



Occurrence and distribution of black pod rot of Cocoa (*Theobromae cocoa* L.) in southern transition zone of Karnataka

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Abstract: Straminipile genus *Phytophthora* cause significant disease losses to global cocoa production. *Phytophthora palmivora* is one of the major constraints in cocoa production causes significant pod losses. *P. palmivora* has a complex disease cycle involving several sources of primary inoculum and several modes of dissemination of secondary inoculum. This results in explosive epidemics during favorable environmental conditions. Highest severity of Seedling blight was observed in raised bed nurseries as compared to poly bag nurseries in Shivamogga district (59.26%) followed by Chikkamagluru (53.85%) of the state Karnataka, respectively. Further, the highest incidence of 72.00, 70.83 and 70.00% of black pod rot disease was recorded in Udupi, Dakshina Kannada and Shivamogga district followed by Chikkamagaluru (65.22%), Kodagu (64.00%) and Davanagere (55.56%) district respectively. Due to continuous rain fall or high moisture conditions and the crop was grown as intercrop with arecanut is vulnerable for the attack of pathogen due to the presence of pathogenic variability.

Key words: Black pod rot Cocoa, Incidence, , *Phytophthora palmivora*, Seedling blight

INTRODUCTION

Cocoa (*Theobromae cocoa* L.) is extensively cultivated in the four southern states of India, viz., Kerala, Karnataka, Tamil Nadu and Andhra Pradesh, getting both South – West (heavy rainfall) and North – East monsoonal rainfall. Coconut (*Cocos nucifera* L.) and arecanut (*Areca catechu* L.) are the principal plantation crops in the southern states of India. Cocoa being a shade loving crop has been found to be a suitable and highly profitable mixed crop in existing coconut and arecanut gardens. Commercial cocoa cultivation was started during 1970s in India. At present, cocoa occupies an area of 71,000 ha with an annual production of 15,000 metric tones (Anon, 2014). Agriculture production of several crops is significantly reduced in wet tropics due to large number of different diseases caused by *Phytophthora*- the plant destroyer. Among the species infecting cocoa in India, *Phytophthora palmivora* the most important pathogen and infects all parts of the plant (Thorold, 1975). *P. palmivora* is one of the major constraints in cocoa production causes significant pod losses up to 30% and killing up to 10% of the trees annually in Karnataka state of India. *P. palmivora* is responsible for causing black pod rot Stem canker foliar infection chupon blight (ChandraMohan 1979) and seedling blight/dieback (ChandraMohan, 2015). Although the occurrence of

black pod was reported in India in 1965 (Ramakrishnan and Thankappan, 1965), further studies on this disease were not carried out for about 12 years, probably, because of the fact that cultivation of crop was confined to a small area until 1970. ChandraMohan (1979) first identified the species responsible for disease as *P. palmivora* in Dakshina Kannada of Karnataka. Later, Sreenivasan and ChandraMohan (1984) reported *P. palmivora* as the sole species associated with black pod in this district. The propagules of the pathogen cause lesions on leaves and pods which results in pod rot. In India, numerous slugs (*Deroceras* spp.) are found voraciously feeding on the *Phytophthora* growth on cocoa pod surface. Infective propagules are found in the feces of these slugs. The fecal matter is found very infective. Such observations are indirect evidences for the major role of *Deroceras* spp. as dispersal vector of *Phytophthora*. Non-adoption or improper adoption of some of the agronomic practices acts as pre-disposing factors for disease spread and its severity. Therefore, an intensive roving survey was conducted during 2014-15 to know the incidence and severity of the disease in nursery and fields of cocoa growing areas of Southern Transition Zone of Karnataka.

MATERIALS AND METHODS

An extensive survey was conducted in major cocoa growing districts of Southern Transition Zone of Kar-

nataka viz., Shivamogga, Udupi, Dakshina Kannada, Chikkamagaluru, Chitradurga, Kodagu and Davanagere to determine the association of *P. palmivora* problem in the cocoa nursery and fields. Random roving survey were conducted in three taluks of Shimoga, two taluks of Udupi, one taluk of Dakshina Kannada, two taluks Chikkamagaluru, three taluks of kodagu, one taluk Chitradurga and two taluks of Davanagere. Here, a total of 98 gardens were surveyed during *Kharif* 2014-15. Occurrence and intensity of diseases (Percentage of the gardens with disease incidence) were recorded from 3-13 gardens per district depending on the area under cultivation and intensity of diseases. The complete enumeration method of survey method of survey was followed to find out the incidence of *P. palmivora* infection in cocoa. Infected and healthy plants were observed in both nursery and main field. The disease incidence in the nursery and fields was assessed with the following formula.

No. of plants infected

Per cent disease incidence = ----- x 100
Total No. of plants examined

RESULTS AND DISCUSSION

A survey was conducted during *Kharif* 2014-2015 in Southern Transition Zone of Karnataka to find out the prevalence and incidence of Seedling blight and black pod rot disease and the data are presented in Tables 1 and 2.

P. palmivora infection of seedlings causing high mortality in the nurseries during rainy season was the major problem in all the nurseries especially in nurseries with very young seedlings. Seedling infection was observed initiating from tip of the seedling (dieback), leaf, cotyledonary region or collar region and ultimately leading to death of seedling (Thorold, 1975, Greogory, 1974). *Phytophthora* infection of cocoa seedlings was observed to be very high when seedlings were raised during rainy season without proper shade and hygienic conditions. Among the nurseries surveyed highest severity of Seedling blight was observed in raised bed nurseries as compared to poly bag nurseries in Shivamogga district (59.26%) followed by chikkamagaluru (53.85%) respectively.

In raised bed nurseries, cent percent seedling blight disease incidence was recorded in Thirthalli followed by Hosanagara taluk (75.00%) of Shivamogga district (70.00%). Whereas the least incidence 33.33% was observed in Harihar and Hiriyyuru taluk of Davanagere and Chitradurga district respectively.

In poly bag nurseries the mean percent disease incidence ranged from 25.00 to 41.67. The percent disease incidence was recorded in Udupi (60.00%) followed by sagara (50.00%) taluk of Udupi and Shivamogga district. Least incidence was observed in Harihar taluk (25.00%) of Davanagere district.

The per cent disease incidence of black pod rot was

noticed in all the locations surveyed, with a range from 33.33 to 86.67 per cent. In India, black pod disease was reported as early as in 1965 (Ramakrishnan and Thankappan, 1965). Based on the disease incidence in five cocoa plantations in Dakshina Kannada district of Kamataka State, Chandra Mohanan (1985) reported that black pod incidence varied from 12.93 to 20.78 per cent and it was 22.83 to 40.84 per cent on nearly mature pods alone. These preliminary studies on the spread and severity of the disease indicated the importance of the disease in India. In the present study, the mean maximum disease incidence (72.00%) was observed in udupi followed by Dakshina kannada (70.83%) and Shivamogga district (70.00%). Whereas the least incidence 40.00% was observed in Chitradurga district. Among fifteen taluks of seven districts, the maximum black pod rot disease incidence of 86.67 and 80.00% was recorded shivamogga and thirthalli taluk of shivamogga district followed by Brahmavar taluk (76.92%) of Udupi district due to congenial climatic conditions during rainy season and heavy mist and dew producing free water throughout night are very much favourable for the pathogen to produce abundant infective propagules. Some of the characteristics of cocoa also make a favourable condition for the establishment of *Phytophthora* and for disease severity and the least incidence was recorded in Channagiri taluk (33.33%) of Davanagere district respectively. These finding are in conformity with several workers. A preliminary study conducted by ChandraMohanan (1985) in Dakhina Kannada District revealed the incidence of black pod disease in 22.10% of the total pods observed in five gardens. Stem canker caused by *P. pamivora* infection was found to be a serious problem in Andhra Pradesh especially in the cocoa gardens in (Prabha and ChandraMohanan, 2011). *Phytophthora* infection of seedlings causing high mortality in the nurseries during rainy season was the major problem in all the nurseries especially in nurseries with very young seedlings. Seedling infection was observed initiating from tip of the seedling (dieback), leaf, cotyledonary region or collar region and ultimately leading to death of seedling (Thorold, 1975, Greogory, 1974). *Phytophthora* infection of cocoa seedlings was observed to be very high when seedlings were raised during rainy season without proper shade and hygienic conditions. *P. palmivora* infection on the stem (canker) of grafted seedlings was also observed in the nurseries in Dakshina Kannada district. In such cases the infection was mostly initiated from the grafted region. Foliar infection of seedling caused by *C. gloeosporioides* caused stunted growth with blighted or malformed leaves (with shot hole). Shot hole symptom caused by *C. gloeosporioides* was mostly observed in seedlings kept under open conditions without proper shade and in the nurseries raised inside coconut gardens.

Vascular streak dieback was noticed only in Kerala

Table 1. Occurrence of cocoa seedling blight disease incidence in southern transition zone of Karnataka during *kharif* 2014-15.

District	Taluk	Seedling blight					
		Raised bed nursery			Poly bag Nursery		
		Total no. of surveyed nurseries	No. of affected gardens	% incidence	Total no. of surveyed nurseries	No. of affected gardens	% incidence
Shivamogga	Sagara	5	3	60.00	4	2	50.00
	Thirthalli	4	4	100.00	10	3	30.00
	Shivamogga	10	3	30.00	0	0	0.00
	Hosanagara	8	6	75.00	0	0	0.00
	Total	27	16	59.26	14	5	35.71
Chikkamagaluru	Mudigere	6	4	66.67	7	3	42.86
	Shringeri	7	3	42.86	5	2	40.00
	Total	13	7	53.85	12	5	41.67
Dakshina Kannada	Sirsi	13	7	53.85	6	2	33.33
	Udupi	10	5	50.00	5	3	60.00
Udupi	Brahmavar	12	6	50.00	7	2	28.57
	Total	22	11	50.00	12	5	41.67
	Madikeri	11	4	36.36	3	1	33.33
Kodagu	Virajpet	0	0	0.00	0	0	0.00
	Kushalnagar	0	0	0.00	0	0	0.00
	Total	11	4	36.36	3	1	33.33
Davanagere	Harihar	3	1	33.33	4	1	25.00
	Channagiri	6	3	50.00	0	0	0.00
	Total	9	4	44.44	4	1	25.00
Chitragdurga	Hiriyuru	3	1	33.33	0	0	0.00
Total		98	50	51.02	51	19	37.25

Table 2. Occurrence of cocoa black pod rot disease incidence in southern transition zone of Karnataka during *kharif* 2014-15.

District	Taluk	Total no. of gardens surveyed	No. of affected gardens	% disease incidence
Shivamogga	Sagara	30	22	73.33
	Thirthalli	25	20	80.00
	Shivamogga	15	13	86.67
	Hosanagara	30	15	50.00
	Total	100	70	70.00
Chikkamagaluru	Mudigere	9	5	55.56
	Shringeri	14	10	71.43
	Total	23	15	65.22
Dakshina Kannada	Sirsi	24	17	70.83
	Udupi	12	8	66.67
Udupi	Brahmavar	13	10	76.92
	Total	25	18	72.00
	Madikeri	11	8	72.73
Kodagu	Virajpet	10	6	60.00
	Kushalnagar	4	2	50.00
	Total	25	16	64.00
Davanagere	Harihar	6	4	66.67
	Channagiri	3	1	33.33
	Total	9	5	55.56
Chitragdurga	Hiriyuru	5	2	40.00
Total	-	211	146	69.19

state. Adequate care should be taken to prevent the entry of this disease into other cocoa growing states where area expansion of cocoa cultivation is fast increasing. Seedlings and cocoa grafts raised in Kerala state should not be transported to other cocoa growing states. Swollen shoot disease, one of the most economically important plant diseases in the world (Thresh, 1958) which is wide spread in Ghana, Ivory Coast, Nigeria, Sri Lanka, Colombia, Trinidad, Venezuela,

Indonesia, Sabah etc. has not been observed in the present study in any of the cocoa growing areas in India.

Phytophthora disease specially seedling blight and black pod are one of the major production constraint causing economic loss to the cocoa gardens in Southern transition zone of Karnataka. The onset and spread of the disease is severe during the wet south-west monsoon period commencing from June to the end of September. Most of the areas cocoa is cultivated as inter-crops in cropping system involving palms, coffee and

tea. The microclimate favours the incidence and spread of these disease. In perennial cropping system when the congenial conditions occur only at a certain months in a year partly infected plant serves as source and focus of secondary spread. Removal of infected plants reduces the initial inoculum for the next season. Being a wet weather pathogen and exacting in its weather requirements, monsoon period provides a congenial condition which is favourable for the pathogen to produce abundant infective propagules and causes more disease severity. The intensity of the disease is increasing year after year due to build up of inoculums causing severe economic loss. Most often the pathogen is introduced inadvertently from diseased nurseries.

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