Coconut Leaf Rot Complex and Perspectives for the Disease Control - Status Report

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Introduction

Coconut (*Cocos nucifera* L.) is cultivated in 1.91 million hectares in the country with a share of 16.02% in global area. The country is the prime coconut producer in the world with its share of 27.57% of the total global production. However, the productivity of the crop is constrained by various stresses. Among them the root (wilt) disease is the major problem affecting coconut. The disease is endemically prevalent in eight southern districts of Kerala, where out of 9.15 crore palms 26.44% palms are affected. Sporadic incidence of the disease in all northern districts of Kerala, its occurrence in various intensities in certain districts of Tamil Nadu (especially in districts bordering Kerala) and its stray incidence in Goa - are also observed in recent years. A very distinct feature of root (wilt) is the common association of leaf rot disease with root (wilt) affected palms - occurrence of leaf rot rampant in disease endemic region (now also in northern districts of Kerala and in districts of Tamil Nadu).

Whereas the root (wilt) is caused by phytoplasma and the affected palm suffer systemically (diagnostic symptom : flaccidity - inward curling / ribbing of leaflets -, followed by yellowing and marginal necrosis in the older leaves), the leaf rot is a non-systemic, foliar - necrotrophic (rotting) syndrome due to a complex of fungi. Usually the emerging spindle leaves are vulnerable to leaf rot, leading to extensive destruction of photosynthetic areas of leaves. It is relevant to note that the phytoplasmal disease of coconut in other countries are all lethal/fatal diseases, but the Indian root (wilt) is non-fatal/a slow decline. The association of leaf rot with root (wilt) becomes, however, significant as it brings about rapid decline of the affected palms; also the leaf rot affected leaves are unsuitable for thatching. Therefore, leaf rot in combination with root (wilt) is a disease complex of more economic concern to growers.

The combination of root (wilt) with leaf rot forms a unique case of phytoplasma plus fungal (compl infections and the nature of st associations of differential pathogen probably less familiar to common m While no effective control/curat measures for root (wilt) is availat there lies a scope for control of the l rot phase. In the management of r (wilt) complex in the disesae ende region, leaf rot control is essenti Hence it was felt that it would be use to provide current status/m information on various aspects of l rot.

Interrelation of Leaf Rot with Root (wilt)

Eventhough leaf rot was close considered with root (wilt) earlier survey conducted established comm occurrence of leaf rot in root (wi endemic region - leaf rot appeared palms with root (wilt) only, even as disease symptom seldom noticeal before the root (wilt) sympto manifested (latent period). The stu brought out that about 65% of root (w affected palms in the disease ende

Fig. 1 Root (wilt) affected coconut palm - flaccidity, yellowing and marginal necrosis symptoms seen

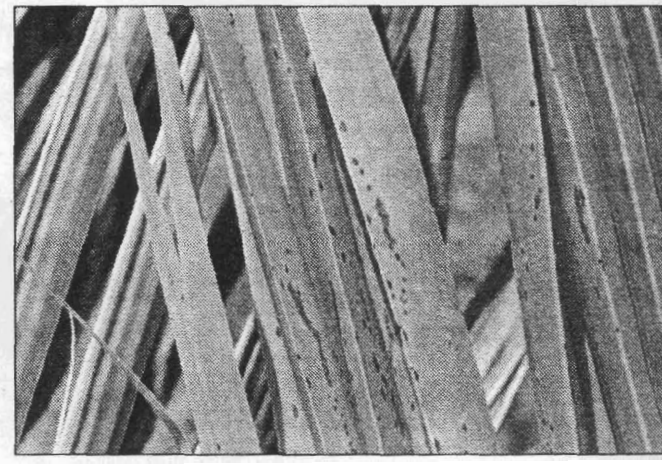

Fig. 2. Early lesions of leaf rot seen in leaflets of emerged spindl

region were superimposed with leaf rot and the level of leaf rot was also influenced by incidence/severity of root (wilt). Among different soil types, the co-occurrence of root (wilt) and leaf rot ranged from 54 to 76%, highest in clay and laterite soils. Further, irrespective of soil types, the young palms (even two year old) with root (wilt) in the field were readily attacked by leaf rot.

The occurrence of leaf rot with root (wilt), therefore, indicates the influence of root (wilt) on the leaf rot - a strong relationship/co-rrelation between them is the point. Incidence of leaf rot increases with an increase in the incidence of root (wilt). Currently, leaf rot along with root (wilt) is also observed in Tamil Nadu (as for example, heavy incidence of the disease complex in Cumbum valley, Theni district) and in northern districts of Kerala, testifying to the strong interrelationship phenomenon of these two diseases.

In this context, it may be noted that in various other crops increased vulnerability of a number of viral infected plants to attack by fungal pathogens (virus + fungal complex) is reported. The co-occurrence of leaf rot with root (wilt), however, is the only known case of a phytoplasma infected plants being vulnerable to attack by a fungal disease (phytoplasma + fungal complex). Hence, it must be known by coconut growers that the palms (root wilt) weakened by phytoplasma are susceptible to leaf rot and the knowledge would be useful in the disease management strategy.

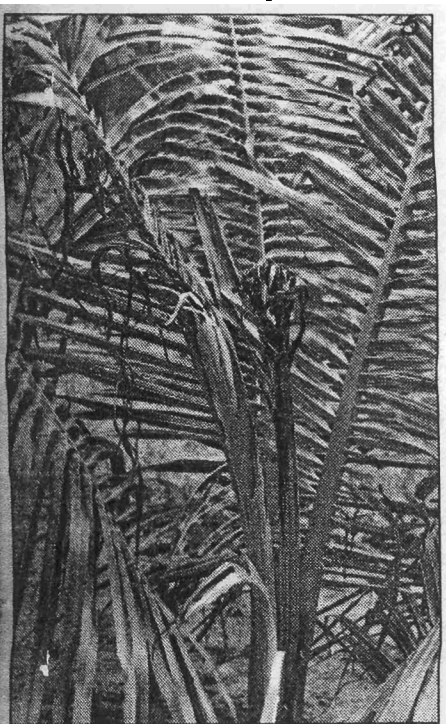

Fig. 3. Enalrgment of lesions leading to rotting of spindle

Diagnosis of Leaf Rot

It is important in knowing that the emerging spindle leaf in the root (wilt) affected palms is weak and it remain white and soft for a relatively longer period as compared to the spindle of healthy palms (*Fig. 1*). This weakened spindle play a critical role in the leaf rot incidence, there it initially appears as minute, water-soaked lesions in different shapes and shades of brown colour (*Fig. 2*). These lesions enlarge and coalesce freely resulting in extensive rotting of soft tissues (*Fig. 3*) favoured by environmental factors such as high rainfall, high relative humidity, low mean-maximum temperature etc. - usually as prevailing during monsoon months. Mould growth (comprising of spore masses and mycelium of various fungi) can also be commonly seen on the surface of lesions, especially in severely affected spindles. Although the rotting severity is observed at the distal end (usually in most cases) extending to the interior of the spindle, symptoms can also be seen occasionally on different parts of the leaflets of tender leaves. It is also relevant to understand that earlier the infection of spindle leaf (during its emergence), expansion of the disease lesion would be rapid. The infected leaf gradually decays emanating a fowl smell and many insects - flies, ants, ear wigs etc. - are attracted towards the decaying tissue; it may also enhance the activities of certain insect pests of coconut such as black beetle, red weevil, etc.

In certain leaf rot infected palms, the tips of rotten leaflets stick together while the base of the leaflets are open. The rotten tissues in due course dry up, turn black and fall off, tips of certain leaflets and midribs often become shrivelled and blackish. With maturity of leaflets the rotting is slowed down (due to hardening of tissue), hence the basal portion of leaflets in certain palms remain healthy and free from the leaf rot - giving a fan-like appearance of leaves in the crown. Although leaf rot is non-systemic, recurrence of the disease in successively emerging leaves does occur. With stability of the disease recurrence in individual palms attained, the disease symptom may be expressed in most or all the leaves (linear disease progression) in the crown (*Fig. 4*). An analysis of quantitative data on pattern of disease expression of infected palms in disease endemic region showed prominent vulnerability of the inner whorls of leaves (spindle + other young leaves close by) to infection and in 24-43% of leaf rot affected palms (in various soil types), the symptom expressed in all (inner, middle and outer) whorls of leaves i.e. vertical spread of the disease in emerging spindles occurs in these (individual) palms almost uninterrupted.

Disease lesions on petiole, mid-rib, mid-veins of leaflets can also be observed in infected palms. In certain palms, digital ends of leaves break (perhaps due to such lesions), becomes yellow and eventually hang, dry and ultimately fall off (*Fig. 5*). Also, in mid-whorl yellow leaves (which appear in certain palms of root (wilt)-lesions/spots appear in leaflets that coalesce leading to severe blighting of lamina. Severe leaf

ay also occur in spindles of mid-
l yellowed palms. Even after
action of leaf rot, the (root wilt +
rot) affected palms generally
nue to exist, remain non-fatal; but
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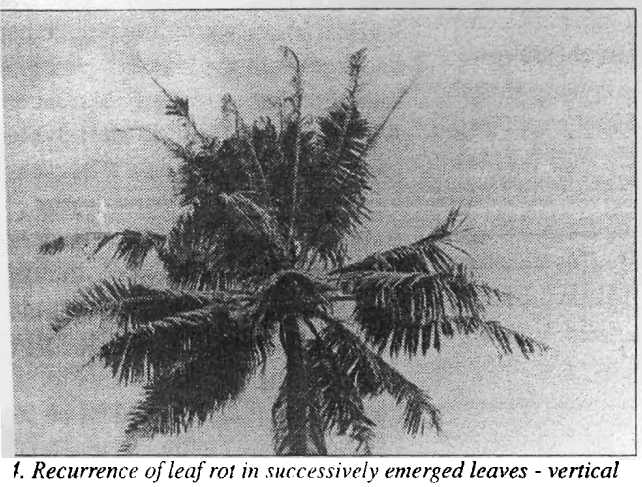
alm decline steadily affecting the
more.

s a corollary the root (wilt) affected
s come to one's attention easily with
nset of leaf rot. The farmers must

complex fungal etiology of leaf rot. The fungi association with leaf rot has been identified in an "International Standard" and are listed below in the order of frequency :

1. *Colletotrichum gloeosporioides* (Penzig) Penzig and Sacc.,
2. *Exserohilum rostratum* (Drechsler) Leonard and Suggs,
3. *Gliocladium vermoeseni* (Biourge) Thom.,
4. *Fusarium solani* Martius (Sacc.),

mould (growth seen on lesions of rotting spindles due to the disease) also lends to observe various fungi. *Pestalotiopsis palmarum* (Usually cause grey-leaf spot in coconut) is isolated from older leaves only. Irrespective of soils, the species composition of leaf rot associated fungi is generally similar; the trend with leaf rot in Tamil Nadu (e.g., Cumbum Valley in Theni dt.) and in northern districts of Kerala also appears to be in such a manner. *C. gloeosporiodes, Fusarium* spp. etc. are also associated with



t. Recurrence of leaf rot in successively emerged leaves - vertical spread of disease in individual palm

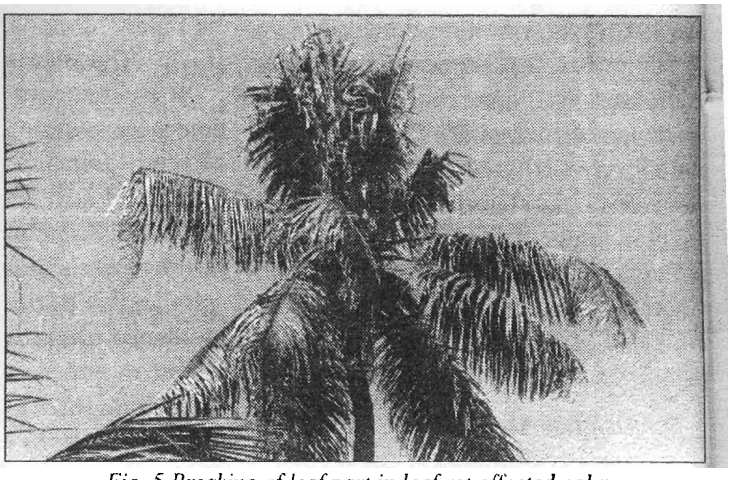


Fig. 5 Breaking of leaf part in leaf rot affected palm

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oung leaves, especially the
ing spindle, play in leaf rot. Early
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l. Keeping in mind that leaf rot
om is a part of root (wilt) complex
me, the features of root (wilt) and
t should be correctly perceived for
nting disease control measures.

Etiology of Leaf Rot

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vogue, earlier emphasis was only
elminthosporium (Bipolaris s). However, isolations of fungi
undreds of leaf rot affected palms
ally from the infected spindle
) established currently the

5. *Fusarium moniliforme* Sheldon var. *Intermedium* Neish and Legget,
6. *Cylindrocladium scoparium* Morgan,
7. *Thielaviopsis paradoxa* (Dade) C. Moreau,
8. *Rhizoctonia solani* Kuhn,
9. *Mortierella elongata* Linnem,
10. *Curvularia* sp.,
11. *Acremonium* sp.,
12. *Thielavia microspora* Mouch,
13. *Thielavia terricola* (J. Gilman & E. V. Abbott) Emmons, and
14. *Chaetomium brasilense* Batista & Pont.

Among them the more frequently associated fungi are : *C. gloeosporioides, E. rostratum, G. vermoeseni, Fusarium* spp., and *T. paradoxa* (*Fig. 6*). Examination of blighted leaves of mid-whorl yellowed leaves which is occasionally observed among root (wilt) affected palms.

Pathogenicity tests of all the fungi (in laboratory and field conditions) revealed that except. *Acremonium* sp., *T. microspora, T. terricola* and *C. brasiliense* all other fungi are pathogenic to coconut spindles and leaf rot symptom inducible. Reisolations of fungi corroborated pathogenic nature of these species. An added feature of the disease symptom is that while other pathogens induce wet-rotting of spindle tissues, the *Fuasrium* spp. invariably induces a distinct dry-rotting symptom. Dry rotting in certain palms among the cases of leaf rot is not uncommon in recent years - there the association of fusarial fungi has been ascertained.

Role of various fungi, individually and in certain combinations, have been also elucidated and their pathogenicity reconfirmed. *In vitro* laboratory analysis of various fungi (in dual cultures) established associative, not antagonistic, relationship among the predominant fungi, bearing significance to the disease as a complex. Tests of the effect of healthy (free - from root wilt) and root (wilt) affected palms in the field revealed that the fungi induce only restricted lesions in healthy palms, whereas on root (wilt) affected palms extensive lesions are produced that expand resulting in severe rotting of spindle tissues; *C gloeosporioides* and *E. rostratum* designated as the main pathogens of leaf rot (more aggressive and higher frequency of occurrence). Symptoms of leaf rot have been further reproduced in field in root (wilt) affected palms, with the main pathogens individually and in combination - disease lesions on leaf petiole, mid-veins, mid-ribs also developed and the disease symptoms appeared in successively emerging leaves as in naturally affected palms.

In this context it is noted that in relatively greater number of leaf rot affected palms more than one fungi co-occur even as the pathogenic fungi individually having role in the disease. Certain pathogens are significantly influenced by weather factors (described later in the article) also. Hence from the evidences of fungal frequency, pathogenic behaviour, seasonal relation, *in vitro* interactions etc., it is found beyond doubt that leaf rot is a disease of fungal complex and the fungi *viz. C. gloeosporioides* and *E. rostratum* are the main pathogens. Root (wilt) affected coconut palms (weakened by phytoplasma) are vulnerable to leaf rot pathogens.

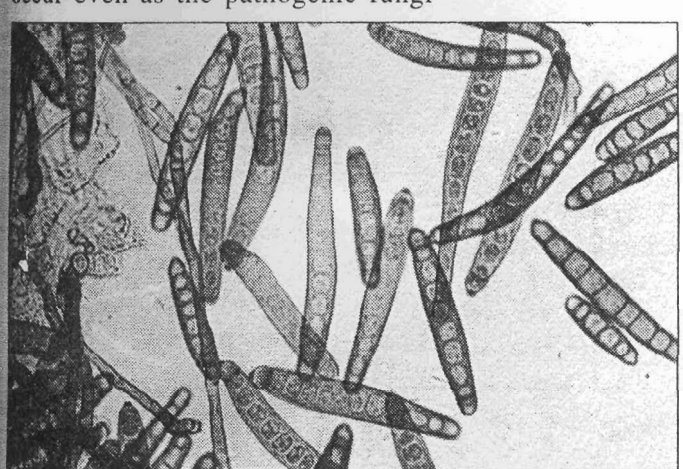


Fig. 6. Photomicrograph showing conidia of Exserohilum rostratum, one of the pathogens of leaf rot (Note : Leaf rot is due to a complex of fungi - see text for details).

Epidemiology - spread of Leaf Rot

Leaf rot is primarily an air-borne disease. Weather factors distinctly influence leaf rot, even while root (wilt) is the critical pre-disposing factor for its incidence. Eventhough leaf rot incidence can be observed in the field irrespective of seasons, its severity is usually greater in the monsoon-rainy seasons (here it need be pointed out that weather has no significant influence on incidence of root (wilt) in contrast to its impact on leaf rot). Free water, rain-drops, high relative humidity, low temperature etc. (experienced during monsoon months) are highly favourable for the leaf rot. The compactness of spindle foliage is an added influence on the fungal infection.

In view of the complex etiology of leaf rot, it is of importance to understand the population fluctuations of the associated fungi. Assessment has been made through multiple sampling and fungi isolated in a series of experiments : *C. gloeosporioides* occur with maximum population during monsoon months (peak in June/July) - strongly correlated with rainfall and relative humidity, and negatively correlated with maximum temperature and hours of sunshine. Further, this pathogen is isolated from early (young) lesions more consistently than from advanced or developed lesions. Hence *C. gloeosporioides* is the principal pathogen of leaf rot during monsoons (*Fig. 7*).

Incidence of *E. rostram* is strongly correlated with weather. In winter, while population of *E. rostratum* is high, the population level of *C. gloeosporioides* is low. Populations of certain other fungi - *Fusarium* spp. and *R. solani* - are high during the dry season (January-May). Presence of such fungi throughout the year in general and their predominance in the dry period draw importance as potential pathogens of leaf rot and in disease perpetuations (in the dry period), respectively. The incidence of other fungi is not influenced by specific weather factor, but they also play some role in the disease. Aggressiveness of particularly *C. gloeosporioides* during monsoons and general trend of fungal population fluctuations (due to weather) specially in young-leaf rot infected palms also have been ascertained.

Comparatively low incidence of *C. gloeosporioides* in the dry season is due to its quiescence in the season (dormant state). However, it sports an aggressive re-emergence with the onset of S.W. monsoon (favourable conditions) - its population is enormously built-up. Since spores of *C. gloeosporioides* is small, it spread fast in the field with cyclic infections resulting in severe rotting of tissues (may be linked to leaf rot severity during monsoons). *E. rostratum* may be next in the order of infection rate. The fungi dominant in dry months perpetuate the disease while certain other fungi too

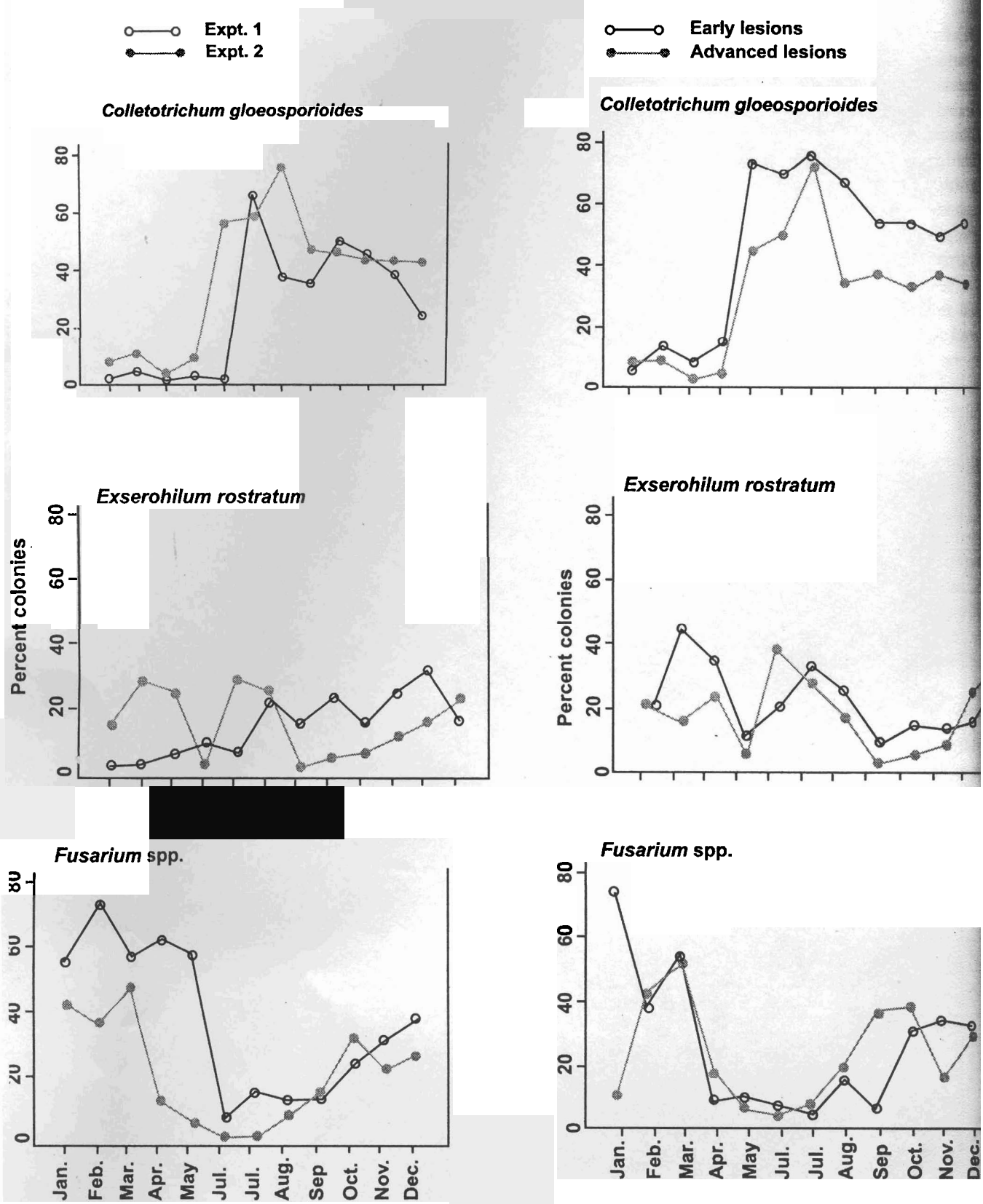
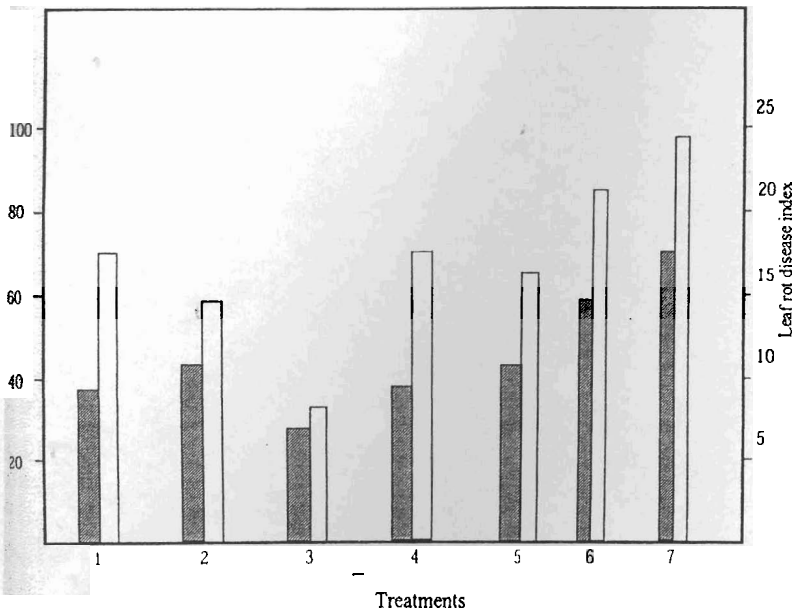


Fig 7. Frequency of isolation of fungi in different months - based on colonies enumerated from leaf pieces drawn from leaf rot affected spi



Sl.No.	Treatment	C.D. (P = 0.01)
1.	Phytosanitation	: 21. 9
2.	Contaf - pouring	7 6 5 2 1 4 3
3.	Phytosanitation + Contaf pouring	
4.	Contaf - spraying	
5.	Phytosanitation + Contaf - spraying	: 9.5
6.	Sequential spraying (Bordeaux mixture; Dithane M - 45; Fytolan) - one / round	7 6 4 1 5 2 3
7.	Control	

Fig 8. Mean % of leaf rot infected leaves (▨) and disease index (□) for emerged leaves of coconut under different treatments

some role in the leaf rot expression spective of specific season.

The root wilt (phytoplasma) is spread n diseased to healthy palms in the d by insect vectors (lace bug and nt hopper) and the incidence of leaf follows by fore mentioned chanism. Increased incidence of root lt) leads to an increase in occurrence leaf rot. Root (wilt) spreads spective of seasons. As one or the er pathogens of leaf rot (inoculum) available throughout the year, new ections of leaf rot may appear in any en season of the year; also, leaf rot recurrence in emerging spindles of already infected palms may occur concurrently. The cycle of incidence of root (wilt) followed by leaf rot leads to a situation wherein more and more palms get affected with the disease complex. Therefore, such information of epidemiology and mechanism of disease spread may be useful for leaf rot prediction, its early diagnosis and for adoption of disease control measures.

Disease Control

Control of leaf rot has received special attention in view of its destructive potential to lamina. As the disease is of fungal etiology, its field control with fungicides (spraying) has been in practice. In the past, results of field control with various fungicides were variable eventhough there were some reduction in the disease intensity reported; the need for more understanding of the disease was necessary. Further, spraying fungicides, etc. on coconut is labour intensive and cumbersome. Therefore, an alternative-simple measure was felt necessary. As eradication of root (wilt) affected palms brings down foci of primary infection - prompt eradication of disease advanced palms - root (wilt) and root (wilt) + leaf rot - is essential. In other palms - at the early stage of disease itself - the infected spindle and few young leaves (vulnerable part) should be promptly pruned (the action renders reduction of inoculum and aid the palm to recover). *In vitro* assay of the effect of contact and systemic fungicides on the pathogens of leaf rot pointed out effectiveness of a systemic fungicide, Hexaconazole/ Contaf - which registered a broad-spectrum activity and completely inhibited the main incitants of the disease. Such a fungicide in leaf rot control programmes is pointed out as useful.

Following broader understanding the vulnerability of young leaves (specially the emerging spindles) to leaf rot, a simple technology of pouring fungicide into axil around the spindle was focused for the first time. Accordingly, the method of pouring of fungicide (into the top leaf axil/well of the spindle) was standardized - by application of a fungicide (Calixin). Root feeding of the systemic fungicide into infected palms was also found possible (absorbed into the plant system without deleterious effect). With refinement of the simple technique in a second experiment, combination of phytosanitation (pruning of young infected leaves) with pouring

of the effective fungicide, Contaf, rendered prevention of incidence of leaf rot in emerging leaves (curative effect) and also helped to suppress incipient/ fresh infections in a prophylactic control manner (*Fig. 8*). Control of the disease in an eco-friendly manner by utilization of biological control measures was recognized. Although *Bacillus subtilis* was earlier indicated inhibitory to a pathogen of leaf rot, recent studies established that the culture of *Pseudomonas fluorescence* and its (culture) filtrate are inhibitory to various pathogens of leaf rot and disease lesions get suppressed. Also, antagonistic micro-organisms isolated from native-coconut rhizosphere/phylloplane offered inhibitory role on leaf rot pathogen/ disease. Hence, the possibility of incorporating the bio-control mechanism against the disease is being evaluated. As root (wilt) affected palm is weak and in a state of (plant) sickness, sound measures of constantly keeping the palm in vigour is necessary that would help reducing the leaf rot incidence/severity. The intensity of leaf rot is usually low in varieties in which the incidence of root (wilt) is low - such information is vital in managing the disease complex.

Based on the updated knowledge available on leaf rot, various parameters have been streamlined and a system approach with integrated measures is recommended to coconut growers of disease endemic region for effective management of the disease.

- All disease advanced, senile and uneconomic palms (both root wilt alone and root wilt with leaf rot) should be promptly removed from gardens (remember that an infected palm deranged to a level, beyond redemption and advanced, does not usually respond to treatments). For replanting use healthy seedlings from elite palms and varieties of hybrids tolerant to the disease complex (e.g. CGD/hybrids of CGDxWCT reportedly tolerant).

- The recommended practices as applicable to root (wilt) endemic region (application of manures and balanced dose of fertilizers; growing green manure crops (e. g., *Peuraria phaseoloides, Mimosa invisa, Crotalaria juncea, Calopogonium mucunoides* - for incorporation in the coconut basins); providing irrigation to palms during summer as well as proper drainage during monsoons, inter/mixed cropping; canopy restructuring of other perennials, etc.) should be observed and followed up in spirit. Constant/judicious adoption of such agronomic practices from crop-beginning onwards would enable the palms to grow in sound and vigour - these measures while countering the state of plant sickness, would also reduce the leaf rot incidence/intensity.

- Individual palms should be regularly monitored, especially the emerging spindle and other young leaves close to it to be scrutinized. If any such leaves are found infected, the affected portions should be pruned and disposed off by burning. This should be followed by pouring of fungicide - Contaf 5E into the well of the spindle leaf (0.2-0.4% conc; upto one litre/palm; 2-3 times/ year).

- The treatment of palms at the initial stage itself would be more useful, since it will aid the affected palm to recover fast. In the cases of palms where disease has progressed moderately, the aforemen-tioned treatments need to be prolonged.

Keep under regular observations of treated palms for any possible recurrence of the disease [as root (wilt) affected palms remain systemically infected and hence stand vulnerable].

- Before the onset of monsoon, general cleaning of palm crown is advisable - it reduces the leaf rot (fung inoculum; palms should be monitor with a thrust during rainy season as t activity of leaf rot pathogen is intens during such seasons.

Control of other major pests alo with leaf rot management could also b appropriately integrated to avo compounding of the problem. Th should be, however, viewed with caut [as the pest (insect) control alone can merit the disease control] and pla protection chemicals utilized wi utmost care, avoiding injur phytotoxicity to the soft-sensiti spindles, and with ecologic consideration.

Conclusions

Recent investigations have clear brought out that incidence of leaf rot correlated to the incidence of root (wil Leaf rot is a phase and should be viewe as a part of root (wilt) disease comple The phytoplasma infected palm (ro wilt) is systemically weakened an vulnerable to the attack of leaf rot. Th interrelationship between leaf rot an root (wilt) has been substantiall established. The leaf rot infection take place in young leaves; especially spindl is the critical part. The early diagnosti symptom of leaf rot (lesions) is observe in the spindles; lesions also on petiole mid-rib etc., recurrence of infection i emerging spindles and a host of othe features of disease symptoms ar significantly evident. It is pertinent to note that phytoplasma disease o coconut in other countries are all lethal but the root (wilt) is a malady of slo decline.

The vulnerability of root (wil affected palms to leaf rot attack i distinct and thus the disesae as a complex draws more importance Although root (wilt) affected palms ca be identified with certainty upon onse of leaf rot, it is also possible sometime

that in certain palms (especially the juveniles) leaf rot is contracted in root (wilt) symptomless stage itself. The incubation period of root (wilt) is relatively long and therefore, usually in certain young palms the leaf rot syndromes sometimes precede the expression of root (wilt) symptoms. This might pre-trend that in young palms leaf rot infection takes place first and the root (wilt) later. But is not necessary so. In nature, young palms are more vulnerable to leaf rot. The plants (due to phytoplasmal infection) are internally weakened even in root (wilt)-symptomless stage itself and the host defence mechanism broken down. The root (wilt) symptom expression (due to host-parasite interaction) actually happens subsequently; by such time leaf rot might have already established in the vulnerable plant. This is confirmed as the severe phase of rotting (leaf rot) appears usually only on root (wilt) affected plants. Another point of importance is that even as the root (wilt) affected palm as a whole is weak, it is the spindle most vulnerable to leaf rot hence predisposition by root (wilt) to leaf rot is the evident and treating leaf rot as a part of root (wilt) disease complex becomes more relevant.

It is confirmed beyond doubt that leaf rot is due to a complex of fungi. Out of 14 species of fungi isolated, 10 species are pathogenic to spindles. More than one fungi are associated in greater number of diseased palms and the predominant fungi are associative (and not antagonistic). *C. gloeosporioides* and *E. rostratum* are the main pathogens of leaf rot. The influence of weather factors on the epidemiology of leaf rot is important. Leaf rot is severe during monsoon months. Population fluctuations of certain pathogens of leaf rot in relation to weather factors is distinctly reported. Activity of *C. gloeosporioides* is conspicuously higher during monsoon months and it is the principal pathogen of leaf rot during monsoons. *E. rostratum* has less strongly correlated to weather. *Fusarium* spp. (and *R. solani*) are common during dry seasons - aid in disease perpetuation.

Destruction of lamina and disfiguration of coconut palm (due to leaf rot) might give apparently an impression that it is the leaf rot acting as the factor for yield loss. This point should be viewed cautiously because even the palm with root (wilt) symptom alone (due to infection by phytoplasma) pathologically suffers (systemically) and yield declines. Leaf rot superinfection certainly makes the condition of such palms to deteriorate fast and the damage compounded. Hence these facts should not be lost sight of. Cause of the disease complex (root wilt/leaf rot) is quite clear and it should be remembered that leaf rot is a syndrome within the root (wilt) complex. As on today phytoplasma induced root (wilt) is not amenable to conventional plant protection measures, but the leaf rot phase is certainly responsive. Therefore, strategies have been evolved for dealing the root (wilt) complex in mildly affected areas and disease endemic region. In the later region, it is the integrated management of root (wilt) complex in which leaf rot control also forms a part. The objective is conserving the photosynthetic areas of leaves (otherwise would have been lost due to leaf rot) along with a host of other measures (mitigating the suffering plants) to prolong crop sustainability. Since spindle is the most vulnerable site for leaf rot pathogens, action should be concentrated towards protection of such a vulnerable part of the plant. Experience has also shown general-poor viability of leaf rot pathogens in older leaves (thus may not be much need for protection of older fronds). Adherence to prevent leaf rot incidence/disease intensity build-up and equal emphasis of enabling the infected palm to recover (cure) at early stage itself would pay rich dividends.

Current understanding on various aspects of leaf rot could be strategically utilized for disease control. Field experiments have pointed out the use of simple technology of pouring fungicide into the cavity (axil/well) around the base of the spindle leaf for control of leaf rot and combining the technique with phyotsanitation augments leaf rot suppression in emerging leaves. Besides the possibility of cure of infected palms, the scope for prophylactic control is also available. Effective broad spectrum fungicide - Hexaconazole/Contaf 5E - has been detected through *in vitro* assays for such control measures; potential antagonistic micro-organisms (*Pseudomonas fluorescence* etc.) also assessed for possible utility.

Growers should view leaf rot only integrally with root (wilt). In overall management of root (wilt) disease complex (in addition to leaf rot control) the other measures like balanced nutrition, irrigation, green manuring, intercropping, etc. would potentiate the vigour of palms and the symptoms of root - (wilt)-leaf rot would be considerably depressed and thereby the sickness of palms countered. The integrated management package along the lines as described in the article would go a long way in disease control, enabling sustainable cultivation of coconut. Root (wilt) disease management practices for the heavily diseased (endemic) area (besides eradication of infected palms in mildly affected areas) need be strictly followed with a systems approach to gain more returns from unit area of land - thereby keeping up the production/ productivity of coconut in the country, retaining the India's position of leadership in coconut industry.