

1995a). Sanitary measures recommended are disposal of leaf litter in the nursery and segregation of diseased seedlings soon after their detection to prevent the lateral spread of the disease. Regulation of the shade over the nursery beds (no shade) and watering quantity (120 l per standard seedbed per day) and low seedling density (500 g seeds per standard seedbed) are suggested (Mohanani 1995a). Application of fungicide (Carboxin 0.2% a.i.) after 7 and 21 days of seedling emergence is also recommended for controlling the disease (Mohanani 1994a, 1995a).

### ■ Seedling Leaf Rust

Leaf rust of bamboo seedlings is widespread in nurseries in Kerala, India (Mohanani 1990, 1994a,b). The disease has been recorded in 4 to 8-month-old bareroot as well as container seedlings of *Bambusa bambos*, *Dendrocalamus brandisii*, *D. strictus*, *Pseudoxytenanthera ritcheyi* (Munro) Naithani, *Ochlandra travancorica* (Bedd.) Benth., *O. scriptoria*

(Denst.) Fisch. and *Thyrsostachys siamensis*. Of these, *B. bambos* and *D. strictus* are the most susceptible species. The overall severity of infection was observed to be low; a severe rust infection was recorded during 1991 in 8-month-old *B. bambos* seedlings in a nursery in the northern part of Kerala which completely devastated seedlings in about 20% of the affected seedbeds (Fig. 12). Recently, leaf rust infection was observed in *B. bambos* and *B. blumeana* seedlings in a nursery at Kanchanburi, Thailand (Mohanani 1995, unpublished observation).



Fig. 12: Severely affected 8-month-old *B. bambos* seedlings



Fig. 13: Leaf rust in *B. bambos* seedling caused by *Dasturella divina*

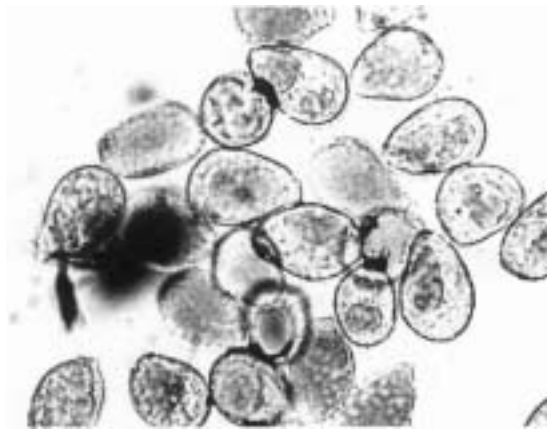


Fig. 14: Urediniospores of *Dasturella divina*

## SYMPTOMS

Infection usually appears during August on mature leaves in the form of greyish brown minute flecks; usually, juvenile leaves are free from infection. The small flecks coalesce and form spindle-shaped dark brown pustules surrounded by a pale area. Mature leaves are more susceptible to infection than younger ones because density of uredinia is higher on the former. Uredinia, yellowish brown in colour, develop in the flecks on the lower surface of the leaves (Figs. 13, 14).

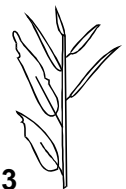
Development of uredinial sori occurs rarely on the upper surface. In severe cases, the lower surface of the entire leaf lamina is covered with uredinia, imparting a yellowish brown colour. The rust infection continues until late May. Dark brown teliosori develop either in mature uredinial sori or separately on the adaxial surface in linear rows during January. Necrosis and withering of leaves occur from rust infection.

## CAUSAL ORGANISM

*Dasturella divina* (Syd.) Mundk. & Khes. (Mohanani 1990, 1994a,b).

## ETIOLOGY

*Dasturella divina* is a heteroecious rust with uredia and telia on bamboo, and pycnia and aecia on *Randia* spp. (= *Catunaragam*, Rubiaceae). Infection on *Randia* produces marked hypertrophy, and formation of



witches'-broom following systemic invasion of the host. Aeciospores produced in chains from *Randia* infect bamboo leaves, causing leaf rust. The period of incubation ranges from 27 to 34 days. Urediospores produced on bamboo leaves spread the disease by secondary infection (Thirumalachar et al. 1947; Bakshi and Sujjan Singh 1967).

### CONTROL

Application of fungicide (Plantavax 0.01% a.i.) on rust-affected seedbeds has been suggested to control the disease (Mohanan 1994a). Sulphur-based fungicides can also be employed (dusting).

## ■ *Bipolaris* Leaf Blight

Leaf blight, affecting both young and mature leaves of 2 to 18-month-old seedlings, has been reported as widespread in bamboo nurseries in Kerala, India (Mohanan 1990, 1994a,b). The disease was recorded in bareroot and container seedlings of *Bambusa bambos*, *Dendrocalamus strictus*, *D. brandisii*, *D. membranaceus* Munro, *Phyllostachys pubescens* Mazel ex H. de Lehaie (= *P. heterocycla* var. *pubescens* (Mazel) Ohwi), *Thyrsostachys siamensis* and *Ochlandra wightii* Fisch. Disease severity, however, was low in all the nurseries. The infection appears in young seedlings during March-April and continues till outplanting of seedlings.

### SYMPTOMS

Minute, spindle-shaped, water-soaked lesions appear on both young and mature leaves, and later turn dark brown to dull violet, with greyish brown centres. Lesions coalesce and form large necrotic areas. Necrosis of leaf tissues starts from the leaf tip downwards or from the leaf margins towards the midrib. Usually, dark brown cross bands occur in the necrotic area (Figs. 15, 16).





Fig. 15: *O. wightii* seedlings showing Bipolaris leaf infection



Fig. 16: Bipolaris leaf blight in *B. bambos*

The colour of the lesions, spread, etc. vary depending on the bamboo species affected, leaf maturity and the associated pathogen. In *Dendrocalamus membranaceus*, *D. brandisii*, *D. strictus*, *Ochlandra wightii* and *Thyrsostachys siamensis* seedlings, Bipolaris leaf blight produces dark brown lesions with greyish brown centres. In *Phyllostachys pubescens* seedlings, the blight produces dark to blackish brown linear to irregular lesions on both young and mature leaves. Under high humidity, the lesions spread rapidly to the entire surface of the leaf lamina, and sporulation of the fungus occurs as dark greyish black mass in the necrotic tissues on the lower surface of leaf.

#### CAUSAL ORGANISMS

Three species of *Bipolaris* act as causal agents of the leaf blight:

***B. maydis*** (Nisikado & Miyake) Shoem. anamorph of ***Cochliobolus heterostrophus*** (Drech.) Drech. on *Dendrocalamus*, *Ochlandra* and *Thyrsostachys*; ***B. urochloae*** (Putterill) Shoem. on *Phyllostachys*; and ***B. bambusae*** Mohan. (Mohan 1994a,b, 1995d) (Figs. 17, 18).

#### ETIOLOGY

Fungal spores germinate on the leaf surface, and the infection hyphae enter the host through stomata, infecting epidermal and mesophyll cells. Proliferation of the fungus results in rupture of infected cells. The





Fig. 17: Conidiophores and conidia of *Bipolaris maydis*

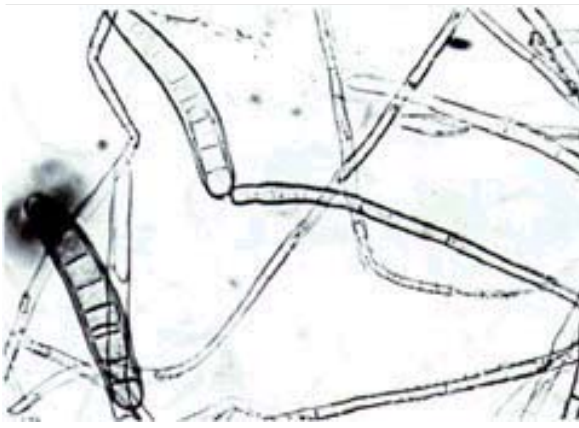


Fig. 18: Conidiophores and conidia of *Bipolaris urochloae*

fungi thrive well under damp conditions, especially when cool nights alternate with hot days; the spores produced in the affected tissues are dispersed by water splash or in damp air currents.

#### CONTROL

Foliar drenching with Carbendazim (0.1% a.i.) is effective in controlling the disease (Mohanani 1994a,b).

### Exserohilum Leaf Spot

Leaf spot disease has been reported in 2 to 8-month-old bareroot and container seedlings of *Bambusa bambos*, *Dendrocalamus strictus* and *Phyllostachys pubescens* in India (Bhat et al. 1989; Harsh et al. 1989; Mohanan 1990, 1994a,b). Average disease incidence in *B. bambos* nursery in Karnataka State has been recorded as 39%, while in *B. bambos*, *P. pubescens* and *D. strictus* nurseries in Kerala State, the infection varied from low (18%) to severe (76%) and caused defoliation (Mohanani 1994a).

#### SYMPTOMS

Minute, greyish brown, water-soaked lesions appear on mature leaves. Lesions are longitudinally distributed over the leaf lamina and measure 2-4 x 1-2 mm. Under

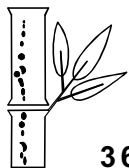




Fig. 19: *Exserohilum* leaf spot in *D. strictus*

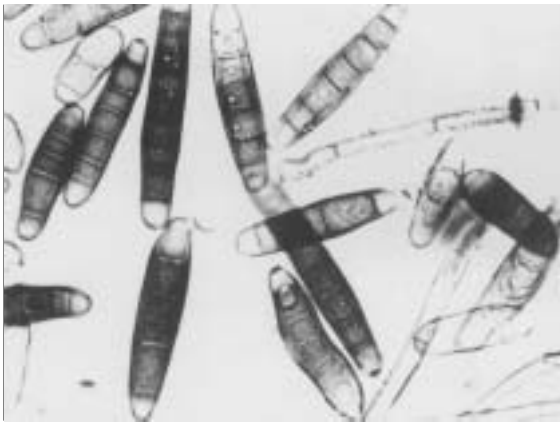


Fig. 20: Conidiophores and conidia of *Exserohilum rostratum*

warm-humid conditions, the individual lesions coalesce to form large spindle-shaped to irregular reddish to dark brown lesions with greyish white centres and dark to chocolate brown margins (Fig. 19).

The diseased areas become necrotic and often give a blighted appearance; under high humidity, sporulation of the fungus occurs as greyish black spore mass on the adaxial surface of the necrotic lesions. Severe infection leads to spread of lesions to the entire leaf lamina, followed by withering of affected leaves and premature defoliation.

#### CAUSAL ORGANISMS

Three species of *Exserohilum* have been reported as the causal agents: *E. rostratum* (Drech.) Leonard & Suggs anamorph of *Setosphaeria rostrata* Leonard; *E. holmii* (Luttr.) Arx. anamorph of *Setosphaeria holmii* (Luttr.) Leonard & Suggs; *E. halodes* (Drech.) Leonard & Suggs (Fig. 20).

#### ETIOLOGY

The pathogen enters the host through stomata and infects epidermal and mesophyll tissues. Proliferation of fungal tissues results in rupture of the infected cells. The fungi thrive well under warm-humid conditions. The conidia produced in the necrotic tissues on the lower leaf surface serve as the inoculum for secondary infection.



## CONTROL

Since the pathogen causes withering and premature defoliation only under conducive microclimatic conditions, the disease may not pose problems in raising bamboo seedlings. Foliar drenching with fungicides Carbendazim (0.1% a.i.) or Mancozeb (0.2% a.i.) is suggested for checking the infection (Mohanani 1994a,b).

## ■ Dactylaria Leaf Spot

Dactylaria leaf spot is widespread in bamboo nurseries in Kerala, India. The disease was recorded in 1 to 10-month-old bareroot and container seedlings of

*Bambusa bambos* and *Dendrocalamus strictus* in most nurseries raised during 1987-92, and seedlings of *D. brandisii*, *Thyrsostachys siamensis* and *Ochlandra wightii* during 1991-92 (Mohanani 1994b). *B. bambos* and *D. strictus* were the most susceptible species but disease incidence was generally low.



Fig. 21: Dactylaria leaf spot in *B. bambos* seedlings

## SYMPTOMS

Minute, water-soaked lesions occur near the leaf tips. They coalesce and

spread to form large circular to irregular greyish brown areas with greyish white centres and dark brown margins (Fig. 21).

Withering of leaf tips occurs in severe infection. Under high humidity, the causal fungus sporulates on the necrotic leaf spots (Fig. 22).

## CAUSAL ORGANISM

*Dactylaria bambusina* Mohan. (Mohanani 1994b, 1995d).

