INTERNATIONAL JOURNAL OF PLANT PROTECTION | VOLUME 7 | ISSUE 1 | APRIL, 2014 | 107-110
e ISSN-0976-6855 | *www.researchjournal.co.in* | Open Access

IJPP

RESEARCH ARTICLE

Integrated management of black pod disease of cocoa caused by *Phytophthora palmivora*

■ PRABHA K. PETER AND R. CHANDRAMOHANAN*

Division of Crop Protection, Central Plantation Crops Research Institute (ICAR), KASARAGOD (KERALA) INDIA

ARITCLE INFO

Received : 10.10.2013
Revised : 22.02.2014
Accepted : 06.03.2014

Key **W**ords :
Cocoa, Black pod, Disease management

***Corresponding author:**
Email: rcmcpcri@yahoo.co.in

ABSTRACT

Black pod disease of cocoa (*Theobroma cacao* L.) caused by *Phytophthora palmivora* (Butl.) Butl. is the major constraint in cocoa production in India. Therefore, integrated field management trials were conducted in two locations of one of the major cocoa growing regions for two consecutive years. There were seven treatments such as four fungicides, one antagonist (*Trichoderma harzianum*), cultural practices alone and absolute control, in three replications. Cultural practices such as nutrient management, pruning, plant and field hygiene etc. were implemented in all treatments except control. The disease incidence in copper oxychloride treated plots at both the sites in both years was the lowest and significantly varied from control plots. There was more than 50 per cent reduction in disease incidence when cultural practices alone were implemented, compared to control plots. This indicates that in gardens with less incidence of black pod disease, economic management of the disease is possible by adopting cultural practices alone. There was also substantial reduction in black pod incidence in *Trichoderma* treated plots compared to control plots. Thus, the results of the study indicated that black pod disease can be effectively managed in gardens with high disease incidence by combining fungicide application with the cultural operations adopted in the trial. Economic management of black pod disease with chemical fungicides depends on magnitude of disease severity and loss.

How to view point the article : Peter, Prabha K. and Chandramohanan, R. (2014). Integrated management of black pod disease of cocoa caused by *Phytophthora palmivora*. *Internat. J. Plant Protec.*, 7(1) : 107-110.

INTRODUCTION

In India, cocoa (*Theobroma cacao* L.) is mainly cultivated as a mixed crop in existing coconut (*Cocos nucifera* L.) and arecanut (*Areca catechu* L.) gardens in the four southern states of India *viz*., Kerala, Karnataka, Tamil Nadu and Andhra Pradesh. The shady conditions in the cropping systems coupled with congenial climatic conditions during south-west monsoon (June-October) season provide favourable conditions for the development and spread of Phytophthora diseases. Among the Phytophthora diseases of cocoa occurring in India, black pod caused by *Phytophthora palmivora* (Butl.) Butl. is the most prevalent and destructive disease. A random survey of cocoa gardens in the 4 states of India during 2009 and 2010 revealed the occurrence of black pod in more than 80 per cent of the gardens surveyed (Peter and Chandramohanan, 2011). The incidence and severity of the disease are increasing *vis-à-vis* increase in area under cultivation leading to heavy economic loss in India. It has been reported that fungicidal spray could control this disease only to a limited extent as the heavy rains resulted in washing off of the fungicides from plant surface (Anderson and Guest, 1990; Guest and Grant, 1991). According to Mc Gregor (1983) and Fagan (1984) the profitability of fungicide spraying is an important matter of concern based on the yield and cocoa price. However, no attempt has been so far made in India to develop integrated disease management strategies for this disease. Considering the importance of black pod disease,

studies were undertaken to develop the effective and economically viable integrated disease management practices.

MATERIAL AND METHODS

Field management trials were laid out in cocoa - arecanut mixed gardens in two locations *viz*., Dharmasthala (Manjusree gardens) and Sullia of Dakshina Kannada district, Karnataka State during 2010 and 2011. These areas had previous history of high incidence of Phytophthora diseases of cocoa. The causal organism of black pod disease in both the localities was identified as *P. palmivora* based on the laboratory examination of samples collected randomly from different locations during the south-west monsoon period of 2009 and 2010.

There were seven treatments with 60 plants / treatment in three replications in each location. Treatments were, Copper oxychloride (Blitox 50 WP 0.5 %), Metalaxyl + Mancozeb (Ridomil 0.5 %), Mancozeb (Indofil M -45 0.5 %). All the three fungicides were sprayed to pods, main stem and branches, Phosphorous acid (Akomin 0.5 %) – sprayed to whole plant, *Trichoderma harzianum* –sprayed mycelial-cum-spore suspension to pods, main stem and all branches + *Trichoderma* coir pith cakes (TCPC) (ChandraMohanan *et al*., 2013) - kept 1 in jorquette and 4 in soil at equidistance around the base of cocoa plant), Cultural practices alone and Control.

Fungicides and biocontrol agent treatments were given four times every year at monthly interval starting from the last week of May. Cultural practices including integrated nutrient management (INM), plant and field hygiene, pruning and other recommended cultivation practices were adopted in all the treatments except control.

Cultural practices adopted in field management trials :

Pre-monsoon period :

- Regular canopy pruning was adopted. While cutting any fan branch, 5-8 cm length was left at the base of the branch and applied mancozeb (Indofil M -45 0.3 %) to the wound.
- All coupons were removed by cutting them close to the main stem or fan branch in all seasons. Canker affected branches and dead plants were removed and destroyed by burning.
- In plants with the initial stages of canker lesions, infected tissues were removed and destroyed and treated the wound with mancozeb (0.3 % Indofil M-45).
- Recommended quantities of nutrients (1st dose) were applied.

During monsoon :

- Infected pods were removed at weekly interval and destroyed by burying in the soil outside the garden.
- Self - grown seedlings (from beans discarded by rodents etc.,) in the garden were removed and destroyed to reduce the inoculum source.

Post-monsoon period :

- The unharvested but infected pods remained on the tree as mummified pods were removed and destroyed.
- Management practices were adopted for stem canker disease in the initial stage.
- Recommended quantities of nutrients (2nd dose) were applied.

General cultivation practices :

- Pods were harvested as soon as they were ripened.
- Drainage channels were opened to avoid water stagnation during monsoon season.
- Plant and field hygienic conditions were maintained.
- Adopted recommended management practices for rodents.
- The thick overhead shade due to other trees such as mango and jack in the border of the garden were removed.

Black pod disease incidence was recorded from June to October by counting the total number of pods and number of pods with disease incidence at an interval of 10 days and from the data monthly per cent disease incidence was calculated.

RESULTS AND DISCUSSION

Results of the field management trials against black pod disease laid out in 2 different locations in Dakshina Kannada district are presented in Table 1 and 2. The field management trials against black pod disease indicated the superiority of copper oxychloride treatment combined with cultural practices over other treatments. The disease incidence in copper oxychloride treated plots at both sites in both the years was the lowest in all the months (June to October) and significantly varied from control plots. Black pod disease incidence in both the years was the highest in the month of August compared to other months of observation in all the plots irrespective of the treatments and locations. In the month of August also, the lowest disease incidence was noticed in copper oxychloride treatment followed by metalaxyl + mancozeb (Ridomil) in both sites in both years when coupled with cultural practices. But there was significant difference in black pod incidence in these two treatments in all the trials except the trial laid out at Dharmasthala during 2010. In this trial, there was no significant difference in disease incidence of copper oxychloride and Ridomil treatments. In the month of August, the disease incidence in phosphorous acid and Ridomil treatments did not vary significantly in the trial at Dharmasthala in 2010 and at Sullia in 2011. But there was significant difference in disease incidence of these two treatments in the trial at Dharmasthala in 2011 and at Sullia in 2010. Such variations in

disease incidence are expected as the incidence, in general, under natural conditions varies from locality to locality as well as from garden to garden (ChandraMohanan, 1985). Akrofi and Appiah (1995) reported that four-weekly spraying of either metalaxyl + copper-1-oxide (Ridomil 72 plus) or copper oxide (Nordox 75) combined with cultural practice was effective against *P.megakarya* pod rot. They have recommended 5 sprayings.

The field trails laid out in Dakshina Kannada dist. not only revealed the efficacy of fungicides in managing black pod disease in India when combined with cultural practices but also clearly indicated100 the effectiveness and importance of adoption of cultural practice in managing black pod disease. There was significant reduction in disease incidence when cultural practices alone were implemented, compared to control plots. The mean disease incidence of 5 months in this treatment

Table 1 : Field management trial against black pod disease in 2010 at Dharmasthala (A) and Sullia (B)

Sr. No.	Treatments	% of infected pods										Mean of 5 months	
		June		July		August		September		October			
		A	B	A	B	A	B	A	B	A	B	A	B
1.	Copper oxychloride (Blitox 50 WP 0.5 %)	2.23	4.85	4.99	9.20	7.89	6.05	3.78	1.29	0.24	0.00	4.07	4.53
2.	Mancozeb (Indofil M-45 0.5 %)	4.79	9.11	7.42	16.14	14.55	13.27	8.63	8.75	2.56	1.33	5.22	9.89
3.	Phosphorous acid (Akomin 0.5 %)	3.57	7.56	6.64	12.13	9.55	10.17	6.10	4.74	1.63	0.23	5.61	7.31
4.	Metalaxyl + Mancozeb (Ridomil 0.5 %)	3.41	6.75	5.77	11.50	8.73	9.24	6.07	3.90	1.38	0.00	7.81	6.68
5.	*Trichoderma harzianum*	4.71	9.57	8.19	18.01	15.33	14.95	7.86	9.49	2.76	1.94	7.94	11.10
6.	Cultural practices alone	6.00	10.04	10.23	21.48	20.06	27.12	10.73	16.58	2.94	2.78	10.52	15.79
7.	Control	13.19	18.91	24.62	48.82	43.71	62.48	25.00	35.96	7.11	8.58	23.13	37.00
	Mean	5.53	9.78	9.63	20.46	16.99	21.12	9.75	12.03	2.62	1.86	9.18	13.49
		A = Dharmasthala		B = Sullia									
C.D. (P=0.05) for Treatments :		0.9430		0.8762									
Month :		0.7970		0.7405									
Interaction :		2.10		1.95									

Table 2 : Field management trial against black pod disease in 2011 at Dharmasthala (A) and Sullia (B)

Sr. No.	Treatments	% of infected pods										Mean of 5 months	
		June		July		August		September		October			
		A	B	A	B	A	B	A	B	A	B	A	B
1.	Copper oxychloride (Blitox 50 WP 0.5 %)	2.37	5.59	7.88	7.48	9.67	9.40	3.50	1.85	0.39	0.00	4.94	5.70
2.	Mancozeb (Indofil M -45 0.5 %)	4.81	10.84	14.41	19.62	18.59	21.91	8.11	7.84	0.64	0.42	6.45	8.60
3.	Phosphorous acid (Akomin 0.5 %)	3.89	7.91	9.88	11.17	13.48	15.31	6.91	5.89	0.42	0.20	6.99	8.92
4.	Metalaxyl + Mancozeb (Ridomil 0.5 %)	3.41	8.15	9.76	10.69	12.14	14.59	6.42	5.35	0.56	0.20	9.43	13.34
5.	*Trichoderma harzianum*	4.91	10.34	14.20	20.38	22.55	22.06	10.17	16.03	2.54	0.23	10.77	14.89
6.	Cultural practices alone	6.34	12.66	16.43	28.33	29.72	28.97	13.01	17.70	4.07	2.01	13.80	19.87
7.	Control	14.31	23.14	34.30	58.90	63.45	67.14	29.75	33.63	9.86	12.01	29.02	41.46
	Mean	5.85	11.40	15.09	22.11	23.79	25.59	10.93	12.15	2.68	2.06	11.60	16.04
		A=Dharmasthala		B=Sullia									
C.D. (P=0.05) for Treatments :		0.3815		0.7857									
Month :		0.322		0.6640									
Interaction :		0.8531		1.7570									

also indicated that there was more than 50 per cent reduction of black pod disease over control in both sites in both the years. In Cameroon, removal of diseased pods helped to reduce black pod disease incidence by 22-31 and 9-11 per cent in first and second year (Ndoumbe-Nkeng *et al.,* 2004). Removal of mistletoes, excess shade, basal chupons, infected and mummified pods, healthy ripe pods and pruning of interlocking branches were recommended as an essential package for black pod management in Ghana (Akrofi, 2000). Opoku *et al.* (2000) also found that black pod caused by *P.megakarya* could be effectively managed by combining crop sanitation practice with fungicide application but not with either practice alone.

Trichoderma harzianum treatment combined with cultural practices was also effective to some extent in reducing black pod disease. In the month of August, when the disease incidence in control plots varied from 43.71 to 67.14 per cent, it was only 14.95 to 22.06 per cent in Trichoderma treatment. The mean disease incidence of five months also indicated that there was substantial reduction in black pod incidence in Trichoderma treated plots compared to control plots. It is expected that Trichoderma treatment combined with cultural practices may become more effective if the treatment is continued year after year so that there will be a build up of Trichoderma population in the garden and cocoa plants. As cocoa is mainly grown as a mixed crop in the existing coconut and arecanut gardens in India and the gardens are frequently irrigated during summer months, the microclimate in the cropping system may favour the survival and multiplication of Trichoderma. Field trials also indicated that in gardens with less incidence of black pod disease, economic management of the disease is possible with recommended cultural practices alone. Thus, the need to control Phytophthora pod rot disease with chemical fungicides depends on the magnitude of disease severity and loss. Fungicide application on farms with very poor yield may not be profitable. The present study clearly revealed that black pod can be very effectively controlled in gardens with higher disease incidence when fungicide application is integrated with cultural practices. It is important to fully integrate Phytophthora disease management practices to overall farm management and such management strategy appears to be the best solution for efficient and sustainable management of black pod disease. However, plant pathologists and extension agencies have to play a major role in transferring the economically viable technologies to the farming community for a sustainable cocoa cultivation and thereby increasing cocoa production in India.

REFERENCES

Akrofi, A.Y. (2000). Managing *Phytophthora megakarya* pod rot disease: the Ghana experience. In: Bong, C.L., Lee, C.H., Shari, F.S. (Eds.), *Proc. INCOPED 3rd Internat. Seminar,* Kota Kinabalu, Sabah, Malaysia, 16–17 October, 2000, pp. 78–83.

Akrofi, A.Y. and Appiah, A.A. (1995). Phytophthora pod rot control trials; intervals of fungicide application trial at Tafo and Bechem. Annual Report, Cocoa Research Institute, Ghana, 1993/94, pp. 74–77.

Anderson, R.D. and Guest, D.I. (1990). The control of black pod, canker and seedling blight of cocoa caused by *Phytophthora palmivora* with potassium phosphonate. *Australasian Plant Pathol.*, **19** : 127–129.

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 J.*, **8** : 91-92.

ChandraMohanan, R., Prabha K. Peter and Sarathraj, K.M. (2013). Production technology of coir pith cake formulation of *Trichoderma harzianum. J. Plantn. Crops,* **41**: 214-218.

Fagan, H.J. (1984). An assessment of pathological research on cocoa in Jamaica from 1950–1980 and current research priorities. *Tropical Pest Mgmt.*, **30** (4) : 430–439.

Guest, D.I. and Grant, B. (1991). The complex action of phosphonate as antifungal agents. *Biological Rev.,* **66** (2) : 159–187.

McGregor (1983). Experiments on the profitability of chemical black pod control in Papua New Guinea. *Tropical Pest Mgmt.,* **29** (2) : 129–136.

Ndoumbe-Nkeng, M., Cilas, C., Nyemb, E., Nyasse, S., Bieysse, D., Flori, A., and Sache, I. (2004). Impact of removing diseased pods on cocoa black pod caused by *Phytophthora megakarya* and on cocoa production in Cameroon. *Crop Prot*., **23** (5) : 415-424.

Opoku, I.Y., Appiah, A.A., and Akrofi, A.Y. (2000). *Phytophthora megakarya*:A potential threat to the cocoa industry in Ghana. *Ghana J. Agric. Sci*., **33** (2) : 237-248.

Peter, P.K. and ChandraMohanan, R. (2011). Occurrence and distribution of cocoa (*Theobroma cocoa* L.) diseases in India. *J.Res. ANG RAU,* **39** (4) : 44-50.