ASEAN PLANT QUARANTINE CENTRE AND TRAINING INSTITUTE

COCOA WITCHES' BROOM

Crinipellis perniciosa (Stahel) Singer

Fig. 1. **Cocoa witches' broom — Lateral broom.**

Synonym

Marasmius perniciosus Stahel

Common name

Cocoa Witches' Broom

Principal hosts

Theobroma spp. (*T. cacao*, *T. speciosum*, *T. subincanus*, *T. grandiflorum* and others)

Other hosts

Herrania spp. (*H. albiflora*, *H. Nitida*, *H. purpurea*)

Geographical distribution

The disease is mainly confined to the lowland of tropical South America namely Bolivia, Columbia, Ecuador, Guyana, Peru, Surinam and Venezeula and the West Indies islands of Grenada, Tobago and Trinidad. Recently it was reported to have advanced to upland cocoa growing areas in Colombia (4).

Biology

Crinipellis perniciosa colonises growing host tissue and lives initially as an obligate biotroph. When nutrients become limiting, the fungus reverts to saprophytic mode, feeding on dead brooms. Basidiocarps are then produced on dead brooms after long incubation periods (6-66 weeks) (2, 16). The factors governing basidiocarp production are still largely obscure. Successive wetting and drying during a rainy season is a necessary prerequisite (3); and temperature between 20 to 25°C and a light intensity of

Fig. 2. **Cocoa witches' broom — star-bloom on flower cushion.**

100μE/m^2/S appear most favourable for basidiocarp production (6). Sporulation of a broom to form basidiocarps can continue for two years or more at a declining rate (6) and detached brooms on the ground also act as source of fruiting body (9). The spores from basidiocarps are vulnerable to desiccation and show limited survival in direct sunlight. Their maximum life expectancy does not exceed 48 hours (3). The germination of spores on suitable host tissue is rapid under favourable conditions of high humidity of over 90 percent and the infection only takes place on expanding tissue. The fungus is intercellular within the host and is largely confined to the hypertrophied tissue (localised). About 5-6 weeks after they are fully formed, the brooms turn brown and are considered dead.

Pure cultures of *C. perniciosa* do not form basidiocarps. White or pinkish felt-like mycelium of irregular and slow growth are produced on various media. Clamp-connections can be diagnosed indicating homothollic nature of the fungus (3).

Means of entry

Introduction of the disease is possible via mycelium on pod surface, in beans from certain type of infected pods and infected premature ripe pods with few external symptoms (5). To prevent the introduction of witches'broom into ASEAN Region, importation of cocoa seeds and budwood from the American Tropics and surrounding regions has been prohibited.

Spread

Dispersal by air has been effective over short distances, 40-60 km range (8). Dispersal is limited largely by spore fragility and its limited life expectancy. During cloudy days of overcast weather, spore survival is enhanced and the range may extend to 100-150 km. There is no concrete evidence for long distance dispersal which has been presumed (11).

There is some evidence of waterborne dispersal, although probably limited to within crop situation (6). The other means of spread are chiefly via planting or 'touristic' material carried by man (8).

Fig. 3. *Crinipellis perniciosa* — **affected mature pods with hard areas.**

Identification-symptoms (3, 18)

Following the infection of a bud by basidiospores, a vegetative broom (flush) is developed. A broom shoot is much thicker than a healthy shoot due to the shortened internodes and carries many short lateral shoots with undeveloped leaves. Hypertrophied and proliferated growths as a result of the fungal attack give rise to its name witches' broom. If infection is close to a terminal bud, a terminal broom results. In fast-growing tissue, such as chupons, the fungus penetrates laterally during elongation and initiates lateral brooms and canker while the growing point remains uncolonised and continues to produce healthy tissues. Such infections have been termed 'grown-through' brooms.

On flower cushions the first indication is usually that one flower fails to fall and its pedicel becomes slightly thickened. Several weeks later, flowering cushions that are infected result in transformation of reduced flowering shoots into leafy brooms or production of abnormal flowers, known as 'star blooms' which sometimes develop malformed pods.

Infected pods exhibit a variety of symptoms depending on the way infection occurred and the age of pod at the time of infection. As pod growth is determinate, there is no secondary infection on pods. Cherelles 2-3 months of age are the most susceptible plant organ, infection results in gross external swellings or distortions. Early infected pods ripen prematurely and irregularly and internal tissues are compacted, watery and show complete necrosis. In later infected pod there is little obvious evidence of infection until maturity. At maturity, in addition to internal necrosis, irregular black hard necrotic lesions appear on the surface of pods which are undistorted. When pods have reached full growth, they are generally less affected by the infection and beans may remain healthy if harvested in time.

Identification-Basidiocarp

Some diagnostic features (12) are pileus crimson tinted, generally faint, becoming paler with age; conspicuous red-black spot in centre with others radially arranged. Lamellae are whitish (0.2 mm thick), medium broad (1-2 mm), collariate, distant (8-20 entire lamellae, mostly 15), corresponding with grooves in pileus. Cheilocystidia rather irregular, bottle shaped, 35-50x9-14 μ. Pleurocystidia none. Stipe white with a citron yellow thickened sub-bulbous base initially. Hyphae with clamp connections. Basidia 31-32 x 7-9 μ, four-spored Basidiospore pure white, hyaline, 7-11x4-5 μ.

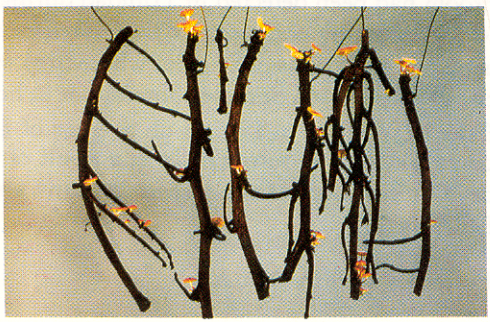

Fig. 4. *Crinipellis perniciosa* — **Basidiocarp formation at nodes and internodes of dead brooms.**

Pathogenic specialisation

It is uncertain whether or not *T. cacao* is susceptible to some *C. perniciosa* isolates which infect other species of *Theobroma*. For example, inoculation experiments on cocoa with a *C. perniciosa* isolate from *T. grandiflorum* did not produce characteristic witches' broom symptom but inoculation on cocoa with a comparable cocoa isolate did (8). In the late seventies three distinct varieties (15) and at least two pathotypes (7) of the fungus had been recognised and identified.

Economic importance

Witches' broom disease of cocoa is a significant factor limiting production and causing heavy financial losses in agricultural development programmes in several nations of South America. It is an impending danger to West Africa and Asian regions where cocoa is grown commercially.

For almost a century now, Surinam has been plagued by the fungal disease and the cocoa industry has been abandoned because of the recurring disease problem. In

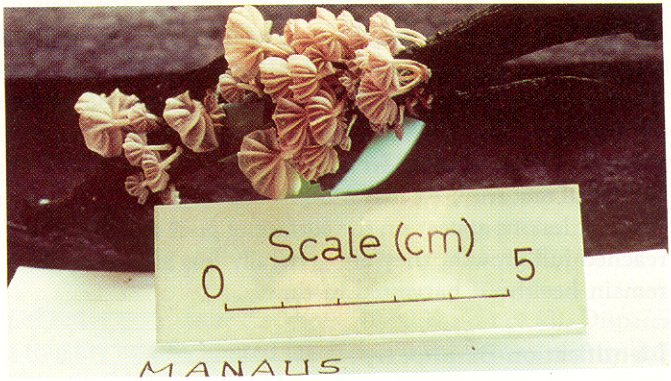

Fig. 5. **Fruiting body — Basidiocarp of** *Crinipellis perniciosa.*

Guyana, cocoa exports came to a standstill between 1923 and 1930 through debilitation of trees and reduced acreage associated with spread of the disease (1,6). Witches' broom had been detected in Trinidad during the 1920s and the severity of the disease was reflected by pod losses of over 70 percent in uncontrolled areas (10). It has been experienced in parts of Ecuador where trees with 200 to 300 brooms resulted in subtantial pod losses (14). Surveys showed that in Ecuador the cocoa export had been slashed from 40,000 tons in 1915 to an average of 25,000 tons in the early 1920s and subsequently to 14,000 tons wholly as a result of the witches' broom disease. To date, the devastating effect of the disease remains a stumbling block to cocoa production in Ecuador (13).

Potential within ASEAN

The climatic factors predisposing witches' broom disease in the American Tropics and the West Indies generally correspond with those for commercial cocoa production in ASEAN. Therefore, there is no question as to the establishment of this disease in ASEAN soil, if introduced.

Although new sources of germplasm materials in the form of budwood and seeds are sought from the Royal Botanical Garden, Kew, stringent post quarantine measures and disease detection must be enforced to prevent any chance introduction. As trade and traffic volume of tourists, businessmen and scientists between the American Tropics and the ASEAN Region have vastly increased, more precautionary measures should be adopted to prevent introduction of witches' broom.

In view of the limited control methods (presently) witches' broom disease is a potential threat to all cocoa growing areas in the world, including the ASEAN Region. Malaysia, a significant world producer of cocoa reaching a forecast production capacity exceeding 250,000 metric tonnes by the year 2000, has every need for precaution.

Control

Effective control measures have not been possible because of the complex interaction between disease incidence, host growth and physiology and agronomic practices (8).

Phytosanitary pruning has been practised but yielded no over-all satisfactory returns. Phytosanitary pruning has been recommended to be an annual event (8) in the American

Tropics when infections are less heavy. Pruned brooms should also be removed and burned.

Copper based fungicides, e.g. cupric hydroxide (4%), have been recommended for developing pods at the correct time. Fungicide application has not been successful because of the difficulty in providing an adequate coverage on rapidly growing tissue as well as other factors.

Programmes to cultivate resistant cocoa varieties as long-term measures are required to cope with the breakdown of resistance.

Managing this disease demands enormous capital expense and long years as cocoa is a tree crop.

REFERENCES

1. Altson, R.A. (1926). Report of the assistant botanist and mycologist. Appendix III, pp. 39-45 *in* Rep. Dept. Sc. Agric. Bc. Guiana 31 Dec 1925.
2. Aranzazu H.F. (1982). Some aspects of the biology of *Crinipellis perniciosa* in the Uraba Region (Columbia). Pp. 323-328 *in* Procceedings 8th Intrnational Cocoa Research Conference, Cartagena, Colombia, 18-23 October 1981. Cocoa Producers' Alliance Lagos.
3. Baker, R.E.D. and P. Holliday,(1957) Witches' broom disease of cocoa *(Marasmius perniciosus* Stahel) Phytopathological Paper No. 2, 1-42. Commonwealth Mycological Institute, Kew.
4. Barros, O. (1978). Algunos aspectos de la 'escoba de bruja' en Colombia. El Cacaoteroa Colombiano No. **7,** 43-45.
5. Croshaw, P.K. and H.C. Evans.(1978) Witches' broom disease of cocoa *(Crinipellis perniciosa)* in Ecuador II. Methods of infection. Ann. app. Biol. **89:** 193-220.
6. Dash, J.S. (1931). Report of the director of Agriculture for the year 1930, British Guiana Administration. pp. 1-37.
7. Evans, H.C. (1978) Witches' broom disease of cocoa (*Crinipellis periniciosa*) in Ecuador 1. The Fungus. Ann. appl. Biol. **89**: 185-192.
8. Evans, H.C. (1981) Witches' Broom disease — A case study. Cocoa Growers' Bulletin. No. **32** pp 5-18.
9. Evans, H.C. and Solorzona G.B. (1982). Witches' broom disease: wrong experiment, right results. Pp 415-418 *in* Proceedings 8th International Cocoa Research Conference Cartagena, Colombia, 18-23 Oct. 1981 Cocoa Producers' Alliance, Lagos.
10. Holliday, P. (1952). Witches' broom disease of cocoa (*Marasmius perniciosus* Stahel) Colonial 286, 1-8. H.M.S.O: London.
11. Holliday, P. (1962). The spread of witches' broom disease of cocoa. Trans. Br. Mycol. Soc. **45,** 281.
12. Holliday, P (1970). *Crinipellis perniciosa.* C.M.I. Descriptions of Pathogenic Fungi and Bacteria, 223.
13. IQCC (1984). Proposal for a research project to develop reliable economic methods of managing witches' broom disease of cocoa. Brussels. 1 August 1984. Pudoc.
14. Lass, R.A. (1975). Diseases. Pp. 125-157 *in* Cocoa. Third Edition. G.A.R. Wood (ed.). Tropical Agric Series.
15. Pegler, D.N. (1978) *Crinipellis perniciosa* (Agaricales) Kew Bulletin **32:** 731-736.
16. Rocha, H.M. (1984). Factors influencing the production of Basidiocarps by *Crinipellis perniciosa*, the causal fungus of cocoa witches' broom. *In* Proceedings, International Conference on Cocoa and Coconuts, Kuala Lumpur, Malaysia. Oct. 15-17 1984. In Press.
17. Solorzano, G.R. (1977). Factores ambientales involucrados en la produccion de basidiocarps de *Marasmius perniciosus* Stahel. Ing. Agr. thesis. University of Manabi Ecuador.
18. Thorold, C.A. (1975). Diseases of Cocoa. Clarendon Press, Oxford.

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