CP2630

Integrated management of leaf rot disease and insect pests on coconut

P.K. KOSHY, YOGESH KUMAR*, D. JAYASREE, UDAYA JOSEPH, and V.K. SOSAMMA

Central Plantation Crops Research Institute, Regional Station, Kayangulam, Krishnapuram-690533, Kerala.

ABSTRACT : The loss due to leaf rot disease of coconut was estimated to be 461 million nuts annually in Kerala. A number of fungi have been reported to be associated with the disease of which *Exserohilum rostratum* and *Colletotrichum gleosporoides* are important among them. The leaf rot affected spindle is also colonised by mealy bugs, mites and nematodes. Increased incidences of red weevil and rhinoceros beetle are known to occur in leaf rot affected palms compared to the healthy palms in the disease prevalent tracts. In view of the above, an experiment was laid out in farmers garden to study the effect of fungicide and insecticide with nematicidal qualities to study their individual and combined effect in the incidence of leaf rot and pests. Fungicides used were Hexaconazole (Contaf 5 EC – 2 ml), Mancozeb 75% WP (Dithane M-45/Indofil M-45 – 3 g), Phorate (Thimmet 10 G-20 g) and Methyl parathion 2% (Folidol Dust – 50 g). The experiment was continued for four years. There were 8 treatments with 8 replications each and had a completely randomized design. The treatment differences were significant. The palms treated with Mancozeb @ 3 g per palm dissolved in 300 ml water applied twice a year gave maximum reduction in disease indices followed by Phorate + Contaf and Phorate + Indofil and Contaf alone. Superiority of treatment with Indofil M-45 was very clear after each round of observation. At the end of the experiment the average disease index was only 1.0 with 6 out of 8 trees showing no disease symptom. Since rotten portions of the spindle is removed before the application of the fungicide, protection of the wound with an insecticide is a must to save the palms from the incidence of red weevil. Sanitation followed by application of Phorate 20 g mixed with 200 g river sand was better than the application of Folidol dust 50 g in controlling leaf rot which indicated that nematodes have a role in the incidence/aggravation/ transmission of fungi between leaflets of the same spindle or to the next spindle. No additional advantage was seen when Contaf and Indofil were applied together or when Contaf, Indofil and Phorate were applied together. Phorate – 20 g treated palms were totally free from red weevil, rhinoceros beetle, mealy bugs and other insects compared to Folidol Dust – 50 g where stray incidences of rhinoceros beetle infestation occurred. Pouring of 3g Indofil-M45 or contaf 5 EC – 2 ml dissolved in 300ml water after removing rotten portions of the spear leaf followed by application of Phorate 20g mixed in 200g fine river sand to the base of the spindle in April-May and in October-November controlled leaf rot and insect pests on coconut. The coconut water, kernel and oil from mature nuts harvested after 45 days of application of Folidol Dust – 50 g, Contaf - 5 EC – 4 ml and Indofil M-45 - 3 g were free from residues.

Key words: coconut, control, leaf rot, insect pests

---

* Rallis Research Centre, Plot Nos. 21 & 22 Phase II, Peenya Industrial Area, Bangalore-60058, Karnataka.

The coconut palm is affected by a number of diseases and pests some of which are lethal while others reduce its vigour resulting in economic loss. Eight hundred and thirty insects and mites, 173 fungi and 78 species of nematodes have been found to be associated with coconut (Anon., 1979). Only a few of them cause serious damage to the crop. In India, root (wilt), Tatipaka, Thanjavur wilt, stem bleeding, and bud rot are the important diseases and red weevil, eriophyid mite, leaf eating caterpillar and rhinoceros beetle are the important pests and among nematodes, *Radopholus similis* is the most important nematode problem on coconut. The low productivity of coconut in Kerala is mainly attributed to the prevalence of leaf rot disease, eriophyid mite and burrowing nematodes.

The occurrence of leaf disease of coconut was first noticed in 1882 in Erattupetta area of Meenachil taluk of Kottayam district (Butler, 1908; Pillai, 1911, Menon and Pandalai, 1958). Around 1907, the disease was reported from Kaviyoor and Kalooppara areas of Thiruvalla taluk and later from Kayangulam of Karthikappally taluk. Today, the disease is present in all districts of Kerala and Chenkottai, Coimbatore, Kumbam, Pollachi and Kulasekharam areas of Tamil Nadu. Recently the disease has also been reported from Mandovi farms, Bhironda, Satari, Goa (Koshy, 2000). The loss due to root (wilt) disease was estimated to be 960 million nuts in Kerala alone (Anon., 1985) and the loss due to leaf rot disease was computed and estimated to be 461 million nuts annually (Joseph and Rawther, 1991). Butler (1908) referred to it as root disease, McRae (1916) and Sundararaman (1925) called it leaf rot disease, Menon (1935) as coconut leaf disease and Menon and Nair (1948) as leaf rot disease. Sreedharan (1941) explained how *Kattuveezhcha,* a Malayalam term meaning wind-borne, came to be used to denote leaf rot. But later, *Kattuveezhcha* came to be used for coconut root (wilt) disease, obviously because leaf rot and coconut root (wilt) diseases were not considered as separate entities then. Root (wilt) disease without leaf rot does not cause much economic loss. Srinivasan (1991) reported that leaf rot disease gets superimposed on 65 per cent of root (wilt) affected palms. Leaf rot disease occurs on palms of all ages. The rotting of spindle occurs even within 10 months of field planting of one year old seedling. Rotting of spear leaf is always the first obvious symptom to appear in seedling. Flaccidity, yellowing and necrosis are not often evident at this stage in these seedlings occur later, on these seedlings. The initial symptom is

the production of tiny spots of various colours (reddish to brownish) and shape (round to elongate) on white, soft, unopened leaflets of the spindle. These water soaked lesions enlarge and coalesce leading to extensive rotting. When the spindle grows the rotten portions dry up, turn black, break and get blown off in the wind. The development of the symptoms and rotting is severe at the distal end of the leaf, specially 1 to 1.5 m in length. On individual leaflets also the distal ends show more of rotting. Occurrence of intermittent rotting of leaflets and mid ribs on the same leaf is also seen. In many cases, the rotten distal portions of the leaflets adhere to each other from top to bottom on both sides thereby giving a fish bone appearance. On drying these drop off. Dwivedi *et al* (1979) reported whitening and softening of leaflets of the spindle as an important symptom of root (wilt) disease. Hardening of the tissues and development of chlorophyll in the maturing leaflets slow down the progress of rotting towards the base of the leaflets so that the basal portions of the affected leaflets remain green and normal giving a fan like appearance. Normally the symptoms would appear on each successive spindle thereby showing symptoms on all leaves.However, the disease is never fatal. In the early stages of the disease, some spindles escape rotting during summer months. Severity of the leaf rot symptom is observed more during monsoons and trees of all ages are susceptible and during summer months the leaflets show more of dry rot. The disease causes drastic reduction in the photosynthetic area which in turn leads to the reduction in yield.

Menon and Nair (1948) reported *Helminthosporium halodes, Gloeosporium sp., Curvularia sp., Gliocladium roseum, Pestalotia sp. and Fusarium sp.* from the leaves. Srinivasan and Gunasekaran (1993) reported isolation and identification by IMI of CAB, UK the following species: *Colletotrichum gleosporoides, Exserohilum rostratum, Gliocladium vermoeseni, Cylindrocladium scoparium, Fusarium solani, F. moniliformae var. intermedium, Thielaviopsis paradoxa, Rhizoctonia solani, Mortierella elongata, Curvularia sp., Acremonium sp., Thielavia microspora, T. terricola, and Chaetomium brasiliense.*

The leaf rot affected spindle leaf is also colonised by nematodes (Nadakkal, 1965), mealy bugs and mites. Infestation by red weevil is also very common in leaf rot affected palms. Individual or collective role played by large number of nematodes *Rhabditis sp., Aphelencchus sp., Aphelenchoides aligarhiensis, Panagrolaimus rigidus,*

Paurodontus sp., *Diplogaster sp* (Sosamma & Jayasree, 2000) as incitants, aggravators or synergists or as disseminating agents of the fungi to the next spindle is yet to be studied in detail.

Menon and Nair (1952) conducted spraying in the field using 1.0% and 0.5% Bordeaux mixture against leaf rot and found 74.5% reduction in the intensity of the disease..

MATERIALS AND METHODS

The plot 4 KM away from CPCRI at Valanjanadakkavu (Karthikappally taluk, Alleppey district) was selected having more than 80 leaf rot affected palms of same age. Palms were indexed according to the scale (Srinivasan and Gunasekaran, 1996).

Rotting of the laminae of leaflets (percent)	Grade / Numerical ratings
1- 25	1
25- 50	2
51- 75	3
76-100	4

The disease index was calculated using the following formula.

$$\frac{\text{The numerical ratings}}{\text{Total no. of leaves x Maximum no. of grades (4)}} x100$$

TREATMENTS

1. Contaf 5 EC(2 ml)
2. Indofil - M45 (3 g)
3. Phorate (Thimet) (20 g)
4. Phorate (20 g) + Contaf 5 EC (2 ml)
5. Phorate (20 g) + Indofil - M45 (3 g)
6. Contaf 5 EC(2 ml) + Indofil - M45 (3 g)
7. Phorate (20 g) + Contaf 5 EC (2 ml) + Indofil - M45 (3 g)
8. Control*

*Folidol dust (Methyl parathion 2% - 50 g) mixed with river sand (200 g) was applied to the control palms and palms under treatments with fungicide alone to protect from insect pests

The leaves were numbered serially on all palms from the lower whorl and disease index was calculated before every application. The unopened spear leaf was marked with red paint. Before each application the rotten portions of the spindle and the adjacent two innermost fully opened leaves were cut and removed. The fungicide, Contaf 5 EC (Hexaconazole) or Indofil M-45 (Mancozeb 75% WP) was dissolved in 300 ml water and poured into the well around the base of the spindle. In treatments where nematicide, Phorate was involved, it was mixed with 200 g fine river sand and was applied into the well around the base after pouring the fungicide mixture. The insecticide, Methyl Parathion 2%, 50 g mixed with 200 g river sand was applied in treatments where nematicide application was not done to protect them from rhinoceros beetle/red weevil attack. This was a completely randomized experiment with 8 treatments, replicated 8 times with 6+1 rounds of observations. The experiment continued for four years. The treatment was given after every six months in April-May and in October-November.

Five palms each on CPCRI farm were treated with Contaf 5 EC – 4 ml, (Hexaconazole), Indofil M-45 – 3 g (Mancozeb 75% W.P) and Folidol dust – 50 g (Methyl Parathion 2%) as above and samples were collected 45 days after application. A sample of three mature nuts were collected from each palm (one replication) for getting enough water, kernel and oil for analysis.

Residues of Hexaconazole in Coconut

The samples were processed and water, kernel and oil obtained after processing were analysed separately for the residues of Hexaconazole.

The residues of Hexaconazole from water were extracted with dichloromethane. The extract was concentrated and analysed directly by GLC. For the extraction of residues from oil and kernel acetonitrile and acetone were used, respectively. The extracts were. diluted with water and cleaned up by partitioning with 3 x 75 ml dichloromethane followed by partitioning between hexane and acetonitrile three times. Each time hexane fraction was discarded and finally acetonitrile was evaporated to

dryness. The residue was re-dissolved in suitable volume of acetone and analysed by GLC operated under following conditions.

Instrument : Chemito model 8510 GC equipped with Ni 63 EC detector and PC based data system

Column : 5% SE-30 on CHW (HP), 1 mt, ¼ " i.d., glass

Temperature

Oven	:180^{0}C
Injector	: 260^{0}C
Detector	: 300^{0}C
Gas flow rates	: Nitrogen: 25 ml/min.
Retention time	: 3.0 min. (approx.)

Residues of Mancozeb in Coconut

The samples were processed and water, kernel and oil obtained after processing were analysed separately for the residues of Mancozeb. The method of residue analysis was essentially the same as described in 13832 : 1993 with slight modifications (Anon, 1993). A representative sample is blended with desecrated ice- water in a ratio of 1: 1 under nitrogen and an appropriate aliquot of the homogenised sample is decomposed with sulphuric acid. The evolved carbon disulphide is absorbed in Viles reagent. The intensity of the resulting colour complex is measured spectrophotometrically at 380 nm and the absorbance compared by means of a standard curve.

Residues of Methyl Parathion in Coconut

The samples were processed and water, kernel and oil obtained after processing were analysed separately for the residues of methyl parathion. The method of residue analysis was essentially same as described in IS-10630 – 1983 (Anon, 1983) with slight modifications.

The residues of methyl parathion from water were extracted with dieffloromethane, the extract was concentrated and analysed directly by GLC. For the extraction of residues from oil and kernel, acetonitrile and acetone was used, respectively. The extracts were diluted with water and cleaned up by partitioning with 3

x 50 ml chloroform followed by adsorption column chromatography using 10 g activated neutral silica gel as adsorbent and 50 ml of 90 : 10 benzene acetone mixture as eluting solvent. The eluent was concentrated to dryness and residues were re-dissolved in suitable volume of hexane and analysed by GLC operated under following conditions.

Instrument : Chemito model 8510 GC equipped with NP detector and PC based data system

Column : 2% OV-101 on Chromosorb -WP,1 metre x ¼". i.d., glass

Temperature

Oven : 160^{0}C

Injector : 225^{0}C

Detector : 300^{0}C

Gas flow

Nitrogen : 30ml/min

Hydrogen : 3ml/min

Air : 110ml/min

Retention time : 2.4 min (approx)

RESULTS AND DISCUSSIONS

The treatment differences are statistically significant, lowest disease index was in T2 – Indofil M-45 (3 g) followed by T4 Phorate (20 g) + Contaf (2 ml) and T5 Phorate (20 g) + Indofil M-45 (3 g). Highest disease index was noted in T8 – Control. Average disease indices observed in the different rounds of observations also differed significantly. The disease index, which stood at 41.9 at the start of the experiment, was showing a moré or less steady declining trend, after every round of application, and at the end of this experiment, this stood at 12.7. Superiority of T2 – Indofil M-45 (3 g) was clear after each round of observation. At the end of the experiment, in T2- Indofil M-45 (3 g) the average disease index was only 1.0, with 6 out of 8 trees showing no disease symptoms.

This experiment has clearly showed that the leaf rot disease can easily be managed by pouring 3 g Indofil M-45 dissolved in 300 ml water to the base of the spindle after removing the rotten portions of the spindle, if any. Since rotten portions

Table 1: Leaf rot disease indices of palms.

Treatment	Pre-treatment	Disease indices after different rounds of pouring						
		1	2	3	4	5	6	Pooled
1.	51.30	29.95	34.38	21.00	14.10	16.70	11.20	25.52
2.	36.70	37.88	23.36	7.00	5.21	7.70	1.00	16.98
3.	55.63	43.75	45.13	36.71	20.00	22.73	17.20	34.45
4.	36.25	39.74	32.14	12.36	3.60	9.90	4.05	19.72
5.	35.00	29.00	24.91	20.60	10.01	9.49	8.81	19.69
6.	38.75	48.67	39.00	29.08	15.89	24.25	11.30	29.56
7.	33.75	36.79	42.26	26.40	13.60	15.60	11.55	25.71
8.	47.50	57.86	52.01	42.46	44.03	35.39	36.10	45.05
Mean	41.86	40.45	36.65	24.45	15.80	17.72	12.65	27.08

F ratios:	Treatments- 18.19**	Rounds of pouring 37.23**	Interaction- 0.82
CD	6.03	5.64	NS

of the spindle is removed before application of fungicide, protection with an insecticide is a must to save the palm from the incidence of red weevil that gets attracted to wounds as well as to leaf rot affected palms.. It is very evident that in T3 where (Phorate 20 g) is applied after removal of affected portion was always better than T8 – Control where Folidol dust 2% 50 g) was applied, though in T3 the pretreatment index

was 55.6 compared to T8 where it was 47.5. Though both insecticides protected from insect pest attack, application of Phorate was found more advantageous in controlling leaf rot. This suggests the indirect role of nematodes in the incidence/aggravation /transmission of fungi between leaflets of the same spindle or to the next spindle.

No additional advantage was seen where Contaf and Indofil was applied together or when Contaf 5 EC, Indofil M-45 and Phorate was applied together. Between Indofil M-45 3 g and Contaf 5 EC 2 ml alone Indofil M-45 3 g was better. When Phorate 20 g was applied with Contaf 5 EC 2 ml or Indofil M-45 3g both were at par. Between Phorate 20g and Folidol dust 50 g, mixed with 200 g river sand Phorate gave better control of the disease and insect attack.. Wherever Phorate was used palms were free from attack of rhinoceros, red weevil, mealy bugs, nematodes etc. compared to palms under treatment where Folidol 50 g was used, where stray incidence of rhinoceros beetle attack was noticed. Though Indofil M-45 3 g is the best followed by Contaf 5 EC 2 ml and Phorate 20 g or Indofil M-45 and Phorate 20 g the combined application of the fungicide and insecticide is recommended in view of the saving of labour and complete protection from leafrot and insect attack. Four sequential spraying of Bordeaux mixture 1%, Dithane M-45 0.3% and Fytolan 0.5% on leaf rot affected palms in farmers' gardens resulted in the control of the disease (Anon. 1985b). Srinivasan and Gunasekaran (1996) reported moderate impact of pouring of calixin and spraying of Indofil M-45 in the control of leaf rot when applied thrice a year, for three years continuously.

Table 2. Residues of Hexaconazole in Coconut

Samples I.D	Residues (in ppm)		
	Water	Kernel	Oil
T1R1	ND	ND	ND
T1R2	ND	ND	ND
T1R3	ND	ND	ND
T1R4	ND	ND	ND
T1R5	ND	ND	ND

ND : Not detected

Detection limit : 0.01 ppm

The results of analysis of Hexaconazole residues in coconut water, kernel & oil are presented in appended table. The residues of Hexaconazole were below detection limit (< 0. 0 1 ppm) in all the samples analysed.

Table 3. Residues of Mancozeb in Coconut

Samples I.D	Residues (in ppm)		
	Water	Kernel	Oil
T2R1	ND	ND	ND
T2R2	ND	ND	ND
T2R3	ND	ND	ND
T2R4	ND	ND	ND
T2R5	ND	ND	ND

ND : Not detected ;
Detection limit : 0.01 ppm

The results of analysis of Mancozeb residues in coconut water, kernel and oil are presented in appended Table 2. The residues of Mancozeb were below detection limit (< 0. 0 1 ppm) in all the samples analysed.

Table 4. Residues of Methyl Parathion in Coconut

Samples I.D	Residues (in ppm)		
	Water	Kernel	Oil
T3R1	ND	ND	ND
T3R2	ND	ND	ND
T3R3	ND	ND	ND
T3R4	ND	ND	ND
T3R5	ND	ND	ND

ND : Not detected ;
Detection limit : 0.01 ppm

The results of analysis of Methyl Parathion residues in coconut water, kernel and oil are presented in appended Table 4. The residues of Methyl Parathion were below detection limit (< 0.01 ppm) in all the samples analysed.

Residues could not be detected using GLC method in water and meat of coconut and water, kernel, oil and oil cake of mature coconuts 40 days after application of phorate, carbofuran and ebufos @ 3 g ai. per palm in the crown and carbofuran and phorate @ 10 g ai/palm in soil within the basin (Koshy, 1992).

Earlier Habebulla *et al* (1983) also could not find residues of aldicarb 45 days after application of Temik @ 3g a.i. per palm to the crown and @ 10g a.i. per palm to the basin by GLC method as well as by bioassay method.

In the management of leaf rot, the role of the photosynthetic area available in every leaf and its contribution to yield is the most important factor to be considered. The second is the labour requirement for the operation and the cost of the chemicals . The fact that the white, soft, achlorophyllous leaflets of spindle alone are susceptible to fungal attack suggest that the spindle alone is to be protected. This was not realized by the earlier workers. The rhinoceros beetle also attacks only the spear leaf. Earlier recommendation of quarterly sequential spraying of Bordeaux mixture 1%, Dithane M-45 0.3% and Fytolan 0.5% on leaf rot affected palms using rocker sprayer (6 labour), and separate application of BHC 10% or Sevidol 8 g for the control of rhinoceros beetle three times a year (3 labour) are known to be effective, but farmers had not adopted them because of the very high requirement of 9 skilled labourers and the cumbersome spraying involved. Thus, the need for a simpler, environment-friendly and less labour intensive method combining the application of fungicide and insecticide, without the aid of a sprayer offering total plant protection was achieved by this study. Since susceptibility is confined to white tender leaflets of spindle alone, pouring is better avoiding cumbersome spraying and environment pollution due to drifting of spray fluid. The requirement of fungicide mixture is also brought down from 3000 to 300 ml. The cost of two applications in a year is Rs. 13.60 if Indofil is used and Rs. 14.60 if Contaf 5 EC is used if climbing charges per palm is Rs.5/-. . Compared to the earlier recommendation of separate quarterly application of fungicides (Rs.50/-) and insecticide (Rs.29/-) complete plant protection for the year is obtained for Rs. 13.60 saving 80% expenditure in labour and cost of chemicals. This simple, cheap and effective integrated management method for leaf rot and pests need to be popularized for the benefit of large number of coconut farmers in Kerala and Tamil Nadu.

Koshy *et al* (2000) demonstrated very clearly that two applications of Dithane M-45 -3 g /Contaf 5 EC 2 ml dissolved in 300 ml water to the base of the spindle in April-May and October-November followed by application of Phorate 20 g mixed in 200 g river sand could prevent the occurrence of leaf rot in serologically positive palms.

Thus the treatment is to be given to all palms (apparently healthy and diseased) in disease prevalent areas for prophylactic and curative effect.

In view of the importance of leaf rot of coconut to the economy of Kerala and Tamil Nadu the following lines of investigations need to be taken up immediately:

1. Development of a simple and fast method for determining the susceptible/ resistant nature in seedlings to leaf rot disease before planting.
2. Use of modern molecular methods in the investigation of leaf rot disease such as identification of resistance linked markers in seedlings and development of diagnostic PCR tests for the various associated fungi.
3. Development of serodiagnostic tests for the detection of important fungi such as *Exserohilum rostratum Colletotrichum gleosporoides, Fusarium solani and Fusarium moniliformae* var. *intermedium* in coconut seedlings.

ACKNOWLEDGEMENTS

We are grateful to Indian Council of Agricultural Research for providing financial support through an A.P. Cess Fund Scheme entitled "Role of nematodes in the incidence of leaf rot disease on root (wilt) affected coconut palms" for carrying out these studies. We are also thankful to Mr. Jacob Mathew, Principal Scientist, CPCRI(RS), Kayangualm for statistical analysis.

REFERENCES

Anonymous, (1979). Nematodes, fungi, insects and mites associated with the coconut palm. *Tech. Bull. No. 2.* Central Plantation Crops Research Institute, Kasaragod - 670 124, Kerala, India. pp. 236.

Anonymous (1983), Indian Standard Methods for Determination of Methyl Parathion residues in Foods. Pesticides Residue Analysis Sectional Committee, AFDC 56, IS10630 – 1983.

Anonymous (1985a), A survey Report. Coconut Root (wilt) disease - Intensity, production loss and Future strategy, Central Plantation Crops Research Institute, Kasaragod. 45 pp.

Anonymous (1985b), Annual Report for 1983, Central Plantation Crops Research Institute. Kasaragod. pp 249.

Anonymous (1993), Indian – Pesticide – Method for determination of residues in Agricultural and food commodities, soil and water – Dithiocarbonates. UDC 664 : 543 (632.95.028 DIT) IS13832 : 1993.

Butler, E. J. (1908). Report on coconut palm disease in Travancore. Agric. *Res. Inst. Pusa Bull.,* No. 9:23 pp.

Dwivedi, R. S., Mathew, C. Ray, P K., Amma, B.S.K. and **Ninan, S.** (1979). Certain closely associated morphological symptoms of root (wilt) disease of coconut *(Cocos nucifera). Plant Dis. Reptr,* 63.461- 463.

Habeebullah, A., Reghupathy, A., Rethinam, P. and **Koshy, P.K.** (1983). Residues of Aldicarb in coconut. In Abstract : Seminar on pesticides and environment. 4-5 August, 1983, Absr. No.37, TNAU, Coimbatore, P21.

Joseph, T. and **Rawther, T.S.S.** (1991). Leaf rot disease. In *Coconut Root (wilt) Disease.* Eds. Nair, M. K., Nambiar. K.K.N, Koshy, P K. and Jayasankar, N. P pp-92, CPCRI Kasaragod.

Koshy, P.K. (1992) Integrated Nematode Management ; Studies on *Radopholus similis* on coconut. CPCRI. Annual Report (1991-92) p 90.

Koshy, P.K. (1999) Root (wilt) disease of coconut. Mundkur Memorial Lecture delivered at the 52nd annual meeting of the Indian Phytopathological Society held at IIS Lucknow on 18th February 1999: *Indian Phytopath* **52(4):**335-353.

Koshy, P.K., Jacob, P.M., Sasikala, M. and **Rajeev, G.** (2000). Prophylatic and curative effect of combined applications of insecticides and fungicides on leaf rot disease of coconut. (Paper presented at the Symposium on Integrated Plant Disease Management for sustainable Agriculture held at CPCRI Regional Station, Kayangulam during 14-16 Dec., 1999, organized by the Indian Phytopathological Society). Abstr.N:01, *Indian Phtopath.* **53**(3) 367.

Koshy, P.K. (2000). Leaf rot Disease of coconut. *Indian Coconut J.* **31(2):**4-10.

McRae.W (1916). Communication to the Dewan of Cochin. In: Menon K.PV and Nair, U.K. 1948. The leaf rot disease of coconuts in Travancore and Cochin. Studies on the physiology of casual fungi. *Indian Cocon. J., (1)* : 33-39.

Menon, M.S. (1935). *The Coconut Leaf Disease.* Bulletin No. 1 Botanical Series, Dept. of Agric., Cochin State.

Menon, K.P.V and **Nair, U.K.** (1948). The leaf rot disease of coconut in Travancore and Cochin. *Indian Cocon. J. 1* (2): 33-39

Menon, K.P.V and **Nair, U.K.** (1952). Scheme for investigation of root and leaf diseases of coconut in South India. Consolidated report of work done from 8th March. 1937 to 31st March, 1948. *Indian Cocon. J.,* **5** 81-100.

Nadakal, A. M. (1965). A note on the occurrence of nematodes on the leaves of coconut palms in Kerala. *Sci. &* Cult. **31**:157-158.

Srinivasan, N. (1991). Occurrence of coconut leaf rot in relation to root (wilt) disease. Indian *Coconut J.,* **21** (10): 14-18.

Srinivasan, N. and **Gunasekaran, M.** (1993). Fungi associated with leaf rot disease of coconut. *Indian Coconut J. 21* **(10):** 2-7

Srinivasan, N. and **Gunasekaran, M.** (1996). Field control of leaf rot disease of coconut with fungicides. *CORD* **12:** 34-42.

Sundararaman, S. (1925). Preliminary note on coconut leaf rot of Cochin. *Year Book Madras.* Agrl. Dept. 6-8 p.