

SUSCEPTIBILITY OF COCOA PODS TO *COLLETOTRICHUM GLOESPORIOIDES* INFECTION

R. CHANDRA MOHANAN, K.M. KAVERIAPPA* and K.K.N. NAMBIAR**
Central Plantation Crops Research Institute Regional Station, Vittal 574 243, Karnataka

ABSTRACT

Cocoa pods of different sizes and ages were inoculated by spraying a conidial suspension of *Colletotrichum gloeosporioides* Penz. with and without injury. Although all types of inoculations caused infection of cherelles and young pods, severity of infection depended upon the method of inoculation and age of pods. The cork borer method of inoculation was preferred on account of the highest percentage of infection and uniformity in the development of lesions, which facilitated the measurement of lesions and proper assessment of the disease. For the measurement of lesion size seventh day of inoculation of cherelles is ideal. When pods were inoculated without wounds, infection was initiated mostly from the stalk end indicating that the stalk end was more vulnerable for infection than other parts.

The susceptibility of pods decreased with increase in age of pods, the cherelles being more susceptible. Nearly mature pods did not take up infection. There was a significant variation in the lesion size between different age groups.

INTRODUCTION

Among the many important diseases of cocoa (*Theobroma cacao* L.) only a few have been reported from India. Of these, the diseases caused by *Phytophthora palmivora* (Butl.) Butl. (Ramakrishnan and Thankappan, 1965; Chandra Mohanan, 1978), *Colletotrichum gloeosporioides* Penz. (Sarma and Nambiar 1976; Reddy and Chandra Mohanan, 1976), and *Botryodiplodia theobromae* Pat. (Nambiar and Nair, 1972) were recorded as the major diseases. Various species of *Colletotrichum* infecting cocoa pods have been reported from other countries. They are: *C. theobromae*, *C. luxificum* and *C. cradwickii* from West

Indies, *C. incarnatum* from Cameroons and Sri Lanka (Briton Jones 1934), *C. fructi-theobromae* from Brazil and *C. theobromicolum* from Congo (Thorold, 1975).

It has been reported that isolation of the pathogen from various cocoa gardens occurring in Kerala, Tamil Nadu and Karnataka States of South India invariably yielded *C. gloeosporioides*. It causes pod rot and three types of foliar infection viz., blight, shot hole and irregular spot (Chandra Mohanan and Kaveriappa, 1983a). The studies on the occurrence and distribution of *Colletotrichum* diseases of cocoa have revealed that the pod rot is wide spread in the

*Mangalore University, Mangala Gangotri, Mangalore 574152, Karnataka.

**Central Plantation Crops Research Institute, Kasaragod 670124, Kerala.

southern states of India (Chandra Mohanan and Kaveriappa, 1983b). In recent years, the incidence of this disease is being increasingly noticed in all the cocoa growing areas of the country. Information on many important aspects of this disease such as susceptibility of pods of different ages is lacking and hence to fill up the gap, the present study was undertaken.

MATERIALS AND METHODS

C. gloeosporioides was isolated from infected cocoa pods of 'Forestero' variety from Vittal (Karnataka State). Inoculum was prepared from 5-day old cultures of the fungus on oat-meal agar medium for all the studies. The pods obtained from a single cultivar were used for the inoculation studies.

Pods of different sizes corresponding to various stages of development and free from bruises, cracks and mechanical injuries were inoculated in the laboratory with and without making wounds. The pods were inoculated by multiple pin prick and injuring by using cork borer. Prior to inoculation, the surface of the pod was sterilized with 0.1 per cent mercuric chloride solution and rinsed in several changes of sterile distilled water (SDW). Cut ends of the stalks were sealed with sterilized paraffin wax. Suitable number of controls were also maintained for each experiment.

(i) *Inoculation by multiple pin prick:* The multiple pin was made by using a cork through which ten randomly placed entomological pins protruded to an extent of 1 mm. Prior to inoculation the pins were sterilized and pressed gently on to

the surface of the pods. Conidial suspension was prepared in sterile tap water and about 0.06 ml of the suspension was aseptically transferred to the surface of each pod with the help of sterile one-ml-pipette.

(ii) *Inoculation by cork borer:* In this method a small cavity of three mm diameter and two mm depth was made on the surface of the pod in the middle region with the help of a three mm dia cork borer. Mycelial disc of similar size cut from the edge of an actively growing colony by using a similar cork borer was placed in the cavity.

(iii) *Inoculation without injury:* To study the mode of infection, entire surface of healthy pods of different ages without wounds was inoculated with conidial suspension in tap water.

(iv) *Disease development of pods:* To study the rate of spread of lesion, pods of different age groups were inoculated with sporulating mycelial disc at the middle part of the pod, using cork borer method.

In all the above experiments, immediately after inoculation the inoculated area was covered with a thin cotton wad dipped in SDW. The inoculated pods were kept in desiccators containing SDW to provide high humidity (90-100%). The desiccators were incubated at room temperature ($28 \pm 2^\circ\text{C}$).

Observations were made on the time taken for the appearance of initial symptoms and size of the lesions. The diameter of the lesion was measured in two directions at right angles and the average was taken.

Table I. *C. gloeosporioides* infection on pods inoculated with injury

Method of inoculation	Age group of pods	Pods inoculated	Pods infected after (days)								
			3	4	5	6	7	8	9	10	
Pinprick method	Cherelles	10	2	10	10	10	10	10	10	10	10
	Young pods	10	0	1	3	5	5	6	10	10	
	Nearly mature pods	10	0	0	0	0	0	0	0	0	
Cork borer method	Cherelles	10	10	10	10	10	10	10	10	10	
	Young pods	10	0	3	6	6	8	9	10	10	
	Nearly mature pods	10	0	0	0	0	0	0	0	0	
Control	Cherelles	10	0	0	0	0	0	0	0	0	
	Young pods	10	0	0	0	0	0	0	0	0	
	Nearly mature pods	10	0	0	0	0	0	0	0	0	

(v) *Susceptibility of pods of different sizes*: Pods of different stages of development were selected for this study. Pods up to 100mm length, 100 to 160mm length and above 160mm length were considered as cherelles, young pods and nearly mature pods respectively.

Intact pods of different sizes from very small cherelles to nearly mature pods were inoculated in the field. The size of each pod was determined. Pods were inoculated by the cork borer method. After inoculation, each pod was covered with a sterile polythene cover containing sterile cotton wad dipped in SDW. The humidity inside the covers ranged from 85-90% as determined with a hygrometer. The lesion diameter was measured seven days after inoculation as explained earlier. Each treatment was replicated three times with five pods per replication.

RESULTS AND DISCUSSION

Although all types of inoculations caused infection of cherelles and young pods, severity of infection and period of incubation for infection depended upon

the method of inoculation. Nearly mature and mature pods could not be infected by any of the methods.

Among the wound inoculation methods, cork borer method resulted in the highest percentage of infection (Table I). Maximum percentage of infected pods was observed after seven days of inoculation by the cork borer method. In addition the lesions caused by cork borer inoculation method were more uniform and regular than by the pin prick method.

The results of infection of pods inoculated without injury are summarised in Table II. In all the cases, cherelles were found to be more susceptible. Maximum infection occurred at the stalk end.

Although the percentage of infection on pods by cork borer and pinprick methods was more or less the same, the cork borer method was preferred for pod inoculation studies on account of the uniformity in the development of lesions which facilitated the measurement of the lesions and proper assessment of the disease. When pods were inoculated without wounds,

Table II. *C. gloeosporioides* infection on pods inoculated without injury

Region of inoculation	Age group of pods	Pods inoculated	Pods infected after (days)								
			3	4	5	6	7	8	9	10	
1. Stalk region	Cherelles	10	0	6	8	10	10	10	10	10	
	Young pods	10	0	0	0	1	2	3	4	5	
	Nearly mature pods	10	0	0	0	0	0	0	0	0	
2. Tip of the pods	Cherelles	10	0	0	3	5	8	8	10	10	
	Young pods	10	0	0	0	1	2	2	2	3	
	Nearly mature pods	10	0	0	0	0	0	0	0	0	
3. Whole of pod surface	Cherelles	10	a.	0	5	7	8	10	10	10	10
			b.	(0)	(0)	(3)	(3)	(5)	(7)	(8)	(10)
			c.	0	0	0	0	0	0	2	3
	Young pods	10	a.	(0)	(0)	(0)	2	2	2	4	4
			b.	(0)	(0)	(0)	(0)	(0)	(1)	(2)	(2)
			c.	0	0	0	0	0	0	0	0
	Nearly mature pods	10	a.	0	0	0	0	0	0	0	0
			b.	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
			c.	0	0	0	0	0	0	0	0

a = Infection from stalk end of the pod

b = Infection from tip of the pod

c = Infection from other regions

Values in parenthesis denote pods infected from both stalk end and tip

Table III. Disease development on cocoa pods inoculated with *C. gloeosporioides*

Age group of pods	Appearance of initial symptom (day)	Lesion diameter (in mm)* Days after inoculation				Mean
		4	5	7	9	
<i>Cherelles:</i>						
60-80 mm length	3	14.70	18.90	26.30	45.90	26.45
85-95 mm length	3	11.90	14.90	18.50	26.90	18.05
<i>Young pods:</i>						
95-115 mm length	4	10.70	14.72	18.70	23.70	16.96
120-135 mm length	5	0	6.70	10.30	12.40	7.35
140-160mm length	9	0	0	0	8.80	2.20
<i>Nearly mature pods:</i>						
180-200 mm length	No infection					No infection
210-245 mm length	No infection					No infection
Mean		7.46	11.04	14.76	23.54	-

CD ($p = 0.05$) for comparing days = 1.58CD ($p = 0.05$) for comparing age group of pods days = 1.77CD ($p = 0.05$) for comparing days \times age group of pods = 3.54

*Mean of 3 replications.

infection occurred from the stalk end in maximum number of pods particularly at the point of attachment of stalk to the pod. This indicated that the stalk end was more vulnerable for infection than other parts. The finding is in agreement with the field observations where maximum number of pods were found infected at the stalk end (Chandra Mohanan and Kaveriappa 1983a). The collection of water and moisture at the point of attachment of stalk to the pod might have favoured the settlement of conidia, their germination and subsequent penetration and infection.

The time taken for initial appearance of

Table IV. Susceptibility of cocoa pods of different sizes to *C. gloeosporioides* infection on

Size of the pods (in mm)		Lesion diameter on 7th day (in mm)*
L	B	
<i>Cherelles:</i>		
60	× 20.7	30.50
66	× 24.2	25.33
67	× 23.9	22.83
76	× 24.2	23.33
80	× 27.1	23.33
85	× 28.7	17.50
95	× 34.4	16.83
95	× 33.4	15.33
98	× 36.6	15.00
<i>Young pods:</i>		
100	× 38.2	11.33
100	× 38.8	11.17
130	× 43.0	9.83
150	× 40.7	0
150	× 43.0	0
155	× 43.3	0
<i>Nearly mature pods</i>		
190	× 63.7	0
200	× 68.4	0
225	× 73.2	0
230	× 74.8	0

CD (P=0.05)

3.14

*Mean of 3 replications

the symptoms and the lesion size at different intervals after inoculation are presented in Table III. The rate of spread of infection was faster on cherelles than young pods. Lesions on cherelles developed uniformly up to seven days and thereafter spread irregularly. The period of incubation for infection depended upon the size of the pods.

The lesion diameter on pods of various sizes measured seven days after inoculation, is given in Table IV. The variation in the lesion size between different age groups was found to be highly significant. The pods of 60-80 × 20-27 mm were found to be highly susceptible. The maximum size of lesion was observed on pods of 60 × 20 mm size. Pods of 150-230 × 43-73 mm (nearly mature) could not be infected. This corroborates the observation of Reddy and Chandra Mohanan (1976) that natural incidence of *C. gloeosporioides* pod rot occurred only on cherelles and immature pods with the intensity being more on cherelles.

ACKNOWLEDGEMENT

The authors wish to thank Dr. K.V.A. Bavappa, Director, Central Plantation Crops Research Institute, Kasaragod, and Dr. K. Shama Bhat, Joint Director, CPCRI Regional Station, Vittal for providing necessary facilities.

REFERENCES

- BRITON-JONES, H.R. 1934. *The Diseases and Curing of Cacao*. Mac. Millan & Co., London, pp. 161.
- CHANDRA MOHANAN, R. 1978. Cacao canker caused by *Phytophthora palmivora*. *Plant Dis. Repr.* 62: 1080-1082.
- CHANDRA MOHANAN, R. and KAVERIAPPA, K.M. 1983a. Symptomatology of

- Colletotrichum disease of cocoa in India. *Planter Kuala Lumpur* **58**: 333-338.
- CHANDRA MOHANAN, R. and KAVERIAPPA, K.M. 1983b. Occurrence and distribution of Colletotrichum disease of cocoa in South India. *Planter Kuala Lumpur* **59**: 432-439.
- NAMBIAR, K.K.N. and NAIR, R.R. 1972. Charcoal pod rot of cacao. *Indian Phytopath.* **25**: 595-597.
- RAMAKRISHNAN, K. and THANKAPPAN, M. 1965. First report of black pod disease of cacao in India. *South Indian Hort.* **13**: 33-34.
- REDDY, M.K. and CHANDRA MOHANAN, R. 1976. Occurrence of pod rot of cocoa caused by *Colletotrichum gloeosporioides* in India. *J. Plant Crops* **4**: 14-15.
- SARMA, Y.R. and NAMBIAR, K.K.N. 1976. Leaf spot of cacao. *Curr. Sci.* **45**: 466.
- THOROLD, C.A. 1975. *Diseases of Cocoa*. Clarendon Press, Oxford. pp. 423.