

A NOTE ON A SOFT ROT OF STORED MANGOES CAUSED BY *BOTRYODIPLODIA THEOBROMAE* PAT.

M. FERNANDO, Ph.D., B.Sc., D.I.C.,
RESEARCH PROBATIONER IN PLANT PATHOLOGY

IN July, 1937, an unfamiliar type of storage rot caused serious damage to a consignment of mangoes of the variety *Chembattan*, from the Farm School, Jaffna. The mangoes had been despatched to Peradeniya in connection with experiments which the division of Plant Pathology was conducting on the control of fruit diseases. Fig. 1 illustrates the course of the disease in this consignment. The upper curve, P, is a progress curve in which the total number of rotted fruits has been plotted against time, and has a sigmoid form. In the lower curve, M, the rate of rotting per day has been plotted against time. This mortality curve appears to conform to the normal type. The curves seem to be expressions of individual differences in susceptibility in a normal population of infected mangoes. Similar curves have been obtained by Kidd (1924) for the fungal invasion of stored apples.

SYMPTOMS OF THE DISEASE

In 38 of the 47 diseased fruits in the Jaffna consignment, infection occurred at the stalk end; in the remaining 9 fruits, infection was lateral. Similar figures were obtained by Mr. W. R. C. Paul, Agricultural Officer, Northern Division, with a parallel batch of 50 *Chembattan* mangoes stored at the Farm School, Jaffna. Forty of the rotted fruits exhibited stalk end infection, and in the rest infection was lateral.

In the case of stalk end rots, visible infection first appears on the ripe fruit as a slight darkening of the epicarp round the base of the stalk. The darkened area may be about 0.5 cm. across. This infected patch spreads with remarkable rapidity, and may cover an area 4 cm. in diameter within the next

24 hours. At this stage the affected area appears water soaked and may exhibit a slight wrinkling of the epicarp. The ochraceous tawny-buckthorn brown (Ridgway, 1912) of the affected area contrasts sharply with the bright orange-yellow of the rest of the fruit. The margin of the invaded area is irregular but fairly clearly defined. The invaded portion lacks the firmness of the surrounding tissue. When the fruit is cut open, no striking difference in colour is observed between diseased and sound tissues, but there is a marked difference in texture. The rotted tissue exhibits an almost complete loss of coherence. The disease is essentially an affection of the ripe fruit. Invasion of green fruits has however occasionally been observed.

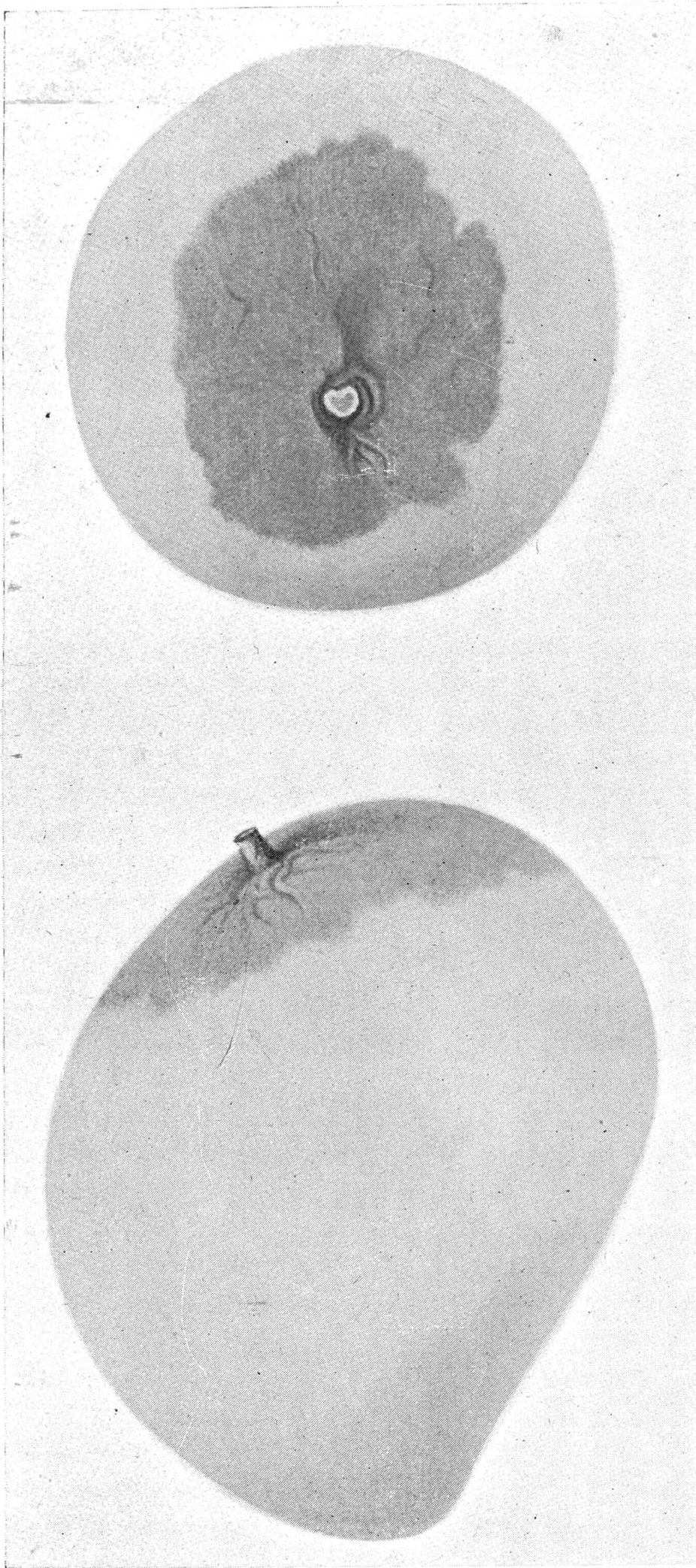
ETIOLOGY OF THE DISEASE

Rotted mangoes were sterilized superficially and isolations were made from the interior at the edge of the advancing rot. Twenty isolations of this type were made, and the fungus *Botryodiplodia theobromae* Pat. grew in every instance. Pathogenicity tests with this organism yielded positive results, and the pathogen was readily re-isolated from the inoculated material.

Su (1934) in Burma, found *Diplodia natalensis* Ev. associated with 8 per cent. of mango rots in a consignment kept in storage for shipment to England. As Nowell (1923) points out, there is little reason for separating *Diplodia natalensis* Ev. from *Botryodiplodia theobromae* Pat. It is accordingly probable that Su's isolation and the writer's pathogen fall within the limits of the same species, possibly with a perfect stage, as suggested by Stevens (1926), in *Physalospora rhodina* (Berk. and Curt.) Cooke.

Die-backs of mango stems in Barbados have been attributed by Bourne (1921) to *Diplodia cacaoicola* Hen., which Petch (1910) has demonstrated is identical with *Botryodiplodia theobromae* Pat.

Although the storage rot which forms the subject of this paper, has not hitherto been recorded from Ceylon, examination of invaded mangoes procured from the Municipal Market, Kandy, showed that the disease was of commoner occurrence



Soft Rot caused by *Botryodiplodia Theobromae* Pat.

than was at first imagined, and strains of *B. theobromae* have been isolated from mangoes of the varieties Parrot and Papaw.

SECRETION OF PROTOPECTINASE BY THE FUNGUS

Microscopic examination of the rotted tissue revealed the fact that the disease was a true soft rot, accompanied by the secretion of protopectinase, the enzyme which dissolves the middle lamella of plant tissues. The cells of the invaded tissue had fallen apart and fungal hyphae were seen ramifying among the dead cells.

Estimations of the protopectinase activity of an extract of the rotted tissue were carried out using Brown's method (1915). The rotted tissue was squeezed through muslin and the extract was cleared by centrifuging. The extract has a pH value of 4.6. A range of hydrogen-ion concentrations was set up by the use of normal sulphuric acid and normal sodium hydroxide. Sound mango tissue of sufficient coherence was not available for the purpose of the tests. Discs of standard dimensions (0.5 mm. × 2 cm.) cut out of the medullary tissue of a potato tuber were accordingly used. Table I records the average time for the complete disintegration of sets of 3 discs, at the various pH values. The reciprocal of this reaction time provides a measure of the protopectinase activity of the extract. The optimum pH value for enzyme action is seen to be in the neighbourhood of neutrality.

TABLE I

pH Value					Reaction time in hours
3.3	..	..	..	..	> 6
4.0	..	..	..	..	3.25
4.6	..	..	..	..	2.08
5.5	..	..	..	..	2.0
7.0	..	..	..	..	1.92
8.5	..	..	..	..	2.75
9.0	..	..	..	..	3.83

Air temperature : 27°C.

PATHOGENICITY OF THE FUNGUS

Pathogenicity tests were complicated by the difficulty of keeping the controls clean. It was found possible to induce infection of mangoes by placing the mycelium of the fungus on a freshly broken stalk. In the variety *Chembattan* this type of inoculation produced an average rot of 41.9 ± 12.2 gm. in 3 days. Invasion was much more rapid if the epicarp had been previously incised.

TABLE II

No. of Mango	Weight of Rotted Tissue in Grams		
	Inoculated with <i>Chembattan</i> strain of <i>B. theobromae</i>	Inoculated with Parrot strain of <i>B. theobromae</i>	Control
1	37.2	27.2	0.0
2	30.2	26.3	0.0
3	31.5	37.8	0.0
4	27.7	32.8	0.0
5	13.4	17.6	12.1
6	21.4	22.5	—
Mean	26.9	27.4	2.4
	<i>t</i>	5 per cent. point	1 per cent. point
For comparison of columns			
	2 & 3 : 0.10	2.228	—
„	2 & 4 : 5.61	—	3.250
„	3 & 4 : 6.38	—	3.250

The results of a typical pathogenicity test are recorded in table II. Two strains of *B. theobromae* were used, *viz.*, the strain responsible for the damage in the Jaffna consignment and a strain isolated from diseased mangoes of the variety Parrot, obtained from the Municipal Market, Kandy. Each

of the strains was inoculated into 6 mangoes of the variety Fibre. Inoculations were made through a wound at the stalk end. Five fruits were kept as controls. The inoculated fruits and controls were stored at a temperature of 26°C.–28°C., in a humid atmosphere under a bell jar. The weights of rotted tissue produced in 4 days by the 2 strains of the fungus are recorded in table II. The value of 't' for the comparison between the two strains is well below the 5 per cent. point. There is accordingly no significant difference in virulence between the two strains.

CONTROL MEASURES

In view of the fact that infection by *B. theobromae* occurs almost exclusively by the stalk end, attempts at controlling the disease should aim at blocking this end against the entry of the pathogen. Dipping the fruits immediately after picking, in a standard copper fungicide to which a spreader had been added, failed to check the disease. The fungicide evidently did not provide effective cover of the stalk end. Continual exudation of the gummy substance from the cut end of the stalk appeared to interfere with the adhesion of the fungicide.

In a second series of experiments, the fruits were immersed in methylated spirits and the stalks broken off under the spirits almost flush with the epicarp. When the alcohol had evaporated off, the stalk ends were dipped in molten beeswax. The treatment gave effective control of the rot, but breaking off the stalk flush with the epicarp resulted in an undesirable oxidase reaction in the neighbourhood of the wound. Besides the application of wax which involved an appreciable area of the upper half of the fruit, affected the appearance of the fruit. The following modification of the above method appears to be commercially practicable. Mangoes should be picked with about a 5-inch length of stalk. The major portion of this stalk is cut off under methylated spirits, leaving about an inch still attached to the fruit. The cut end of the attached piece of stalk is then dipped up to a distance of about 0.5 in. in molten wax. As it is possible that deposition of spores of the pathogen on the fruits occurs in the orchard itself, the fruits should be subjected to this treatment immediately after picking.

Banerjee, Karmarkar and Row (1934) attempted to control the fungal wastage of mangoes in storage by washing the fruit in a solution of fungicide. Five per cent. sodium chloride, 0.5 per cent. potassium permanganate, lime water and a formalin-phenol mixture were tested out. In the case of the formalin and phenol, the fungicidal wash was followed by immersion in molten paraffin wax with a view to providing the fruit with a thin, protective coat of wax. None of the above-mentioned treatments adequately checked fungal invasion. The fruits had been secured from the local market in India, and the inefficacy of the treatments may have been due to the fact that although there was no macroscopically visible invasion, infection and penetration by the pathogens had already occurred.

SUMMARY

Strains of *Botryodiplodia theobromae* Pat. have been isolated from a soft rot of stored mangoes. The pathogenicity of two of the strains has been established.

The secretion of a vigorous protopectinase enzyme by the pathogen has been demonstrated.

Measures for controlling the disease are discussed.

ACKNOWLEDGMENT

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