

## Symptomatology of Stem Canker of Cocoa in India\*

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*Stem canker of cocoa was observed in 2 to 18-year-old plants. Detailed studies of the symptoms of this disease revealed oval to round, brownish rusty discolouration on the external bark as the most characteristic and common symptom. The collar infection usually appeared as dark brown, irregular, water-soaked lesion with comparatively more bleeding. Greyish brown water soaked lesion with a dark brown to black margin and a rusty deposit due to drying up of the exudate from the lesion was also observed. In two to three-year-old cocoa plants the stem appeared slightly sunken at the infected area without any external symptom on the bark.*

Internal tissues beneath the outer lesions always had a reddish brown discolouration. Wood infection appeared as greyish brown to black discolouration with black streaks.

Lesions on outer bark and wood were always smaller than the lesions in internal bark.

Advanced stages of disease caused foliar yellowing, severe defoliation leading to die back and ultimately the death of the tree.

When the lesions enlarged or coalesced, the disease was found spreading from the stem to the pod through the stalk causing rare incidence of black pod disease during dry weather period.

*Phytophthora palmivora* (Butl.) Butl. was found to be the causal organism of stem canker of cocoa irrespective of the variations in the symptoms on external bark.

Stem canker of cocoa (*Theobroma cacao* L.) is a very important disease in high rainfall areas. Rorer (1910) reported the occurrence of canker in a number of cocoa growing countries

from 1897 to 1907. Since then canker disease has been reported from various cocoa growing countries. In India, stem canker of cocoa was first reported in 1978 from Dakshina Kannada district of Karnataka State (Chandra Mohanan, 1978). A detailed survey of cocoa growing areas in India in 1980 revealed the occurrence of canker in 22 per cent of the gardens surveyed. It has been found occurring in both Kerala and Karnataka states (Chandra Mohanan & Kaveriappa, 1981). Canker incidence in Dakshina Kannada district increased with the age of plantation and also with expansion of area under planting.

In most of the reports on symptoms of canker, the external symptom was described as a greyish brown water soaked lesion with a broad dark brown to black margin and a rusty deposit on the lesion due to drying up of a reddish brown liquid oozing out from the lesions. During a recent survey of cocoa gardens in Kerala and Karnataka states, the major cocoa growing areas in India, various types of canker symptoms were noticed. Hence, the present study

was undertaken to clearly distinguish the various symptoms of stem canker of cocoa.

#### MATERIALS AND METHODS

During a survey of cocoa gardens in Kerala and Karnataka states symptoms of cocoa canker on 2 to 18-year-old plants in different localities in these two states were studied in detail. Observations were also recorded on the symptoms of the disease occurring at different heights of the plant such as collar, main trunk, jorquette and fan branches. Symptoms on the surface of the bark, internal bark and wood were recorded separately. Length of lesions on the outer surface of bark, internal bark (4-6 mm below the surface) and wood were measured. Lesion size was recorded from 35 plants occurring in seven gardens (5 plants/garden) in Dakshina Kannada district of Karnataka state.

Samples of canker tissue were collected from 2 to 18-year-old affected cocoa plants with various kinds of symptoms. A total of 25 samples were collected from 15 gardens occurring in different localities in Dakshina Kannada district. The causal organism was isolated by the method described by Manco (1966). Nearly mature cocoa pods were surface sterilised and the cut ends of the stalks were sealed with paraffin wax. Pieces of diseased tissue were inserted into the cocoa pods. The inoculated area was covered with a small wad of moist cotton. The inoculated pods were enclosed in polythene bags containing moist cotton to provide high humidity and incubated at a room temperature of  $22 \pm 2^\circ\text{C}$ .

Isolations were made from the lesions developed on pod surface. For this, pieces of infected tissue were cut

from the advancing edge of the lesions on the pod, surface sterilised and plated on potato dextrose agar medium. The fungal growth was subcultured and identified on the basis of cultural and morphological characters.

#### RESULTS AND DISCUSSION

Cocoa canker was generally observed during December to February after the south-west monsoon period (June-September). But during December to February, there was no rain. Probably, the infection might have started during the south-west monsoon period and the symptoms became apparent during the dry weather period since the rate of spread of infection is slow in the mature stem. Cankers were observed on 2 to 18-year-old plants with varying intensities.

##### *External symptoms*

The symptoms on the surface of the bark could be detected only by close examination. Cankers appeared at different levels of the tree including the branches. The size and shape of external lesions varied. Usually it appeared as round to oval brownish patch on the surface of the bark. The size of the individual external lesion varied from 1.2 to 10.3 cm. Some trees had multiple cankers and the number of lesions per plant varied from one to many (*Figure 1*). In one of the diseased trees as many as 35 external lesions were observed on the main stem. The symptoms of external bark also varied. In majority of the cases a reddish brown liquid oozed out as a result of infection which later on dried up and formed a brownish patch. Detailed studies of the symptoms of the disease revealed dark brown discolouration on the external bark formed as a result of exudation of reddish brown liquid from the point

of infection and this can be considered as the most characteristic and usual symptom of cocoa canker in the west-coast of India. In general the symptoms on the external bark was reported as a greyish brown water soaked lesion with a broad dark brown to black margin. A reddish brown liquid oozing out from the lesions dried up and formed a rusty deposit (Briton-Jones, 1934; Zaiger & Zentmyer, 1965; Chandra Mohanan, 1978). This type of symptom was also observed during the present investigation (Figure 2). But this was not the usual symptom.

The cankers at the collar region of 10 to 18-year-old plants usually had a

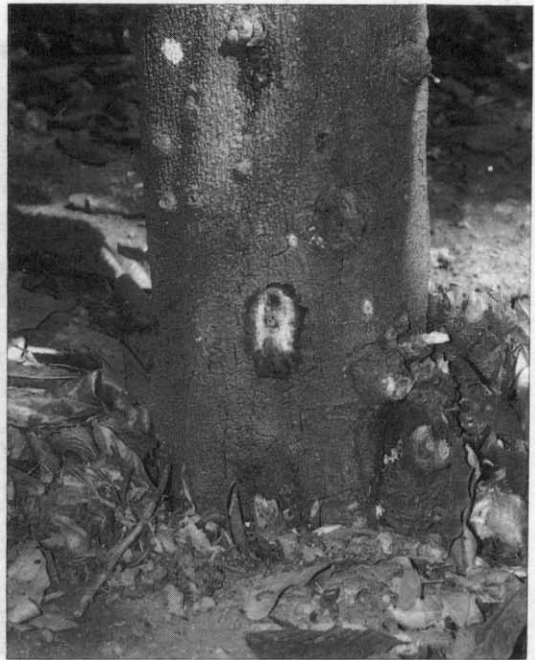


*Figure 1: Cocoa trunk with multiple cankers: typical brown to dark brown lesions on the surface of bark.*

bigger external lesion spreading faster than those above 30 cm height from the ground level in the main stem or fan branches. The collar infection appeared as dark brown, irregular, water soaked lesion with reddish brown liquid oozing out (Figure 3). The exudation of reddish brown liquid was found to be more at the collar region than other parts of the stem. The collar infection was found spreading to the tap root and the main stem. As a result the tree succumbed to death much earlier.

The cankers on the jorquette and fan branches generally appeared as brownish rusty discolouration. On the branches, lesion size on the outer surface of bark was comparatively smaller.

In a cocoa plantation, two to three-year-old plants were found very unhealthy with poor growth and yellowing of leaves. Very close examination of



*Figure 2: Greyish brown canker lesion with dark brown to black margin and reddish brown liquid oozing out.*

these plants revealed the presence of stem infection without any external symptom on the bark. The stem appeared slightly sunken at the region of infection to a length of 1-3 cm. There was no bleeding symptom. Examination of the internal bark after removing the external bark of the sunken area revealed the presence of reddish brown discolouration of the infected tissue (Figure 4). Such cankers could be identified only by examining the internal tissue.

*Internal symptoms*

Bark tissue beneath the outer lesion always had a reddish brown discolouration, which could be easily distinguished from the surrounding healthy tissue (Figure 5) Internal spread of infection was always found to be more rapid than the spread on the surface of bark. Briton-Jones (1934) also reported about the rapid spread of internal lesion compared to external lesion. Lesions in the internal bark coalesced leading to extensive rotting. The lengthwise spread of internal infection was always found to be more than that on either side of the lesion. The infection spread from the cortical tissues into vascular tissues reaching wood. Lesion in the wood was always irregular. Wood infection appeared as greyish brown to black discolouration with black streaks (Figure 6).

Measurement of external and internal lesions of affected trees in different localities revealed that lesions on outer bark were always smaller in size than the lesions in internal tissue. Again it became smaller in the wood (Table 1). The size of lesion was the biggest in internal bark.

When the cankers girdled the main stem or branches dieback symptoms

occurred. Ultimately the tree died. It was very difficult to recognise cankers developed without any external symptoms on the bark. Such cankers could be recognised only in the advanced stages of the disease. Branch cankers were also found spreading to the main stem and ultimately causing the death of the tree. In certain cases canker lesions were confined to a particular area and did not spread further. It has been also observed that some of the cankers, which dried up and became inactive in the summer season became active cankers causing rotting of the tissue during the rainy season. Such revived cankers may serve as a source of inoculum for black pod disease in the garden.

The cankers mostly developed from the black pod disease affected cocoa pods. The infection was found spreading from the pod to the stem through the stalk. These observations corroborate

TABLE 1.  
CANKER LESION SIZE AT DIFFERENT DEPTHS IN THE MAIN STEM OF 8-12 YEAR OLD COCOA PLANTS IN DAKSHINA KANNADA

| Garden no. | * Length of the lesion (cm)  |  |      |
|------------|------------------------------|--|------|
|            | Depth of tissue              |  |      |
|            | Outer surface of bark (0 mm) | Internal bark (4-6 mm) below the surface | Wood |
| 1          | 4.8                          | 7.0                                      | 3.0  |
| 2          | 2.8                          | 2.8                                      | 2.2  |
| 3          | 5.2                          | 6.8                                      | 5.8  |
| 4          | 6.3                          | 5.9                                      | 5.6  |
| 5          | 4.2                          | 7.8                                      | 6.2  |
| 6          | 7.4                          | 7.6                                      | 6.5  |
| 7          | 8.0                          | 18.8                                     | 13.0 |
| Mean       | 5.5                          | 8.1                                      | 6.0  |

\* Mean of 5 trees per garden



Figure 3: Collar canker: Dark brown, irregular, water soaked lesion with comparatively more bleeding.



Figure 4: Stem of two-year-old cocoa plant showing reddish brown discolouration of the internal tissue.



Figure 5: External bark removed from upper part of collar canker lesion to show reddish-brown discolouration of the internal tissue.



Figure 6: Cocoa trunk showing greyish brown to black discoloration in the wood caused by canker.



Figure 7: Cocoa pods showing symptoms of black pod disease caused by the spread of infection from stem canker through stalk.

the earlier findings (Gregory, 1974) Canker lesions were also found developing directly on the bark. In advanced stages of infection the disease was found spreading from the stem to the pod through the stalk causing typical symptoms of black pod disease, during the dry weather period (Figure 7). Otherwise, during this period black pod disease was not noticed in any of the gardens in this country. Black pod disease has been reported to occur only during the south-west monsoon period from June to September, with the maximum incidence in July to August (Chandra Mohanan, 1985). But the rare incidence of black pod observed during December to February was always found to be associated with canker. Microscopic examination revealed the presence of sporangia of *Phytophthora palmivora* on the pod surface. Presence of sporangia were also observed in the reddish brown liquid oozing out from the lesions. Thus the rare occurrence of black pod disease caused by *P. palmivora* during summer months when there was no rain, though associated with the canker, is reported for the first time from this country.

The causal organism of canker was isolated and identified as *P. palmivora* based on cultural and morphological characters. Isolation of the pathogen from the samples collected from various gardens invariably yielded *P. palmivora*, irrespective of the various types of external symptoms.

The different kinds of symptoms on the external bark such as brownish

rusty discolouration, dark brown irregular lesions with more bleeding and infection on two to three year old plants without any symptom on the external surface of the bark have been recorded during the present investigation.

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#### REFERENCES

- BRITON-JONES, H.R. (1934). *The Diseases and Curing of Cocoa*. pp. 161. McMillan & Co., London.
- CHANDRA MOHANAN, R. (1978). Cacao canker caused by *Phytophthora palmivora*. *Plant Dis. Repr.* 62, 1080-1082.
- CHANDRA MOHANAN, R. & KAVERIAPPA, K.M. (1981). Occurrence and distribution of cocoa diseases in South India. *Proc. 8th Intl. Cocoa Res. Conf.* Cartagena, 445-449.
- CHANDRA MOHANAN, R. (1985). Incidence of cocoa black pod disease in Dakshina Kannada district (Karnataka) - a major cocoa growing area in India. *Indian Cocoa, Arecanut & Spices Journal*, 8, 91-92.
- GREGORY, P.H. (ed.) (1974). *Phytophthora disease of cocoa*. pp. 348. Longman Group Ltd., London.
- MANCO, G.R. (1966). *Phytophthora palmivora* in flower cushion, old infected pods and leaves of cocoa plants. *Turrialba* 16, 148-155.
- RORER, J.B. (1910). The relation of black rot of cacao pods to the canker of cacao trees. *Bull. Dep. Agric. Trinidad, Tobago*, 9, 38.
- ZAIGER, D. & ZENTYMYER, G.A. (1965). *Phytophthora canker of cacao in the Caroline Islands*. *Plant Dis. Repr.* 49, 565-567.