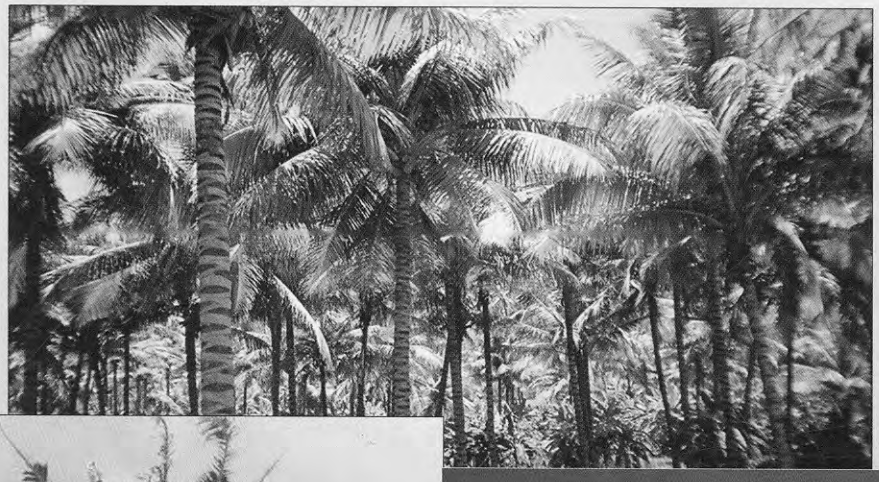
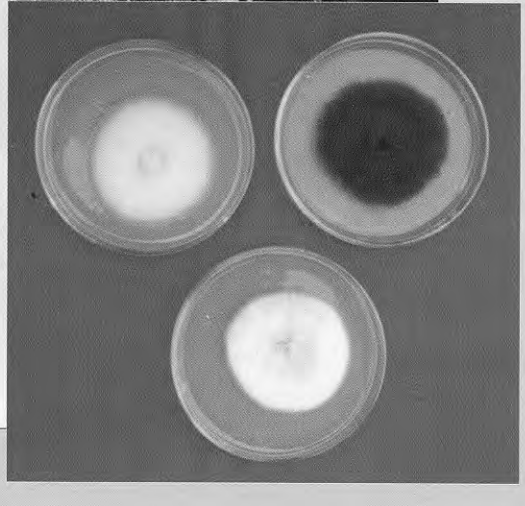
Technical Bulletin

MANAGEMENT OF COCONUT LEAF ROT DISEASE





Central Plantation Crops Research Institute

(*Indian Council of Agricultural Research*)

Kasaragod - 671 124, Kerala, India

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A view of root (wilt)-leaf rot affected coconut garden (Top), coconut palm showing typical leaf rot disease symptoms (Bottom-L) and major pathogens of leaf rot (Bottom-R): *Colletotrichum gloeosporioides*, *Exserohilum rostratum* and *Fusarium solani* – Top-L, Top-R and Bottom, respectively.

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MANAGEMENT OF COCONUT LEAF ROT DISEASE

Dr. N. Srinivasan*

OCCURRENCE AND DISTRIBUTION

Among the diseases affecting the coconut, leaf rot disease (LRD) is considered to be very important owing to the economic loss. In India, LRD is widely prevalent in Kerala state, where the root (wilt) disease is endemic. Leaf rot generally appears on palms affected by root (wilt) disease. The root (wilt) affected palms succumb to infection by LRD sometimes even before the manifestation of the root (wilt) symptoms. Leaf rot incidence can be noticed on palms of all ages especially in palms below 25 years of age. Surveys conducted in Kerala state revealed the occurrence of varying intensities of LRD and up to 65%. The disease is rampantly distributed in the eight southern districts (Thiruvananthapuram, Kollam, Alappuzha, Pathanamthitta, Kottayam, Ernakulam, Idukki and Thrissur) of Kerala. Its incidence in pockets of Palakkad district and also sporadically in northern districts of the state is also observed. Leaf rot occurrence in Cumbum Valley (Theni-Dindigul districts) of Tamil Nadu has been also documented. While the yield loss due to root (wilt) has been estimated the precise computation of loss in yield due to LRD is not easy as the disease is part of the disease complex and it is difficult to separate the damages caused by root (wilt) and LRD. LRD incidence brings about rapid deterioration in condition of palms and significantly contributes to the loss in nut yield (on an average of 70% yield loss) besides loss in quality and quantity of leaves.

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SYMPTOMS

As the root (wilt) affected palm systemically suffers, the deterioration is observed in spindle, the unopened youngest leaf. The tender spindle leaf with thinner epidermal layer and higher moisture content serve as an ideal infection court, and play a critical role for the incidence of LRD. Leaf rot initially appears as minute, water-soaked lesions with different shapes and shades of brown colour (brown, reddish brown etc.). The symptoms also appear occasionally on different parts of the leaflets of other young tender leaves. These lesions enlarge; coalesce freely resulting in extensive rotting especially under favourable environmental conditions such as high rainfall, high relative humidity and low maximum temperature (Figs. 1 to 3).

Fig. 1. Early lesions of leaf rot on spindle leaflets.

Fig. 2. Leaf rot in spindle leaf of infected palm– disease extending from tip downwards.

Fig. 3. Leaf rot affected adult coconut palm.

In the affected spindles, a visible mould growth (fungal mycelium and spore masses) is also commonly seen on the surface of the affected tissues. The rotting may progress extending into the interior of the spindle also. If leaf rot infection happens to be in the early period of spindle leaf emergence, expansion of the lesions would be rapid and tissue rotting acute. The infected spindle gradually decays; emanate a fowl smell attracting many insects-ants, earwigs, maggots, etc. It may also increase the

activities of certain major insect pests of coconut. The rotten portion of leaf lets dry up, turns black and shrivelled, and may fall off. Often, the tips of the rotten leaflets of the spindle stick together even while the bases of the leaflets are open. This is one of the striking features of the disease. Another characteristic feature is that the rotting is very slow in mature leaflets. It is because of the hardening of tissues and hence the basal portions of leaflets in certain palms remain without symptoms, giving a fan - like appearance of leaves in the crown.

Although leaf rot is non-systemic, successive infection of emerging spindles occurs and with varying intensities of rotting. Such successive infection ultimately leads to appearance of the disease symptoms in most or even in all leaves of the crown. The disease lesions on petiole, midrib and mid-veins of leaflets were also observed in infected palms. In certain palms, the digital ends of leaves break due to the disease lesions and part of the leaf dry and fall-off and prevalence of distinct dry rot symptoms with fast expansion of tissue drying in certain palms is also common.

DISEASE INDEXING

A five point grading system to index the disease intensity (O-no infection, 1-upto 25% leaf area affected, 2-26 to 50 %, 3-51 to 75 % and 4 -above 75 %) in each leaf in the crown was evolved. From the total numerical ratings the disease index is arrived at by the following formula:

$$\text{Disease Index (DI)} = \frac{\text{Total Numerical Rating}}{\text{No. of leaves x Maximum No. of grades}} \times 100$$

This method of disease indexing gives satisfactory comparison of disease intensity among affected palms.

ETIOLOGY

The investigations conducted during the period 1930s - 1950s revealed the association of a number of fungi (*Helminthosporium halodes, Colletotrichum paucisetum (Gloeosporium sp.), Gliocladium roseum, Pestalotia palmarum* etc.) with the disease. Wind dispersal (air-borne nature), conidial germination, patho-physiology, infection histology, events leading to tissue rotting etc. of especially *Helminthosporium (Bipolaris) halodes* in relation to leaf rot was investigated. Earlier emphasis was only on *H (B). halodes* as it was considered as the notable pathogen. But, further detailed studies on isolations of the causal organisms from hundreds of leaf rot affected spindles revealed consistent association of a number of fungal species and substantatively established the complex fungal etiology of LRD. Among these the fungi more frequently associated are: *Colletotrichum gloeosporioides, Exserohilum rostratum, Gliocladium vermoeseni, Fusarium solani, F. moniliforme* var. *intermedium* and *Thielaviopsis paradoxa* (Fig. 4). *Pestalotiopsis palmarum* is usually isolated form older leaves only.

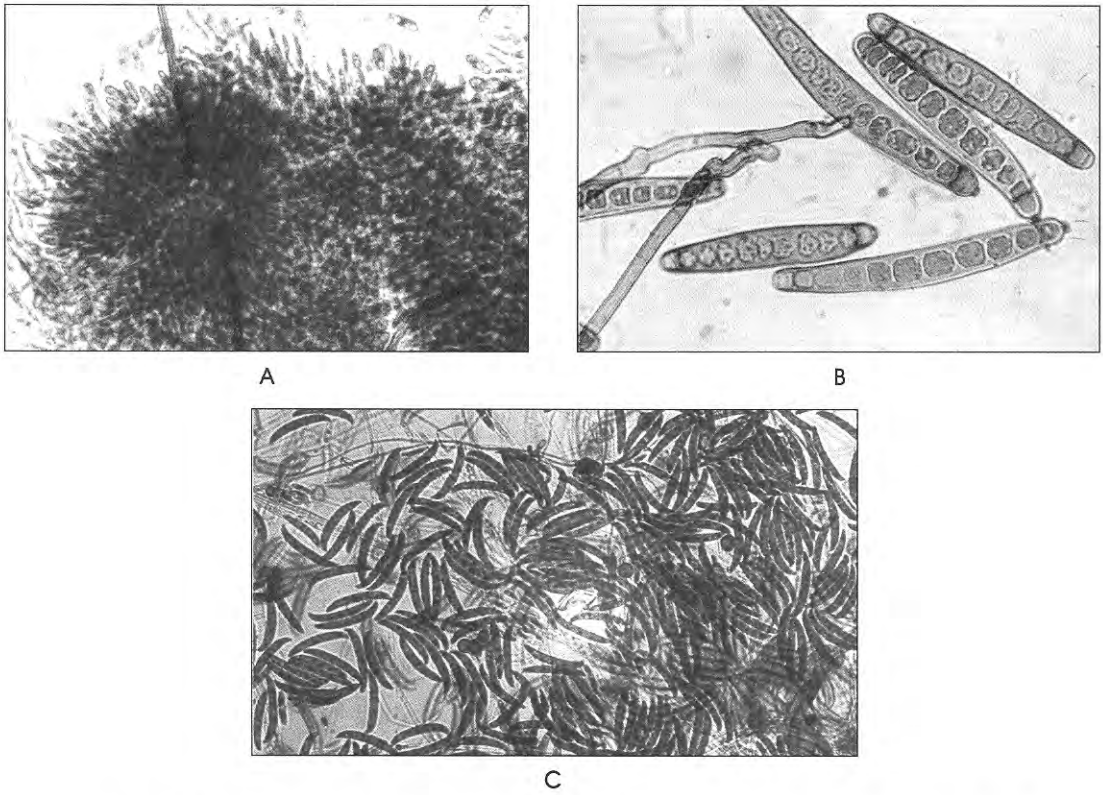


Fig. 4. Conidia of major pathogens of leaf rot - *Colletotrichum gloeosporioides* (A), *Exserohilum rostratum* (B) and *Fusarium solani* (C).

While all other pathogens induced wet rotting, *Fusarium* spp. distinctly developed dry rotting symptoms in coconut leaf tissues. In palms, free from root (wilt), the fungi induced only restricted spots, whereas on root (wilt) affected palms these fungi produced extensive lesions, which coalesced subsequently resulting in extensive rotting of the leaf tissues. Further, *C. gloeosporioides* and *E. rostratum* were found to be comparatively more aggressive and had higher frequency of occurrence and were therefore considered as the main pathogens of LRD. From the evidences accrued and in summary, various factors such as fungal frequency, pathogenic behaviour, seasonal relationship, *in vitro* interaction (predominant fungi associative than antagonistic) etc. have clearly established that LRD is a disease of fungal complex and that *C. gloeosporioides* and *E. rostratum* are the main pathogens.

EPIDEMIOLOGY

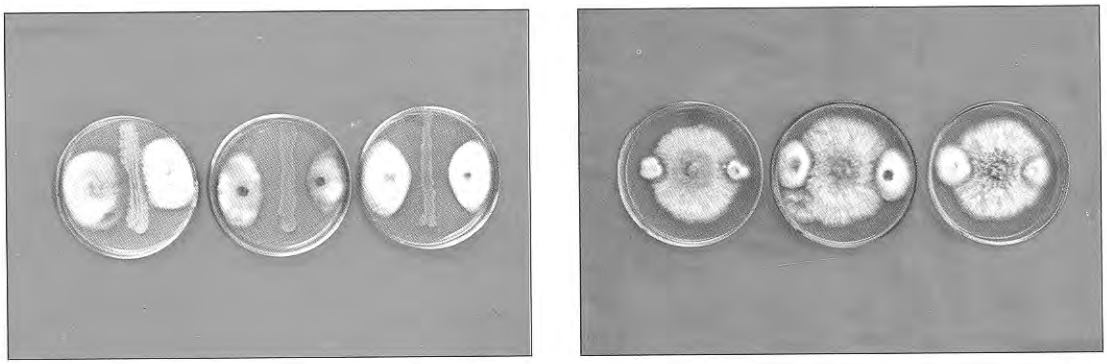
Leaf rot is an air-borne foliar disease. With only scant information been available on role of edaphic factors on the disease, soil factors seem to have no direct relation to LRD incidence. Although root (wilt) is the critical pre-disposing factor in LRD incidence, the severity, and incitants

of LRD are distinctly influenced by weather factors. Most severe incidence of LRD is observed during monsoons with accompanied high atmospheric humidity and low temperatures. The fungal spore population in the atmosphere is also high during monsoons. Free moisture or wetness (rain water) and dew (during dry months), and certain conditions in coconut crown itself - compactness of spindle foliage (helps in delaying the drying of leaf surface) are also found to influence the incidence of LRD.

Maximum population of *C. gloeosporioides* occurred during monsoon months (peak being June-July) coinciding with high rainfall and high RH and negatively correlated with the maximum temperature and hours of sunshine. *C. gloeosporioides* has been implicated as the **PRINCIPAL PATHOGEN** of LRD during monsoons. Incidence of *E. rostratum* was less strongly correlated with weather. In winter, *C. gloeosporioides* incidence was subdued and its population level became less, whereas population of *E. rostratum* was high. During the dry season (January through May) *Fusarium* spp. were found common. Because of their presence throughout the year and predominance in the dry period the potentiality of Fusarial fungi in LRD, co-occurring with other fungi and perpetuating the disease in the dry period is recognized. *Rhizoctonia solani* was also seen at higher frequencies during dry months. The incidences of other fungi were not influenced by specific weather factors and may have lesser significant role in LRD, but may play some role in disease expression under certain circumstances.

INTEGRATED MANAGEMENT

Disease control efforts were initiated and had been in practice, from as early as 1930s chiefly by using fungicides in affected palms. Over the years, from 1950s onwards, application of fungicides against leaf rot gained momentum. In recent years, advances have been made on biological control of leaf rot with bio agents such as *Pseudomonas fluorescens, Bacillus subtilis* etc., singly or in consortium mode of treatments (Fig. 5). Moreover, numbers of experiments have been conducted for evolving disease management practices (Tables 1 and 2). As no immune variety is available against root (wilt) complex the disease control relies on the integrated management practices in which various methods are applied for maximal exploitation. Leaf rot disease commonly occurs with root (wilt) and therefore control of leaf rot as a part of root (wilt) management becomes inevitable. Eventhough the root (wilt) is not amenable to conventional crop protection measures, leaf rot control is possible (Fig. 6).



A B

Fig. 5. *In vitro* effect of biological control agents on pathogen of leaf rot – Left to Right: *Bacillus subtilis*, *Pseudomonas fluorescens*, consortium of *B. subtilis* + *P. fluorescens* (A); *Trichoderma viride* (B).

Fig. 6A. A coconut palm showing recovery – development of healthy leaves – after treatment.

Fig. 6B. Deterioration of a control palm without treatment.

Table 1. Leaf rot incidence and disease index in coconut palms under fungicidal control trial (Mean of 10 palms/treatment)

Treatment	% of leaves infected at Pre-treatment (In parentheses- Disease Index)	% of emerged leaves shown leaf rot in different rounds (Figures within the parentheses - Disease Index levels of emerged leaves in different rounds)								Mean % (Mean Disease Index)
		I	II	III	IV	V	VI	VII	VIII	
Phytosanitation	60.1 (16.4)	40.0 (17.5)	34.8 (17.9)	35.5 (17.0)	34.4 (17.2)	38.3 (16.9)	41.5 (18.4)	40.3 (17.8)	43.2 (17.2)	38.5 (17.5)
Contaf - Pouring	55.3 (16.4)	37.5 (14.0)	38.3 (14.5)	42.3 (14.5)	42.9 (14.2)	42.8 (13.7)	43.2 (15.8)	44.1 (15.2)	43.8 (15.3)	41.9 (14.6)
Phytosanitation + Contaf - Pouring	52.8 (16.6)	28.0 (10.6)	21.9 (8.5)	19.1 (6.6)	25.9 (7.8)	25.7 (7.6)	27.8 (8.2)	28.2 (8.0)	28.0 (8.4)	25.6 (8.2)
Contaf - Spraying	60.9 (16.9)	42.0 (20.3)	31.4 (16.4)	36.4 (18.5)	37.0 (17.2)	37.4 (16.7)	39.4 (18.2)	39.8 (16.7)	38.4 (17.2)	37.7 (17.6)
Phytosanitation + Contaf - Spraying	61.0 (16.8)	66.5 (22.3)	54.0 (17.8)	37.4 (14.3)	32.7 (14.8)	34.5 (14.0)	37.2 (17.6)	36.6 (17.2)	36.8 (16.5)	42.0 (16.8)
Sequential Spraying	60.8 (16.6)	44.5 (19.7)	50.6 (21.9)	56.9 (20.7)	62.7 (21.0)	63.7 (20.9)	60.3 (22.3)	62.0 (21.8)	61.5 (22.0)	57.8 (21.3)
Control	58.1 (16.6)	60.5 (20.7)	60.7 (22.1)	66.1 (24.1)	69.9 (24.4)	71.6 (23.9)	74.2 (26.5)	74.7 (26.8)	74.0 (27.2)	69.0 (24.5)
Mean % (Mean Disease Index)	58.4 (16.6)	45.6 (17.9)	41.7 (17.0)	42.0 (16.5)	43.7 (16.7)	44.8 (16.2)	46.2 (18.1)	46.5 (17.6)	46.5 (17.7)	

C. D. (P=0.01) for treatments: 9.2 (for %leaves); 4.1 (for Disease Index). Difference from pre-treatment value as covariate: Differences in treatment are significant.

Table 2. Leaf rot disease index levels in coconut palms - in cumulatively emerged leaves - treated with talc-based preparation of *Pseudomonas fluorescens* (Mean of 20 palms in each category)

Category of palms	Pre-treatment Disease Index*	Leaf rot Disease Index (DI) in emerged leaves in different rounds **					Mean of rounds
		I	II	III	IV	V	
Palms treated with *Pseudomonas fluorescens*	14.71	12.65	11.80	08.83	08.25	08.00	9.91
Improvement over pre-treatment (Decrease in DI)	-	(-) 14.00%	(-) 19.78%	(-) 39.97%	(-) 43.92%	(-) 45.62%	(-) 32.66%
Improvement over control (Decrease in D I)	-	(-) 32.75%	(-) 41.35%	(-) 63.99%	(-) 67.39%	(-) 70.91%	(-) 55.28%
Control palms	15.68	18.81	20.12	24.52	25.30	27.50	23.25
Deterioration over pre-treatment (Increase in DI)	-	(+) 19.96%	(+) 28.32%	(+) 56.38%	(+) 61.35%	(+) 75.38%	(+) 48.28%
Deterioration over treatment (Increase in DI)	-	(+) 48.69%	(+) 70.50%	(+) 177.69%	(+) 206.67%	(+) 243.75%	(+) 149.46%

*For leaves in whole crown, at the time of Experiment initiation.

**For leaves emerged subsequent to pre-treatment - Cumulatively emerged leaves.

Based on the knowledge available and for effective management of the disease complex, a systems approach with integrated measures is suggested in which various methods are integrated:

- Removal of all disease advanced and uneconomic palms (both root (wilt) alone and root (wilt) with LRD). If replanting becomes necessary (based on crop density) use healthy seedlings from elite palms and varieties or hybrids tolerant to root (wilt)/ LRD. There lies scope for disease preventive measures by using quality planting materials.

- Observe general recommendation practices as applicable to root (wilt) affected regions such as application of balanced dose of fertilizers and farm yard manure and growing green manure crops (for incorporation in the coconut basins); provision of proper drainage and irrigating the palms during summer. Judicious adoption of good agronomic practices right from planting onwards - there by keeping the palms in good health and vigour.

- Regular monitoring of individual palms, especially the emerging spindle and young leaves - cut and remove the infected portions of spindle and other young leaves close to it. By pruning of rotten portions the fungal inoculum load in the crown is much reduced. This reduces infection chances by about 50%.

- This should be followed by application of treatments. For this a simple-low cost measure could be adopted and especially spindle leaves can be protected from infection. There are fungicides as well as biological control agents available for treatment. Apply fungicide - Hexaconazole (Contaf 5E) at least in the level of 2 ml or alternatively another fungicide - Mancozeb (Dithane M-45/Indofil M-45) in the level of 3 g - either one by mixing in 300 ml of water and pouring the liquid on to the base region/axil of the spindle leaf of every palm. Alternatively, the biological control agents - *Pseudomonas fluorescens* or *Bacillus subtilis* (singly or in consortium/combination) - in the form of talc - based preparation at the level of 50 g mixed in 500 ml of water may be applied for every palm. By application of fungicide or biocontrol agent(s) at the base of the new spindle leaf the treatment also protects the next emerging spindle. With adoption of such a method sprayer and the task of laborious spraying operation are not necessary, and only 300-500ml of treatment fluids is required per palm. Due to easy of treatment and eco-friendly attributes this control measure can be adopted for effective control of the disease.

- Usually no infection occurs in the maturing (green) leaves and hence application may be confined to the tender susceptible portions only.

- Leaf rot can be effectively controlled by treatment at the initial stage of symptom appearance; on slight-moderately affected palms two to three rounds of applications may be required. But it would take a longer time to control the disease in seriously affected palms. As such the treatments should be done at least twice per year (April - May, October - November) for all palms in the garden. Regular monitoring of individual palms, especially the emerging spindle and other young leaves close to it would be useful.

- Pests such as rhinoceros beetle, red palm weevil, mealy bugs etc. also may infest the leaf rot affected palms. Hence leaf rot management measures could also be appropriately integrated with the control of important pests of coconut and thereby the protection of palms against pests and disease are simultaneously achieved. The dosage and frequency of chemical application, however, are very important to avoid phytotoxicity to the spindle leaf, which is soft, tender and sensitive. Leaf axil filling with Phorate 10 G - 20g or Furadan 3 G - 30 g or oil seed cake of Neem or Marotti - 250 g mixed with equal amount of sand or naphthalene ball at the rate of 12 g per palm covered with sand (2-3 times per year) can be adopted.

- Treatment measures with fungicide or biocontrol agent(s) if used in this manner the climbing charges (including coconut harvesting) per palm would be in the order of about Rs. 7-8 only for a round towards total expenditure. Besides treating not only the disease affected palms, taking care of the disease free palms through management methods in root (wilt) affected region would derive benefits, and hence all palms may be subjected to control measures as recommended. The benefit of controlling leaf rot could be felt, as further deterioration in condition of palm is checked, thereby gaining nut yield by avoidance of loss besides quality and quantity of leaves.

As control of LRD is a big relief to the root (wilt) infected coconut and no immune coconut variety available against the disease complex management of LRD with protection measures is essential in the integrated disease management practices. Adoption of integrated management measures can improve the overall health of the palm and thereby better productivity.