

DISEASES OF COCONUT PALMS.

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The present position of the problem of Palm Diseases is much advanced compared with the position some six years back. Even to-day the position is not altogether clear, but the main cause of the past obscurity has been fairly well eliminated and as a result, investigators on Palm Diseases can get at close grips with the varied symptoms which have to be connected up with definite causes. The study of Palm diseases is of the utmost importance in connection with the development of Malayan Oil-Palm plantations; it is the writer's intention to give a resume of the diverse diseases which have claimed notice in Malaya, at the same time calling attention to the important researches made in other countries.

Bud-Rot of Coconut Palms.

All planters interested in Palm cultivation have come in contact with "Bud-Rot." "Bud-Rot" is a classical instance of an epidemic disease and some writers state that "Bud-Rot" attacks have been so severe in many places that Coconut palm growing has been practically destroyed. The cause of Coconut Bud-Rot, after the investigations of Johnson (2) in the West Indies was attributed to *Bacillus coli* (Escherlich, Migula). Later investigations in India by Butler (1) proved that *Phytophthora palmivora* caused a Bud-Rot of Palmyra palms (*Borassus flabellifer* Linn.); this work was followed up by Shaw and Sundaraman (6) who obtained evidence which led them to the conclusion that *Phytophthora palmivora* was the cause of Bud-Rot in Coconut palms; Reinking (4) in the Philippines came to a similar conclusion, but considered the causal fungus to be *Phytophthora jaheri*. The work in India has been followed up and Mc. Rae (3) published a striking article giving the methods and results of the work of the Indian investigators over a period of many years. The conclusions and methods of organising the control work are so interesting as to justify the reprinting of portions of the article.

The position with reference to the Bud-Rot problem in the Eastern Hemisphere has now been soundly stated; investigators in the West Indies, *i.e.*, Ashby, Nowell, and others, have followed up the lines indicated and shown that *Phytophthora palmivora* Butl. is commonly associated with Bud-Rot of Coconut Palms; the position from practically all the large Coconut growing countries has been stabilised and *Phytophthora palmivora* Butl. or some closely related species must be considered the cause of Coconut Bud-Rot.

It should be mentioned that to the layman "Bud-Rot" is a very comprehensive term, for any cause interfering with vital processes usually lays the Bud open to attack, without the necessary entry of *Phytophthora palmivora*; in the writer's opinion there is no doubt that, in the past, many symptoms have been dubbed "Bud-Rot" without due consideration. The position is better understood to-day, and investigators are aware that all obscure symptoms cannot be assigned to "Bud-Rot," simply because the central leaves fall out easily with an accompanying putrefaction of the bud tissue.

Mr. Rae's publication mentioned above is divided into two parts: Part I details operations undertaken to combat the spread of Bud-Rot on Palmyra palms (*Borassus flabellifer*); Part II includes inoculation experiments which prove definitely that Coconut palms can be attacked by *Phytophthora palmivora* Butl.

The clear exposition of the work carried out in India enables one to judge the position in Malaya much more accurately. Mc. Rae proves that although "Bud-Rot" of Palmyra Palms is a serious epidemic disease it can be controlled by systematic measures; that comparatively, Coconut palms, in a badly infected area of Palmyra palms, show relative freedom from the disease. The relative freedom of Coconut palms with regard to attacks of *Phytophthora palmivora*, as compared with Palmyra palms is ascribed to (a) structural differences, (b) less handling of the palms. With reference to the latter, Palmyra Palms in India are largely used for toddy gathering; in Malaya Coconut palms are used exclusively for this purpose, yet there is little difference in this country as regards amount of Bud-Rot to be found on palms used for toddy gathering, and those from which nuts are gathered for Copra. Structural differences are undoubtedly of large significance, as regards comparative freedom of Coconut Palms.

The writer (2) criticising the value of evidence published in papers on 'Bud-Rot' stated as regards the cause in India "that *Phytophthora palmivora* might be assumed to be the deciding factor in any epidemic of 'Bud-Rot' though this must be proved by inoculations on mature trees." In this respect the publication by Mc. Rae is complete, and no further doubt can exist as to the primary factor which has to be controlled in Bud-Rot epidemics.

The position in Malaya can be gauged from Mc. Rae's statements—"On Palmyra palms in India 'Bud-Rot' is a serious epidemic disease which spreads slowly but can be controlled by systematic measures. Coconut Palms, in districts where the causal fungus is present, are relatively free from attacks by the fungus." These conclusions lead to the position that in Malaya "Bud-Rot" of Palms need not be considered a great menace to Coconut and African Oil Palm cultivation, as has been usually understood previously.

As pointed out in (2) the writer is fairly certain that most of the so-called Bud-Rot in Malayan plantations can be ascribed to agencies other than attacks by *Phytophthora palmivora*. This is well seen on mature African Oil Palms; on these palms some form of "Bud-Rot" is common, but the palms practically always recover. Over a period of three years there has only been one casualty, the rot travelling down the stem and so preventing the ascent of water. In previous years several groups of mature trees were taken out annually and destroyed.

With reference to the systematic position of the presumably different *Phytophthora* species suggested as the cause of Bud-Rot of Coconuts, Reinking (4) considered *Phytophthora faberi*. Maublanc, as the cause; in 1924 C. M. Tucker at the Porto Rico Agricultural Station considers this infectious disease as caused by a fungus which has been described as a strain of *Phytophthora faberi*. Maublanc. Recently the writer had the opportunity of meeting Dr. Reinking who, in turn, had been in communication with Dr. Butler. The conclusion has now been reached that the fungus named

Phytophthora palmivora by Dr. Butler, and that isolated from Bud-Rot in the Philippines and considered by Dr. Reinking as *Phytophthora faberi* are practically identical, so that there is a common cause for "Bud-Rot" in both Eastern and Western Hemispheres.

The following general review of the operations in India is extracted from Mr. Rae's article.

General Review of the Operations (In India).

(a) *The Numbers.*—The earliest attempt in 1906 to deal with the disease over a limited area accounted for 40,000 dead palms. The number of dead palms cut during the 19 months, June, 1907 to December, 1908, viz., 398,000 included many trees that had died from about June, 1904, because it takes up to three years for all the leaves to wither, reckoning from the time the growing-point dies and the topmost leaf has withered. Consequently a considerable number of such cases would still be standing and be dealt with by the staff as they moved over the infected area. As mentioned on page 47, the intensity of the disease was greatest in 1908 when probably about 100,000 died, even though 183,000 were actually cut that year, the excess being cases that had died in the years immediately preceding. From 1908 to 1913 there was not much of a fall in the annual figures this being due to the gradual perfecting of the operations, to trees being cut more promptly and to the area being better patrolled. From 1914 to 1917 there was a steady fall in the number of outwardly diseased and dead trees owing to the fact of 74,800 inwardly infected trees having been dealt with and cured. 1918 was a disappointing year because the number suddenly rose in all categories. However, there was a considerable fall in 1919. In 1920 the Pest Act was applied and the numbers again fell both in that year and in 1921 the last year of the operations under review. From 1913 onwards 100,000 diseased trees in the early stages of infection had the diseased tissue removed and were restored to health during the examination of 2,800,000 apparently healthy palms growing in the vicinity of dead ones, and there can be no doubt that this had a great influence in quickly reducing the number of dead palms in the later years of the operations.

(b) *The Area.*—The area said to have been infected in the earlier years was given by Dr. Butler for August, 1905 * and for the end of 1908, † and in a report to Government I gave the known infected area about the middle of 1910. The diagram ‡ shows in colour the different areas which were about 500, 1,200 and 1,800 square miles respectively. The extension in the Northern part is fairly accurate but that towards the Kistna is inadequate in all three estimates. The information in the earlier estimates was got chiefly by a young member of the Agricultural Department whose home was in the Godavari delta, and it is likely that he had more detailed information about the Godavari where his home and his work were than about the Kistna District. The people in Tanuku and Narasapur Taluqs say they noticed it in 1903, the year of the cyclone, but the people beyond the Narasapur canal had no reason to report the presence of disease in those early days, thus it could only be located by actually seeing it and there was little or no touring done in the Kistna District before 1910 with the object of finding the

* Butler, E.J. Agri. Jour. India, Vol. I pl. XX, p. 305

† Butler, E.J. l.c.

‡ Not reproduced.

extension of the disease. With later more accurate and detailed knowledge of the disease in this locality it seems more than probable that long before 1905 the disease had already crossed the Vasishta branch of the river, and that it had extended further into Kistna District by 1908 or by 1910 than is shown in the map. Early in 1910 cuttings were being made in Bunder Taluq around Masulipatam and from observations on the dead palms there I am certain the disease had been there for over three years before this date. Yet at the end of 1908 the disease had not been reported, nor was it known to exist there, by members of the Department. In 1910 there were only two infected localities known between Masulipatam and the infected area in Narasapur and Tanuku Taluqs adjacent to the main infected area in Godavari District, viz., Gudivada near the former area and Kaikalur near the latter. Hence I was inclined to think that the disease had been carried to Masulipatam by sea by human agency, (as printed) which of course was quite possible. Subsequent information got by the Special Deputy Collector and Tahsildar, by one of my assistants and myself in extensive tours have led me to think that this explanation is unnecessary and that the disease could have travelled overland from the Godavari area. Granted that Kistna was infected earlier than was at first thought, and this seems very likely, the overland extension is quite feasible and in conformity with the facts of the then better known extension northwards in Godavari. The boundaries of the infected area about the end of 1912 enclosed a total area of about 4,000 square miles and with the exception of two small extensions along the coast at the extreme ends, comprise the limits of the infected area. Beyond the railway line from Rajamundry to Samalkota and Cocanada the land is not irrigated but is upland dry land of a slightly undulating nature. Here the extension has been slow and the disease has generally occurred in the shallow depressions. From quite early in the operations efforts have been made to banish it from this tract and with success. It is now confined to two small tracts near the railway line and one further up the coast. In one of the former round Rajamundry the disease is of long standing and is still intense. This has come about because the tree-owners there have all along been difficult to persuade to do anything or allow anything to be done, but the stimulus of the Pest Act will no doubt have the desired effect. The tract Peddapur consists of two very small areas where very few diseased trees are found now. The tract along the coast in Tuni Division comprised parts of two villages in 1914 but later was found to extend to eight. It was outside the area patrolled and had the diseases for some time before it was discovered, but work is being concentrated on it now. Beyond the railway line from Rajamundry to Bezwada the disease, so far as is known, has not appeared except in a few villages on the right banks of the Godavari river once believed to be free but now known to be still infected. It has actually reached Bezwada and Ellore halfway between the two as an extension from the delta. The Kistna river is the boundary on the west side except for two small areas near Repalle and Tenali which were discovered in 1920 beyond the patrolled area. They are now being dealt with thoroughly.

(c) *Intensity of the disease.*—The Kistna area was never so intensely infected as the Godavari one, with the exception of those parts of Tanuku and Narasapur Taluqs between the Narasapur canal and the Vasishta branch of the river, and has been more amenable to treatment by the operations. The

disease is in several isolated areas and is nowhere severe except perhaps comparatively so in the river-side villages. Though not to the same extent as in Kistna the disease has disappeared throughout the Godavari District from many places where it once existed and there are still five areas in which it is severe though nothing like to the same extent as formerly, viz., around Rajamundry, Mundapeta, Karapa, Vemavaram and Kottapeta. In general the disease has been pushed out and kept out of the uplands around the deltas except to a short distance on the banks of the Godavari river and in two other small areas, while in the deltas it has been thinned out especially towards the Kistna side and reduced in intensity.

(d) *The Cost.*—The total expenditure in connection with the operations from 1906 to 1921 has been in round figures three lakhs of rupees or £ 20,000.

Results of the Operations.

As in every fight against a disease it is well nigh impossible to make a complete estimate in figures of the good that has accrued, for besides the definite arithmetical value that can be put on the individuals that have been cured, there remains the value of those that have escaped taking the infection because of the protection given them through the preventive measures, and any estimate of this value is more or less speculative. The capital cost of a palmyra in the deltas is about two rupees on the average. The benefits of the operations may be stated under four heads. (a) The value of the palms that have been cured, taking the number at a conservative estimate at 90 per cent. of 231,631 "inwardly" and "outwardly" infected palms operated on, is 417,000 rupees. (b) in 1907 and 1908 the number of dead palms cut includes the accumulation of several years, but in 1909 the bulk of the old standing cases had been removed and the operations would have had some little effect in reducing the yearly number of dead palms, so 100,000 may be taken as representing the maximum intensity of the disease in 1908. Now if the disease had continued steadily at that intensity then in the 15 years of the operations 1,500,000 palms would have died. But during that time 758,000 died, so it can be said with confidence that 742,000 have been saved from infection and these represent a value of 1,484,000 rupees. (c) Again from the number of dead palms that were cut in 1907 and 1908 (398,000) it is clear that the intensity of the disease had been increasing rapidly since 1890 when it was first noticed and there was no reason against its going on as rapidly to increase in the next 13 years. Besides, from an analysis of the figures from June 1907 when the operations began to the end of 1908, together with the knowledge that an interval of three and half years may elapse between the death of the growing point and the withering of all the leaves of the crown, and that the disease arose in epidemic dimensions from a definite place in the Godavari delta about the year 1890 we can assume a simple progression in the rate of increase, then the figures for

	1908 would be	100,000
	1907	94,000
	1906	88,000
	1905	82,000
and for half of	1904	38,000
		402,000

the total of which is very near the figure for those actually cut, viz., 398,000. At the same rate of progression for the next 13 years the figures for dead trees would be about 1,790,000 multiplied by some factor comparable to 100,000, the number of dead trees in the beginning of the period of 13 years under consideration. Of course, the actual number is purely speculative, but it does show the nature of the proportions to which the disease was approaching. The prevention of the disease in this case has a potential value that cannot be accurately estimated in money. (d) In conclusion, we can affirm definitely that the disease has been reduced from a grave menace (100,000 in 1908) to a controllable factor (8,700 in 1921).

Though the disease has been greatly reduced it is still dangerous and requires to be treated with caution. So many times has it been found, more especially in the earlier years, that when a village was put out of the sphere of operation after it had shown no diseased trees for one year, and sometimes two in later years, after an interval of two or three years the disease appeared again, sometimes because of re-infection from outside but undoubtedly also from the appearance of a small number of cases in which the fungus had been developing slowly, consequently the disease had appeared after a longer period than usual and had again started a nucleus of infection that spread the disease to surrounding trees requiring the village to be brought under the operations once more. Hence the operations under the Pest Act will have to be continued for some years longer (1) to reduce still further the amount of disease and (2) to deal thoroughly and expeditiously with the three or four small outbreaks that have occurred beyond the hitherto patrolled infected area.

It was the influence the Collectors of the two districts and their subordinate officers had with the people that made it possible for these irksome operations to be carried on, the members of the special staff being recruited wholly from the revenue branch of the district administration. For years there was no legal compulsion behind the staff and the only authoritative backing it had till 1919 was the order of the Collectors to the village officers to attend to this work. (Naturally it was Government in the first instance that decreed the operations, provided the funds for the special staff, and decided on the continuance of the work. But I am referring just now only to the actual working of the operations in the districts.) The revenue inspectors could not legally compel anyone to cut diseased trees, nor had they the right to enter on anyone's land and cut diseased trees. Everything had to be done with the acquiescence and the co-operation of the people, and naturally it took a considerable time to get them to agree at first to allow the work of cutting to be carried on at Government expense and then gradually at their own expense, especially as for some years there was no very apparent good result and as they believed the disease to be the scourge of a malign deity which there was little use trying to escape. It reflects credit on the members of the staff that they did so much for so long without any person's taking proceedings against them, and again that the people have been induced to carry on the work during the last two years under the Pest Act with only one prosecution. That the credit for carrying on the operations against this disease with the measure of success achieved is due to the special staff under the direction of the Collectors of the two districts is freely acknowledged. The Agricultural Department's activities consisted in elucidating the life-history of the fungus, devising and improving methods of combating the disease, and giving encouragement.

During 1917, 1918 and 1919 the general examination went on during the dry months and the number of diseased palms decreased except in 1918 when it suddenly increased. This was a bitter disappointment. Even though there had been a series of unusually wet years we hoped that the operations now had a greater influence on the disease than natural conditions. In Kistna District the disease appeared again in thirty-seven villages that had been given over to the supervision of the ordinary revenue staff in 1912 and in twenty-one other villages in Bhimavaram, Kaikalur and Gudivada, and a few stray cases were cut at Bezwada, Ellore and Masulipatam, while in Godavari District a few cases were cut in Pelavaram. This shows the insidious character of the disease and how difficult it is to eradicate entirely from a village. From March 1918, when the number of infected trees were greatest, a special effort was made to get the disease again under control, and the general examination in 1919, when the staff tried to find every diseased tree, showed that the number had fallen again to previous proportions. In December 1919 and January 1920 my assistant Mr. Sundararaman and I toured by separate routes through the worst infected villages of both districts. Altogether we saw under thirty dead or outwardly infected palmyras even though operations had been suspended for the previous two months. In former years during December and January there had always been a large number of diseased palms and we expected to see several hundred. That so small a number of diseased trees was found on this tour of inspection was very encouraging and was an undoubted proof of the success of the operations.

From November 1919 to March 1920 the operations were suspended at the instance of the Director of Agriculture in order that the staff might carry on a campaign of publicity before the application of the Pest Act to the disease. It was in connection with the attempt to have outwardly infected trees dealt with that we first suggested early in 1912 to take legislative power to cut compulsorily such trees, but the Government declined to resort to compulsion till the need for it was much more clearly established. The operations went on accordingly relying on the tact and persuasiveness of the members of the special staff to overcome the difficulties. That they were successful in great measure has been shown in the discussion of the position of the operations from year to year, but they never induced any great body of the tree-owners to do the work spontaneously though they did persuade them to allow the cutting to be done at their (the tree-owner's) expense. By 1919 a definite proposal for a local Pest Act was accepted by the Government of Madras, and at a special meeting at Pusa, where the subject was discussed, the last objection to such an act was withdrawn and the way was finally opened for having it passed. Throughout the whole period of the operations there was one hope that never was realized to any great extent—the hope of interesting the tree-owners in the measure taken to combat the disease to such an extent as to get them to act for themselves. Had this hope been realized the special staff might have been withdrawn gradually and the people left to protect themselves against the loss from the disease. Most people in the infected area know about the disease and its symptoms but entirely depended on the official staff to deal with it. The next step was to stir up this interest. By the application of the Pest Act of 1919, dealing with

diseased palmyras became a duty, and it seemed not unreasonable to believe that after people got accustomed to tackling the disease themselves they would come to realize that they could fight it without extraneous help. To ensure that every person in the infected area and around it did know sufficient about the methods of dealing with diseased trees, his duties under the Act and the penalties for non-compliance, the special staff stopped the operation and devoted themselves to a publicity campaign. The fact of the operations being entirely stopped for four months seemed to have impressed the people that Government was in earnest. Pamphlets in the vernacular were written with illustrations given in colour and distributed to all the literate people directly and indirectly connected with the villages and small posters with an illustration of a diseased palmyra palm were posted in thousands on conspicuous places. To reach the great bulk of the tree-owners, who were illiterate, meetings were held in the villages where "sandwichmen" were sent round by day and lantern demonstrations were given by night. Verses were written and folksongs adapted and they were sung at festivals and fairs and mask dances were also a feature. Everything possible was done to excite interest and there is no doubt of the success of the campaign, and the credit is in great measure due to the energy and fertile brain of M. R. Ry. Rao Sahib, V. Bhogappayya Sastry Garu, B.A., Special Deputy Collector on Palm Duty in Godavari and Kistna Districts.

In 1924 when the complete operations were being carried on with the additional stimulus of the Pest Act, the number of diseased trees found remained low, being 16,500 in 1920 and 8,700 in 1921.

- (1) Butler, E. J.—Some diseases of Palms: Agricultural Journal of India, Vol. I, Pt. 4, October 6th, 1916 and Memoirs of the Dept. of Agriculture of India, Vol. I, No. 5, February, 1917.
- (2) Johnstone, R. John.—The History and cause of the Coconut Bud-Rot: No. 228, Bureau of Plant Industry, United States Dept. of Agriculture.
- (3) McRae, W.—I. History of the operations against Bud-Rot of Palms in S. India. II. Inoculation experiments with *Phytophthora palmivora* Butl. on *Borassus flabellifer* Linn and *Cocos nucifera* Linn. Memoirs of the Dept. of Agriculture in India. Bot. Series, Vol. XII, No. 11, July, 1923.
- (4) Reinking, A. Otto.—Coconut Bud-Rot in the Philippines: Philippine Journal of Science, Vol. XIV, No. 1, January, 1919.
- (5) Sharples, A and Lambourne, J.—Observation in Malaya on Bud-Rot of Coconut, Anns. of Botany, January, 1922.
- (6) Shaw, F. J. F. and Sandararaman, S.—The Bud-Rot of Coconut Palms in Malabar: Annals of Mycology. Vol. XII, No. 3, 1914 and Agri. Journal of India, Vol. IX, Part 2, 1911.

The Malayan Agricultural Journal, Vol. XIV, No. 3.