Studies in the Resistance of *Theobroma cacao* L to *Phytophthora palmivora* (Butl.) Butl.

General Introduction

Black pod or brown rot disease of cacao, causative organism *Phytophthora palmivora* (Butl.) Butl., is at the present time, the most widely spread of the more important cacao diseases. While the complex of viruses known as swollen shoot, witches broom (*Marasmius perniciosus* Stahel) and the disease caused by *Ceratocystis fimbriata* E. & H., Elliot may be of greater importance in restricted areas, on a worldwide basis it is believed that more crop is lost to Black pod than any other disease.

The losses experienced in various cacao producing countries are represented in Table 1.

Table 1

Percentage loss in production to black pod disease of cacao

Country	Percentage of black pod	Authority
Brazil (Bahia)	18-25, in some years 50	Miranda and da Cruz (1953)
Costa Rica	47	"La Lola" Estate Orellana (1953 a)
Colombia	35	Garces (1953)
Cameroons	56-67	Von Faber (1907)
	90-95	Sanders (1956)
Ghana	17	Quansah (1964)

Table 1 cont'd.

Country	Percentage of black pod	Authority
Mexico	up to 40	Wood (1957)
Nigeria	58-74 (wet area)	Thorold (1953 b)
Trinidad	36 (wet area)	Holliday (1954)
	26	Dale (1952)
	1.7 (dry area)	Baker (1953)
Samoa	50	Cacao (1956)

Padwick (1956) gave a conservative estimate of the loss to this disease of 50,000 tons i.e. 10 per cent of the world's production at that time. If this percentage is applied to the 1963/64 crop the loss would have been 121,700 tons, which represents a loss of £14.6 million to the producer.

The disease is caused by the fungus Phytophthora palmivora (Butl.) Butl. which is widespread throughout the tropics. P. palmivora, so far as is known, has been recorded on fifty-one genera in twenty-nine families of flowering plants (Hickman 1958). There is evidence that the fungus differs in pathogenicity to various crop plants (Ashby 1929; Tucker 1931; Orellana 1959; Turner 1960, 1961).

On the cacao plant if conditions are favourable the fungus is able to attack the pods at all stages of growth (causing a pod rot and cherelle wilt), flowers, and flower cushions (Dade 1928, 1930 a, 1930 b; Orellana 1953 a). Infection of the trunk, branch canker, and chupon wilt (Rorer 1910; Malaguti 1956), leaf necrosis and defoliation (Mc Laughlin 1950; Turner and Wharton 1960) and root infection (Turner and Asomaning 1962), are various manifestations of attack by this fungus.

Pod rot is the most common and important expression of the disease and

consequently has received the most attention, both in the past and in the present (Rorer 1910; Orellana 1953; Holliday 1954; Thorold 1955; Spence 1961). Spread of the disease is by sporangia (Thorold 1952, 1953 a; Grimaldi 1957; Hardy 1960) or zoospores, especially at low temperatures (Gadd 1924; Holliday 1954). Epiphytotic outbreaks of the disease are attributed to zoospore infection (Desrosiers and Dias 1956; Hardy 1960) under heavy rainfall conditions.

Partial control of canker infections has been achieved by selection of suitable types (Hardy 1960). With pod and leaf infection, control measures are mainly field sanitation, and the use of fungicides (Rorer 1910; van Hall 1914; Mc Laughlin and Bowman 1952; Miranda and Da Cruz 1953; Thorold 1953; Holliday 1954; Sanders 1956). Control costs are substantial and often the degree of control is far from satisfactory.

The most effective control would be the development of resistant clones. So far no clones have shown immunity and only a few have shown some resistance to pod rot and root infection.

The need is clearly for reliable small scale laboratory methods for assessing resistance. In this way the present commercial clones could be screened to detect resistance for plant breeding purposes. Various workers have advocated various tests for resistance, but no attempt has been made to apply these tests to a standard set of clones in any one environment and thus investigate possible correlations between them.

The widespread pathogenicity of P. palmivora (Hickman 1958) suggests that the fungus possibly possesses an efficient mechanism for penetration and establishment of the mycelium. This may be due to the fact that the fungus, which is considered primitive, and thus less specific of hosts, is able to adapt itself to varying hosts by the formation of new physiologic races.