THE WILT (ROOT DISEASE) DISEASE OF COCONUTS IN TRAVANCORE AND COCHIN

BY K. P. V. MENON AND U. K. NAIR

THE wilt (root disease) is by far the most important disease of the coconut palm in Travancore and Cochin. The exact place or time of first occurrence of the disease in Travancore is not definitely known, but it is evident from records that it has been existing there for the last 75 years. The belief also is current that the disease made itself significantly manifest soon after the great floods of 1832. It is of interest here to note that it had attained sufficient magnitude to invite the attention of the Government of Travancore as early as 1900 when an officer of the Department of Agriculture was deputed to go into the question and submit a report on the disease. This officer in his report postulated two probable causes for the disease—an indirect or predisposing cause in the impoverishment of the soil and a direct cause in some insect or fungus attack. Six years later, Mr. T. F. Bourdillon, Conservator of Forests, Travancore went into this matter and reported on the disease. His conclusions were that the disease was fungoid in character probably identical with the 'budrot' of coconuts in Ceylon and the "*Pythium*" rot of palmyra and coconuts in Godavary. He was of the opinion that the disease was hereditory and infectious and that for a rapid spread of the disease some predisposing factors like the depletion of mineral constituents of the soil, improper drainage conditions, etc., were necessary. The problem was next tackled by Dr. E. J. Butler, Imperial Mycologist at that time at Pusa. He visited the infected areas of Travancore, collected samples of diseased material, examined and analysed them and prepared an exhaustive report on his findings. This has been published as bulletin No. 9 of 1908 of the Imperial Agricultural Research Institute, Pusa. (Butler E. J. 1908). Dr. Butler refuted Bourdillon's suggestion that this disease was similar to the bud rot of palms in

DR. K. P. V. MENON, B. Sc., Ph. D., D. I. C. is Joint Director and Coconut Pathologist and MR. U. K. NAIR, B. A., B. Ag., a Junior Research Assistant at the Central Coconut Research Station, Kayamkulam.

Godavary. He was also of the opinion that rotting of the bud occasionally met with was not of primary importance with regard to the etiology of the disease. He found that the root systems of diseased palms were rotten by the attacks of a parasitic fungus. He isolated a species of *Botryodiplodia* from rotten roots and stated that the root-rot produced by this fungus was probably sufficient to produce the disease.

In 1920 a separate section for Mycology was started in the Travancore Department of Agriculture and investigations on this problem was one of the main activities of this section. As a result of this it has been shown that what was loosely termed as the "Coconut Palm Disease of Travancore" is not one specific disease but consists of different diseases like 'bud-rot', 'Leaf blight', 'leaf rot', etc., each having an independent existence with separate symptoms (Varghese M. K. 1934.) "Several of these diseases may often attack the same tree more or less simultaneously, as a result of which has arisen an amount of confusion regarding the sequence of symptoms described for diseased palms." In 1937 a scheme for the investigation of the 'Root' and 'Leaf' diseases of coconuts under the auspices of the I. C. A. R. was started. In January 1947 this scheme was transferred to the Indian Central Coconut Committee and from 1-4-1949 onwards the scheme was absorbed in the Central Coconut Research Station at Kayamkulam. The present paper, third of the series, the first two on the "Leaf-rot" disease of coconuts having already appeared in this Journal (Menon K. P.V. & Nair U.K. 1948), deals with some of the observations recorded and results obtained since the scheme was started in 1937.

SYMPTOMS OF THE DISEASE

The most common and obvious symptom of the disease is a yellowing and drooping of the outer whorls of leaves of an infected palm. Generally in a healthy palm it is common for the oldest leaf to become yellow in colour and to droop slightly before it falls off. But when a coconut palm is infected with the disease, not only the oldest leaf, but the entire outer whorl of leaves develops a yellow colour and droops. In some cases a sickly, pale yellow colour is developed in the leaves of the inner whorls also. All the leaves of an infected palm become flaccid, the leaflets curling slightly at the tips and the observer gets the impression that some derangement has taken place in the metabolism of the palm arresting its normal growth and development. The leaflets soon become brown in colour and start drying up from their tips. The leaves are shed in quick succession. After a palm is infected the leaves that are subsequently produced get smaller and progressively stunted

in size. In a coconut palm the presence of a large number of leaves is an index of its health, vigour and productivity. The reduction in size of the crown adversely affects the normal growth of the palm and it starts tapering at its growing point.

Shedding of all immature nuts if the tree is bearing at the time of infection is another important and early symptom of the disease. This might happen either before the yellowing of leaves occurs or soon after it, but these two symptoms are sure signs of initial infection. The shedding of nuts stops after a few months. The tree now appears to be considerably weakened. The spathes that appear later on are smaller and weaker and the inflorescence contains fewer female flowers. This adversely affects the yield of infected trees. The quality of the nuts also is affected. The husk is thinner and fibres weaker. The shell also does not harden properly. The kernel or endosperm is thinner and when it is converted into copra it does not dry up properly but remains soft and flexible. It is generally believed by coconut growers that incidence of the disease causes a lowering of the percentage of oil produced in the nuts. Experimental evidence however does not bear out this belief. Results of analysis of copra samples from trees in different stages of the disease showed that there was no significant difference in the percentage of oil content. The loss of oil appears to be due to loss in total tonnage of copra on account of reduced yield. The milk of tender coconuts in infected trees has a flat and insipid taste.

In very advanced stages of the disease the spathes of infected trees become very small and weak and in some cases they are unable to burst open normally. All this time, the heart of the crown remains healthy. It dries up after the tree is completely exhausted or in its weakened state it falls an easy prey to bud rot organisms which quickly develop a soft rot destroying the crown which is blown off in the wind leaving the headless stem.

The roots of infected trees show distinct deterioration. The cortex develops a deep brown discolouration and dries up in flakes. Under the microscope the cortical portions may be found to be interspersed with fungal hyphae. In order to examine 'in situ' the root systems of infected trees, palms showing typical symptoms of the disease in different stages were selected. Trenches about six feet in depth were dug at right angles some distance from the base of the stems, thus separating a quadrant at the base of each. The soil within this area was washed out by applying a

powerful jet of water with a foot pump and bailing out the soil that was being washed down into the trenches. A fourth part of the root system of each tree could thus be exposed for examination. In the case of trees in advanced stage of the disease the roots were found to be in an extreme state of deterioration. The horizontal feeding roots which are so necessary for absorption of food materials from the soil had nearly all been destroyed. The vertical water roots present when traced along their courses easily crumbled up and broke away due to their tips being rotten. A distinct dark stain was observed proceeding upwards along the roots. With trees showing symptoms of the disease in its earlier stages the root system was observed to be quite elaborate and comparatively fresh. Horizontal roots were found in abundance and were branching profusely. These were traced along their courses to over 30 feet, and were found to be quite fresh and healthy but here again their tips were observed to be rotten. The vertical water roots grew straight into the water table and were healthy. The percentage of rotten roots in such trees was small and they appeared to have adequate supply of healthy roots to carry on the normal function of food absorption, so as not to exhibit symptoms of starvation due to the roots being choked up by fungal or bacterial invasion. Still the trees were showing visible external symptoms of the disease. A coconut palm in normal health puts forth a fresh complement of roots every year to replace those that may be destroyed. When a tree is infected with the disease this capacity to produce fresh roots becomes weakened. With the onward progress of the disease lesser number of roots are produced progressively every year. The disease lingers on undermining the health of the tree till in course of time the latter succumbs to it. The 'boles' of the trees examined were quite healthy and isolations made from the inside of stems of infected trees gave only saprophytic moulds. Some special features of the disease may be mentioned. The age of a coconut palm has no relation to disease incidence, since the disease has been noticed on trees of all ages. Usually it is the best and most vigorous palm in a garden that first develops disease symptoms. Differences in the nature of the soil appear to have no effect on the incidence of the disease. The disease has been found to infect palms growing in all kinds of soil.

SIMILAR DISEASE IN OTHER COCONUT GROWING COUNTRIES

West Indies. Two forms of wilt disease have been described by Briton-Jones in the West Indies, (Briton-Jones H. R. — 1928), namely the

"Bronze Leaf Wilt" and "Yellow Leaf" or "Tapering Stem Wilt". Of the two, the Bronze leaf wilt is the most serious disease there. Briton Jones and Bain (Bain F. M. 1937) who have worked on this disease in detail in Trinidad are of the opinion that it is a non-parasitic wilt caused by unsuitable soils which inhibit the proper formation of an adequate root system thereby reducing the supply of necessary water to the palms in dry weather or by the soils themselves being of the type that tend to dry out very quickly in the dry season. Martyn who worked on a similar disease in Jamica is however of the opinion that the "experimental evidence on which this theory is based is somewhat scanty." (Martyn E. B. 1945). He thinks that "the appearance of "bronze wilt" in Jamica is suggestive of an infectious disease" and suggests that "a disease of a virus nature must be considered as a possibility." After Martyn, investigations on this disease in Jamica were continued by Leach. He made a detailed study of the symptoms and stated that "Martyn was fully justified in maintaining that Bain's hypothesis could no longer be accepted as an explanation for the behaviour of the disease in Jamica." He visited Trinidad and British Guiana and made a comparative study of the symptoms of the disease obtaining in these places at first hand. As a result of his investigations he came to the conclusion that "the disease in Jamica is definitely not the same disease as "bronze wilt" and that the Jamican disease is not present in Trinidad or British Guiana. He has given it the name of the "Unknown Disease of the Coconut Palm in Jamica". (Leach. R. 1946). He was of the opinion that "the disease may be associated with a facultative root parasite but that soil conditions are the main controlling factor in as much as they affect the nutrient status of the palms." He has also suggested reasons for suspecting a minor element deficiency. He was of the opinion that a co-operative investigation by a plant pathologist, physiologist and chemist is desirable for investigating the disease.

New Guinea. In New Guinea diseases of coconuts have been receiving attention for the last twenty-five years or more. (Bryce G. 1924. Dwyer R. E. P. 1937, 1939 & 1940). In his article on the "Diseases of coconuts in New Guinea" 1937, Dwyer has given a masterly review of coconut disease in other countries also. He has given the following general description of condition of coconut palms affected by root disease. "The outer leaves of palms affected wither and hang drooping downwards around the stem. The central upright leaves and the unfolded sword like leaf remain green and of full size. A few green half ripe nuts may remain on the palm

while the bud is quite sound. Later, the outer drooping leaves fall away leaving a cluster of upright leaves at the tip of the stem. This condition may persist for some years; the new leaves formed being successively smaller until at last they will wither away and the bud decays. The palm in this condition does not set any nuts and later ceases to produce spathes and flowering branches. It is hardly necessary to point out that this description fits in accurately with what occurs under conditions of soil deficiency causing dying back, incipient chlorosis of the coconut palm." He was of the opinion that the "Bronze wilt" disease of coconuts of the West Indies was not important in New Guinea. Diseases which may be associated with soil deficiency, soil exhaustion or unfavourable soil conditions were proving a serious menace to the coconut industry there. (Dwyer R. E. P. 1939). A disease of young coconut palms known as "maturation wilt" which is attributed to physiological causes occurs in New Guinea. Dwyer states that the "Relative importance of physiological disorders of coconut palms as related to fungus diseases or distinct from virus diseases, is not yet determined. The necessity for chemical and botanical research on the nutrition of the coconut palm in relation to soil condition obtaining here is clearly indicated." (Dwyer. R. E. P. 1940.) Root diseases of coconuts caused by *Fomes lignosus* and *F. lamoensis* have also been recorded in New Guinea. (Bryce G. 1924).

Ceylon. Some root diseases of coconuts have been recorded in Ceylon. Petch has described a butt disease produced by *F. Lignosus* (Petch T. 1906, 1928). Later on, Small who investigated the disease attributed the primary cause of the disease to *Rhizoctonia bataticola.* (Small W. 1926-27, 1927-28). Park who followed Small suggested that *R. bataticola* may be present in the roots of coconut palms as a mycorrhizal fungus and that conditions which upset the balance between the root and the fungus are of great importance. (Park M. 1928). Gadd and Briton Jones however does not accept this hypothesis and are of the opinion that the Ceylon root disease is caused by physical or physiological drought . (Gadd. G. H. 1923). (Briton Jones 1928 & 1940) De Mel has described a "Tapering disease" of coconuts in Ceylon. (Melde C. N. E. J. 1927) where a large number of healthy palms which were good bearers showed a gradual tapering of the trunk which continued inspite of manuring and good cultivation.

PHILIPPINES

A disease almost similar to the 'Travancore wilt disease of coconuts

[*Please turn to page 40.*]

[*Continued from page 10.*]

has been described by Ocfemia with Philippines. There it has been named the "Cadang-Cadang" disease of coconuts and exists on San Mignel island. "Cadang-Cadang" means growth failure or running out disease in the local language. After examining the infected palms and studying the symptoms of the disease Ocfemia suggested that the disease was probably of virus origin (Ocfemia G. O. 1937). From the foregoing paragraphs it may be evident that the following observations made by Martyn that "At present the nomenclature of the diseases is confusing and what would appear to be the same disease is described under different names in various parts of the World" is fully justified.

DISTRIBUTION OF THE DISEASE IN TRAVANCORE AND COCHIN

The disease first broke out more than 70 years ago at Erattupetta in Meenachil Taluk of Travancore. Five years later it was reported from Kaviyoor and Kalloopara of Thiruvella Taluk and a little later from Kayamkulam. It may be mentioned in this connection that these places are more than 30 miles distant from one another and the coconut areas intervening were devoid of any disease symptoms. It may, therefore, safely be assumed that the disease broke out in Travancore from more than one independent focus of infection and since then it has been spreading steadily.

Along with the 'leaf rot' disease of coconuts it occurs in a virulent form in Meenachil, Changanacherry, Thiruvella, Kayamkulam, Mattancherry, Ernakulam, Trippunithura etc. In the United State of Travancore and Cochin the northern boundary of the diseased zone is that lying between Narakkal and Thottuva in the north and southern boundary lies between Quilon in the South-west and Punalur in the South-east. The coconut palms within this area may be seen to be suffering from the disease in different degrees of infection. It has already been stated in the introduction that there is a general belief here that the disease made its appearance after the great floods of 1882 when the land water logged for a considerable period. It is not definitely known to what extent water-logging of the soil is responsible for producing predisposing conditions for disease incidence, but it is seen that coconut palms growing on the banks of rivers which remain flooded for some days every year during the monsoons invariably show disease symptoms in a severe form.

ECONOMIC IMPORTANCE

To most of the people of Travancore and Cochin coconut is the most

important money crop, and the peace, contentment and happiness of the people of these areas depend far more on the coconut palm than on any other single item. The loss sustained by the coconut industry due to the ravages by coconut diseases is collossal. The present authors had in an earlier article estimated the loss caused by the "leaf-rot" disease of coconuts in Travancore at 56 lakhs of rupees a year. (Menon K. P. V. and U. K. Nair 1948) The wilt or root disease of coconut is a far more serious disease of coconuts and, therefore, it may be computed that the annual loss due to coconut diseases to the coconut industry is to the tune of more than one crore of rupees.

ISOLATION OF ORGANISMS ASSOCIATED WITH THE DISEASE

In order to obtain the organisms associated with the root disease of the coconut palm extensive tours were conducted in the diseased areas and samples of diseased roots were collected for laboratory examination and analysis. For purposes of root isolation small pieces of root tissue were dipped in 0·1 per cent mercuric chloride for external sterelisation and then washed in repeated changes of sterile distilled water. These pieces were then transferred carefully on to petri dishes containing sterile plain agar medium. Fungal mycelium growing out of such transfers were subcultured into culture tubes containing Brown's agar.

In another series of isolations part of the root symptoms of infected trees were exposed by washing with water. The roots were then examined carefully and isolations were made in the usual manner from the roots at the junction of healthy and diseased areas. In a third series of experiments pits 2' x 2' x 2' were dug near the bases of infected trees and these pits were filled with river sand. The pits were carefully covered and the sand inside was kept moist by frequent watering. The pits were examined from time to time in order to find out whether new roots had grown out from the trees into the sand. Roots showing rotting or necrosis were collected for further examination. Sections were taken from roots showing necrosis and the sections were examined under the microscope. These sections which showed fungal mycelium were used for isolations. A large number of isolations were studied and as a result the following organisms were obtained. *Botryodiplodia theobramae*, *Rhizoctonia batatícola* (*Macrophomina phaseoli*), R. Solani, *Fusarium sp.* *Pencillium sp.* and two species of bacteria — one having yellow pigmentation and the other red pigmentation. A large number of other saprophytic fungi were also obtained.

INFECTION EXPERIMENTS

Fungi for inoculation purposes were grown in wide mouthed 500 c.c. conical flasks on sterelised ricemeal sand medium in the proportion of one part of starch to ten of river sand. All the fungi grew luxuriantly in these flasks and after 15 to 20 days growth the content of the flasks were emptied into ordinary healthy garden soil in large size cement tubs and mixed with the soil. Healthy coconut seedlings, 18 months old, were transplanted into the inoculated soil in the cement tubs. Controls were maintained by transplanting coconut seedlings into soil not inoculated by the fungi. A large number of inoculation experiments were conducted like this. In some cases a wilting of the leaves of seedlings was observed when *B. theobromae*, *R. ibatalicola* or *R. Solani* were used as the inoculum.

In another series of experiments the seedlings in cement tubs were kept in a water-logged condition for two days at the time of inoculation by keeping the drainage holes closed and freely pouring in water into the tubs. Controls were maintained by having seedlings in water-logged soil not inoculated with the fungi. After keeping the soil thus water-logged for the period, the drainage holes were opened and the water drained off. Disease symptoms developed in the case of the seedlings that were kept water-logged at the time of inoculation. Steady progress of the disease was maintained and the seedlings died within the course of about two months. Seedlings in the water logged tubs the soils of which were not inoculated, showed a drooping of leaves in the beginning but quickly recovered after the excess water was drained away.

Inoculations were next conducted on the roots of seedlings four to five years old. The root symptoms of the seedlings were exposed by washing the soil away with a powerful jet of water from a foot pump. The tips of healthy roots thus exposed were inoculated with the fungi by allowing the root tips to grow into wide mouthed culture tubes in which the organisms were growing. The roots thus inoculated were covered up with soil and again examined later on. It was observed that many of the inoculated roots developed root rot, but the infection appeared to be purely localised because disease symptoms did not appear on the leaves of these seedlings. Similar sets of experiments were also conducted having the tips of the roots injured mechanically. In these ready infection of the roots took place in all cases, but here again disease symptoms did not appear on the leaves.

Adventitious roots growing from healthy adult trees were also inoculated with the different fungi but here again even though some of the

inoculated roots took infection disease symptoms were not manifested on the leaves.

Infected soil on roots from the base of badly diseased trees from the affected areas of Kayamkulam were transported to Quilon and applied around the bases of healthy trees in the garden of the Agricultural Research Laboratory. Disease symptoms have not developed even after eight years since this was done.

SOIL SURVEY OF INFECTED AREAS

The prevalence and severity of plants in general are greatly influenced by soil factors. Pathological symptoms exhibited by many crop plants have been attributed to the deficiency or lack of one or more of the major or minor (trace) elements in the soil and consequent defective metabolism. The chemical composition of the soils of infected areas has, therefore, a very important bearing in this connection. Work on this aspect was commenced in 1938. Representative soil samples were collected from a large number of infected areas in Travancore and Cochin. For purpose of comparison a number of soil samples were also collected from representative healthy areas as well. Soil samples were collected in the first instance up to a depth of 18 inches from the soil and they were analysed in the laboratory for nitrogen, phosphoric acid, potash and calcium. Determinations were also made for available potash and available phosphoric acid. A large number of soils were examined in this manner. As a result of this it was found that the soils from diseased areas were generally defecient in the major nutritional soil constituents. Defeciency of potash was markedly prominent. A state of ill-balanced nutrition was thus observed in trees in the diseased areas and such a condition, *inter alia*, appears to favour disease incidence. Soil conditions in relation to the disease will be discussed in a later paper.

REFERENCES

1. Bain F. M. (1937) "Bronze Leaf Wilt" Disease of Coconut Palm. Trinidad Government Printing Office, 1937.
2. Britton – Jones H. R. (1928) Wilt Diseases of Coconut Palms in Trinidad. Part I. Tropical Agriculture 5. 1928. Part II. Tropical Agriculture 12. 1928.
3. –Do–(1940) Book on the Diseases of the coconut palm.
4. Bryce G. (1924) – Coconut diseases – *Fomes Lucidus* (leys) Fr. "Root Disease" Leaflet No. 8 TNG. Dept. of Agriculture, Rabault. Dec. 1924.
5. –Do–Coconut Diseases–Root diseases caused by *Fomes lignosus and Fomes lamoensis*.

6. Butler E. J. (1908) – Report on coconut palm disease in Travancore, Bulletin No. 9. Agric. Res: Institute, Pusa – March 1908.

7. Dwyer R. E. P. (1937) Diseases of coconuts in New Guinea. New Guinea Agric. Gazette, Vol. 3. April 1937.

8. Gadd G. H. (1923) – A Possible Physiological Cause for Nut fall of Coconuts. Trop. Agriculturist Vol. LX. No: 2. Feb. 1923.

9. Leach R. (1946) – The Unknown Disease of coconut palm in Jamica. Trop.Agriculture.Trinidad – Vol. XXIII-3. 1946.

10. Martyn E. B. (1945) Coconut Disease in Jamica – (1) Bronze Wilt and other diseases affecting the bud of coconuts. (2) Diseases affecting the leaf, crown and stem of coconuts. Trop. Agriculture – Trinidad – XXII-3. 1945.

11. Menon K. P. V. & Nair U. K. The "Leaf Rot" disease of coconuts in Travancore and Cochin. The Indian Coconut Journal Vol. I. No. 2-January March 1948.

12. Mel – de C. N. E. J. 1927 – Pest and diseases of coconuts i North-Western Province-Trop Agriculturist. LXVIII No. 4 April-1927.

13. Ocfemia G. O. (1937) – The Probable Nature of "Cadang-Cadang" disease of coconuts Philippine Agriculturist – Vol XXVI. No. 4–September 1937

14. Park M. (1928) – Investigation o root diseases of coconuts Trop. Agriculturist – Vol.LXX No. 6 – June, 1928.

15. Petch T. (1908, 1909 and 1910) – Trop. Agriculturist.

16. Small W. (1926, 1927) Trop. Agriculturist. Vol. LXVII, No. 6, LXVIII – No. 2, LXVIII No. 4.

17. –Do– (1928) Transactions of the Br. Mycological Soc. Vol. XIII, 1928.

18. Varghese M. K. (1934) – Diseases of the coconut palm. Dept, of Agriculture and Fisheries. Travancore, 1934.