

Diseases of rattan in nurseries, plantations and natural stands in Kerala, India

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Abstract—A disease survey in rattan nurseries, plantations and natural stands in Kerala State, India, revealed that *Calamus dransfieldii*, *C. gamblei*, *C. hookerianus*, *C. pseudotenuis*, *C. rotang*, *C. thwaitesii*, *C. travancoricus* and *C. vattayila* are susceptible to various fungal pathogens in different growth phases. In nurseries, seedlings are affected with diseases caused by *Bipolaris ellisii*, *Colletotrichum gloeosporioides*, *Corynespora cassiicola*, *Fusarium longipes*, *Guignardia calami*, *Sclerotium rolfsii* and *Rhizoctonia solani*. Of these, seedling blight caused by *Guignardia calami* and seedling collar rot caused by *Fusarium longipes* are the most important diseases. In plantations and natural stands, rattans are affected by various foliage pathogens, such as *Bipolaris ellisii*, *Colletotrichum crassipes*, *Colletotrichum gloeosporioides*, *Glomerella cingulata*, *Pestalotiopsis theae*, *Phomopsis palmicola*, *Phyllachora calamigena* and *Sphaerodothis*. Among these, *Colletotrichum* infection on unopened spear (frond) and *Sphaerodothis* foliage blight caused severe damage to young as well as mature plants. Stem rot and staining, caused by *Pellicularia filamentosa* and *Botryodiplodia theobromae*, respectively, are the other important diseases. Nursery diseases can be effectively controlled by application of fungicides, viz., carboxin, mancozeb, carbendazim by seed dressing, soil drenching or by foliar spraying.

Key words: Fungal diseases; *Calamus* spp.; rattan seedlings; natural stands; plantations.

INTRODUCTION

In India, rattan, represented by four genera, *Calamus*, *Daemonorops*, *Plectocomia* and *Korthalsia*, with about 62 species, occurs in the Western Ghats, Eastern and North-eastern States and Andaman and Nicobar Islands. They are generally found in the evergreen, semi-evergreen and moist-deciduous forests. The Western Ghats harbour about 22 species of rattan belonging to the genus *Calamus*, of which 15 are present in different forest areas of Kerala State [1–3]. Among these, *Calamus gamblei* Becc., *C. hookerianus* Becc., *C. rotang* L., *C. thwaitesii* Becc. and

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C. travancoricus Bedd. are the commercially exploited species. Recently, small-scale plantations of commercially important species have been initiated in the State. Due to increasing demand for rattan products, over-exploitation of the commercially important species from the natural stands as well as other factors like forest fire, pest and diseases, etc., have depleted the rattan resources at a fast rate. Diseases appear to be one among the various factors affecting the regeneration, growth and survival of the rattan in natural stands and plantations. Rattan nurseries have been raised in different parts of the State to supply the seedlings for raising plantations as well as augmenting the stock in the natural stands. As information on diseases affecting rattan is meagre, a disease survey was carried out in rattan trial plantations, natural stands and nurseries, and data collected are reported here.

MATERIALS AND METHODS

A disease survey was carried out in 12 selected natural rattan stands, four trial plantations and six rattan nurseries (Table 1). Three plots each of 20 × 20 m, were selected at random in each of the 16 localities. The selected plots were visited at least twice a year, from June to August (wet period) and December to May (dry period) and observations on incidence, severity and spread of diseases were recorded. As far as possible the rattan nurseries were visited frequently between December and July, when the seedlings were at different stages of growth. Disease assessment was made and disease specimens were brought to the laboratory and isolations of the causal organism were made on Potato Dextrose Agar (PDA) medium. An identification of the causal organisms was made up to species level and for confirmation the fungal cultures and fungal herbarium specimens were referred to CABI Bioscience (Egham, UK). The pathogenicity of the fungal isolates to the respective rattan species was confirmed by usual glasshouse procedures. Two- to four-month-old *C. gamblei*, *C. hookerianus*, *C. pseudotenuis*, *C. rotang*, *C. thwaitesii* and *C. vattayila* seedlings were used for screening the pathogenicity of the test fungus. A conidial suspension (2000 conidia/ml) of the test fungi (*Alternaria alternata*, *Bipolaris elisii*, *Colletotrichum gloeosporioides*, *C. crassipes*, *Corynespora cassiicola*, *Curvularia lunata*, *Fusarium longipes*, *F. oxysporum*, *F. pallidoroseum*, *F. solani*, *Guignardia calami*, *Pestalotiopsis theae*, *Sphaerodothis* sp. and *Phomopsis palmicola*), prepared in sterile distilled water from 10-day-old fungal cultures were used for the inoculation; mycelial discs (5 mm diameter) of *Rhizoctonia solani* and *Sclerotium rolfsii*, taken from 7-day-old cultures of the respective fungus, were also used for inoculation. Inoculated seedlings were kept in humidity chamber (>90% relative humidity (RH)) for 7–10 days for disease symptoms to develop. Re-isolation of the causal organism from the respective infected plants was done and pathogenicity confirmed. Fungicides (carbendazim, macozeb, thiride, carboxin) were screened against different fungal pathogens following poison-food technique and or modified soil fungicide screening method [4]. The most effective fungicide(s) were applied in the nursery/trial plantations for controlling the diseases.

Table 1.

Nurseries and representative plots selected in rattan natural stands and plantations for the disease survey

Sl. No.	Locality	Forest Division	Geographical attributes	Rattan species
1	Kottiyoor	Kannur	11°56'N, 75°48'E	CG, CH, CT, CV
2	Ambumala	Nilambur	11°18'N, 76°11'E	CG, CH, CT
3	Mancheri	Nilambur	11°15'N, 76°19'E	CG, CH, CT
4	Nelliampathy	Nemmara	10°31'N, 76°40'E	CH, CT, CV
5	Peruvannamuzhy	Kozhikode	11°18'N, 75°53'E	CG, CH, CT, CTR, CV
6	Chully*	Vazhachal	10°19'N, 76°37'E	CH, CT
7	Dhoni	Olavakode	10°50'N, 76°38'E	CD, CH, CT
8	Nilakkal	Ranni	9°24'N, 76°58'E	CH, CT
9	Achenkoil	Thenmala	9°6'N, 77°8'E	CH, CT, CTR
10	Chozhiakode*	Thenmala	8°51'N, 77°3'E	CH, CT, CTR
11	Arippa*	Trivandrum	8°49'N, 77°2'E	CH, CT
12	Kottoor	Trivandrum	8°39'N, 77°6'E	CH, CT
13	Harippad	Kollam	9°17'N, 76°27'E	CR
14	Chenagiri	Thenmala	9°0'N, 77°6'E	CH, CT, CTR
15	Peermedu*	Kottayam	9°35'N, 76°59'E	CP
16	Chalakkayam	Ranni	9°23'N, 77°4'E	CH, CT
Rattan nurseries				
1	Peechi	Thrissur	10°32'N, 76°20'E	CG, CH, CP, CT, CTR, CTRC, CV
2	Palappilly	Kodanad	10°29'N, 76°23'E	CG, CH, CP, CT, CTR
3	Nilambur	Nilambur	11°16'N, 76°14'E	CG, CH, CT, CTR
4	Peermedu	Kottayam	9°35'N, 76°59'E	CP
5	Periya	Wayand	11°50'N, 75°50'E	CH, CT
6	Kulathupuzha	Thenmala	8°54'N, 77°4'E	CH, CG, CT, CTR

CD, *Calamus drensfieldii*; CG, *C. gamblei*; CH, *C. hookerianus*; CP, *C. pseudotenuis*; CR, *C. rotang*; CT, *C. thwaitesii*; CTR, *C. travancoricus*; CTRC, *C. trachycoleus*; CV, *C. vattayila*.

*Rattan plantations.

RESULTS

Until recently, very little attention has been paid to the cultivation of rattan on a commercial basis, and also to study the limiting factors affecting regeneration, growth and stand establishment. Usually, rattan seedlings are raised either in polythene containers or in seedbed nurseries [5]. Rattan seeds are dibbled in polythene containers (16 × 24 cm) filled with sawdust/soil or soil/sand in the ratio of 3 : 1. Bare root seedlings are also raised in nursery beds consisting of a 10-cm layer of sandy loam, overlaid by a 3-cm-thick layer of saw dust. Seedling emergence occurs about 3–10 days after sowing. After 2–3 months of growth in nursery beds, the bare root seedlings are transplanted to polythene containers. Usually, the container seedlings are maintained in the nursery for a period of 10–12 months before planting out in the field [5]. The Kerala State receives an annual rainfall of 4000–6500 mm and the atmospheric humidity ranges from 60 to >90% RH.

Table 2.

Checklist of diseases in rattan stands and the associated fungi

Sl. No.	Disease	Fungi associated	Rattan species affected
1	Colletotrichum leaf spot	<i>Colletotrichum gloeosporioides</i> <i>C. crassipes</i>	CG, CH, CP, CT, CTR, CV CD, CP, CV
2	Bipolaris leaf spot	<i>Bipolaris ellisii</i>	CG, CH, CTR
3	Corynespora leaf spot	<i>Corynespora cassiicola</i> <i>Corynespora</i> sp.1	CP, CT CP
4	Fusarium leaf blight	<i>Fusarium pallidoroseum</i>	CH, CG, CT
5	Guignardia leaf spot	<i>Guignardia calami</i>	CG, CH, CP, CT, CR, CV
6	Pestalotiopsis leaf spot	<i>Pestalotiopsis theae</i>	CG, CH, CP, CTR, CV
7	Phomopsis leaf spot	<i>Phomopsis palmicola</i>	CG, CH, CT, CTR
8	Tar spot	<i>Phyllachora calamigena</i>	CG, CH, CT
9	Sphaerodothis leaf blight	<i>Sphaerodothis</i> sp.	CD, CG, CH, CP, CT, CTR
10	Fusarium fruit rot	<i>Fusarium moniliforme</i>	CH, CP
11	Stem rot	<i>Pellicularia filamentosa</i> <i>Botryodiplodia theobromae</i>	CH, CTR, CP CG, CH, CT

CD, *Calamus drensfieldii*; CG, *C. gamblei*; CH, *C. hookerianus*; CP, *C. pseudotenuis*; CR, *C. rotang*; CT, *C. thwaitesii*; CTR, *C. travancoricus*; CTRC, *C. trachycoleus*; CV, *C. vattayila*.

Due to the tropical humid climate prevailing in Kerala, most of the agricultural, horticultural and forestry crops are affected with various diseases. Like other forestry species, rattan seedlings are also found succumbed to various diseases, which affected seriously the availability of planting stock. Rattan, a slow growing species, at its early establishment phase is found affected with various diseases and mortality of planted out seedlings was recorded. In natural stands, foliage and stem diseases were found causing considerable damage to the plants. During the survey, a total of 23 fungi were recorded as associated with various diseases of rattans in nurseries, plantations and natural stands (Tables 2 and 3). Most of the rattan species surveyed were found susceptible to one or more diseases. Below the diseases found in the nurseries are described in more detail.

Damping-off

Occurrence and symptoms. The disease was recorded in all the rattan nurseries surveyed. *C. gamblei*, *C. hookerianus*, *C. pseudotenuis*, *C. rotang*, *C. thwaitesii* and *C. travancoricus* seedlings in containers and seedbeds were found affected with the disease. The disease often goes undetected and is ascribed as failure of germination of "poor seeds". The disease characterized by rotting of the emerging radicle and plumule was observed within 3–10 days of sowing. Water-soaked lesions appeared on the emerging plumule at the soil level. The lesions spread and the affected tissues become constricted, discoloured and decayed; the affected plumule collapsed at the soil level.

Table 3.

Checklist of rattan seedling diseases and associated fungi

Sl. No.	Disease	Fungi associated	Rattan species affected
1	Damping-off	<i>Fusarium oxysporum</i>	CG, CH, CP, CR, CT, CTR
		<i>Rhizoctonia solani</i>	CG, CH, CP, CR, CT, CTR
2	Seedling collar rot	<i>F. longipes</i>	CH, CP, CT
		<i>Sclerotium rolfsii</i>	CP, CT
3	Seedling blight	<i>R. solani</i>	CT, CG
		<i>Guignardia calami</i>	CG, CH, CP, CT, CTR, CTRA, CV
4	Seedling wilt	<i>F. solani</i>	CH, CT
5	Foliage infection	<i>Alternaria alternata</i>	CG, CP, CT
		<i>Colletotrichum gloeosporioides</i>	CG, CH, CP, CR, CT, CTR, CTRC
		<i>Corynespora cassiicola</i>	CH, CP, CR, CT, CTRC
		<i>Curvularia lunata</i>	CT, CP
		<i>Bipolaris ellisii</i>	CH, CT, CP
		<i>Pestalotiopsis theae</i>	CP
		<i>Phomopsis sp.</i>	CH, CP, CT, CTR
<i>Phyllosticta sp.</i>	CT, CG		

CD, *Calamus drensfieldii*; CG, *C. gamblei*; CH, *C. hookerianus*; CP, *C. pseudotenius*; CR, *C. rotang*; CT, *C. thwaitesii*; CTR, *C. travancoricus*; CTRC, *C. trachycoleus*; CV, *C. vattayila*.

Causal organism(s) and control measures. *Fusarium oxysporum* Schlecht and *Rhizoctonia solani* Kuhn state of *Thanatephorus cucumeris* (Frank) Donk were the pathogens associated with the damping-off of rattan seedlings. In nurseries, damping-off was controlled effectively by application of Thiram 75 WP or Captan 75 WP as pre-sowing seed treatment (2 g/kg of depulped seeds); application of fungicide as post sowing soil drench (Captan 0.05% a.i. or Carboxin 0.05% a.i.) two times at weekly intervals also controlled the disease.

Seedling collar rot

Occurrence and symptoms. The disease occurred in 2–5-month-old seedlings in most of the rattan nurseries surveyed. Among various rattan species *Calamus hookerianus*, *C. pseudotenius* and *C. thwaitesii* were the most severely affected ones. In seedbeds, the disease occurred in small patches consisting of 5–10 seedlings. The infection occurred at the basal collar area of the seedling, causing necrosis, canker and decay of the affected stem tissues. Infection also spread to the petiole of the lower leaves. Often mycelial strands of the causal fungus were seen spreading from the soil to the seedling stem and petioles. A large number of small pale yellow sclerotia of the causal fungi (*Rhizoctonia solani*/*Sclerotium rolfsii*) were found produced on the rotting stem and petioles. Diseased seedlings also showed advanced browning and decay of the roots. Severe infection often resulted in the collapse and death of the seedlings.

Causal organisms and control measures. *Rhizoctonia solani* Khun state of *Thanatephorus cucumeris* (Frank) Donk, *Sclerotium rolfsii* Sacc., and *Fusarium longipes* Wollenw and Reinking (IMI No. 322577) were found associated with the collar rot disease. *F. longipes* caused severe seedling collar rot (50–65%) of *C. hookerianus* in rattan nursery at Peechi. Control of the collar rot disease was achieved by drenching the seedlings twice with Carboxin (0.2% a.i.) at an interval of ten days. As the disease manifests and spreads under high soil moisture levels, by reducing the watering frequency as well as quantity in the nursery beds, the disease spread can be checked.

Seedling blight

Occurrence and symptoms. Seedling blight affected 2–6-month-old container-grown *C. hookerianus*, *C. pseudotenuis*, *C. rotang*, *C. thwaitesii* and *C. trachycoleus* seedlings. The disease is very common in most of the rattan nurseries surveyed and the incidence ranged from 10 to 20%. However, very high disease incidence (60–70%) was recorded in *C. pseudotenuis* container nursery at Peermedu, which caused 15–20% mortality of the seedlings. The disease manifested in the form of minute water-soaked lesions on the leaves, usually on the margin and tips of the lower fronds. The lesions later coalesced and spread to form dark brown to shining chocolate brown, spindle shaped lesions with pale yellowish brown margins. Later, the infection spread further, covering the entire leaf, petiole and seedling stem, resulted in necrosis and seedling blight. Fructifications of the causal fungus were produced in concentric rings on the necrotic lesions.

Causal organism and control measures. *Guignardia calami* (H. Sydow & Sydow) von Arx & E. Muller (IMI Nos 319290, 319291, 320692) was the causal fungus. Application of carbendazim (0.02% a.i.) as foliar spray two times at 10-day intervals was very effective in controlling the disease.

Seedling wilt

Occurrence and symptoms. The disease was recorded in 4–6-month-old *C. hookerianus* and *C. thwaitesii* seedlings in nurseries at Peechi, Palappilly and Nilambur. Usually, the disease occurred in over-watered container seedlings. The disease manifested as yellowing and drooping of foliage and also exhibited the general symptoms of vascular wilt.

Causal organism and control measure. *Fusarium solani* (Mart.) Sacc. (IMI No. 327741) was identified as the causal fungus. Application of fungicide (carbendazim 0.05% a.i.) on the affected container seedlings three times at weekly intervals controlled the disease.

Foliage infection

Occurrence and symptoms. Foliage infection was recorded in almost all the rattan species raised in the nurseries in both seedbed and container nurseries in the State. The infection ranged from small insignificant leaf lesions to large necrotic areas often spreading to the entire leaf lamina and causing leaf blight. Various fungal organisms were found associated with these infections. Symptoms of the infection generally varied with the rattan species and also with the fungi associated. Microclimatic conditions prevailed in the nursery contributed to the development and spread of the foliage infections. Foliage infection caused by *Bipolaris* sp. was recorded in *C. hookerianus*, *C. pseudotenius* and *C. thwaitesii* bare root and container seedlings in different nurseries. The disease appeared during March–April in the nurseries and persisted until June. The infection manifested as water-soaked greyish brown spindle-shaped to irregular lesions (5–15 mm diameter) which later spread and coalesced to form dark brown to greyish black necrotic areas with dark brown margin.

Usually, *Corynespora* sp. caused dark brown angular lesions on *C. hookerianus*, *C. pseudotenius* and *C. thwaitesii* seedlings. Infection occurred during the month of August in the nurseries and persisted until December. Heavy sporulation of the fungus on the necrotic lesions on the abaxial surface of the leaf was observed.

Colletotrichum leaf infection appeared as pin-head sized, dark brown necrotic lesions, which later coalesced and spread to form angular to irregular pale to dark brown, lesions. All the rattan species raised in nurseries were found infected with *Colletotrichum gloeosporioides*.

Foliage infection caused by *Alternaria* sp. occurred during September–October and persisted until April–May. Pestalotiopsis leaf spot was recorded in all the rattan nurseries and found usually intermixed with *Colletotrichum* sp. The infection manifested as pale brown angular lesions on the abaxial surface of the mature leaf. The lesions spread to form irregular dark brown necrotic areas. The causal fungus sporulated on the adaxial surface of the necrotic lesions.

Foliage infection caused by *Curvularia* sp. manifested as small pin-head sized greyish brown, water-soaked lesions on the abaxial surface of the leaves. Under high humidity and presence of free water on the surface of the foliage, the lesions spread and coalesced to form large greyish black necrotic areas, usually at leaf margins and leaf tips.

Phomopsis leaf infection was recorded in 4–16-month-old seedlings of *C. gamblei*, *C. hookerianus*, *C. pseudotenius*, *C. thwaitesii* and *C. travancoricus* from all the rattan nurseries surveyed. Usually, the infection was recorded during the wet period (July–August). Infection appeared as greyish brown water-soaked, spindle-shaped small lesions (3–5 mm diameter) on the abaxial surface of the mature leaves. Later, the lesions spread and coalesced to form large oval to irregular dark brown necrotic lesions with a pale yellow halo. The centre of the lesions becomes greyish black and fructifications of the causal fungus developed as raised black structures

(pycnidia) on the abaxial surface of the lesions. Under high humidity the spore mass of the fungus extruded as pale yellow cirri.

Causal organisms and control. *Bipolaris ellisii* (Danquah) Alcorn, anamorph of *Cochliobolus ellisii* Alcorn (IMI No. 326948), *Colletotrichum gloeosporioides* (Penz.) Penz. and Sacc. (IMI No. 331798), *Corynespora cassiicola* (Berk. and M.A. Curtis) Wei (IMI No. 327744), *Alternaria alternata* (Fr.) Keissler (IMI No. 327736), *Pestalotiopsis theae* (Saw.) Steyaert, *Curvularia lunata* (Wakker) Boedijn, *Guignardia calami* (H. Sydow. & Sydow) von Arx & E. Muller (IMI No. 320692), *Phyllosticta* sp., *Phomopsis palmicola* (Winter) Sacc. (IMI No. 331633), and *Fusarium pallidoroseum* (Cooke) Sacc. (IMI No. 322579) were found to be the fungi associated with foliage infections.

In nurseries, usually prophylactic application of fungicides, like carbendazim (0.01% a.i.) during the wet period or mancozeb (0.2% a.i.) during the dry period, controlled the foliage diseases caused by different fungi.

Diseases in plantations and natural stands

From the rattan plots selected in 16 localities, a total of 11 diseases caused by 14 fungi were recorded (Table 2). Almost all the rattan species were found affected with one or other fungal diseases. Severity of the disease varied from locality to locality; rattan stands at Ambumala (*C. grandis*, *C. hookerianus*, *C. thwaitesii*), Chully (*C. hookerianus*, *C. thwaitesii*), Peermedu (*C. pseudotenuis*), and Choziakode (*C. hookerianus*, *C. thwaitesii*, *C. travancoricus*) were the most severely affected ones, where 80–90% of the rattan clumps were found affected with foliage diseases. However, most of the diseases affecting rattan stands were of little importance, except a few diseases like *Colletotrichum* foliage infection, *Sphaerodopsis* leaf blight and *Fusarium* fruit rot.

Colletotrichum foliage infection

Occurrence and symptoms. The disease was widespread in rattan growing areas in the State and was recorded in almost all the rattan species (Table 2). The disease severity was recorded low in all the plots surveyed. Among the rattan species, *C. thwaitesii* was found severely affected by the disease during the South-West monsoon (June–August). Infection occurred as small greyish brown angular to irregular lesions, usually on the newly expanded fronds. Infection was also noticed on unopened frond; the lesions spread very rapidly after the opening and expansion of the frond and lead to rotting of the entire frond or severe necrosis and partial withering of the leaf. In *C. travancoricus* and *C. vattayila* infection caused circular to irregular large necrotic areas.

Colletotrichum state of *Glomerella cingulata* (Stonem.) Spauld. & Shrenk (IMI No. 331798) and *Colletotrichum crassipes* (Speg.) Arx. were the causal agents of the infection.

Sphaerodothis leaf blight

Occurrence and symptoms. The disease was widespread in rattan natural stands and plantations through out the State affecting almost all the rattan species (Table 3). The infection in rattan foliage persisted year round and became severe during the months of April–May. *C. thwaitesii* and *C. pseudotenuis* were the most severely affected species. The disease manifested as small spindle shaped, pale yellow lesions on the leaves, and spread very fast by coalescence of the lesions; later the lesions become pale to dark brown with a yellow halo. Occasionally, infection also spreads to the petiole and then to the stem. Dark brown to black coloured fungal fructifications (ascocarps) arranged in linear rows developed on the necrotic areas of the lesions on the adaxial surface of the leaves. Occasionally, fungal fructifications produced in linear rows spread to the entire adaxial surface of the leaves.

Causal organism. *Sphaerodothis* (Sacc. & Syd.) Shear (IMI Nos 322088, 322089).

Fruit rot

Occurrence and symptoms. Severe fruit rot was recorded from *C. hookerianus* and *C. pseudotenuis* plots at Nelliampathy and Peermedu, respectively, affecting the developing fruits during December–January. Infection occurred as water-soaked greyish brown lesions on the developing fruits in the bunch; the lesions spread to the entire fruit and also to the pedicel and neighbouring fruits in the bunch. Cool nights alternating with hot days increased the disease severity and infection often spread to all the fruits in a bunch. The infected fruits become shriveled and heavy sporulation of the causal fungus was observed on the necrotic tissues.

Causal organism. *Fusarium moniliforme* Sheldon.

Tar spot

Occurrence and symptoms. Tar spot was recorded in *C. gamblei*, *C. hookerianus* and *C. thwaitesii* stands in almost all the localities. Infection appeared as small pale to dark yellowish brown spindle-shaped lesions on the abaxial surface of the mature leaves. Later, the lesions spread and developed into large oval to spindle-shaped spot (5–10 mm diameter) with dark brown center and pale yellow margin. Ascocarps of the causal fungus developed as dark brown to black raised structures in the necrotic spot.

Causal organism. *Phyllachora calamigena* (Berk. & Broome) Sacc. (IMI No. 322085).

Bipolaris ellisii, *Corynespora cassiicola*, *Corynespora* sp., *Fusarium pallidroseum*, *Guignardia calami*, *Pestalotiopsis theae*, *Phomopsis palmicola* (Winter) Sacc. (IMI No. 331633), were the other fungi associated with foliage infection in various rattan species in natural stands and plantations (Table 2).

Stem rob.

Occurrence and symptoms. Stem rot was recorded in *C. travancoricus*, *C. pseudotenuis* and *C. hookerianus* stands in Kulathupuzha, Peermedu and Ranni Forest Divisions. Infection was observed as growth of white mycelial strands of the causal fungus over the basal part of the stem from the debris on the forest floor. The mycelium spread further to the upper part of the stem, petiole and leaves. Severe infection caused white spongy rot of the stem and petiole and often led to rot of the whole rattan clump. The infection spreads very fast during the rainy period (June–August).

Causal organism. *Pellicularia filamentosa* (Pat.) Rogers.

Stem necrosis and rot of C. thwaitesii and C. gamblei

Occurrence and symptoms. Infection was observed mostly in fire affected areas. Fire injuries predispose to infection and caused blemishes on the affected rattan stem.

Causal organism. *Botryodiplodia theobromae* Pat.

DISCUSSION AND CONCLUSIONS

The disease survey conducted in representative rattan plots in natural stands, plantations and rattan nurseries raised in the State facilitated a comprehensive coverage of as many rattan species as possible grown in the State and also to record a large number of diseases affecting rattans, though, most of them are of minor significance. A total of 23 fungal pathogens were found associated with various diseases in rattans. Of these, 13 fungi were recorded in rattan nurseries, 14 in plantations and natural stands. Six fungi occurred in both nurseries as well as natural stands/plantations. In rattan nurseries, *Fusarium* spp. are common pathogens causing damping-off, collar rot and seedling wilt. *F. oxysporum* is a common damping-off and collar rot pathogen capable of causing large-scale mortality of young seedlings under favourable nursery conditions [6, 7]. Keeping the rattan fruits in water for a long period for de-pulping and separation of seeds, use of contaminated saw dust as growing medium in the seedbeds and containers and over watering the seed beds/containers are the possible factors for the severe incidence of the disease. By maintaining the general hygiene in the nursery, the disease can be avoided to a certain extent. Earlier, infection of tissue cultured rattan seedlings caused by *Fusarium* sp. has been reported from Malaysia [8]. Among the nursery diseases, seedling collar rot and seedling blight are the most important diseases, since they affect the seedling production considerably. Seedling collar rot, a complex disease caused by three fungi, viz., *F. longipes*, *R. solani* and *S. rolfsii* affects both bare root and container seedlings. *R. solani* and *S. rolfsii* are the common nursery pathogens and they affect most of the nursery crops

in the tropical and sub-tropical areas [6–10]. Earlier, collar rot of *C. manan*, caused by *F. oxysporum*, has been reported from Malaysia [8–11]. *F. longipes*, causing seedling collar rot, and *Guignardia calamii*, causing seedling blight, are new diseases of rattan as well as both are new pathogen record from India [10, 12]. In forest nurseries, *Colletotrichum*, *Corynespora*, *Bipolaris*, *Alternaria*, *Curvularia*, *Pestalotiopsis*, *Phomopsis*, etc., are common pathogens and they affect most of the forest seedling crops [6]. Earlier, *C. gloeosporioides* and a *Phomopsis* sp. have been recorded in *C. trachycoleus* and *C. manan*, respectively, from Malaysia [9, 13]. *Bipolaris ellisii*, *Corynespora cassiicola*, *Alternaria alternata*, *Pestalotiopsis theae* and *Curvularia lunata* are new pathogen records on rattan in India.

Most of the fungi recorded from rattan nurseries were also found associated with foliage diseases of rattan in natural stands and plantations. Foliage blight caused by *Sphaerodothis* sp. was found restricted in natural stands and plantations. *Sphaerodothis* sp. recorded on various rattan species in Kerala State differs from the earlier recorded *S. coiminatorica* Ramkr. on *C. rotang* from Tamil Nadu [14]. Fruit rot caused by *F. moniliforme* is of great concern as it may adversely affect the seed production, especially in rattan seed orchard. Though staining and blemishes of rattan poles caused by *B. theobromae* was observed only in fire-affected areas, it is a major problem in post-harvest rattans, which adversely affects the rattan industry in India [15].

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