mr. Park for his interesting paper. There are many members in this Conference who know a great deal about coconuts. I hope they will take part in the discussion and give the Conference the benefit of their experience.

MR. WANIGASEKERE said that he was struck by a remark made by Mr. Park that one of the factors which led to root diseases in coconuts was the deficiency of Phosphoric Acid and Potash in soils. He (the speaker) had examined a large number of soils and had noticed that most of the coconut soils in Ceylon were deficient in Phosphoric Acid and also deficient in nitrogen and organic matter. Although it had been stated by some gentlemen who were interested in tea that soil analyses were not useful in solving agricultural problems, he had found that soil analyses were helpful.

MR. PARK stated that in the experiments he had carried out in the Negombo District for controlling the disease, he must admit that he did not include phosphoric acid. He had used potash, potash and lime, and lime alone, and he had found that the palms so treated had improved. But there was no doubt that the experiments could be extended to include heavy doses of phosphoric acid. He (the speaker) was, however, not concerned with the chemical side.

HIS EXCELLENCY suggested that Mr. A. W. R. Joachim might give them his opinion in the matter.

MR. A. W. R. JOACHIM stated that there was no doubt that Ceylon soils were generally deficient in Phosphoric Acid. That was an established fact. Soil analysis had established that beyond doubt, and if it had done nothing else, it had shown one important point of the soil problem in Ceylon. As they all knew, any plant needed a certain amount of each of the more important fertilizing constituents, viz: nitrogen, phosphoric acid and potash. If the soil was deficient in any of those constituents, the increase in the yield was bound to be limited.

Continuing the speaker said that all coconut mixtures contained an excess of phosphoric acid, as that was necessary for fruit production.

MR. WACE DE NEISE.—May I ask Mr. Park why he states that the absence of humus in the Eastern Province soils is aggravated by ploughing? My own experience is that ploughing was beneficial.

MR. PARK said that he had seen the condition in one estate in the Eastern Province. There heavy ploughing was undertaken with the result that humus was used up.

MR. STOCKDALE said that he knew the particular area which Mr. Park alluded to. There intensive ploughing had been undertaken and now that estate had found it necessary completely to change its system.

MUDALIYAR RAJAPAKSE thought that if ploughing was done once in two years or once a year, it would be quite sufficient.

MR. G. ROBERT DE ZOYSA agreed with what Mudaliyar Rajapakse had stated on the matter.

MR. C. N. E. J. DE MEL said that he had been asked whether a lack of certain constituent in the soil, such as phosphoric acid was directly responsible for root disease. There was divergence of opinion on that subject of root disease. About two years ago a certain planter who was greatly alarmed in seeing a number of trees tapering off brought the matter to his notice, and since then they had made observations, and lately Mr. Park had taken up the subject, and he (the speaker) could say at the moment that it was not right to run away with the idea that it was due to a lack of any constituent in the soil. From his experience he could put down the tapering of trees to other causes than root disease. It was sometimes due to pure neglect and hard soil.

DR. SMALL stated that the investigation of tapering disease was still in its infancy and it was too premature to arrive at any conclusions. It would, however, lead to a line of work that would have important results for the coconut industry. The solution of that matter in his opinion was the early establishment of the Coconut Research Scheme in which in the midst of coconut districts, chemists, mycologists and entomologists could work together. The Mycological Division of the Department of Agriculture at Peradeniya, was doing its best but their efforts in that particular direction of coconut root disease was necessarily limited.

MR. STOCKDALE.—With regard to the discussion generally, I would like to mention that this investigation is still in its preliminary stage. What we do ask is that coconut estate owners and others, when they find definite signs of diseases should communicate with us with regard to those diseases. Then it will be possible to make further headway with the work which has been started. As regards the question of ploughing, I do not think I need go into that in detail. The question of ploughing coconuts as for any other crop depends entirely upon the conditions prevailing, and the owner or occupier of the land must use his agricultural sense. Agriculture is, after all, an art, and unless the owner or occupier of the land has any agricultural sense, sound practice cannot result. He might plough once a month or once a year; everything depended on the soil and climatic conditions. Everyone must use his common sense in dealing with practical agricultural operations.

HIS EXCELLENCY.—Ladies and gentlemen, we have had a very interesting discussion which I am sure will be helpful and instructive to many of us engaged in this very important industry.

HIS EXCELLENCY then called upon Mr. G. Robert De Zoysa to read his paper entitled "The Marketing of Produce."