

## Full Paper

## Integrated Management of Bud Rot Disease of Coconut Palm in India

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## Abstract

Bud rot, a fatal disease of coconut palm (*Cocos nucifera*) caused by *Phytophthora palmivora* is increasing year after year, leading to heavy economic losses to farmers. Hence, large scale field trials with nine treatments including control were laid out in disease endemic areas during 2008 and 2009. The treatments were given 4 times at bimonthly interval starting from the end of May each year and post treatment disease incidence was recorded till the end of December. Among the treatments, pouring Potassium phosphanate (Akomin 0.5% @ 300 ml/palm) to the innermost leaf axils and pouring mancozeb solution (5 g mancozeb in 300 ml water/palm) coupled with placing 2 perforated sachets each containing 5 g mancozeb in the innermost leaf axils were found to be effective in the integrated management of bud rot disease of coconut. The effectiveness of these two treatments was again confirmed during 2010. The cost of application of fungicides including climbing charge was found to be Rs. 23.75 and Rs.19.28 per palm per treatment of mancozeb and Potassium phosphanate respectively. Based on the results of the field trials, an integrated disease management strategy has been evolved.

**Key words:** Bud rot, coconut, IDM, mancozeb sachets, Potassium phosphanate.

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Bud rot disease of coconut palm (*Cocos nucifera* L.) caused by *Phytophthora palmivora* (Butl.) Butl. has been a widespread problem in Kerala and other parts of India. Bud rot incidence on coconut was first noticed in Grand Cayman, an island of British West Indies just south of Cuba in 1834 (Tucker 1926). Since then the disease has been reported from different coconut growing countries. In India, bud rot was reported as early as in 1906 (Butler, 1906). It occurs commonly in west and east coasts of India (Menon and Pandalai 1958). In recent years the disease has attained a serious proportion in some districts in Kerala, Karnataka and Tamil Nadu especially in hilly tracts with high humidity. Since coconut palm is a perennial crop the loss due to the disease is very high. Prophylactic spray of Bordeaux mixture and curative treatment with Bordeaux paste are generally recommended for the management of bud rot disease of coconut palm (Nambiar 1999). Though the oldest recommendation of Bordeaux mixture treatment is effective to some extent many farmers do not adopt this mainly due to the difficulty in preparing Bordeaux mixture, high cost of copper sulphate and its phytotoxicity in certain varieties. Therefore, detailed field experiments were carried out to develop an economically viable IDM strategy.

## Materials and Methods

**Disease survey.** Random surveys were conducted during 2008 and 2009 in coconut bud rot disease endemic areas

of Kasaragod district of Kerala State to select disease affected gardens for laying out field management trial by considering different criteria such as disease severity, area under cultivation, cropping system, topography, cultivation practice and incidence of other diseases and pests. In 2008, a total of 41.94 ha of coconut gardens consisting of 5462 palms were surveyed in the disease endemic areas of Kasaragod district. A total of 26 gardens consisting of 2110 palms were surveyed in Kasaragod district to select a suitable area for disease management trial in 2009.

**Establishing field trials.** Based on the survey, 30 coconut gardens comprising of 10 ha area in Baidi Panchayath of Kasaragod district were selected for laying out the management trial in 2008 and 10 ha area consisting of 9 coconut gardens in Konakkad and Narkillakkad area of Kasaragod district were selected in 2009. Thus, the disease management trials were laid out in 2008 and 2009 at two different locations with nine treatments including a control.

**Treatments.** The treatments were: (a) bordeaux mixture (1%) pouring to innermost leaf axils around spindle (30 ml/palm); (b) placing mancozeb sachets (2 perforated sachets each containing 5 g mancozeb/palm) in the innermost leaf axils; (c) pouring mancozeb solution (5 g in 300 ml/palm) + placing mancozeb sachets (2 perforated sachets each containing 5 g mancozeb/palm) in the innermost leaf axils; (d) drenching the soil around

the palm with *Bacillus amyloliquefaciens* (20 L/palm) + placing *Bacillus amyloliquefaciens* talc formulation sachets (2 perforated sachets each containing 100 g formulation/palm) in the innermost leaf axils; (e) placing *Trichoderma harzianum* talc formulation sachets (2 perforated sachets each containing 100 g formulation/palm) in the innermost leaf axils; (f) drenching the soil around the palm with potassium phosphonate (Akomin 0.5%): 20 L solution/palm; (g) pouring Akomin 0.5% solution to the well around the base of the spindle leaf: 300 ml/palm; (h) removal of dead palms without any treatment and (i) control (diseased palms not removed).

In 2008 field trial, there were 150 palms per treatment in three replications whereas in 2009, there were 50 palms per treatment in five replications. The diseased and dead palms of the previous years that were retained in the gardens were recorded as pre-treatment disease incidence. During May of 2008 and 2009 the disease advanced and dead palms were cut and removed from the experimental plots (Treatments 1 to 8). The affected portion of the crown was destroyed by burning or deeply burying in the soil. Every year the first round of prophylactic treatment was given during the last week of May, just before the onset of South-West monsoon and thereafter at bimonthly-intervals till December (4 times). Recommended management practices for other pests and diseases and crown cleaning were also implemented. Integrated nutrient management (INM) was also given equal importance in the experimental plots.

During 2009 and 2010, in addition to conducting experimental field trial, a farmers participatory demonstration trial involving the most promising treatments of 2008 viz., a) placing mancozeb sachets, b) pouring mancozeb solution coupled with placing mancozeb sachets and c) pouring Akomin solution to the crown was implemented in comparison with the treatments removal of disease affected palms and control as a demonstration trial in 23.12 ha, in 24 coconut gardens in disease endemic area of Kasaragod district (Table 2). All the palms in demonstration plots laid out with farmers participation were observed for disease incidence at 15-d-intervals.

Based on the results of 2008 and 2009 trials, the most promising prophylactic treatments were selected to further confirm their efficacy in 2010. A total of 300 palms were included under each promising treatment and a control. Integrated disease management practices including integrated nutrient management were adopted in these selected plots. The pre treatment and post treatment disease incidences were recorded.

**Curative treatment.** Whenever bud rot incidence was noticed during bi-weekly observation, the palms in the field trials were given curative treatment. For this, the palms were observed for initial symptoms of bud rot such as yellowing and drooping of the spindle leaves. The disease affected palms except those in control plots were treated with mancozeb (pouring + sachets) in the very initial stage of bud rot disease after completely removing the infected tissue.

**Data recording and analysis.** All the palms in the field trials were observed at 15-d-intervals from June to December for post-treatment disease incidence. The disease incidence was recorded as the number of bud rot affected palms out of the total palms treated. The data were compiled as monthly post-treatment disease incidence and analyzed statistically following Kruskal-Wallis Test and Mann-Whitney Test. When the nine treatments were analysed using Kruskal-Wallis Test all the treatments were significant based on the Chi-square value. Hence, treatment combinations were compared following Mann-Whitney Test and based on individual Chi-square value treatment significance was determined. The data were presented as post-treatment disease incidence of each year.

## Results and Discussion

Bud rot disease of coconut was found to be a major problem in the hilly tracts compared to plain areas. The disease incidence also varied from garden to garden as well as from locality to locality.

**Pre-treatment disease incidence.** The number of bud rot affected palms and the palms died due to the disease during the previous years, which were not removed by the farmers, were recorded as the pre treatment disease incidence. The percentage of diseased palms in the experimental plots selected varied from 12.7 to 44.8 in 2008 and 12.3 to 20.63 in 2009 (Table 1). As one of the practices in integrated management, all the diseased and dead palms were removed from the experimental plots except from the control plot to reduce the inoculum load in the garden. Otherwise these palms could serve as reservoir of inoculum for secondary spread of the disease during monsoon.

**Post-treatment disease incidence.** The 2008 field trial revealed significant differences between the treatments. Significant disease reduction was recorded in some treatments compared to control. Disease incidence in plots receiving Akomin pouring to crown and mancozeb solution pouring coupled with placing sachets were 2.0% and 2.7%, respectively, compared to 14.7% disease in the control plots (Table 1). Even though there were no significant differences in disease incidence amongst three treatments viz., placing mancozeb sachets to leaf

**Table 1. Pre- and post-treatment bud rot disease incidence in experimental plots during 2008 and 2009**

Treatment	Pre-treatment disease incidence (%)		Post-treatment disease incidence			
	2008	2009	2008		2009	
			Total palms infected (no.)	Disease incidence (%)	Total palms infected (no.)	Disease incidence (%)
Bordeaux mixture pouring	20.6	20.6	8	5.3	3	6.0
Placing mancozeb sachets to leaf axils	12.7	13.8	6	4.0	2	4.0
Pouring mancozeb solution to crown and placing mancozeb sachets	38.9	19.4	4	2.7	1	2.0
<i>Bacillus</i> soil drenching + sachets	19.3	19.4	14	9.3	5	10.0
Placing <i>Trichoderma</i> sachets	18.9	12.3	11	7.3	4	8.0
Akomin soil drenching	13.8	13.8	16	10.7	4	8.0
Akomin pouring to crown	16.7	16.7	3	2.0	1	2.0
Removal of dead and disease advanced palms	29.8	19.4	18	12.0	5	10.0
Control -affected palms not removed	44.7	15.3	22	14.7	6	12.0

# Bud rot affected palms of previous years; Data analysed by Kruskal- Wallis Test & Mann-Whitney Test ; treatment significance determined based on individual Chi-square value.

2008: T7 Significantly different from T1; T1 Not significantly different from T2 & T3

2009: T3 & T9 and T7 & T9: Significant difference

**Table 2. Bud rot incidence in the demonstration plots of promising treatments laid out with farmer participation**

Treatment	Pre treatment incidence (%)		Post treatment incidence (%)	
	2009	2010	2009	2010
Placing mancozeb sachets to leaf axils	13.5	12.7	5.0	4.5
Pouring mancozeb solution to crown and placing mancozeb sachets	12.7	38.9	3.0	3.6
Akomin pouring to crown	14.4	16.7	2.0	2
Removal of dead and disease advanced palms	5.3	29.8	15.0	8.5
Control -affected palms not removed	8.2	44.8	16.6	15

The number of palms/garden per treatment varied because the promising treatments were demonstrated with farmer participation

axils, pouring mancozeb solution coupled with placing mancozeb sachets and Akomin pouring to crown, the disease level in the latter two treatments were less than only placing mancozeb sachets to leaf axils.

Bordeaux mixture pouring to crown was also not significantly different from mancozeb treatments, but disease incidence in this treatment was more than that in mancozeb treatment. Though the disease incidence in the treatment removal of diseased palms without any other treatment was statistically on par with that in control plot, the disease incidence was 2.7% (Table 1) less than

that in the control plot. This indicates that removal of dead and diseased palms have a beneficial effect in reducing the disease incidence. Thus, two treatments, Akomin pouring to crown and pouring mancozeb solution coupled with placing mancozeb sachets in the innermost leaf axils were found superior than all other treatments.

The 2009 field trial showed a similar trend as that in 2008. Disease incidence in the two treatments viz., Akomin pouring to crown and mancozeb pouring coupled with placing mancozeb sachets were equally

effective. These two treatments showed significant differences from the control. The overall disease incidence in the control plot was 12.0% whereas it was only 2% in the Akomin and mancozeb treated plots (Table 1). Thus, mancozeb and Akomin treatments were again found to be better than other treatments.

The farmers participatory demonstration trial also revealed the superior efficacy of Akomin and mancozeb in reducing bud rot incidence (Table 2). Removal of diseased and dead palms was again found to be an important operation for reducing the inoculum load, thereby reducing the disease incidence. The disease incidence in the plots from where the diseased and dead palms were removed was less than that in the control plot (Table 2).

Based on the results of trials conducted in different localities in two years mancozeb and Akomin treatments were selected as the most promising in the integrated management of bud rot disease of coconut palm. Earlier, tying perforated sachets containing 2g mancozeb to the leaf axil was recommended to protect the palms which are sensitive to copper containing fungicides (KAU 2002). But a pilot study conducted during 2007 revealed that even placing perforated sachets containing 5g mancozeb per palm in the innermost leaf axil was not effective in the management of bud rot of coconut, especially in high rainfall areas. Moreover, tying of sachets to spindle leaf of tall palms is not only expensive but may also affect the efficacy of

mancozeb as it is more exposed to sunlight. Saraswathy (2006) reported that Akomin treatment is very effective in the management of bud rot and crown rot of arecanut, and recommended soil drenching of 0.3% Akomin as effective in controlling crown rot of arecanut in the very initial stage of the disease. But in the present study application of 20L Akomin solution (0.5%) as soil drench to the base of the palm was not found effective in controlling bud rot of coconut. Renard and Quillec (1984) reported that two rounds of stem injection with systemic fungicides like Aliette (Fosetyl-Al) and Ridomil (metalaxyl) 3g a.i. per injection per palm were effective in protecting the palms from bud rot of coconut caused by *Phytophthora hevea*.

The efficacy of crown treatment by mancozeb and Akomin was further confirmed by treating 300 palms each in these two treatments in addition to 300 palms in control during 2010. Bud rot was completely controlled in the mancozeb and Akomin treated palms whereas there was 18% disease incidence in the control plot.

The cost of application of fungicides including palm-climbing charges was found to be Rs.23.75 and Rs.19.28 per palm per treatment of mancozeb (pouring + sachets) and Akomin, respectively (Table 3). Detailed investigations were carried out to replace the plastic sachets with a container for mancozeb. A pesticide slow release product (PSRP) was developed using plantation crop waste. Field trials with PSRP containing mancozeb

Table 3. Comparative cost of prophylactic fungicide treatments

Items	Cost (in Rs.)
<b>Mancozeb treatment</b>	
Cost of 5 g mancozeb for solution	1.45
Labour charges for preparing mancozeb solution, filling in bottles and distribution of bottles in the garden to the climbers	1.44
Cost of polythene covers (2 numbers)	0.16
Cost of 10 g mancozeb (5 g/ sachet)	2.90
Cost of preparation of 2 mancozeb sachets	0.70
Climbing charges for pouring mancozeb solution and keeping mancozeb sachets in the innermost leaf axils	17.10
<b>Cost of Mancozeb treatment per palm Rs. 23.75</b>	
<b>Cost (in Rs.)</b>	
<b>Akomin treatment</b>	
Cost of Akomin (1.5 ml)	0.84
Preparation of Akomin solution in water (@ 5 ml in 1000 ml), filling in plastic bottles and distributing to climbers	1.44
Climbing charges for pouring Akomin solution	17.00
<b>Cost of Akomin treatment per palm Rs. 19.28</b>	

to manage bud rot disease of coconut are in progress. Thus, based on the results of field trials conducted during three years the following integrated management strategies have been evolved for the control of bud rot disease of coconut in endemic areas:

### Prophylactic treatment

**Before the onset of rainy season.** Remove all disease advanced and dead palms and destroy the infected crown region; crown cleaning; maintain field hygiene by removing bushes, weeds, excess shades from other trees and fallen & dried coconut leaves and other plant parts; adopt management practices recommended for rhinoceros beetle attack (Rajan et al., 2009); improve drainage, if necessary; control other pests and diseases; practice integrated nutrient management (INM) recommendation; apply recommended dose of mancozeb (solution + sachets)/ Akomin (potassium phosphonate) solution just before the onset of rainy season (May end).

**During rainy season.** Repeat the prophylactic fungicide treatment at 2 month-intervals; observe all the palms at 15-d-intervals for bud rot symptoms; identify bud rot infected palms and adopt curative treatment in the initial stage of disease.

**Post-monsoon.** Continue prophylactic fungicide treatment bi-monthly till the end of December; observe all the palms at 15-d-intervals and take up curative treatment, if necessary; follow INM practice.

**Bud rot disease- curative treatment.** Observe all the palms in the garden once in 15d during the rainy season and thereafter till the end of December; identify bud rot incidence in the initial stage; remove infected tissues completely with a sharp knife in the early stage of disease; immediately after removing the infected tissue, pour mancozeb solution (5 g mancozeb in 300 ml water) to the wound and inner most leaf axils; keep 2 perforated mancozeb sachets each containing 5 g mancozeb in the two innermost leaf axils; cover the wound with a polythene sheet to prevent entry of rain water (the protective covering has to be retained till normal shoot emerges); destroy the removed infected tissues by burning or deeply burying in the soil and follow prophylactic treatment with mancozeb/ phosphorous acid at bi-monthly interval.

Non adoption of prophylactic measures against bud rot, climatic changes especially erratic rainfall

pattern, non adoption of scientific cultivation practices, improper and inadequate use of fungicides and lack of skilled climbers coupled with high wage rates have been often pointed out as the constraints in proper implementation of recommended integrated management practices against bud rot disease of coconut. The control of bud rot disease of coconut in disease endemic areas can be achieved very effectively by adopting the recommended management practices with the active involvement of farmers, extension agencies, developmental agencies, local organizations and self help groups.

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