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SUSTAINABLE MANAGEMENT OF BUD ROT DISEASE OF COCONUT

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Abstract

Bud rot incited by *Phytophthora palmivora* Butl. is a fatal disease in coconut. Different fungicides were tested under *in vitro* condition and highly effective fungicides were selected for evaluation under field condition to develop IDM strategies against bud rot. All the fungicides and *Trichoderma* coir pith cake significantly reduced the bud rot disease incidence compared to the control. Five fungicides were highly effective for three consecutive years. Chlorothalonil 78.12 WP was found cost effective in the management of bud rot disease and *Trichoderma* coir pith cake could be used for eco-friendly management of the disease.

Introduction

Coconut (*Cocos nucifera* L.) is an important plantation crop. It is extensively grown in 94 countries in the world and India accounts for 31.46 per cent of the world's coconut production (CDB 2019). Four southern states such as Kerala, Karnataka, Tamil Nadu and Andhra Pradesh account for 90% of the coconut production in India. Even though coconut palm is hardy and adaptable to varied climatic conditions, it is counteracted by many pests and diseases (Nambiar 1994, Henry Louis 2002). Among the fungal diseases, bud rot caused by *Phytophthora palmivora* Butl. is a fatal disease causing huge loss by killing hundreds of coconut trees every year. Though the disease is generally sporadic in nature, severe outbreaks of epidemics have been noticed in major coconut growing places of Andhra Pradesh, Goa, Kerala, Karnataka, and Tamil Nadu (Sharadraj and Chandra Mohanan 2013).

A snapshot survey conducted by ICAR-Central Plantation Crops Research Institute (CPCRI), Kasaragod in six panchayaths; three each in Kasaragod and Kannur districts during 2013 indicated that the incidence of bud rot disease in the selected panchayaths ranged from 7 to 21 % (CPCRI 2014). Chandran *et al*. (2017) estimated the yield loss up to 7.16 million nuts if 50% of the bud rot disease affected palms would die in Kasaragod district of Kerala.

Prophylactic treatment with 300 ml of 1% Bordeaux mixture or Mancozeb 75 WP (0.3 %) in the base of the spear leaf before the onset of monsoon and placing two perforated sachets containing 5 g of Mancozeb in the inner most leaf axil were recommended as an effective control measure (Nambiar 1999, Sharadraj and Chandra Mohanan 2012). However, Mancozeb has been withdrawn for use on coconut and recently Government of India has also banned this fungicide. Though Bordeaux mixture is effective as prophylactic treatment, farmers find it difficult to prepare the mixture. Also an improper preparation style and application method makes it ineffective. Thus there is an urgent need to formulate effective disease management strategies for bud rot disease. The present study was aimed to develop integrated management strategies for effective management of the bud rot disease.

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Materials and Methods

Bud rot diseased coconut samples were collected from disease endemic regions of Karnataka and Kerala states during 2012 to 2015. *Phytophthora* isolates were purified from the diseased samples by following standard tissue isolation and baiting methods (Drenth and Sendall 2004). The pathogen was identified based on morphological traits described by Erwin and Ribeiro (1996) and molecular confirmation was done by carrying out-PCR amplification and sequencing of ITS region in selected isolates using universal primers ITS1 (5´TCCGTAGGTGAACCTTGCGG3´) and ITS4 (5´ TCCTCCGCTTATTGATATGC 3´) primers (White *et al*. 1990).

In order to induce sporulation in *Phytophthora* isolates, Petri plates containing carrot agar media were centrally inoculated separately with 5 mm mycelial disc of each *Phytophthora* isolate and incubated under a 12 hrs light and dark regime at 24 ± 1°C for seven days. Subsequently isolates containing plates were initially rinsed twice with sterile distilled water. Twenty ml of sterile distilled water was added to each plate and incubated at 15^0C for 15 min. Then the plates were transferred to room temperature for 20 min until the zoospores released. Zoospore suspensions from each isolate was adjusted to 5×10^{-5} spores/ml with sterile distilled water using haemocytometer.

All the *Phytophthora* isolates were tested for pathogenicity or aggressiveness by following detached leaf method. Spindle leaves of West Coast Tall (WCT) coconut variety were used for inoculation (Sharadraj 2010). The isolate which produced highest lesion size was considered as highly virulent and used for further screening of different fungicides under *in vitro* condition. Efficacy of 11 fungicides were tested against highly virulent isolate of *P. palmivora* (KLCO-1) under *in vitro* condition (Table 2). Suitable dilutions of each fungicide from 0.001 to 0.2 % were prepared and tested against KLCO-1 (Nene and Thapliyal 1971). Per cent inhibition of mycelial growth was calculated with slight modification of Gade (2012) and Prathibha *et al*. (2016) and data were statistically analyzed.

Bud rot disease management trial was conducted at disease endemic gardens in Konnakad of Ballal panchayath, Kasaragod district, Kerala from 2015 to 2018. Bud rot affected dead and disease advanced palms were removed from the gardens after recording pre-treatment disease incidence.

Integrated nutrient and pest management strategies were also taken care in the experimental plots. Each treatment consisted of 200 palms with five replications. A total of eight fungicides and *Trichoderma* coir pith cake were evaluated by placing two perforated sachets containing 3 g of fungicide in the innermost leaf axil at bimonthly interval starting from the last week of May to December. The Bordeaux mixture treatment was given by pouring 300 ml of freshly prepared 1% Bordeaux mixture with pH 7 in the innermost leaf axil at bimonthly interval instead of perforated sachets. In case of *Trichoderma* coir pith cake treatment, two cakes were placed in the innermost leaf axil of coconut palms at same intervals like fungicide treatments. The observations on bud rot disease incidence were recorded as the number of bud rot affected palms out of the total palms treated. In case of fresh bud rot incidence, the particular infected palms were treated with respective fungicide @ 3g in 300 ml of water after removing infected tissue except in the control plots. Data were compiled as monthly post-treatment disease incidence and analyzed statistically.

Results and Discussion

Total of twenty isolates of *Phytophthora* were purified after isolation and were designated as KLCO and KACO. Further identification of the *Phytophthora* species was confirmed molecularly by sequencing ITS region amplified in PCR reaction. ITS sequences of selected isolates when run in BLASTn programme of NCBI showed homology to *P. palmivora*. The sequences were

submitted to NCBI GenBank and accession numbers (LC076467, JX155790, JX155791, JX155794 and JX155796) obtained for respective isolates. All the twenty isolates of *P. palmivora* were identified as A2 mating type.

All the *P. palmivora* isolates were found to be pathogenic on coconut and expressed disease infection lesions from the third day after inoculation. The isolate KLCO1 was considered as highly virulent and used for further screening of fungicides.

All the fungicides employed in *in vitro* screening significantly inhibited the growth of *P. palmivora* (KLCO1). Out of ten fungicides tested, seven fungicides (Iprovalicarb + Propineb, Fosetyl Al + Propineb, Metiram + Pyraclostrobin, Copper oxychloride, Copper hydroxide, Chlorothalonil and Dimethomorph) were highly effective at 0.01% (Table 1).

Table 1. *In vitro* inhibition of mycelial growth of *Phytophthora palmivora* by different fungicides.

Fungicides	Concentration (%)	Inhibition (%)
Bordeaux mixture	1.0	100[a]
Iprovalicarb 5.5 + Propineb 61.3 WP	0.01	100[a]
Metiram 50 + Pyraclostrobin 50% WG	0.01	100[a]
Dimethomorph 50 WP	0.01	100[a]
Fosetyl-AL 80 WP + Propineb 61.25 % WP	0.01	100[a]
	0.05	100[a]
Chlorothalonil 78.12% WP	0.01	100[a]
Copper hydroxide 77% WP	0.01	100[a]
Copper oxychloride 50 WG	0.01	90.4[b]
	0.05	100[a]
Cymaxanil 8 + Mancozeb 64 WP	0.01	60.0[ef]
	0.05	76.1[d]
	0.1	85.2[c]
	0.2	100[a]
Famoxadone 16.6 + Cymoxanil 22.1% SC	0.01	55.4[fg]
	0.05	66.2[e]
	0.1	77.5[d]
	0.2	100[a]
Kresoxim methyl 44.3% SC	0.01	45.3[gh]
	0.05	57.0[f]
	0.1	80.2[c]
	0.2	100[a]

*Means with the same letters are not significantly different according to DMRT (P = 0.05)

The number of disease advanced and dead palms due to bud rot were considered as pre-treatment disease incidence. Field level evaluation of effective fungicides against bud rot disease revealed significant differences between the treatments compared to control. All the eight fungicides and *Trichoderma* coir pith cake were quite effective in reducing the bud rot incidence compared to control. Among these, significant disease reduction was recorded in five fungicides namely Chlorothalonil, Iprovalicarb + Propineb, Dimethomorph, Fosetyl-AL + Propineb and Metiram + Pyraclostrobin (Table 2). These were found highly effective (zero incidences) for all the three consecutive years in comparison to control which showed increased bud rot incidence

from 13.2 to 24%. In case of *Trichoderma* coir pith cake treatment, disease incidence of 10.2% was observed during initial year but in subsequent years significant reduction in disease incidence (3.1%) was also recorded.

Table 2. Efficacy of different fungicides against bud rot disease of coconut.

Treatments	Bud rot disease incidence			
	Pre treatment	2015-16	2016-17	2017-18
Copper oxychloride 50 WG	32.0	8.3^{cd}	6.4^{d}	4.0^{b}
Copper hydroxide 77% WP	40.2	7.2^{c}	5.0^{c}	4.2^{b}
Chlorothalonil 78.12% WP	50.0	0.0^{a}	0.0^{a}	0.0^{a}
Iprovalicarb 5.5 + Propineb 61.25 % WP	44.2	0.0^{a}	0.0^{a}	0.0^{a}
Dimethomorph 50 WP	48.0	0.0^{a}	0.0^{a}	0.0^{a}
Fosetyl-AL 80 WP + Propineb 61.25% WP	42.2	0.0^{a}	0.0^{a}	0.0^{a}
Metiram 50 + Pyraclostrobin 50% WG	35.0	0.0^{a}	0.0^{a}	0.0^{a}
1% Bordeaux mixture	42.0	3.3^{b}	0.0^{a}	0.0^{a}
Trichoderma coir pith cake	43.2	10.2^{d}	3.3^{b}	3.1^{b}
Control	40.0	13.2^{e}	20.3^{e}	24.0^{c}

*Means with the same letters are not significantly different according to DMRT (P = 0.05).

In present study all the isolates were identified as *P. palmivora* which are in conformity with previous studies carried out by Rashmi (2003). Srinivasalu and Rao (2007) reported that *P. palmivora* isolates causing coconut disease were A2 mating types. Current study also indicated presence of A2 mating type. DNA based diagnostic techniques were developed as highly sensitive and species specific tool for the detection and taxonomy of fungi (Cook and Duncan 1997, Drenth *et al.* 2006). Therefore, identification of the *Phytophthora* isolates collected from major coconut growing regions of Karnataka and Kerala were further confirmed based on sequencing of ITS region. White *et al.* (1990) and Goodwin *et al.* (1992) found that the internal transcribed spacer (ITS) regions were suitable for PCR amplification. Chowdappa *et al.* (2003) concluded that ITS regions can be used as taxonomic markers for the identification of *Phytophthora* spp.

Removal of bud rot disease affected advanced and dead palms before the occurrence of monsoon season is pivotal in reducing inoculum buildup of pathogen in gardens. Prophylactic treatment of Chlorothalonil in the innermost leaf axil at bimonthly interval starting from the last week of May to December and curative treatment for freshly infected palms @ 3g in 300 ml of water was found cost-effective in the management of bud rot disease because of relatively less price of Chlorothalonil (Rs.1600/Kg) compared to other effective fungicides. *Trichoderma* coir pith cake formulation can be used for eco-friendly management of disease in organic system of cultivation.

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