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FIJI DISEASE IN MADAGASCAR

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(Presented by Mr. R. Antoine)

INTRODUCTION

Fiji disease of the sugar cane was observed for the first time in Madagascar in April 1954 by BARAT[3] on the East Coast in a field of M. 134/32. A general survey which was immediately carried out in cane lands revealed that the disease was present in

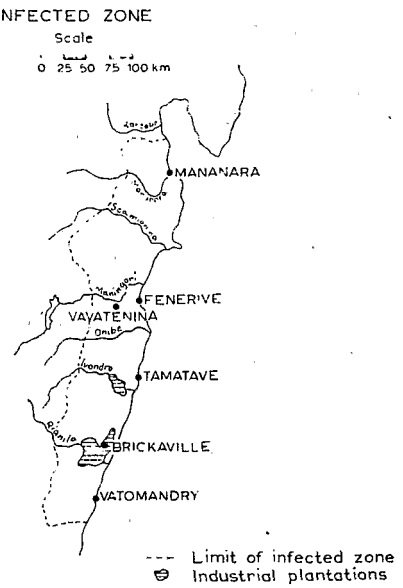

Fig. 1. Zone infected with Fiji disease on the East Coast of Madagascar.

five districts of the province of Tamatave, namely, Brickaville (where infection was already widespread), and Tamatave, Fénérive, Vavatenina, and Mananara (where the disease was beginning to spread from isolated infected fields) (Fig. 1). On the other

hand, plantations on the West Coast, which produce nine-tenths of the sugar were, and are still, disease-free (Fig. 2).

No doubt the disease had been present in Madagascar for several years before its discovery. The cane varieties then cultivated, Louzier, Batavia, Port Mackay, P.O.J. 2878 were all susceptible. However, the widespread occurrence of leaf scald and pokkah-boeng was probably responsible for the fact that the presence of Fiji disease

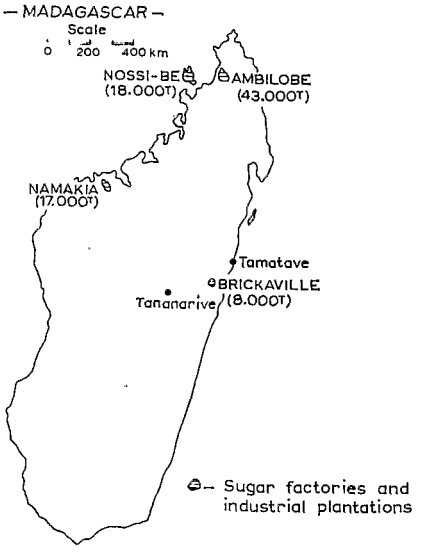

Fig. 2. Industrial sugar cane plantations in Madagascar.

was not noticed earlier, when its incidence was low. It appeared that the spread of the disease was related to the extensive propagation of M.134/32, highly resistant to leaf scald and mosaic and well adapted to environmental conditions prevailing on the East Coast.

BARAT[3] in 1954 observed several fields of variety M.134/32, propagated since 1952, still totally healthy, although in the vicinity of highly infected plantations. ORIAN[12] thought that the disease was then beginning to spread rapidly, following a period of slow establishment. Indeed, in 1955, with a plant protection service not yet adapted to its new task, the rate of infection increased catastrophically. Thus, in 60 ha of M.134/32 virgins, the rate of infection fluctuated between 60% and 80% diseased stools. Besides, the disease was spreading to pratically all fields in the contaminated districts. Results obtained later in resistance trials have shown that the sudden spread of the disease was in fact the result of the extensive propagation of the highly susceptible M.134/32. Indeed, the variety showed experimentally the highest rate of infection: 30% in first ratoons.

Fiji disease was thus recorded for the first time in the Western Indian Ocean area. The nearest infected area is 12,000 km away from Madagascar. BARAT[5] believes that the outbreak of the disease is the result of an illicit introduction of cuttings during the post-war period when the Plant Protection Service was still disorganized.

The presence of the insect vector *Perkinsiella saccharicida* Kirk. was noted for

the first time in the island of Nossi-bé, on the West Coast, by PAULIAN[13], then at Ambilobe and lastly on the East Coast on both occasions by BARAT[5]. WILLIAMS in 1957 observed[2] high population densities of the vector on the West Coast near the end of the rainy season and comparatively low populations on the East Coast, the infected zone. ORIAN[12] has drawn attention to the absence of the insect vector in the region of Tananarive, lying at an altitude of 1,200 m, important as the local and international aerial communication centre. A Delphacid related to *P. saccharicida*, namely, *Dicranotropis muiri* Kirk., is also encountered in sugar cane plantations on both the East and West Coasts[16] but it is not known to be a vector of the disease.

In October 1959, ROGER and SIGWALT observed galls on the lower surface of sugar cane leaves in plantations on the West Coast and thought that Fiji disease had spread to that area[14]. Investigations by ANTOINE[1] and BAUDIN[6] have established that the galls are the result of hypertrophia and hyperplasia in the perivascular tissue and not in the phloem as is the case with Fiji disease. Furthermore, no visible effect on the cane was associated with the presence of the galls. BAUDIN[8] has reported the presence of similar galls on a large number of Gramineae, particularly in the region of Tananarive.

BOSSER[9] has confirmed that wild *Saccharum* species are not represented in the flora of Madagascar but one has to consider the presence of a large number of sugar cane stools, at one time cultivated and then more or less abandoned, now semi-spontaneous in the jungle.

The presence of the disease on the East Coast of Madagascar represents a serious menace to the industrial plantations of the West Coast and also to the neighbouring islands of Mauritius and Réunion whose economies are based on the production of cane sugar. The protection of those regions is one of the most important and intricate aspects of the control campaign and is complicated by the fact that the disease occurs in a region where, except for the industrial zone of Brickaville where the crop is grown for sugar production, cane cultivation is of secondary importance.

SUGAR CANE CULTIVATION ON THE EAST COAST OF MADAGASCAR

The only factory on the East Coast of Madagascar is in the industrial zone of the district of Brickaville. Sugar production which amounted to 4,500 tons in 1954 rose to 8,500 tons in 1961. The cane fields there are cultivated according to established methods of good husbandry. But, as is the case in all regions of Madagascar where water is not limiting, there are no villages and few gardens where stools of cane are not grown for chewing purposes by the family itself or for sale at the local market or on the roadside. There are also a few distilleries fed on an average by about 20 ha of cane fields and more particularly a large number of small primitive mills for the production of the favourite local beverage, cane juice more or less fermented, known as betsa-betsa. The producers usually grow one or two ha of cane for that purpose. Harvesting operations are carried out regularly over the year with the result that in a field a proportion of mature cane is always standing. The cane stools are ratooned as long as a crop can be obtained, often a considerable number of times, and then usually abandoned. There are thus, scattered here and there in the whole cane area of the East Coast, a large number of small plantations and abandoned cane stools growing amid wild vegetation. The majority of the small plantations are far away

from communication centres and inaccessible by road. A visit to such fields usually involves a journey on foot, taking one to several days, along forest paths and at times going part of the way by boat.

Such a scattering of small plantations does not favour disease transmission by the insect vector. Generally the disease is carried by the cutting and consequently the rate of infection remains low. Even with the most susceptible varieties the disease will not always lead to death and disappearance of the stools, and the planter is not inclined to uproot them, the more so that the damages of leaf scald are often more apparent than those of Fiji disease. Under these circumstances, it is difficult to conceive the voluntary elimination of susceptible varieties as a normal sequel, as has been the case with other crop plants in Madagascar. Moreover, the production of sugar is not the primary objective of the native growers. The taste of the juice, hardness of the rind and ability of the cane to whithstand the continuous harvest for feeding the 'mills' throughout the year are much more important criteria. It is evident that those factors are incompatible with normal disease-control measures and have thus made more difficult the task of the Plant Protection Service. It was found necessary, apart from the indispensable varietal replacement, to induce the small planter to change his cultural methods in the whole infected area.

THE CAMPAIGN AGAINST FIJI DISEASE

From the moment Fiji disease was discovered, BARAT[3] thought that eradication was possible. However, from the economic point of view, such eradication had to be progressive. The measures recommended by BARAT[4] for the infected regions of the East Coast included:

(a) the systematic roguing of diseased plants upon detection;

(b) the ploughing out of entire plots when infection level reached 1% and the elimination of whole field on the limit of the infected zone upon detection of a single infected stool;

(c) the insecticidal control of the vector;

(d) the selection of healthy planting material;

(e) the rapid renewal of the sugar cane crop.

Measures which were taken immediately to prevent the spread of the disease from the infected zone and to protect the neighbouring islands of Réunion and Mauritius, included:

(a) the prohibition of the transport and sale of cane for eating purposes;

(b) the establishment of phytosanitary control posts along the periphery of the infected zone;

(c) the control of airfields and the port of Tamatave.

At the beginning of the control campaign the cultivation of resistant varieties was not contemplated for several reasons. The first was that the reaction of varieties was unknown. Also, the cultivation of varieties classified elsewhere as resistant was looked at with suspicion because it was feared that symptoms on such canes, if and when present, would not be conspicuous and that infected stools would thus be missed by roguing gangs. As the very nature of disease resistance is unknown, it was claimed that a symptomless carrier, if it existed, could probably spread the disease further. The most important reason, however, was the remarkable performance of the

variety M.134/32 and the reluctance to replace such a high yielding variety despite its susceptibility to the disease. The eradication campaign conducted during the first years did not accordingly aim at a total replacement of M.134/32 and in fact the large scale planting of that variety once more was even contemplated.

However, in the light of the difficulties encountered by the Plant Protection Service and the disastrous losses caused by the disease on M.134/32 in 1955, the necessity of cultivating resistant varieties only is being realized, bearing in mind the outstanding results obtained by the method of control in Queensland.

As no breeding and selection work is carried out in Madagascar, leading commercial canes known to be resistant to Fiji disease had to be imported and tested. In this respect, the sugar industry of Madagascar was fortunate. The variety Pindar, already imported in the country, showed high resistance to Fiji disease and excellent adaptability to the conditions prevailing on the East Coast. It was thus possible to carry out immediately the rapid multiplication of that variety.

Canes known to be resistant in other countries where the disease prevails are imported regularly and resistance trials are conducted with the technical co-operation of the Mauritius Sugar Industry Research Institute. The trial is based on the lines adopted in Queensland with the exception that imported varieties are tested in a highly contaminated field, the level of natural infection being 60% in 1961 (Fig. 3).

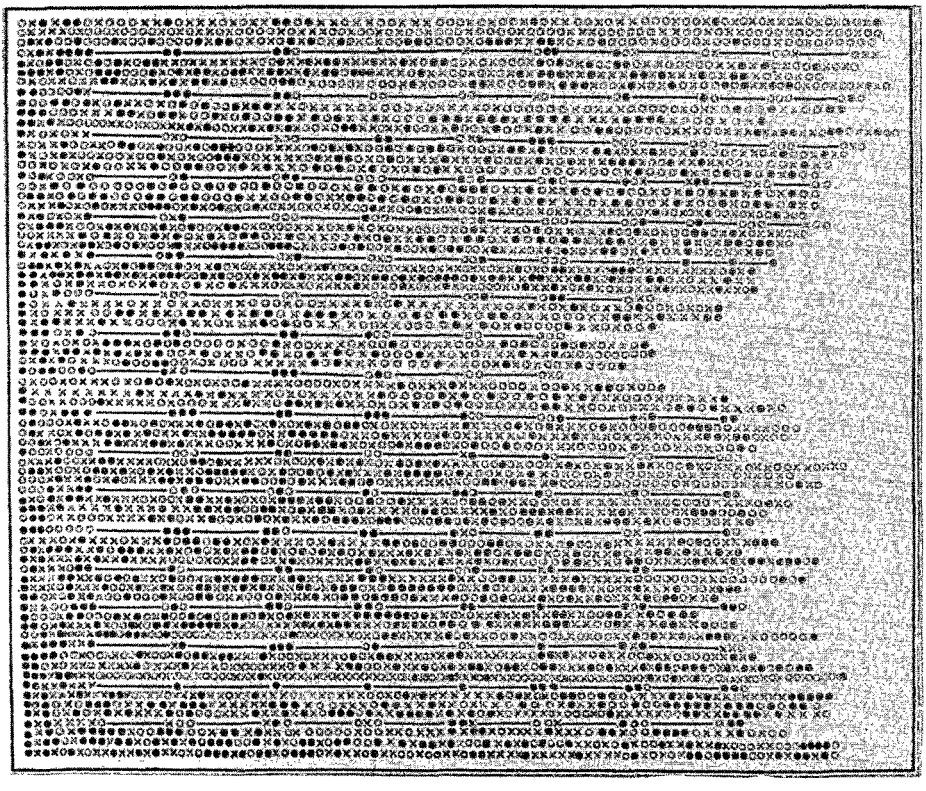

Fig. 3. Plan of Fiji disease-resistance trial, 1961. ● healthy stool (1,647); ○ infected stool (1,377); × dead stool (1,961); — plot of variety under test.

The standard varieties are the highly susceptible M.134/32, the susceptible Q.47, and the highly resistant Pindar. There are four replications. In the assessment of results, the stool is taken as the unit of infection, varietal reaction being reckoned in terms of resistance to infection rather than to the causal agent as mentioned by HUGHES[10].

The first results, obtained in 1961, have shown that the varieties cultivated on the West Coast, producing nine-tenths of the sugar, are all highly susceptible to the disease. The highly resistant varieties cannot be grown in that area as they are either unsuited to environmental conditions or susceptible to smut, leaf scald or the stem borer.

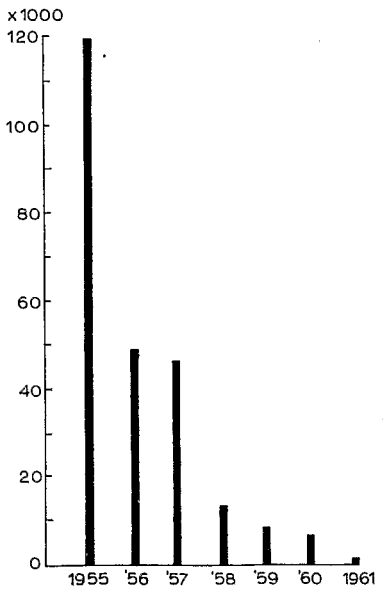

Fig. 4. Total number of infected stools uprooted annually in the industrial zone (1,200 ha).

In the industrial zone of the East Coast, the economic importance of the disease has been already brought down to an insignificant level through the cultivation of the resistant Pindar, a variety which, apart from the nine infected stools observed by LAUFFENBURGER[11] in 1957, has never shown disease symptoms in commercial plantations, or in the resistance trials. The replacement of susceptible varieties was almost completed by the end of 1961, having covered the normal period of seven years. Yet, as early as 1957, the disease was under check through the roguing of infected stools (Fig. 4). An insecticidal treatment over a radius of 15 m round the stool always preceded the digging up and burying of the infected plant in order to prevent the scattering of contaminated vectors. At first HCH was used and later DDT, an insecticide with a more residual action.

SIGWALT[15] prepared a scheme for an insecticidal treatment aiming at a control of the disease in the industrial zone. His plan involved treatments at intervals of three weeks, the time taken for the re-establishment of the second larval stage, the

first to be infective. The method has not been used, however, in view of the replacement of susceptible varieties in the industrial plantations.

In the sugar cane areas outside the industrial zone the effort has been directed, until 1960, on the up-rooting of all diseased plots, regardless of the infection level (Fig. 5). In spite of the extensive and painstaking work[11] the results have been disappointing. Under the conditions prevailing on the East Coast, the direct method of control, through roguings, leads to stagnant results. A certain number of diseased stools is always present in the innumerable and widely scattered plots. That very

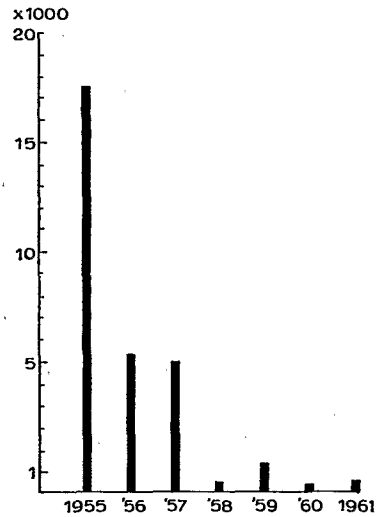

Fig. 5. Total number of infected stools uprooted annually in the non-industrial zone (2,000 ha).

small number is of no direct economic importance but is enough to serve as a starting point for the spread of the disease in susceptible varieties. Accordingly, BAUDIN[7] is of the opinion that the replacement of all susceptible varieties by highly resistant ones is the only method by which the disease will be brought under control in that zone. By the end of 1961, the digging up of all susceptible varieties, whether infected or not, was made compulsory in family gardens as well as in commercial plantations.

RESULTS AND CONCLUSIONS

The Fiji Control Section of the Plant Protection Service can claim two very important achievements: the infected zone has not spread beyond its original limits and the Malagasy sugar production has not been hampered in its progress, even on the East Coast.

As a result of the compulsory cultivation of resistant varieties in the infected area, the disease has almost completely disappeared from the industrial zone, excluding evidently the resistance trial. However, in plantations outside the industrial area, the replacement of susceptible varieties is well behind schedule owing to the difficult problems, mainly human, with which the Fiji Control Section has to contend. So long as infected stools are present in that zone, the plantations of the West Coast and of the neighbouring islands, where the varieties cultivated are susceptible to the virus, are menaced.

The possibility of eradicating the disease, the ideal solution to the problem, raises a controversy among phytopathologists. BARAT[3] and others, believe that complete eradication is possible because of such favourable factors as the absence of wild *Saccharum* species and the restriction of the vector to sugar cane. A failure could result but from the special human factors

which may affect the efficiency of the Plant Protection Service. On the other hand, ROGER[14] does not believe in the possibility of disease eradication but he considers that, as a result of the cultivation of resistant varieties, the disease will assume minor importance, as has been the case with mosaic. However, he considers that the health status of all plantations on the East Coast should be improved considerably by roguing and other restrictive measures in order to delay the spread of the disease to the West Coast for as long as resistant varieties, adapted to the various environmental conditions prevailing in Madagascar, are not available. From the practical standpoint this outlook is not incompatible with the progressive eradication formula suggested by BARAT[3,4].

The control campaign has now reached the critical stage at which the low infection level may lead to some falling-off in vigilance. However, as it has been observed, the smallest error in the control work as well as any attempt to establish variety trials with susceptible canes are immediately sanctioned by new outbreaks of the disease. It is evident that the slightest slackening in the work would entail the loss of the positive results obtained and would condemn the Malagasy industry to the cultivation of resistant varieties only. As the number of such varieties is at present too small to satisfy the numerous requirements of cane cultivation in Madagascar, it is foreseen that vigilance will have to be exercised over several years in order to eliminate all susceptible varieties from the infected zone. The authorities are fully aware of the seriousness of the problem and have decided to act accordingly.

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DISCUSSIONS

E. V. ABBOTT (U.S.A.): Do you fear introduction of Fiji disease into Mauritius from Madagascar through clandestine movement of sugar cane?

R. ANTOINE (Mauritius): Yes. In this connection, however, we have had the full cooperation of the authorities in Madagascar for the last seven years. Sale of cane for chewing purposes was prohibited in the port of Tamatave, but since last year the prohibition has been lifted and the danger has consequently increased, notwithstanding strict control of the port area. The danger of the insect vector being carried here by plane is negligible because it does not exist in the region of the airport at Tananarive.

P. O. WIEHE (Mauritius): It has been suggested that the vector might be blown to Mauritius during cyclones. Would anyone like to comment on this?

J. R. WILLIAMS (Mauritius): Presumably part of our original insect fauna arrived in that way.

J. P. BRUYNS-HAYLETT (S. Africa): What is there to prevent insect vectors of Fiji disease being carried from Madagascar by ship?

MR. ANTOINE: The importation of fodder from Madagascar is prohibited while cattle may not be shipped from the port of Tamatave.

C. G. HUGHES (Queensland): Have you any observations on different strains of Fiji disease? For example, Pindar in Madagascar appears to be very resistant while in Fiji it is rather tolerant.

MR. ANTOINE: Diseased Pindar has never been found in Madagascar and its yields have not decreased either despite the fact that it has been grown for several years with the highly susceptible M.134/32.

DR. WIEHE: How effective has insecticidal treatment been in the control of Fiji disease?

MR. ANTOINE: Enormous amounts of insecticide, mainly BHC and later DDT, have been used, especially before roguing was carried out.

MR. WILLIAMS: Have systemic insecticides been used?

MR. ANTOINE: No.