

**FUNGAL PATHOGENS AS POTENTIAL THREAT TO
TROPICAL ACACIAS**
A case study of India

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1. ABSTRACT

The disease survey conducted in *Acacia aulacocarpa*, *A. crassicarpa*, *A. mangium* and *A. auriculifonnis* trial plots and plantations in the States of Kerala, Tamil Nadu, Karnataka and West Bengal revealed a large number of new and serious diseases. All the four acacias suffered more from foliar diseases than diseases of other parts. Maximum number of diseases were recorded on *A. auriculifonnis* (28), followed by *A. mangium* (23) *A. crassicarpa* (17), and *A. aulacocarpa* (13). All the diseases recorded on *A. aulacocarpa* and *A. crassicarpa* are new records for India. In the case of *A. mangium* and *A. auriculiformis* except for a few diseases already recorded, the rest are new disease records. Though the number of diseases appeared to be high, the number of genera causing diseases was not high as different species of the same genus produce variable symptoms. The common genera associated with the acacias were *Colletotrichum*, *Pestalotiopsis*, *Altemaria*, *Curvularia* and *Phomopsis*.

Though some of the foliar diseases such as *Phomopsis* leaf spot of *A. aulucocarpa*, *Colletotrichum* leaf spot, *Cercosporidium* leaf spot, an unidentified leaf spot and powdery mildew of *A. mangium* were quite severe resulting in premature defoliation, stem and root diseases recorded in various *Acacia* species were most damaging as they caused mortality of trees, In *A. aulacocarpa* and *A. crassicarpa*, root rot caused by unknown Basidiomycete is responsible for mortality. In *A. mangium*, root rot caused by *Ganoderma* and die-back by *Hendersonula* were the serious diseases which caused extensive mortality. In *A. auriculifonnis* also, die-back caused by *Hendersonula* the most damaging disease.

Considering the spectrum of diseases recorded in various parts of India the study suggests further surveys to cover other states where species/provenance trials have been established and acacias are grown in large scale to get a better picture of the disease situation in Australian acacias in India.

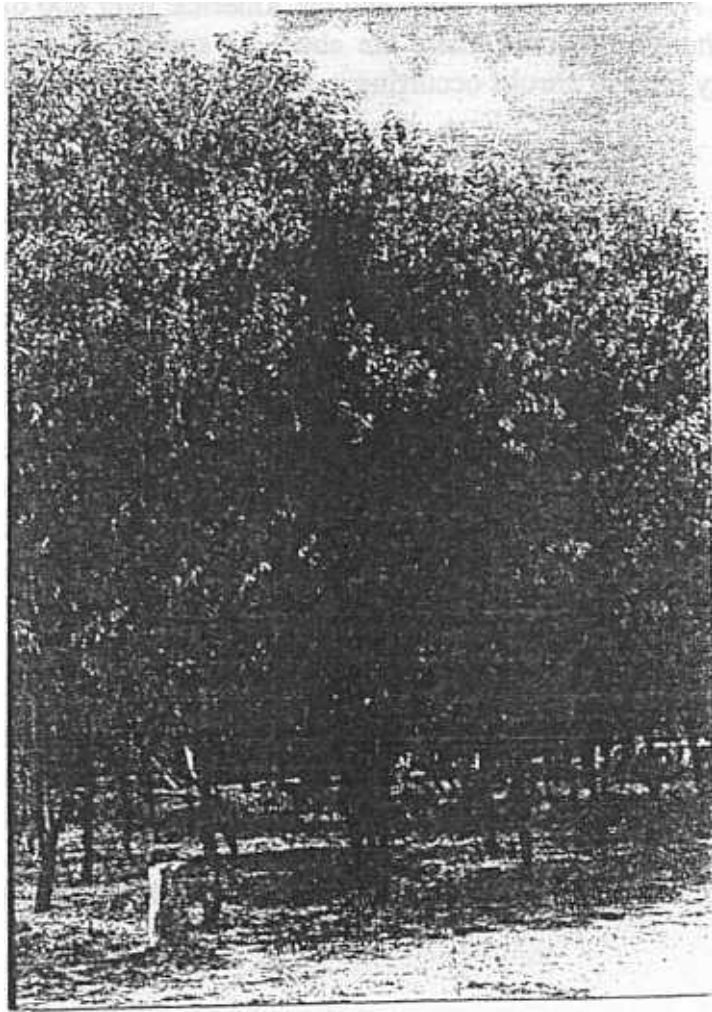


Fig. 1: A view of 5-year old species trial plot of *A. aulacocarpa* at Neyveli Tamil Nadu.

2. INTRODUCTION

Due to critical shortage of fuelwood in rural communities and the need for multipurpose trees in agricultural systems it required a reappraisal of tree and shrub species available for planting. Australian acacias were the first choice as the afforestation species as they possess many attributes, specially their fast growth which characterise them as successful exotic trees. They are adopted to a wide range of tropical environments including acidic infertile soils, saline and arid sites, in addition to their ability to fix biological nitrogen.

The genus *Acacia* includes about 1200 species of trees and shrubs with its natural distribution in Australia, Asia, Africa and the America; over 800 of these species are endemic to Australia. Although, in India, there are about 23 species of *Acacia*, most of them are slow growing thorny trees or shrubs occurring in arid regions of deciduous thorny forests.

Among the first introductions, *Acacia melanoxylon* R. Br. was introduced in Nilgiris and Palani Hills in Tamil Nadu State in 1840 from Australia along with a few other acacias. However, large scale introduction of Australian exotic acacias, specially that of *A. auriculiformis* A. Cunn. ex. Benth., was only in the middle of 1980's under World Bank aided afforestation programmes in different States of India. At the same time species/provenance trials of Australian acacias were also initiated in different States to find out the best species/provenances suited to a particular geographical area. Provenances of the most common species tried were: *A. auriculiformis*, *A. aulacocarpa*, *A. crassicarpa*, *A. dunnii*, *A. podalyriifolia*, *A. baileyana*, *A. prominens*, *A. pycnantha*, *A. torulosa*, *A. tumida*, *A. citrinovirides*, *A. ampliceps*, *A. trachycarpa*, *A. eriopoda*, *A. cincinate*, *A. mangium*, *A. leptocarpa* and *A. platycarpa*.

Due to adaptability under various adverse climatic and soil conditions and their suitability in the pulp industry, the area under acacias has been increasing steadily in the past decade and so far ca. 45,000 ha have been planted with acacias, mostly *A. auriculiformis*. However, considering the excellent performance in south-east Asia, it is being taken up in a big way in most of the States and trial plantations as well as commercial plantations are being established.

With the emergence of significant disease problems in large scale commercial plantations of exotic acacias, especially those of *A. mangium* in Malaysia and Indonesia, it became necessary to take a stock of disease situation in neighbouring countries so that appropriate strategy can be chalked out for taking appropriate measures against some of the serious diseases. Hence, a disease survey was conducted in species/provenance trials, commercial plantations as well as native populations of four major species viz. *A. aulacocarpa*, *A. auriculiformis*, *A. crassicarpa* and *A. mangium* (Fig. 1-4) in India, Indonesia, Thailand, Malaysia and native Australia to provide an indication of the potential of fungal pathogens a Limiting factor to growth and productivity. This report presents the results of the Indian case study.

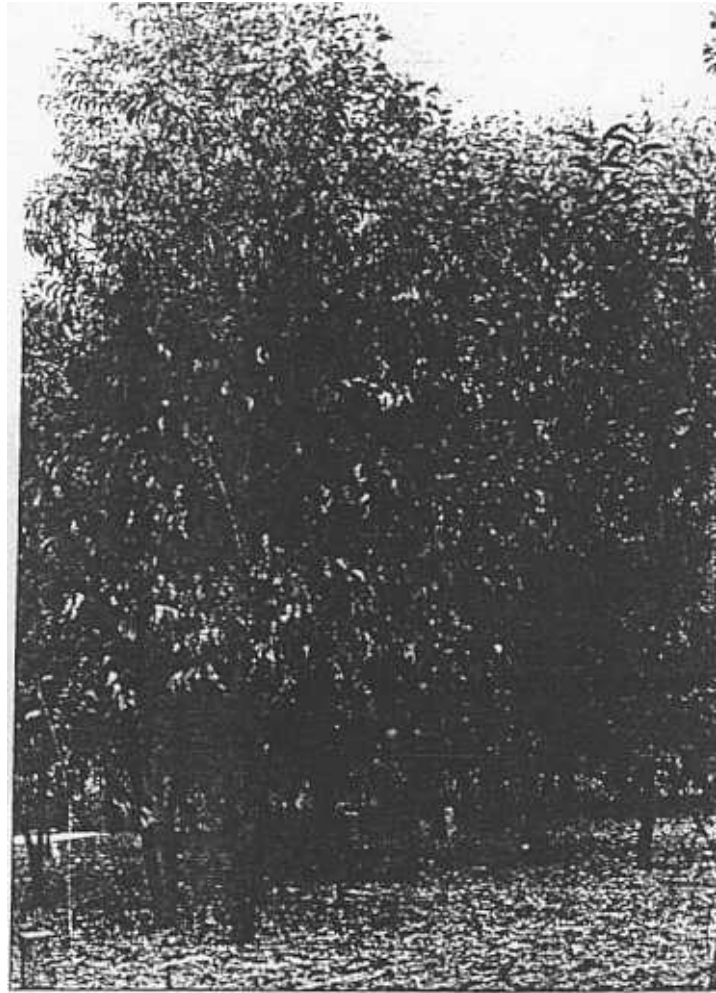


Fig. 2: A view of 5-year-old species trial plot of *A. crassicarpa* at Neyveli Tamil Nadu.

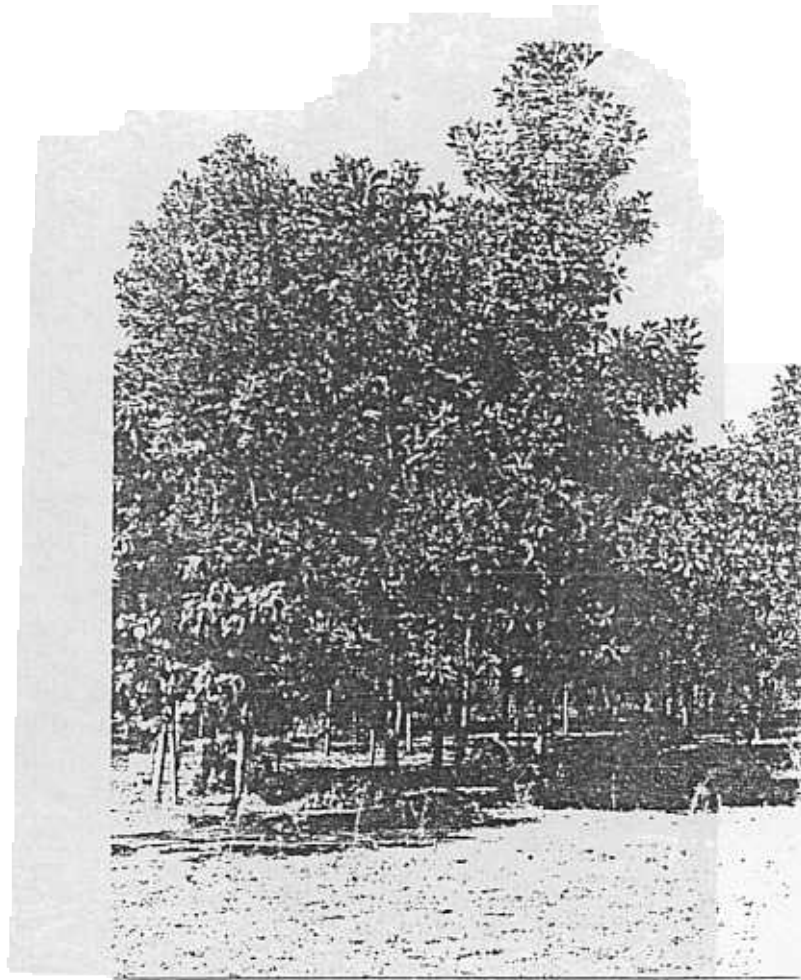


Fig. 3: A view of 5-year-old species trial plot of *A. mangium* at Sadivayal, Shiruvani, Coimbatore (Tamil Nadu).

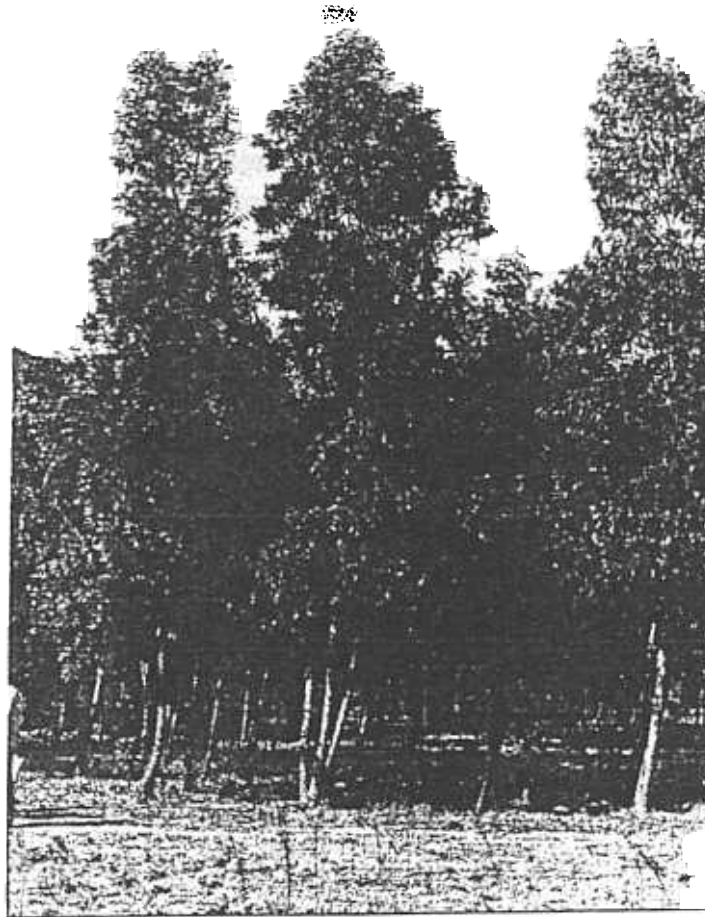


Fig. 4: A view of 5-year old spetal trial plot of *A. auriculiformis* at Sadivayal Shiruvani, Coimbatore (Tamil Nadu).

3. REVIEW OF LITERATURE

Information on diseases in acacias and other multipurpose woody legumes is largely restricted to host records and there have been only a few detailed studies on their pathology, etiology and management (Boa and Lenne, 1994). In India, though exotic acacias have been grown for quite sometime there has been no systematic detailed study on their disease problems, except a few which were of limited nature.

In India, a total of sixteen pathogens have been reported to cause diseases of *A. auriculiformis* of which majority of them are root pathogens. Of these only three diseases namely, *Cylindrocladium* leaf spot and *Phomopsis* leaf spot (Mohan and Sharma, 1988) and leaf web blight (Mehrotra, 1990) affected the foliage of seedlings (Table 1). Among the eleven plantation diseases, *Exserohilum* leaf spot, *Colletotrichum* leaf spot are the only foliar diseases and pink disease is a stem disease while the rest affected the roots. Since there is no information available on the severity and Occurrence of root diseases it is not possible to judge their impact on the productivity. Mohan and Sharma (1988) reported that during monsoon severe infection of *Colletotrichum* leaf spot and *Cylindrocladium* leaf spot may result in premature defoliation and twig die-back. Florence and Balasundaran, (1991) recorded ten percent mortality of trees in a roadside strip plantation of *A. auriculiformis* due to pink disease caused by *Corticium salmonicolor* in Kerala.

Only a very few diseases have been recorded on *A. mangium* in India. Probably it does not indicate the resistant nature of this species but merely it is due to its recent introduction in plantation forestry and consequently not much attention paid to disease problems. Of the four diseases reported three affected the foliage. Severe infection of *Colletotrichum* foliar infection caused premature defoliation and shoot die-back during monsoon (Mohan and Sharma, 1988). No details are available on the incidence and damage caused by *Botryodiplodia theobromae* causing root disease and canker.

So far, no disease has been recorded on *A. aulacocarpa* and *A. crassocarpa* from India.

Table 1. Diseases recorded on exotic Acacias in India

Sl. No.	Disease	pathogen	Reference
	<i>A. auriculiformis</i>		
1	Foliar spot	<i>Alternaria alternata</i>	Browne (1968)
2	Foliar spot	<i>Colletotrichum state of Glomerella cingulata</i>	Mohanani & Sharma (1988)
3	Foliar spot (Seedlings)	<i>Cylindrocladim quinquesepatum</i>	Mohanani & Sharma (1988)
4	Foliar spot	<i>Exserohilum rostratum</i>	
5	Foliar spot (Seedlings)	<i>Phomopsis</i> sp.	Mohanani & Sharma (1988)
6	Leaf web blight (Seedlings)	<i>Rhizoctonia solani</i>	Mehrotra (1990)
7	Pink disease	<i>Corticium salmonicolor</i>	Florence & Balasundaran (1991)
8	Die back, gummosis, root death	<i>Armillaria mellea</i>	Browne(1968)
9	Die back, gummosis, root death	<i>Mucrophomina phaseolina</i>	Bakshi (1957)
10	Wilt	<i>Fusarium oxysporum</i>	Bagchee (1945,1958)
11	Wilt	<i>F. moniliforme</i>	Bagchee (1945,1958)
12	Wilt	<i>F. solani</i>	Bagchee (1945,1958)
13	Root disease	<i>Botryodiplodia rheobromae</i>	Gibson (1975)
14	Root rot	<i>Phellinus</i> sp.	Browne (1968)
15	Root rot	<i>Ganoderma</i> sp.	Bagchee (1945, 1958)
16	Root rot	<i>Ganoderma lucidum</i>	Bakshi <i>et al</i> (1968)
	<i>A. mangium</i>		
1	Root disease and canker	<i>Botryodiplodia rheobromae</i>	Boa & Lenne (1994)
2	Foliar spot	<i>Cylindrocladium quinquesepatum</i>	Mohanani & Sharma (1988)
3	Foliar spot	<i>Colletotrichum state of Glomerella cingulata</i>	Mohanani & Sharma (1988)
4	Sooty mould	<i>Meliola</i> sp.	Mohanani & Sharma(1988)
	<i>A. crassicarpa</i>		
	No disease record		
	<i>A. aulacocarpa</i>		
	No disease record		

4. MATERIALS AND METHODS

4.1. Selection of representative species trial/plantation

Details on the species/provenance trials of exotic acacias, especially those of *A. crassicarpa* and *A. mangium* were sought from the Forest Departments of various States in a proforma. The response was very poor and, therefore, only those species trials and plantations were selected about which the information was received or gathered through other sources. If there was any knowledge on the occurrence of a disease(s) on *Acacia* sp. in a particular area such locations were also included for disease survey. Host-wise lists of localities where the four acacias were surveyed in the States of Kerala, Tamil Nadu, Karnataka and West Bengal are given in Tables 2,3,4 and 5. Major locations are also shown in a map (Fig. 1).

Acacia nurseries were surveyed only if they were located closely to a species trial/plantation selected for the disease survey.

Table 2. Details of *Acacia aulacocarpa* species trials surveyed for the occurrence of diseases

Sl. No.	Locality	Dist./State	Year of planting	Espace-ment(m)	Extent (ha) No. of trees	Average height (m)	Average GBH(cm.)	Remarks/ Seed source CSIRO seed lot No.
1	Sadivayal	Coimbatore TN	1990	2.0 x 2.0	14	4 - 5	15.5	45 trees died over the year
2	Neyveli	S. Arcott, TN	1990	2.5 x 2.5	25	7.0	24.6	CSIRO
3	Brahmadev ragadde*	Shimoga, KA	1985	2.5 x 2.5	50	8.62	6.77**	Garich Qld. 13866
4	Dejuri	Bankura, WB	1994	2.5 x 2.5	25	2.5 - 3.6	---	CSIRO 15715
5	Dharmapur	Bankura, WB	1995	2.5 x 2.5	---	0.60-0.75	---	16976
6	Dhengkend	Bankura, WB	1995	2.5 x 2.5	---	1.0-1.75 0.30-0.90	---	16976 PNG

*1993 measurements; ** Diameter; TN, Tamil Nadu; KA, Karnataka; B, West Bengal

4.2. Observations recorded

Observations on disease severity (low, medium, severe) were recorded based on a numerical scale (1-3) of disease rating index. In the case of serious diseases either all the trees were assessed in species/provenance trials or a small plot of 100 trees was selected at random for the assessment of disease incidence and severity. The average severity of the disease was calculated following a formulae provided by Sharma *et al*, (1985). The incidence of the disease a plot was rated on the basis of percentage of trees affected as follows:

Percentage Diseased trees	Rating
75 and above	Widespread
50 - >75	Very common
25 - >50	Common
10 - >25	Occasional
>10	Rare

Table 3. Details of *Acacia auriculiformis* provenance trials, plantation and seed stands surveyed for the occurrence of diseases

Sl. No.	Locality	Dist/State	Year of planting	Espace-ment (m)	Extent (ha) No. of trees	Average height (m)	Average GBH (cm.)	Remarks/seed source CSIRO seed lot No.
1	Sadivayal	Coimbatore, TN	1990	2.0 x 2.0	420	10.5	21.2	60-70% hybrid CSIRO Australia
2	Mettupalayam	Coimbatore, TN	1986-87	2.0 x 2.0	25	8.8	-	Survival poor
3	Neyveli Lig. Corp.	South Arcot, TN	-	-	-	-	-	Two CSIRO provenances
4	Neyveli Res. Plot	south Arcot, TN	1990	2.0x 2.0	25	4.50	-	Roadside planting
5	Neyveli Res. Plot	South Arcot, TN	1990	2.0x2.0	1306	-	-	Espace-ment trial
6	Auroville	Pondicherry	1991	25 x 25	-	-	-	community planting
7	Nallal	Bangalore, KA	1989	2.0x2.0	-	-	-	ST, PT
8	Jarakbande	Bangalore, KA	1989	2.0x2.0	-	6.5	2.14	ST; 16152
9	Tyaranadur	Shimoga, KA	1995	2.0 x 3.0	1800	-	-	ST; Springvale
10	Beede	Shimoga, KA	1993 1993	15 x 2.5 15 x 2.5	- -	22.5 18.35	7.55 5.75	Springvale Balamuk, PNG half sib
11	Dejuri	Bankura, WB	1994	25 x 25	25	3.0	6.85	ST; CSIRO
12	Dharampur	Bankura, WB	1995	25 x 25	100	1.39- 2.32	-	ST; CSIRO
13	Dharampur	Bankura, WB	1995	25 x 2.5	100	1.5-5.0	-	ST; CSIRO
14	Arabari	Midnapur, WB	1987	25 x 2.5	-	-	-	Mixed softwood plantation
15	Ramavarmapuram	Trichur, KL	1986	2.0 x 2.0	5.0	-	-	
16	Kalathode	Trichur, KL	1986	2.0 x 2.0	-	-	-	Roadside block plantation
17	Kottappara	Trichur, KL	1991	2.0x2.0	-	-	-	Roadside block plantation

(TN, Tamil Nadu; KA, Karnataka, KL, Kerala; WB, West Bengal ST. Species trial; PT, provenance mal)

Table 4. Details of provenance trial plots of *Acacia crassicarpa* surveyed for the Occurrence of diseases

Sl. No.	Locality	Dist/State	Year of Planting	Espace-ment (m)	Extent (ha) No. of trees	Average height (m)	Average GBH (cm)	Remarks/ Seed source/ CSIRO seed lot No.
1	Mettupalaya	Coimbatore, TN	1988,89	2.5 x 2.5	25+25 +25	3-5,6-7.3	--	Three CSIRO provenances including 15950, 16128; out of 30 trees only 8 Surviving
2	Neyveli	S. Arcot, TN	1990	2.0 x 2.0	8	8.5	36	
3	Nallal Block (hosekote)	Bangalore, KA	1989	2.5 x 2.5	60	8.3	33.2	ST
4	Beede	Shimoga, KA	1993	1.5 x 2.5	0.1	6.08	20.7	Half sib progeny trials
5	Beede	Shimoga, KA	1985	2.5 x 2.5	50	11.48*	10.58**	Brahmadevaree adde
6	Dharampur	Bankura, WB	1995	2.5 x 2.5	100	1.95-2.25	-	ST
7	Dhengaked	Bankura, WB	1995	2.5 x 2.5	100	0.50-1.50	-	ST

*Reorded in 1993; ** Diameter; (TN, Tamil Nadu; KA, Karnataka; KL, Kerala; WB, West Bengal; ST, Species trial

Symptoms of the disease were recorded in the field as well as from the herbarium specimens. Disease specimens were collected in clean polythene bags or paper bags for isolation and herbarium. Fungi associated with the disease were isolated in pure culture on potato dextrose agar (PDA) medium and cultures maintained on PDA slants for identification. Non sporulating cultures were also inoculated on malt extract medium to induce sporulation. Appropriate photographs of the diseased phyllodes/trees were taken to illustrate symptoms, plant part affected and damage. Wherever available climatic data and soil characters were also gathered for the surveyed plantation/trial (Table 6).

Table 5. Details of *Acacia mangium* provenance trials and plantations surveyed

Sl. No.	Locality	Dist/State	Year of planting	Espace-ment(m)	Extent (ha)	Average height (m)	Average GBH (cm.)	Remarks/ seed source CSIRO seed lot No.
1	Mettupal-ayam	Coimbatore, TN	1986-87	2.0 x 2.0	25	-	--	ST; all trees died
2	Sadivayal	Coimbatore, TN	Jan, 1990	2.0 x 2.0	420	7.5	33.6	ST; all trees died
3	IFGTB	Coimbatore, TN	1995	--	--	--	--	ST; all trees died
4	Nallal B Block (Hosekote)	Bangalore, KA	1989	2.0 x 2.0	380	7.16	28.7	ST, CSIRO 15677
5	Nallal B Block (Hosekote)	Bangalore, KA	1992	2.0 x 2.0	0.5	4.5	--	Dip irrigation trial
6	Jarakbande	Bangalore, KA	1990	3.0 x 3.0	100	7.0	--	ST
7	Beede	Shimoga, KA	1993	2.0 x 2.0	1+2	6.75	23.7	Fertilizer trial
8	Brahmadeva-regadde	Shimoga, KA	1985	2.5 x 2.5	-	1.8	79.0	ST
9	Dejuri	Bankura, WB	1994	2.5 x 2.5	25	3.75	8.25	CSIRO Local
10	Dharampur	Bankura, WB	1995	2.0x 2.0	900	1.57	--	ST; CSIRO 13139
11	Dhengkend	Bankura, WB	1995	2.0 x 2.0	25	0.80	55.0	--
12	Ghuchisola	Midnapur, WB	1987	--	1.0	11.0	75.0	Seed stand 1993
13	Sapodiha	Midnapur, WB	1985	--	0.2	17.5	75.5	Seed stand 1993
14	Kusumadh-ari	Midnapur, WB	1985.86	--	1.5	10.25	13.0	--
15	Manjhigarh	Midnapur, WB	1993	--	1.5	8.4	--	--
16	Khadalgobra	Digha, WB	1987	--	200	--	--	--
17	Gangadh-arpur	Digha, WB	1991,92	~ . 0 x1.0	1	--	--	--
18	Velakkarith-addam/ Vilangannor	Trichur, KL	1995	--	-	--	--	Container seedlings
19	Kutanellur	Trichur, KL	1995	2.5 x 2.5	48	--	--	

(TN, Tamil Nadu; KA, Karnataka; KL, Kerala; WB, West Bengal, ST, Species trial)

Table 6. Climatic data and soil characteristics of the areas surveyed for diseases in exotic acacias

Locality (State)	Altitude	Temperature		Rain fall (mm)	Soil type	pH	Available			Soil depth	Remarks
		Max.	Min.				N	P	K		
Mettupalayam (TN)											
Sadivayal (TN)	100			850- 1000	Clayey loam						
Neyveli (TN)	70			1000	Red sandy loam						
Hosekote (KA)											
Nallal (KA)					Red sandy soil	7.5					
Tyranadur (KA)				2500	Laterite	6.0-6.5					
Dejuri (WB)				1000-1100	Laterite	5.65-6.55					0.011-0.20 (OC)
Dharampur (WB)						5.0-5.45				1.25- 11.2	0.0115- 0.022 TotalN
Dhaenagakend (WB)				800	Clayey	6.22	17ppm	15ppm		8-75	0.08-0.4 (OC)
Ghuchisola (WB)		32- 43	9-24		Red laterite soil	5.35	0.289	0.0035	0.0297		0.01-0.05 TotalN
Sapodiha (WB)					"	5.15	0.0225	0.0002	0.0048		0.28 (OC)
Kusumadhari (WB)					"	5.53	0.0035	0.0035	0.0247	120	
Vellakkarithadam/Vilanganoor,Peechi,Ramavar mapuram Trichur	5.50			2500	Laterite	4.8-5.6					

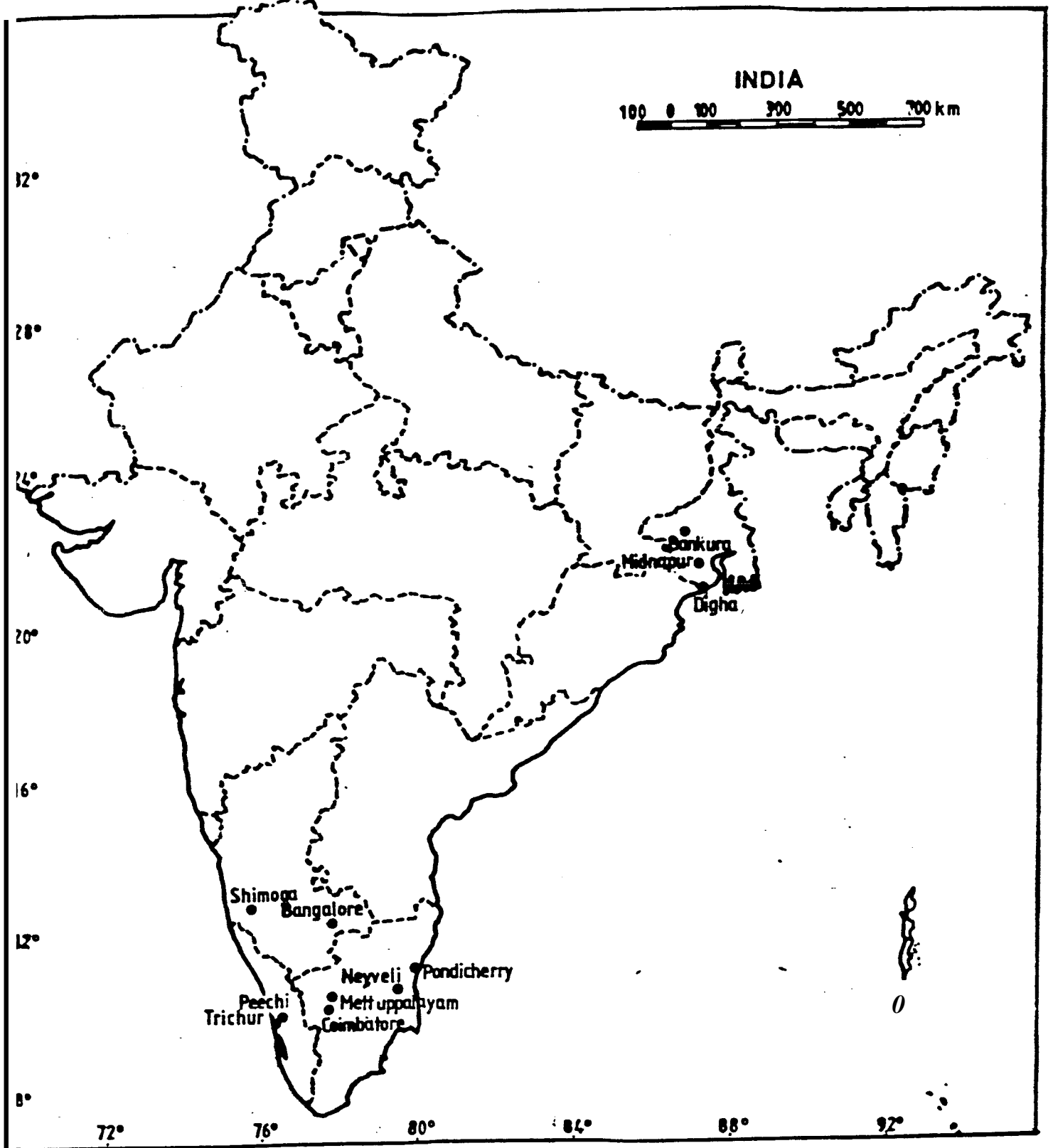


Fig. 5: Major locations in the States of Kerala Tamil Nadu, Karnataka and West Bengal where disease survey was conducted in exotic acacias.

5. RESULTS

During the survey a total of 165 disease specimens from different plant parts of all the four species were collected for isolation and identification of the pathogen (Table 7).

<i>Acacia</i> species	Total specimens	Phyllodes	Stem	Roots
<i>A. aulacocardia</i>	22	20	-	2
<i>A. crassicarpa</i>	24	18	4	2
<i>A. mangium</i>	42	27	11	4
<i>A. auriculiformis</i>	77	66	10	1

Most of the cultures were identified upto generic level with the help of standard taxonomic books, monographs, etc. However, there were quite a few cultures which could not be identified for want of sporulation. These were inoculated on malt extract agar for sporulation and identification of the fungus attempted.

5.1. Diseases of *Acacia aulacocarpa*

Four types of basic symptoms were identified with which 12 fungal species were associated. Foliar diseases were more common than diseases of other plant parts (Table 8).

5.1.1. Foliar tip necrosis

There were five distinct tip necrosis type of diseases. Since tip necrosis was caused by various fungi producing varied symptoms each disease is described separately.

1. *Alternaria* tip necrosis

Occurrence: Though the disease was very common during January - February affecting phyllodes of most of the trees, the severity was low.

Symptoms: The disease was characterised by drying up of the tip of phyllodes. Tip necrosis, dark brown in colour, proceeded slowly downwards towards the centre of the phyllode as seen from dark brown zonation lines in the necrotic region.

Causal organism: *Altemaria* sp.

Colony on PDA greyish black, effuse, reverse black; mycelium dark brown, septate; conidiophores dark, simple; conidia dark brown with transverse (2-5) and longitudinal septa (1-2), obclavate, with short beak, occasionally with long beak, 25.2-72 μ x 10.8-18 μ ; perithecia spherical, pale brown, 28.8-36 μ .

Table 8. Checklist of diseases recorded on *Acacia aulacocarpa* in India

Disease	Causal organism	Locality	Disease status	
			Incidence*	Seventy**
1. Foliar tip necrosis	i. <i>Alternaria</i> sp.	Neyveli	VC	L
	ii. <i>Pestalotiopsis</i> sp.	"	WS	L
	iii. <i>Colletotrichum</i> sp.	Dharampur	C	M
	iv. Unidentified	"	R	L
	v. Unidentified	Neyveli	C	M
2. Foliar spots	i. <i>Sporodesmium</i> sp.	Dharampur	O	L
	ii. <i>Alternaria</i> sp.	"	VC	M
	iii. <i>Phomopsis</i> sp.	Sadivayal	WS	S
	iv. <i>Pestalotiopsis</i> sp.	"	O	M
	v. Unidentified	Dharampur	R	L
	vi. Unidentified	"	WS	L
	vii. Unidentified	Tyranadur	C	L
3. Branch canker	<i>Botryodiplodia rheobromae</i>	Sadivayal	C	S
4. Root decay	Basidiomycete	Neyveli	C	M

* WS, Widespread; VC, Very common; C, Common; O, Occasional; R, Rare.
 ** S, Severe; M, Medium; L, Low.

2. *Pestalotiopsis* tip necrosis

Occurrence: The disease was widespread in a species trial plot at Neyveli (Tamil Nadu). Almost all the phyllodes of the lower branches of most of the trees were affected with this disease. As the disease was localised at the tip apparently it did not cause any defoliation.

Symptoms: The tips of the affected phyllodes had greyish brown necrosis on which the fungus sporulated in the form of minute black dots.

Causal organism: *Pestalotiopsis* sp.

Colony on PDA white, matted, appressed; reverse pale turning greyish; numerous dark discoid acervuli covered with mycelium present; conidia dark, fusoid, 5-celled with hyaline, pointed end cells, 14.4-21.6 μ x 3.6-5.4 μ ; apical appendages 2, hyaline, 7.2-18 μ long; basal appendage, small, 3.6-7.2 μ .

3. *Colletotrichum* tip necrosis

Occurrence: The disease was common in a species trial plot (1995) at Dharampur (West Bengal) during February. The infection was rated as medium.

Symptoms: The symptoms of the disease were characterised initially by the appearance of a dark brown spot with pale margin near the tip of the phyllode. It gradually spread towards the tip as well as centre of the phyllode. The disease affected mostly the mature phyllodes.

Causal organism: *Colletotrichum* sp.

Colony on PDA grey, floccose, reverse dark, mycelium pale brown; acervuli absent, conidia directly produced on simple conidiospores on the mycelium; conidia hyaline, 1-celled,

ovoid to oblong, guttulate, $5.75-11.5 \mu \times 2.3-4.6 \mu$, sclerotia spherical, dark brown, in short chains, upto 27.6μ long.

4. Unidentified (11-6) tip necrosis

Occurrence: The disease was observed on mature phyllodes at Dejuri (West Bengal). Though only a few plants were found affected with this disease it appeared to be a serious one.

Symptoms: Initially the necrotic area, reddish brown in colour, developed at the tip, which gradually spread downwards covering almost half of the phyllode.

Causal organism: Unidentified; non-sporulating.

5. Unidentified (7-1) tip necrosis

Occurrence: The disease. common in a species trial plot at Neyveli (Tamil Nadu), mostly affected the phyllodes in the lower branches of trees. The disease appeared to be of serious nature as the affected phyllodes defoliated prematurely.

Symptoms: The primary symptom of the disease was the development of water soaked linear lesions along the veins near the tip which soon turned greyish. These lesions coalesced to form greyish light brown large necrotic area. As more and more spots developed they coalesced to enlarge the necrotic area. characterised by dark greyish brown advancing margin or zonation line. The affected phyllode became pale and defoliated prematurely.

Causal organism: Unidentified: non-sporulating.

5.1.2. Foliar spots

Seven different types of foliar spot diseases were recorded from various localities with which different fungal organisms were associated.

1. Colletotrichum foliar spot

Occurrence: The disease occurred during February in low frequency in a species trial plot (1995) at Dharampur (West Bengal).

Symptoms: The typical symptoms of the disease were spherical to oval black spots, 1-2 mm dia scattered on the lamina irrespective of vein arrangements. The tissue around the spots became necrotic and such small necrotic lesions coalesced to form large necrotic areas, which spread from tip downwards.

Causal organisms : *Colletotrichum* sp.

Colony on PDA dull brownish, effuse. slightly appressed, reverse dark brownish; acervuli absent, conidia borne directly on simple conidiophores arising from mycelium. conidia hyaline, 1-celled, guttulate, ovoid, $9.2-16.1 \mu \times 2.87-4.6 \mu$.

2. Sporodesmium foliar spot

Occurrence: The disease was recorded in low frequency in a species trial plot (1995) at Dharampur (West Bengal). It occurred mostly on mature phyllodes.

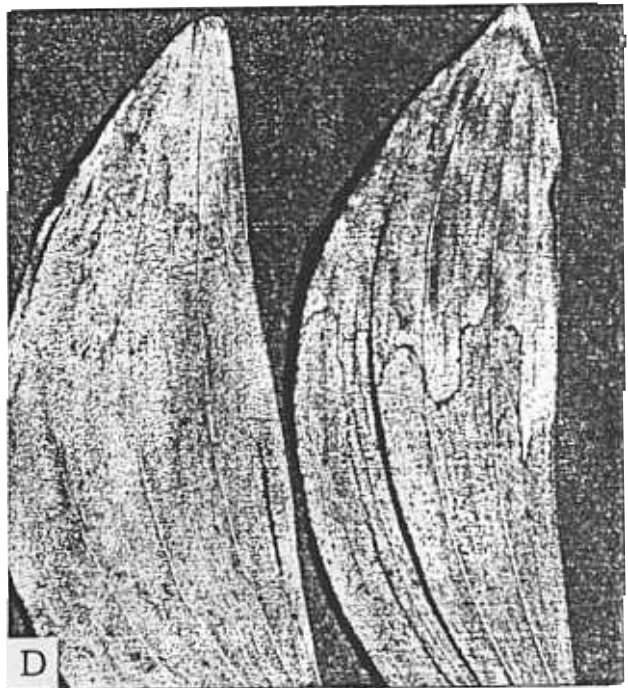
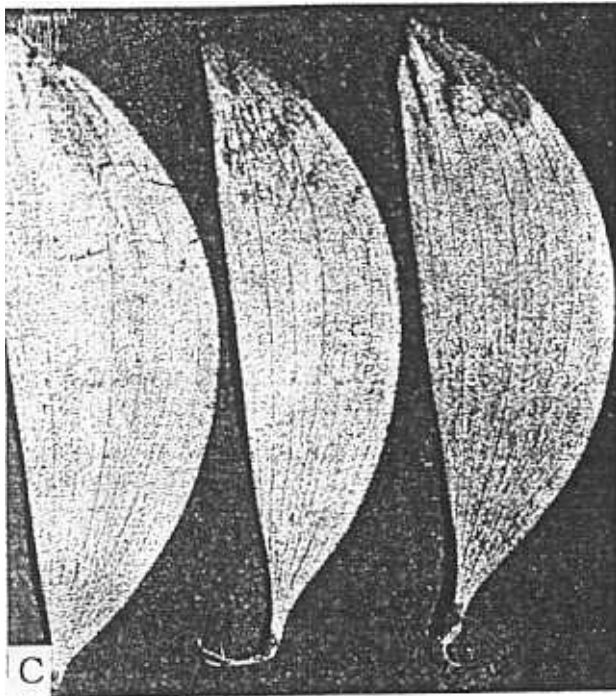
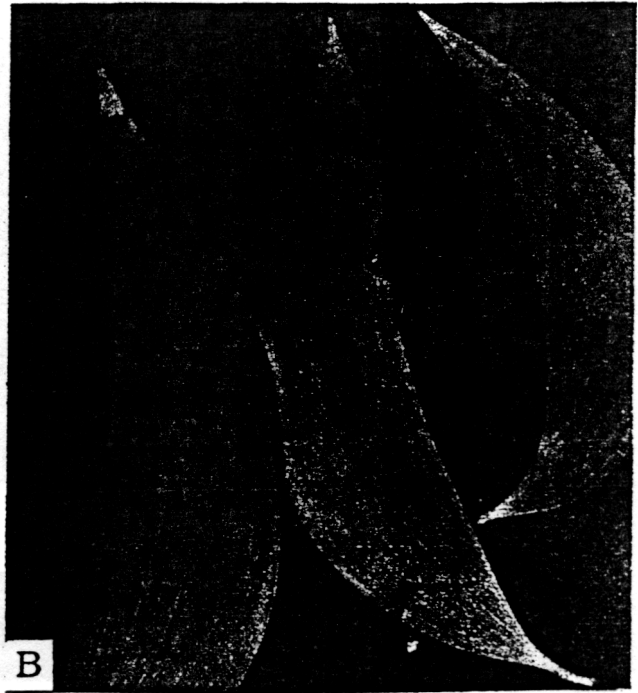
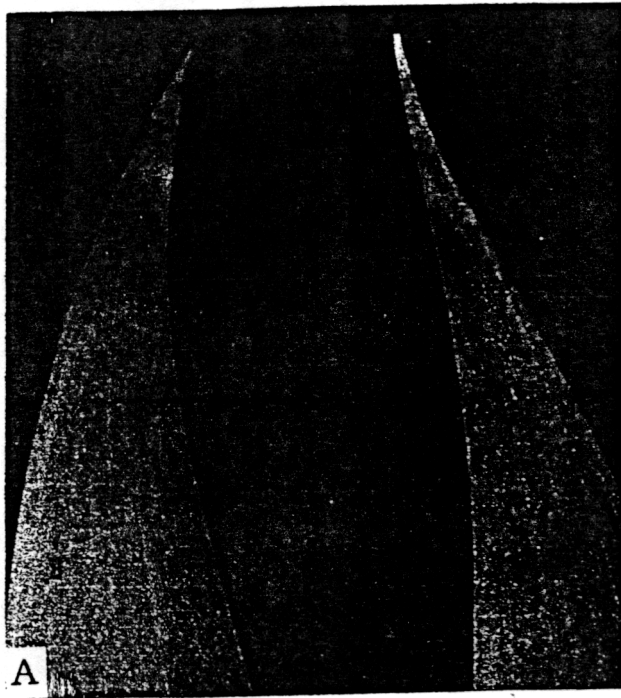
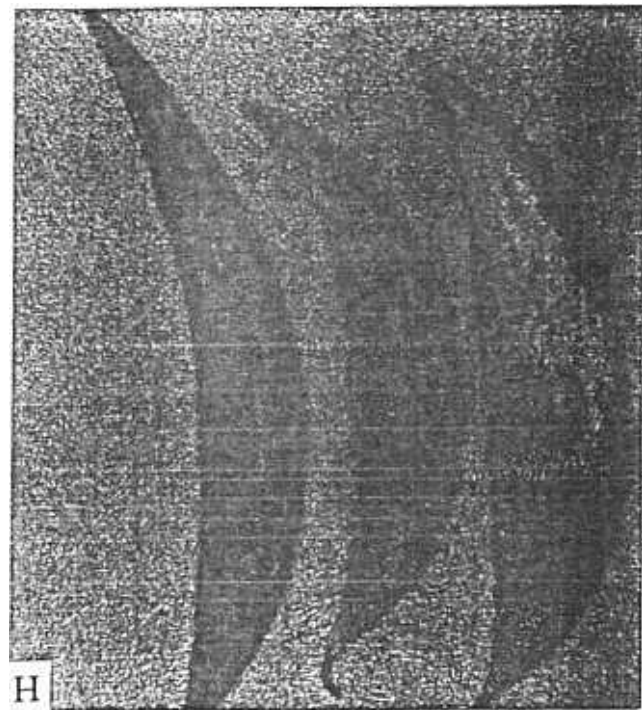
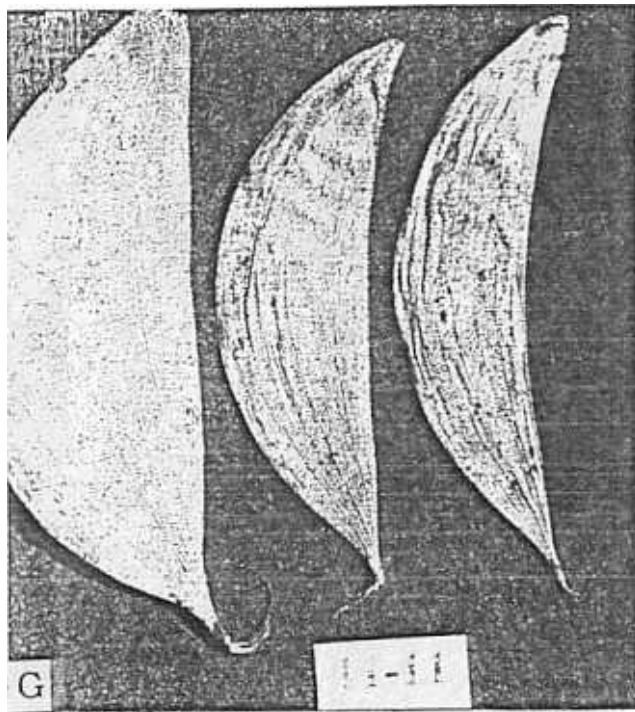
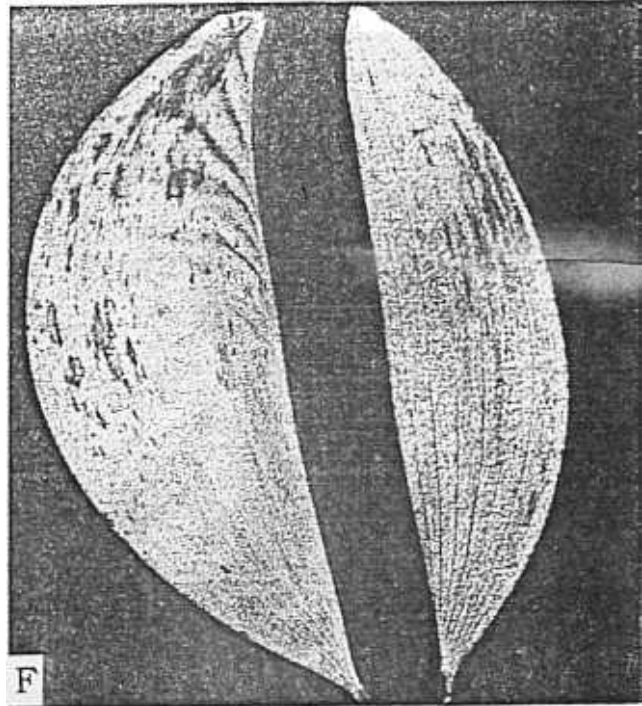
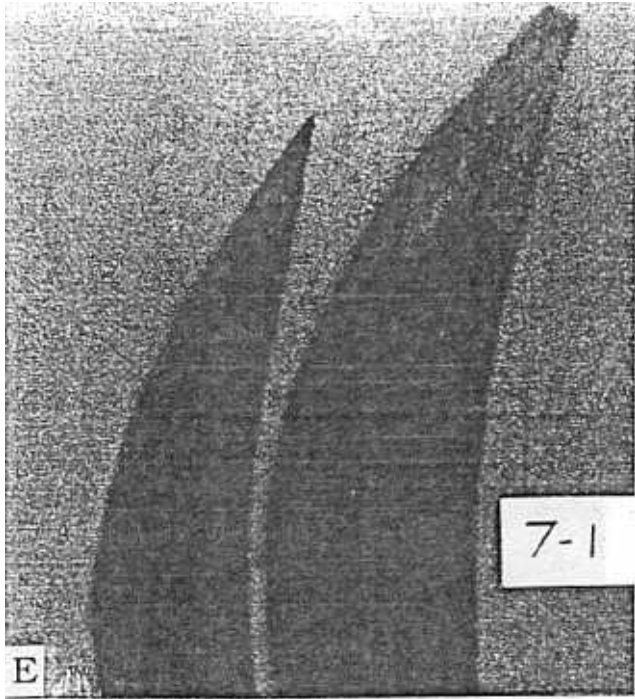


Fig. 6 Diseases of *Acacia aulacocarpa*. A, *Alternaria* foliar tip necrosis; B, *Pestalotiopsis* foliar tip necrosis; C, *Colletotrichum* foliar tip necrosis; D, Unidentified foliar tip necrosis.



Diseases of *Acacia aulacocarpa*. E, Unidentified foliar tip necrosis; F, *Sporodesmium* foliar spot; G, *Alternaria* foliar spot; H, *Phomopsis* foliar spot.

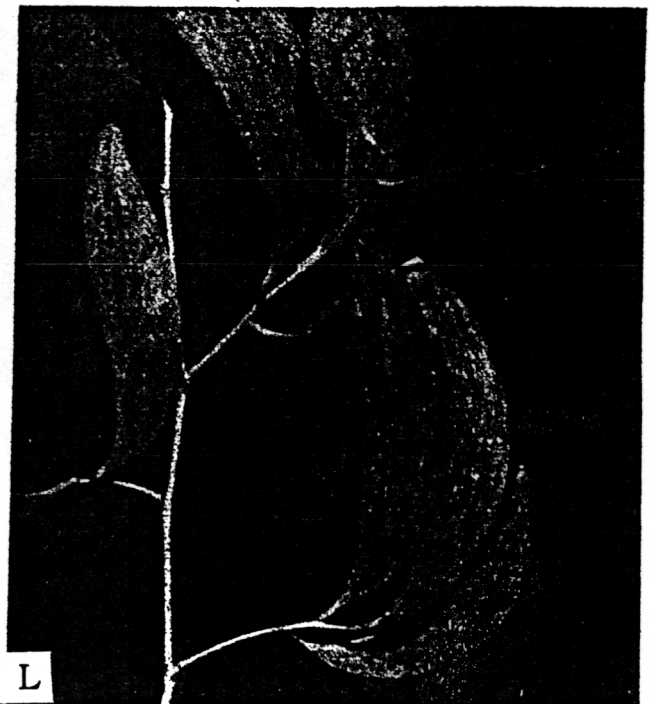
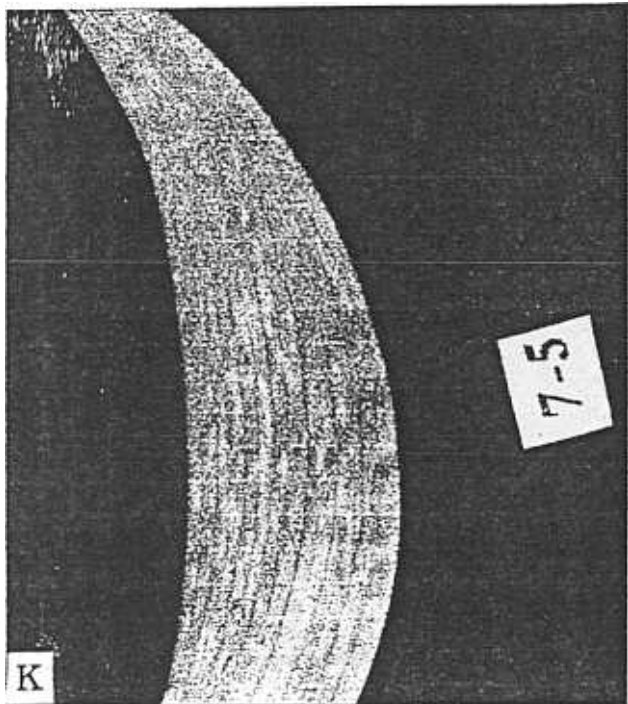
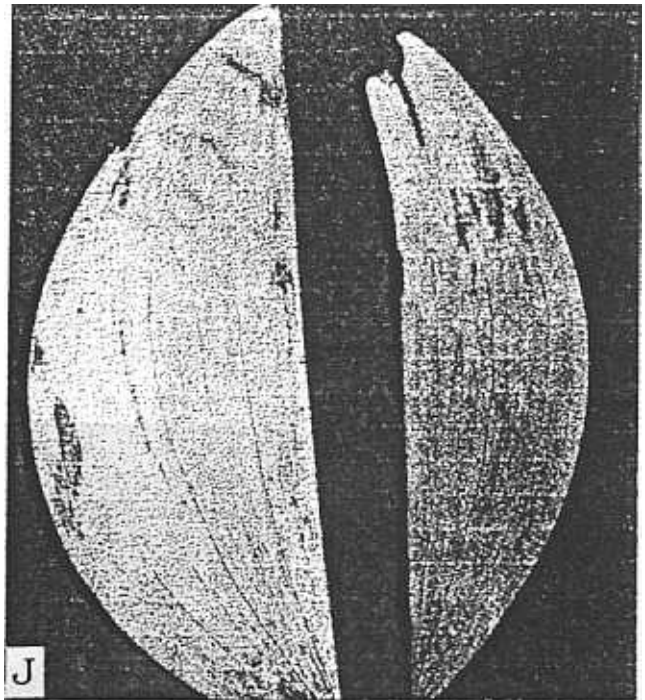
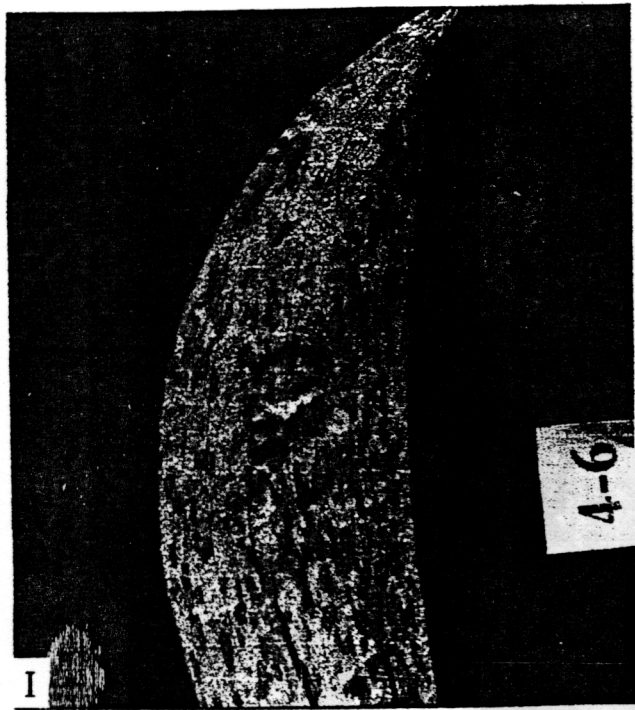


Fig. 8: Diseases of *Acacia aulacocarpa*. I, *Pestalotiopsis* foliar spot; J Unidentified foliar spot; K, Unidentified foliar spot.



Fig. 9 M, Branch canker of *Acacia aulacocarpa* caused by *Cytospora* sp

Symptoms: The disease was characterised by elongated dark brown lesions, 0.5 to 1 mm wide running parallel to veins. These lesions enlarged and coalesced to give rise to large dark reddish brown spots, which usually initiated from the tip of the phyllode. Severely affected phyllodes turned pale and defoliated prematurely.

Causal organism: *Sporodesmium australiense* Ellis (?)

Colony on PDA grey to dark grey, floccose, reverse dark; mycelium pale to light brown; conidiophores straight, septate, smooth, dark brown; conidia straight or rarely curved, fusiform to obclavate, conidia truncate at the base with cells at each end hyaline to pale $2.7-71.3 \mu \times 1.5-16.1 \mu$ in certain conidia the apical cells tapered into a small beak.

3. *Alternaria* foliar spot

Occurrence: The disease, very common in a species trial plot (1995) at Bharampur (West Bengal), affected young as well as mature phyllodes. The infection had a patchy distribution and it attained moderate severity resulting in premature defoliation.

Symptoms: Initially, dark brown spots appeared more towards the margins of phyllode. Around the spots the tissues became light brown which coalesced to give rise to large necrotic light brown areas along the margins. Severely affected phyllodes turned pale and defoliated prematurely.

Causal organism: *Alternaria* sp.

Colony on PDA dark grey, floccose, reverse dark; mycelium dark brown, septate, conidiophore simple, pale to mid olivaceous brown; conidia in short chains, obclavate, oval to ellipsoidal with or without cylindrical beak, pale, upto 13 septa; conidia with long beak with 2-4 transverse septa $25-142 \mu \times 6.9-9.2 \mu$ small conidia without beak with transverse and longitudinal septa $18.4-23 \mu \times 9.2-11.5 \mu$.

4. *Phomopsis* foliar spot

Occurrence: Severe infection of this disease was recorded in a species trial at Sadivayal - Shiruvani (Tamil Nadu) where almost all the plants had > 75 per cent of the foliage infection.

Symptoms: Initially, light discoloured areas developed on any part of the phyllode. At the centre of these areas irregular small greyish spots appeared with dark brown margin. The greyish spot enlarged in size and covered up to half of the lamina. Severely infected phyllodes defoliated prematurely.

Causal organism: *Phomopsis* sp.

Colony on PDA white turning off white to light brown, reverse pale brown; mycelium appressed, branched, septate, hyaline; conidiomata pycnidial, eustromatic, dark brown, separate or aggregated, thin-walled textura angularis; conidia of two basic types: α -conidia small hyaline, fusiform, straight, eguttulate, aseptate, $4.6-6.9 \mu \times 1.3 \mu$ β -conidia hyaline, filiform, curved or hamate, eguttulate, aseptate, $12.8-23 \mu$.

5. *Pestalotiopsis* foliar spot

Occurrence: The disease was recorded only on a few trees in a species trial plot (1995) at Sadivayal - Shiruvani (Tamil Nadu). The affected phyllodes defoliated prematurely due to severity of infection.

Symptoms: The disease was characterised by irregular, elongated brown coloured spots which spread rapidly to coalesce and form large necrotic areas. Severely affected phyllodes got defoliated prematurely.

Causal organism: *Pestalotiopsis* sp.

Colony on PDA white, effuse, mycelium scanty, appressed and immersed; conidiomata acervular, dark, aggregate; conidia fusiform, straight, 4-septate, $16.1018.4 \mu \times 4.6-5.75 \mu$; basal cell hyaline, truncate, with a simple appendage, $4.6-11.5 \mu$ long; apical cell conical. hyaline with 2 simple appendages, filiform $9.2-27.6 \mu$. medium cells brown.

6. Unidentified (11-10) foliar spot

Occurrence: The disease was recorded only on a few plants in a species trial plot (1995) at Dharampur (West Bengal).

Symptoms: Characteristic brownish red irregular spots of varying size developed near the margins of mature phyllodes which enlarged to form large necrotic lesions.

Causal organism: Non-sporulating Hyphomycete.

7. Unidentified (12-2) foliar spot

Occurrence: The disease was widespread during October/November in a species trial at Nallal Hosekote (Karnataka) and Neyveli (Tamil Nadu).

Symptoms: The disease was characterised by elongated dark coloured streaks parallel to veins, more towards the outer margin of phyllodes. These streaks enlarged and coalesced to give rise greyish black lesions which resulted in premature defoliation.

Causal organism: Non-sporulating Hyphomycete.

8. Unidentified (7-5) foliar spot

Occurrence: Though the spot disease was common on young as well as mature phyllodes in a species trial plot at Neyveli (Tamil Nadu) it apparently did not cause much damage due to its low severity.

Symptoms: The symptoms resembled nutrient deficiency. The affected phyllodes had typical elongated faint yellowish streaks running parallel to veins throughout the lamina. The spots were clearly visible if the phyllode was observed against the light.

Causal organism: Non-sporulating Hyphomycetes.

5.1.3. Cytospora branch canker

Occurrence: A branch canker disease was recorded in a species trial at Sadivayal - Shiruvani (Tamil Nadu). The incidence of the disease was very high and it caused extensive mortality of branches ultimately killing the trees. Of the 59 trees initially planted in the plot only 14 survived due to severe infection.

Symptoms: Canker developed as a depressed area initially only on one side of the branch. Tissues in the depressed area died and developed black streaks where the fructifications formed. The canker gradually girdled the tissues thus killing the whole branch.

Causal organism: *Cytospora* sp.

Colony on PDA dark greyish black, effuse; reverse black; mycelium appressed, immersed, dark brown, septate; conidiomata pycnidial, eustromatic, spherical, dark brown, convoluted, unilocular; conidiophore, simple, hyaline, 11.5-23 μ long; conidia, hyaline, allantoid, non-guttulate, 2.3-4.6 μ x 1.15 μ .

5.1. Root decay

Occurrence: Root decay was recorded in two plots of CSIRO seed lot No.16168 in a species/provenance trial plot (1990) at Neyveli (Tamil Nadu). The affected trees were found in patches. Out of 60 trees in two plots seven trees were already dead and three showed initial symptoms of the disease.

Symptoms: The affected trees showed yellowing of phyllodes and premature defoliation resulting in thinning of crown. On excavation of the root system it was found that some of the roots of such trees were either already dead or in the process of dying; dead roots showed zonation lines. No fructifications were observed on the affected roots.

Causal organism: Basidiomycete.

Culture on PDA white; reverse pale, mycelium appressed with clamp connections.

5.2. Diseases of *Acacia crassicarpa*

Four distinct types of disease symptoms were identified with which 15 fungal and one algal species were associated. Foliar diseases were more common than others (Table 9).

5.2.2. Foliar tip necrosis

There were six different types of symptoms and associated causal organisms recorded on *A. crassicarpa*.

1. *Curvularia* tip necrosis

Occurrence: The disease was recorded on phyllodes of only a few plants in a species trial (1995) plot at Dharampur (West Bengal) during February. The infection was mostly localised on lower phyllodes.

Symptoms: The infection initiated as greyish light brown spot at the tip gradually spread downwards. The rapidly spreading infection caused premature defoliation.

Causal organism: *Curvularia* sp.

Colony on PDA greyish, floccose, fluffy; reverse dark greyish brown; mycelium dark brown septate; conidiophores brown, simple, conidia apically or geniculate, sympodial, growing points on sides; conidia light brown, 3-septate, middle cell larger and dark brown, end cells lighter, slightly fusiform, curved 13.8-27 μ x 6.9- 11.5 μ .

Table 9. Checklist of diseases recorded on *Acacia crassicarpa* in India

Disease	Causal organism	Locality	Disease status	
			Incidence	Severity**
1. Foliar tip necrosis	i. <i>Curvularia</i> sp.	Dharampur	R	L
	ii. <i>Alternaria</i> sp.	Mettupalaya	0	L
	iii. <i>Alternaria</i> sp.	m	R	M
	iv. <i>Phomopsis</i> sp.	"	WS	M
	v. Unidentified	Jarakbande	C	L
	vi. Unidentified	"	0	L
2. Foliar spots	i. <i>Glomerella</i> sp.	Beede	0	L
	ii. <i>Colletotrichum</i> sp.			
	iii. <i>Altemaria</i> sp.		C	
	iv. <i>Pestalotiopsis</i> sp.		WS	M
	v. Unidentified		0	L
	vi. Unidentified		C	L
	vii. Unidentified		C	L
	viii. Unidentified		C	L
	ix. Sooty mould		WS	
3. Basal stem canker and root decay	<i>Botryodiplodia theobromae</i>		WS	S
4. Green algae	Unidentified	Beede	WS	M

* WS, Widespread; VC, Very common; C, Common; 0, Occasional; R, Rare
 ** S, Severe; M, Medium; L, LOW.

2. *Alternaria* tip necrosis

Occurrence: The disease was recorded in a species trial plot (1986-89) at Mettupalayam (Tamil Nadu). The incidence of the disease was very low.

Symptoms: Initially, small dark tan lesions developed near the tip which gradually extended towards the central portion of the phyllode. These lesions coalesced to form large necrotic dark tan coloured area extending from the tip downwards, more towards the inner margin. The affected phyllodes defoliated prematurely.

Causal organism: *Altemaria* sp.

Colony on PDA olivaceous grey, floccose, spreading, reverse dark; mycelium pale brown to brown; conidiophores simple; conidia pale to dark brown, verrucose with two types of conidia; with beak obclavate 23.0-73.6 μ x 9.2-13.8 μ with 3-6 transverse and 2 longitudinal septa, septa in beak 0-4; conidia without beak, small, oval, ellipsoidal, 23.0-32.2 μ x 9.2-13.8 μ with 3-4 transverse and 0-3 longitudinal septa.

3. *Alternaria* tip necrosis

Occurrence: This disease, recorded in a species trial (1986-87) at Mettupalayam (Tamil Nadu) appeared to be similar to the above but the symptoms and the causal organisms differed. The disease was quite severe in one tree affecting > 50 per cent of phyllodes.

Symptoms: Dark brown coloured necrosis started from the tip and extended downwards.

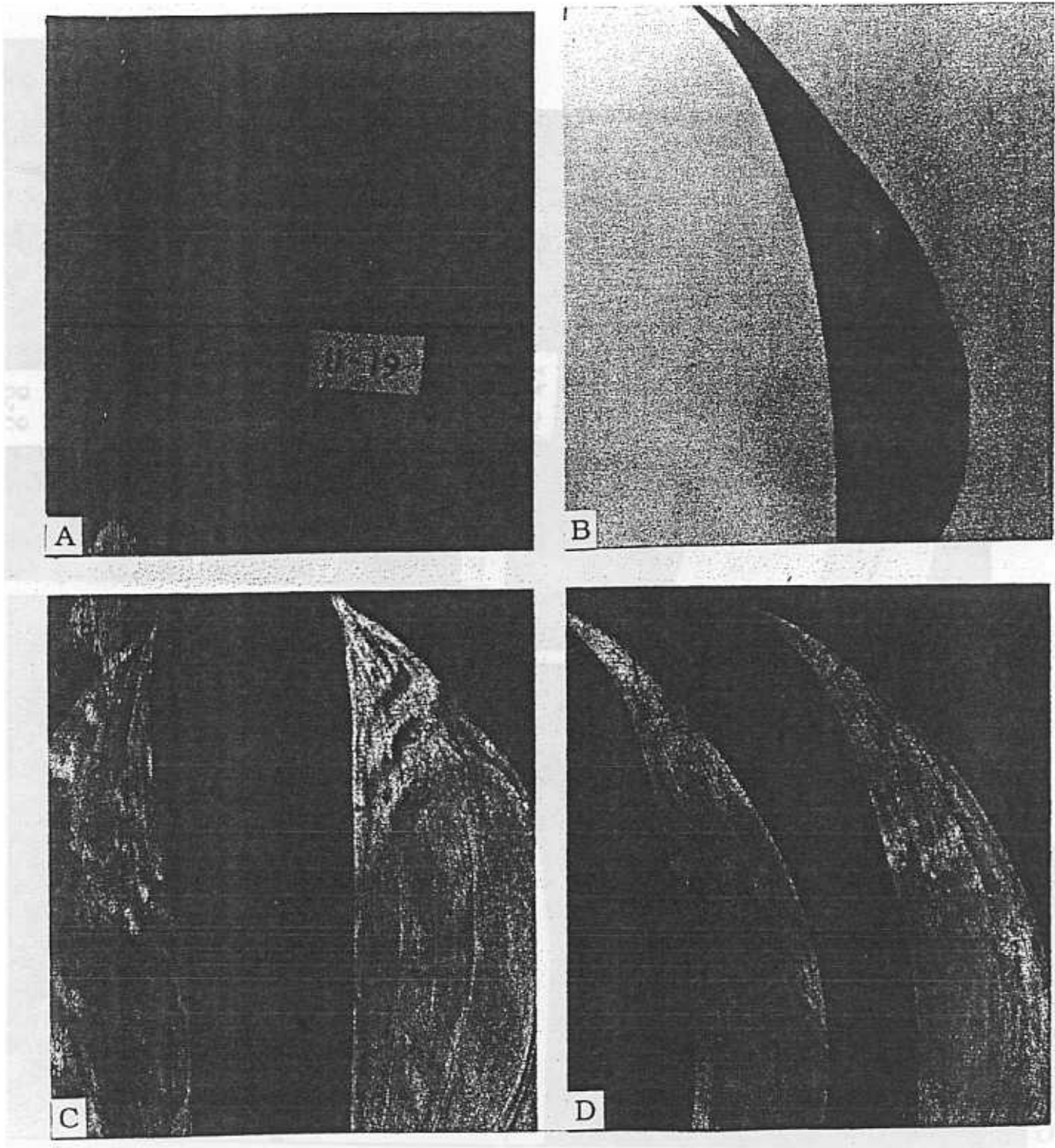


Fig. 10: Diseases of *Acacia crassicarpa*. A, *Curvularia* foliar tip necrosis; B, *Alternaria* foliar tip necrosis; C, *Phomopsis* foliar tip necrosis; D, Unidentified foliar tip necrosis.

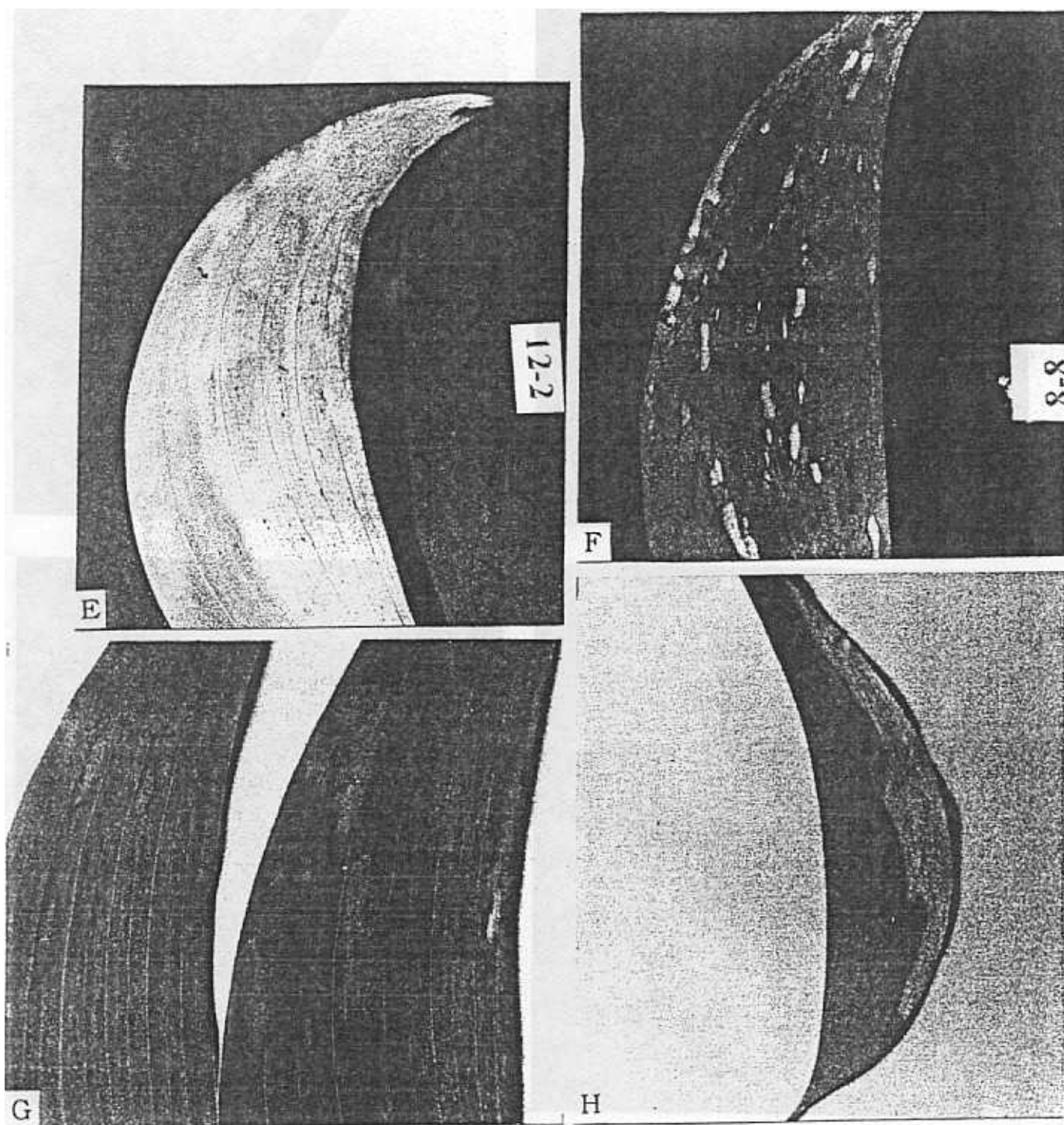


Fig. 11: Diseases of *Acacia crassicarpa*. E, Unidentified foliar tip necrosis; F, *Glomerella* foliar spot; G, *Colletotrichum* foliar spot; H, *Alternaria* foliar spot.

Characteristic dark grey streaks running parallel to veins, developed in the necrotic area where dark minute fructifications were produced.

Causal organism: *Alternaria* sp.

Colony greyish white, floccose; reverse dark; conidiophores simple, dark brown; conidia dark brown with three types of conidia, with long beak, short beak and without beak; short beak conidia with 3-4 transverse and 1-2 longitudinal septa; septa in beak 0-2.

4. Phomopsis tip necrosis

Occurrence: The disease was widespread in a species trial plot (1993) at Beede (Karnataka). The severity of the disease was rated as medium.

Symptoms: Light greyish necrosis was initiated at the tip which spread gradually down the lamina with irregular raised and well demarcated dark brown margin. Occasionally, the fructifications of the causal organism were also produced over the necrotic area.

Causal organism: *Phomopsis* sp.

Colony white turning dull brown; mycelium scanty, appressed, immersed; conidiomata pycnidial, dark, aggregate, straight, septate, branched, only β -conidia present, hyaline, filiform, eguttulate, non-septate, $13.8-20.7\mu \times 1.5-23\mu$.

5. Unidentified (8-7) tip necrosis

Occurrence: Though the disease was commonly encountered in species trial plot (1993) at Beede (Karnataka), its severity was rated as low.

Symptoms: Dull greyish brown necrosis initiated from the tip and spread down the phyllode in an oblique fashion, covering more than one-fourth of the lamina. Numerous greyish black streaks developed in the necrotic area running parallel to veins on which black fructifications of the causal organism developed.

Causal organism: Non-sporulating fungus.

6. Unidentified (12-2) tip necrosis

Occurrence: This disease was observed occasionally on mature phyllodes in a species trial (1995) at Dharmapur (West Bengal); the disease severity was low.

Symptoms: Almost three-fourth (length-wise) of the phyllode was covered with a large necrotic area which was characteristically light palish brown at tip and dark tan towards the base of the lamina. Within the necrotic area elongated light greyish spot with diffused margins were also seen.

Causal organism: Non-sporulating fungus.

5.2.2. Foliar spots

A total of nine distinct foliar spots were recorded on the phyllodes of *A. crassicarpa* growing in different localities.

1. *Glomerella foliar spot*

Occurrence: The disease was recorded on mature phyllodes in a species trial plot (1993) at Beede (Karnataka). The incidence and severity of the disease were low.

Symptoms: The disease was characterised by irregular greyish brown spots with dark brown margins. Smaller spots coalesced to form large necrotic areas. Occasionally, dark coloured fungal fructifications of the causal organism were observed in some of the spots.

Causal organism: *Glomerella cingulata*.

Colony on PDA initially white turning light greyish, effuse; mycelium sparse, appressed; reverse light greyish, conidiomata acervular, formed on the outer periphery; conidial mass orange; seta present, dark brown, septate 27.6-87.4 μ , conidia, hyaline guttulate, straight, oblong, with rounded ends, 9.2-13.8 μ x 2.3-4.6 μ perithecia present, light to dark brown, thin walled, immersed, formed singly or in groups, scattered.

2. *Colletotrichum foliar spot*

Occurrence: The disease, recorded only in a few trees in a species trial (1986-87) at Mettupalayam (Tamil Nadu), had very low incidence.

Symptoms: The disease was characterised by chocolate brown large necrotic spots, mostly elongated with darker margins. The spots were found only on mature phyllodes.

Causal organism: *Colletotrichum* sp.

Colony on PDA white turning light grey from the centre, effuse to cottony; reverse pale greyish; acervuli not seen; conidia borne directly on short conidiophores; conidia hyaline, guttulate, straight, oblong to oval, 10.35-23 μ x 2.3-4.6 μ .

3. *Alternaria foliar spot*

Occurrence: The disease was recorded in low incidence only on a few phyllodes at Mettupalayam (Tamil Nadu).

Symptoms: Usually, the necrotic spots initiated from the outer margin near the tip of phyllodes and extended downwards towards the base developing into a large greyish brown spots; the spots were lined with dark brown margin. Numerous black coloured fructifications developed on both the sides of the spots.

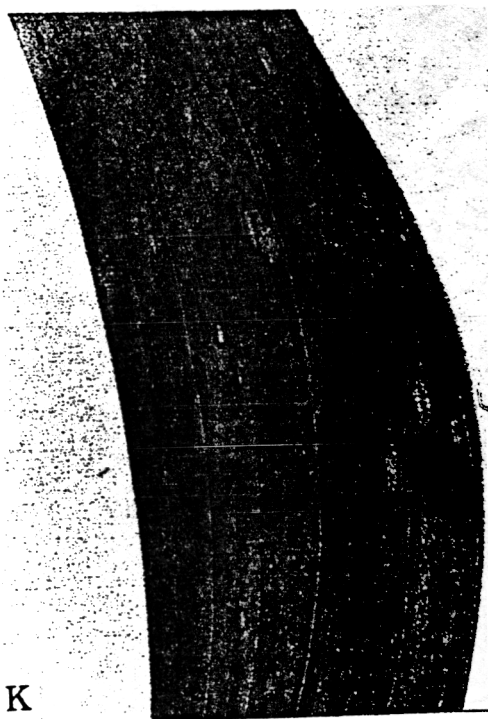
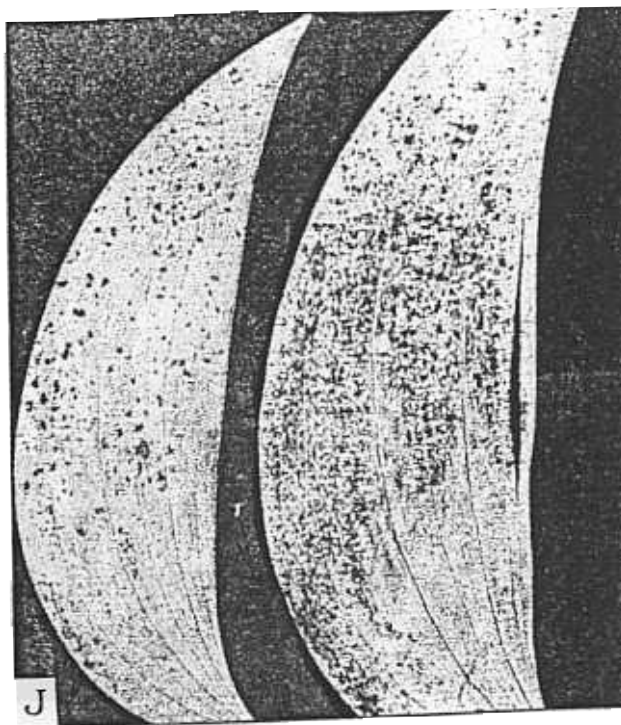
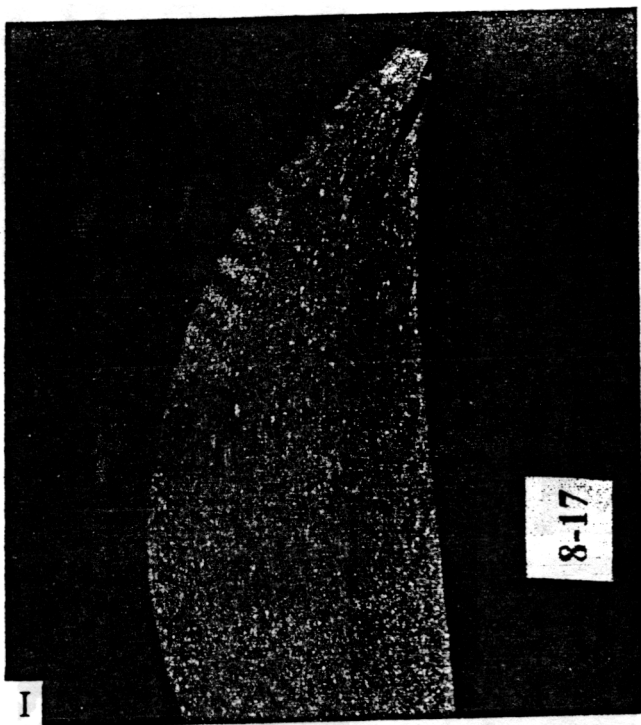
Causal organism: *Alternaria* sp.

Colony on PDA greyish brown, floccose, reverse dark; mycelium olivaceous brown, septate; conidiophores, long, brown to dark brown; conidia dark brown, obclavate, vermose, two types; short beak, 39.1-69 μ x 11.5-16.1 μ , with 3-7 transverse and 0-3 longitudinal septa; septa in beak 0-2; conidia with long beaks, 85.1-117.3 μ x 8.05-9.2 μ , with 3-5 transverse and 0-2 longitudinal septa.

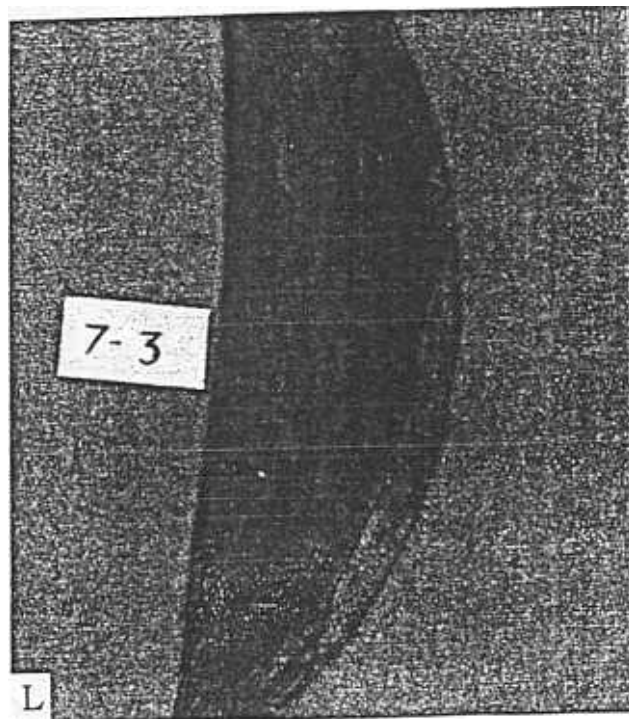
4. *Pestalotiopsis foliar spot*

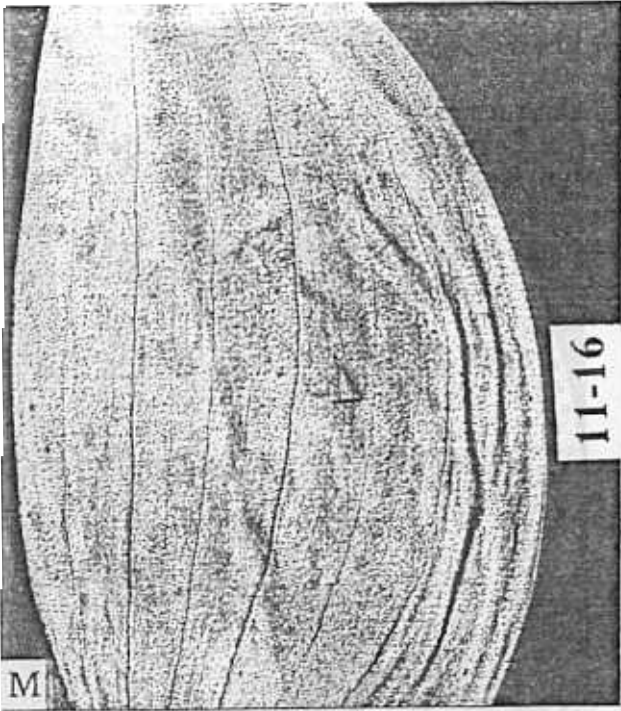
Occurrence: The disease was commonly observed at Brahamadevaragadde and Beede (Karnataka) and Neyveli (Tamil Nadu). Though the disease equally affected young and mature phyllodes it was found only on the lower branches.

Symptoms: The phyllodes had numerous spots, pale brown in colour with dark brown centre. There were more spots near the tip and middle of the phyllode than at the base. When



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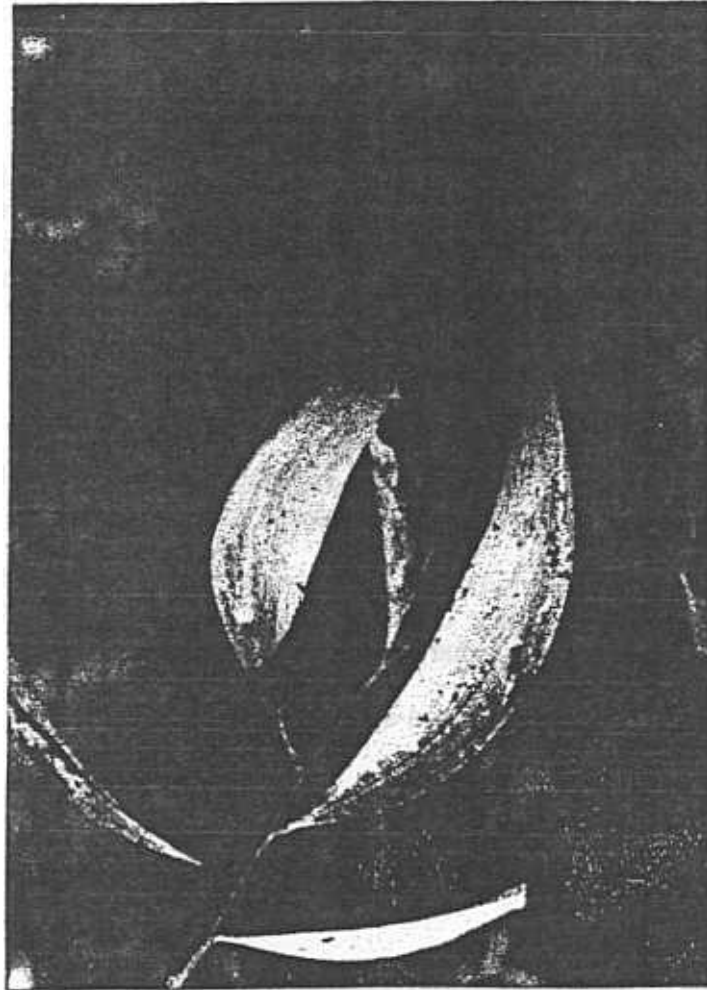


Fig 4 Combined infection of green Algal leaf spot and sooty mould on the leaves of *Acacia crassicarpa* at Beede, Shimoga, Karnataka.

seen against the light the spots appeared pale translucent areas with dark centre.

Causal organism: *Pestalotiopsis* sp.

Colony on PDA white cottony, reverse light orange; conidiomata acervular, separate or confluent, near the margin immersed, dark black; conidia fusiform, straight, 4-septate, dark brown, except the end cells; basal cell truncate with a short appendage, 5.75-9.2 μ long; apical cell conical with 3 appendages of equal size, simple spatulate, 9.2-23 μ long.

5. Unidentified (11-17) foliar spot

Occurrence: The disease was widespread on mature phyllodes of one-year-old plants in a species trial (1995) at Dharpur (West Bengal). The foliar spots spread from basal phyllodes to upper phyllodes.

Symptoms: Initially reddish brown shining irregular spots appeared on the mature phyllodes. As more smaller spots developed they coalesced each other to form larger spots. The affected phyllodes turned pale and defoliated prematurely.

Causal organism: Unidentified; Sphaeropsidales.

Colony on PDA white turning dull, reverse light pale; mycelium hyaline septate, scanty; conidiomata pycnidial, dark brown, non-ostiolate, 80.5-172.5 μ , covered with appendages, dark brown, non-septate, pointed, straight or curved, 119.6-161.0 μ ; young conidia hyaline, mature conidia light brown, 1-celled, thin walled, oval with slightly pointed ends, 9.2 - 11.5 μ x 5.75 - 8.5 μ .

6. Unidentified (3-11) foliar spot

Occurrence: The disease was recorded in a species trial plot (1986-87) at Mettupalayam (Tamil Nadu). The incidence and severity of the disease were very low.

Symptoms: The affected phyllodes had minute dark coloured spots which expanded and developed light grey areas in the centre resulting in the light brown to light grey, more or less elliptical spots with dark brown margins.

Causal organism: Unidentified; non-sporulating Hyphomycete.

7. Unidentified (7-3) foliar spot

Occurrence: Though the disease was common in a species trial plot (1990) at Neyveli its severity was low.

Symptoms: The disease was characterised by elongated greyish brown long spots along the outer margin of phyllodes. The necrotic spot had dark greyish long lesions where the fructifications of the causal organism developed.

Causal Organism: Unidentified; non-sporulating Hyphomycete.

8. Unidentified (11-16) foliar spot

Occurrence: This foliar spot was common in a species trial (1995) at Dharpur (West Bengal), but its severity was low.

Symptoms: The affected phyllodes had light yellowish orange spots with defused margins

throughout the lamina. When looked against the light these spots appeared bright yellowish orange. The disease affected the mature phyllodes but it progressed upwards also affecting the younger ones. The affected phyllodes defoliated prematurely.

9. Sooty mould

Occurrence: The disease was very widespread in a mix species trial (1993) of *A. mangium* and *A. crassicarpa* at Beede (Karnataka). Occasionally the incidence of sooty mould was so high that it covered almost >75 percent of the phyllode.

Symptoms: The affected phyllodes had dark black to greyish black superficial growth on the surface of phyllodes. In severe cases the phyllodes defoliated prematurely.

Causal organism: Unidentified; Meliolales.

5.2.3. Basal stem canker and root decay

Occurrence: Stem decay was recorded in a species trial plot (1989) at Nallal, Hosekote (Karnataka) and 1986-87 trial plot at Mettupalayam (Tamil Nadu). At Nallal, of the 60 trees 12 were removed after they dried up and eight standing trees had basal cankers. At Mettupalayam, out of 50 trees, 43 of them had already died and of the seven remaining trees one was affected with basal canker. In general the incidence of the disease was very high.

Symptoms: The affected trees had a basal canker near the ground characterised by appressed bark with cracks. Under the bark, the sapwood was discoloured and dead with prominent black zonation lines. The roots on the side of the canker were found dead and decayed with black zonation lines. In some trees, the dead bark and the underlying dead sapwood were eaten up by termites.

Etiology: After excavating the root systems of some of the recently affected trees, it was apparent that the infection was initiated in the subsurface roots. From the roots the infection spreaded upwards in the stem. Possibly, complete girdling of the stem due to the infection killed the trees.

Causal organism: *Botryodiplodia theobromae* Pat.

Colony on PDA dark greyish black, floccose, reverse dark; mycelium dark brown, septate; conidiomata synnematous, pycnidial, unilocular, ostiolate, thick walled; immature conidia hyaline, mature conidia 1-septate, dark brown, with longitudinal striations, 9.2 x 4.6 μ .

5.2.4. Green algal spot

Occurrence: An algal spot was recorded in a mixed species trial (1993) of *A. crassicarpa* and *A. mangium*. The incidence of the algal spot was very high and appeared to be severe, it occurred in combination with sooty mould.

Symptoms: Epiphytic growth of a light green algae covered a larger part of the phyllodes, at times covering the entire lamina. Such phyllodes turned yellow and defoliated prematurely.

Organism: Unidentified; Chlorophyceae

5.3. Diseases of *Acacia mangium*

Seven different types of disease symptoms were recorded in *A. mangium* with which 22 fungal organisms were associated. Foliar diseases were predominant in most of the younger plantations whereas root/stem diseases were significant in older plantations/trials.

5.3.1. Foliar tip necrosis

Only two foliar tip necrosis diseases were recorded in young (<2-year-old) species trial plots in West Bengal.

1. *Colletotrichum* tip necrosis

Occurrence: The disease was commonly found in species trial plot (1995) at Dharampur (West Bengal); the disease severity was rated as low.

Symptoms: Necrosis, dull greyish in colour, was initiated at the tip and it progressed downwards, sometimes covering up to one-fourth of phyllodes. The necrotic area became brittle and started to crack and break into smaller pieces. Occasionally, fructifications of the causal organism were also found over the necrotic tissues.

Causal organism: *Colletotrichum* sp.

Colony on PDA light to dark greyish, effuse, reverse dark grey, sclerotia absent, acervuli absent; conidia born directly on small conidiophores; conidia few in numbers, small, hyaline cylindrical, straight, guttulate, $6.9-11.5 \mu \times 2.3 \mu$.

2. Unidentified (12-8) tip necrosis

Occurrence: The disease was observed in a trial plot (1995) at Dharampur (West Bengal) only on a few plants in low incidence; the severity was also low.

Symptom: Light brown necrotic lesions developed near the tip, which coalesced to form large necrotic spot. The spot advanced further affecting the lamina. The advancing margin of the spot was defined and lighter in colour. Numerous minute brown fructifications developed in the necrotic area.

Causal organism: Unidentified; non-sporulating Hyphomycete.

5.3.2. Foliar spots

A total of fourteen different types of foliar spot diseases were recorded based on symptom expression. Except a few, most of the diseases occurred in low incidence and were not of any serious consequences.

1. *Curvularia* foliar spot

Occurrence: The disease occurred occasionally on young phyllodes in a species trial (1995) at Dharampur (West Bengal); the disease severity was low.

Symptoms: The disease produced irregular shaped reddish brownish spots at any place on the phyllode. The smaller spots coalesced to give rise large irregular spots with defused margin. The infection was also observed at the tip and margins.

Table 10. Checklist of diseases of *Acacia mangium* recorded in India

Disease	Causal organism	Locality	Disease status**	
			Incidence*	Severity
1. Foliar trip necrosis	i. Colletotrichum sp.	Gangadharpur	L	
	ii. Unidentified	Gangadharpur	R	L
2. Foliar spot	i. Curvularia sp.	Dharampur	L	
	ii. Colletotrichum sp.	Vilangannur	WS	S
	iii. Pestalotiopsis sp.	Vellakkarithadam	O	S
	iv. Pestalotiopsis sp.	Vellakkarithadam	O	L
	v. Pestalotiopsis sp. & Colletotrichum sp.	Vellakkarithadam	C	L
	vi. Glomerella sp.	Sadivayal	C	L
	vii. Colletotrichum sp.	Hosekote	R	L
	viii. Cercosporidium sp.	Dharampur	WS	S
	ix. Alternaria sp.	Dharampm	R	L
	x. Unidentified	IFGTB, Coimbatore	C	S
	xi. Unidentified	Hosekote	WS	S
	xii. Unidentified	Dharampur	O	L
3. Powdery mildew	Oidium sp.	Peechi	WS	S
4. Die-back	Hendersonula sp.	Hosekote, Angamaly	VC	M
5. Stem decay	i. Gliocladium sp.	Sadivayal	WS	S
	ii. Basidiomycete		C	S
	iii. Basidiomycete	Gangadharpur	WS	S
6. Root decay	i. Basidiomycete	Khadhalgobra	C	S
7. Root rot	i. Ganoderma lucidum Complex	Sapodiha, Kusumadhari, Angamaly	WS	S
8. Heart rot	i. Basidiomycete	Kusumadhari	R	L

*WS, Widespread; VC, Very common; C, Common; O, Occasional; R, Rare ** S, Severe;

Causal organism: *Curvularia* sp.

Colony on PDA dark blackish, spreading, effuse, reverse dark; mycelium pale brown, septate, branched; conidiphores long, brown geniculate; conidia dark brown, kidney shaped, curved, 2-3 septate, middle cells larger and dark brown than the end cells, 16.1 -34.5 μ x 9.2-13.8 μ .

2. Colletotrichum foliar spot

Occurrence: The disease was recorded in container plants (4-month-old) in a nursery at Vellakkarithadam near Peechi (Kerala). The infection was widespread and severe on mature phyllodes. The plants were closely spaced providing conducive microclimatic conditions for disease manifestation and spread.

Symptoms: The disease was characterised by initial circular to oval reddish brown spots of variable sizes with raised defined margin. There were more spots in the centre and basal part of the phyllode. Smaller spots coalesced to produce larger irregular spots. Severe infection caused premature defoliation.

Causal organism: *Colletotrichum* sp.

Colony on PDA white with greyish centre, cottony; reverse pale; mycelium hyaline, septate, branched with brown sclerotia, terminal or intercalary; conidiomata acervular, black; conidia numerous, hyaline, aseptate, guttulate, straight, oval, $9.2-20.7 \mu \times 2.87-4.6 \mu$.

3. Pestalotiopsis foliar spot

Occurrence: The disease was observed in a 6-months-old container nursery at Vellakkarithadam, near Peechi (Kerala). Though the disease had low incidence, the infection was severe as it caused considerable damage to phyllodes.

Symptoms: Initial smaller dark brown spots coalesced to produce elongated dark brown to tan spots with irregular margins in between the veins, occasionally leading up to the tip or the margin. Severe infection caused yellowing and premature defoliation. The disease mostly occurred on younger phyllodes.

Causal organism: *Pestalotiopsis* sp.

Colony on PDA white cottony, reverse pale; mycelium hyaline, septate profusely branched; conidiomata acervular, black, aggregate, mostly towards the centre of the colony; conidia dark brown, numerous, 4-euseptate, straight fusiform, spindle shaped with two hyaline end cells, middle cell dark $18.4-23 \mu \times 5.75-6.9 \mu$, apical cell conical with 2 appendages, filiform to spatulate, $11.5-23 \mu$. basal cell truncate with a smaller appendage.

4. Pestalotiopsis foliar spot

Occurrence: The disease was recorded in a 6-month-old container nursery at Vellakkarithadam, near Peechi (Kerala). The incidence and severity of the disease were low.

Symptoms: The disease produced in between the veins typical dark brown large elongated spots with rounded/obtuse ends and dark margin only at the apical end. The spots enlarged more lengthwise than across; adjacent spots coalesced together to form larger spot. Numerous black coloured fructifications were produced in the necrotic area.

Causal organism: *Pestalotiopsis* sp.

Colony on PDA white floccose, reverse pale; conidiomata acervular, large, black, scattered in the mycelium; conidia dark brown, euseptate, straight, fusiform, spindle shaped, $18.4-23 \mu \times 4.6-5.75 \mu$, end cells hyaline; apical cell conical with two terminal appendages, rarely three; appendages, spatulate $6.9-16.1 \mu$; basal cell truncate with one small appendage $2.3-4.6 \mu$.

5. Pestalotiopsis/Colletotrichum foliar spot

Occurrence: The foliar spot, recorded in 6-month-old container nursery at Vellakkarithadam, near Peechi (Kerala) was quite common on mature phyllodes but the severity was rated as low.

Symptoms: The spots appeared as elongated necrotic areas dark brown in colour on the lamina. The spots also grew over the veins unlike in the previous disease where they were restricted by veins. The margin of the spots was defined, slightly raised and dark brown in colour. Black coloured fructifications of the causal organism developed over the spots.

Causal organism: Both *Pestalotiopsis* sp. and *Colletotrichum* sp. were isolated consistently from the same spot.

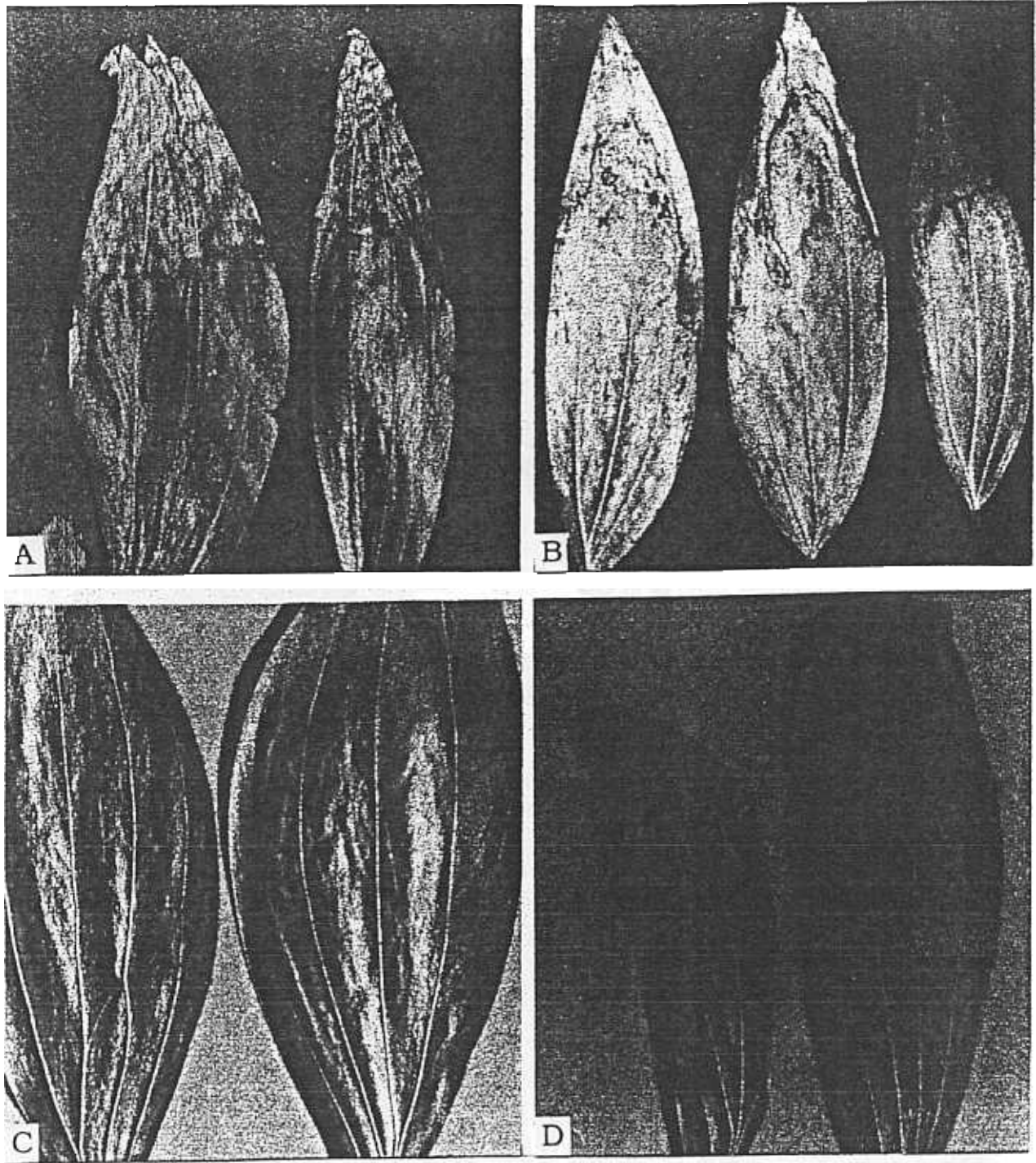


Fig. 15: Diseases of *Acacia mangium*. A, *Colletotrichum* foliar tip necrosis; B, *Curvularia* foliar spot; C, *Colletotrichum* foliar spot; D, *Pestalotiopsis* foliar spot.

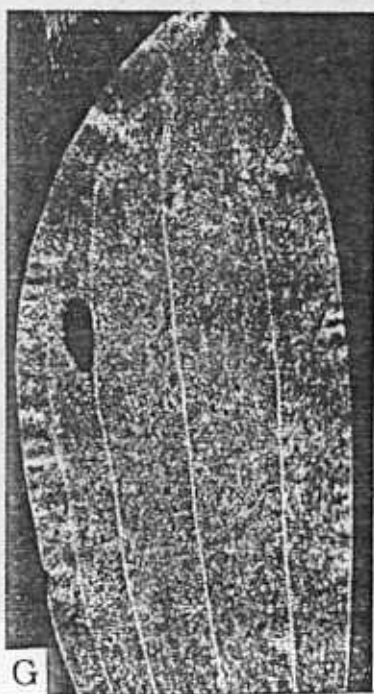
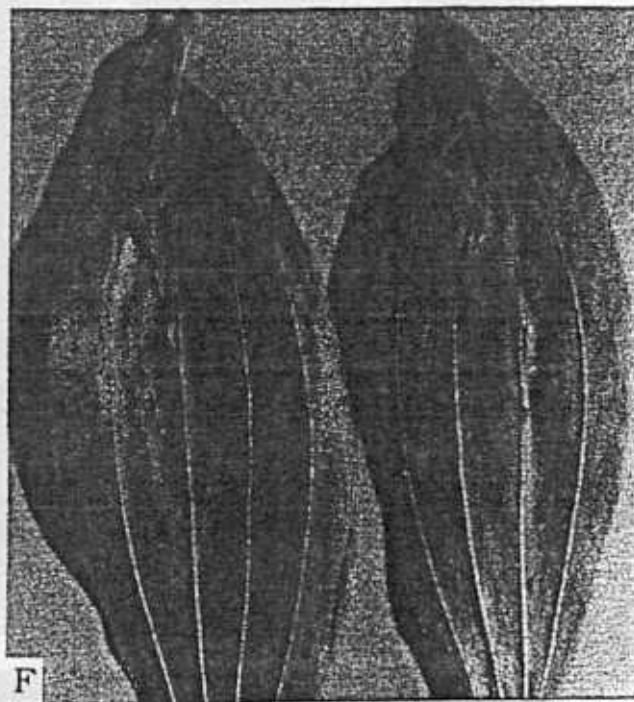
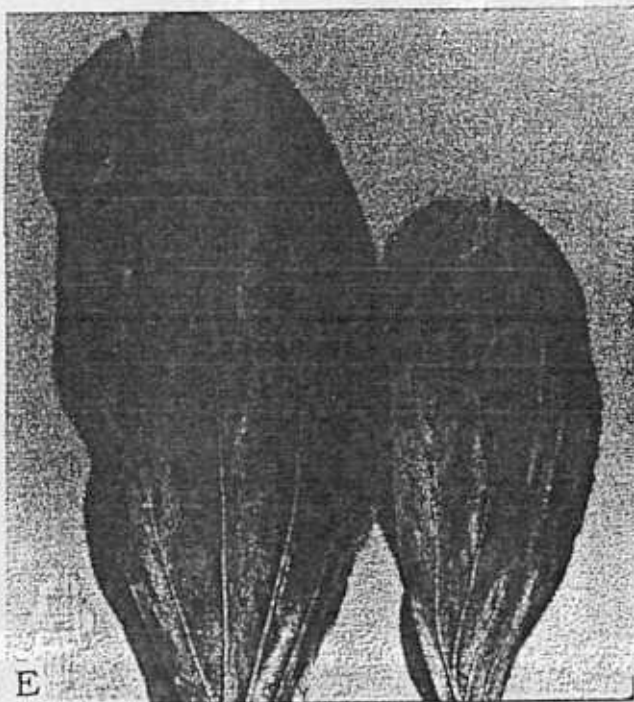


Fig. 16: Diseases of *Acacia mangium*. E, F, *Pestalotiopsis* foliar spot; G, *Glomerella* foliar spot; H, I, Unidentified foliar spot.

***Pestalotiopsis* sp.:** Colony on PDA white, floccose with restricted growth; conidiomata acervular dark, restricted in the centre; conidia dark brown, 4-euseptate with 3 medium dark cells and 2 end cells hyaline, straight, fusiform, spindle shaped $20.7-23 \mu \times 6.9 \mu$; apical cells conical with two appendages, spatulate, euguttulate, aseptate, 9.2-16.1 μ ; basal cell truncate with one appendage, 2.3-4.6 μ .

***Colletotrichum* sp.:** Colony on PDA grey, effuse, reverse palish grey; mycelium hyaline to pale to light brown, septate, acervuli absent, conidia borne directly on small conidiophores; conidia hyaline, straight, cylindrical, oblong, aseptate, guttulate, proximal end slightly pointed, distal end obtuse, 8.05-19.55 $\mu \times 2.3-4.6 \mu$.

6. *Glomerella* foliar spot

Occurrence: The disease, recorded in a species trial (1990) at Sadivayal-Shiruvani (Tamil Nadu), was common on the mature phyllodes of lower branches. The severity was rated as low.

Symptoms: The disease appeared as circular to oval dark brown spots up to 3 mm in dia. The spots were surrounded by light pale brown hallow. Occasionally, the spots were marked by veins.

Causal organism: *Glomerella* sp.

Colony on PDA light brown with immersed and scanty mycelium, reverse light greyish brown; sclerotia present, dark brown, terminal, 9.2-11.5 $\mu \times 6.3 \mu$; ascocarp dark brown, spherical, 108-133.24 μ ; acervuli absent, conidia borne on simple conidiophores; conidia, elongate, oblong, straight, hyaline, aseptate, guttulate, 9.2-13.8 $\mu \times 2.3 \mu$.

7. *Colletotrichum* foliar spot

Occurrence: The disease was recorded in a 0.5 ha plot (1992) with drip irrigation at Nallal, Hosekote (Karnataka). It was not of common occurrence and the severity was low.

Symptoms: Initially, the spots appeared as light pale brown interveinal areas which turned dark brown to dark tan oval to elongated spots measuring upto 3-4 mm. The smaller spots coalesced to give rise long necrotic areas. Spots also occurred at the margins and tip of phyllodes. The disease was observed only on mature phyllodes.

Causal organism: *Colletotrichum* sp.

Colony on PDA dark greyish, floccose, reverse dark; conidiomata acervular, setae absent; conidia straight, cylindrical, oblong, aseptate, hyaline, guttulate, 6.9-13.8 $\mu \times 3.45 - 4.6 \mu$.

8. *Cercosporidium* foliar spot

Occurrence: This disease was recorded in a species trial plot (1995) at Dharampur (West Bengal). The disease was widespread and of serious consequences as it caused premature defoliation.

Symptoms: Initially, the spots appeared on the lower phyllodes and the infection progressed upwards, causing defoliation of the bottom phyllodes due to extensive spotting. Numerous spots appeared as dark reddish brown necrotic areas, circular to oval 1-2 mm in dia. These spots increased in size to 3-4 mm across. When the expanding spots coalesced large size necrotic spots were formed. Rarely, the spots also affected the veins.

Causal organism: *Cercosporidium acaciae* sp. nov.

Colony on PDA dark brown, effuse, reverse dark; mycelium pale brown, septate, branched, conidiophores simple macronematous, unbranched, brown, septate, geniculate; conidiogenous cells sympodial, conidial old scarce flat situated on the shoulders; conidia solitary, dry cylindrical, oval with conspicuous hilum, 1-septate, $11.5-16.1 \mu \times 6.9-11.5 \mu$.

9. *Alternaria* foliar spot

Occurrence: The disease was recorded on the same phyllode affected with *Cercosporidium* foliar spot at Dharampur (West Bengal). The incidence and severity of the disease were low.

Symptoms: *Alternaria* foliar spots, occurred intermingled with *Cercosporidium* spot disease on the same phyllode, were light greyish circular to elliptical areas with rough outline measuring 2-3 mm. The spots mostly occurred near the base of the phyllode.

Causal organism: *Alternaria* sp.

Colony on PDA greyish, floccose with concentric rings, alternating dark and lighter rings, reverse dark; mycelium dark brown, septate, highly branched; conidiophores dark brown, simple, septate, long, bearing conidia terminally; conidia dark brown, obclavate, oval, obovate generally with no beak, transverse septa 3, longitudinal septa 0-2, $18.4-23 \mu \times 6.9-12.65 \mu$; conidia with beak very few, transverse septa upto 1-3, longitudinal 0-1, $41.4-71.3 \mu \times 6.9-9.2 \mu$.

10. Unidentified (4-9) foliar spot

Occurrence: The disease was observed in 2-month-old seedlings in the nursery of Institute of Forest Genetics and Tree Breeding, Coimbatore (Tamil Nadu). The disease was very severe on mature phyllodes and it resulted in premature defoliation.

Symptoms: The disease appeared as minute dark reddish brown to maroon coloured spots, <1mm in dia, spread throughout the lamina. These spots expanded to 1-2 mm dia and developed pale to light brown colour in the centre; coalesced spots formed larger irregular reddish brown coloured spots. Severely affected phyllodes defoliated prematurely.

Causal organism: Unidentified; non-sporulating Hyphomycete.

11. Unidentified (7-8,7-10) foliar spots

Occurrence: The disease, recorded in a 0.5 ha irrigation trial plot (1993) was widespread and severe on mature phyllodes. Similar disease was also recorded in a 1 ha trial plantation (1993) at Beede, Shimoga (Karnataka); the severity and incidence of the disease, found only on mature phyllodes, were very low.

Symptoms: Initially, the elliptical spots, about 1 cm long, appear as light orange blotches with defused margins; these blotches seen against the light appeared yellowish water-soaked areas. In these blotches small necrotic spots developed in concentric rings which coalesced to form large reddish brown to dark brown necrotic spots with light brown hollow around them; severely affected phyllode defoliated prematurely.

Causal organism: Unidentified; non-sporulating Hyphomycete.

12. Unidentified foliar spot

Occurrence: This disease was recorded in a species trial plot (1995) at Dharampur (West Bengal). The incidence and severity of the disease were very low.

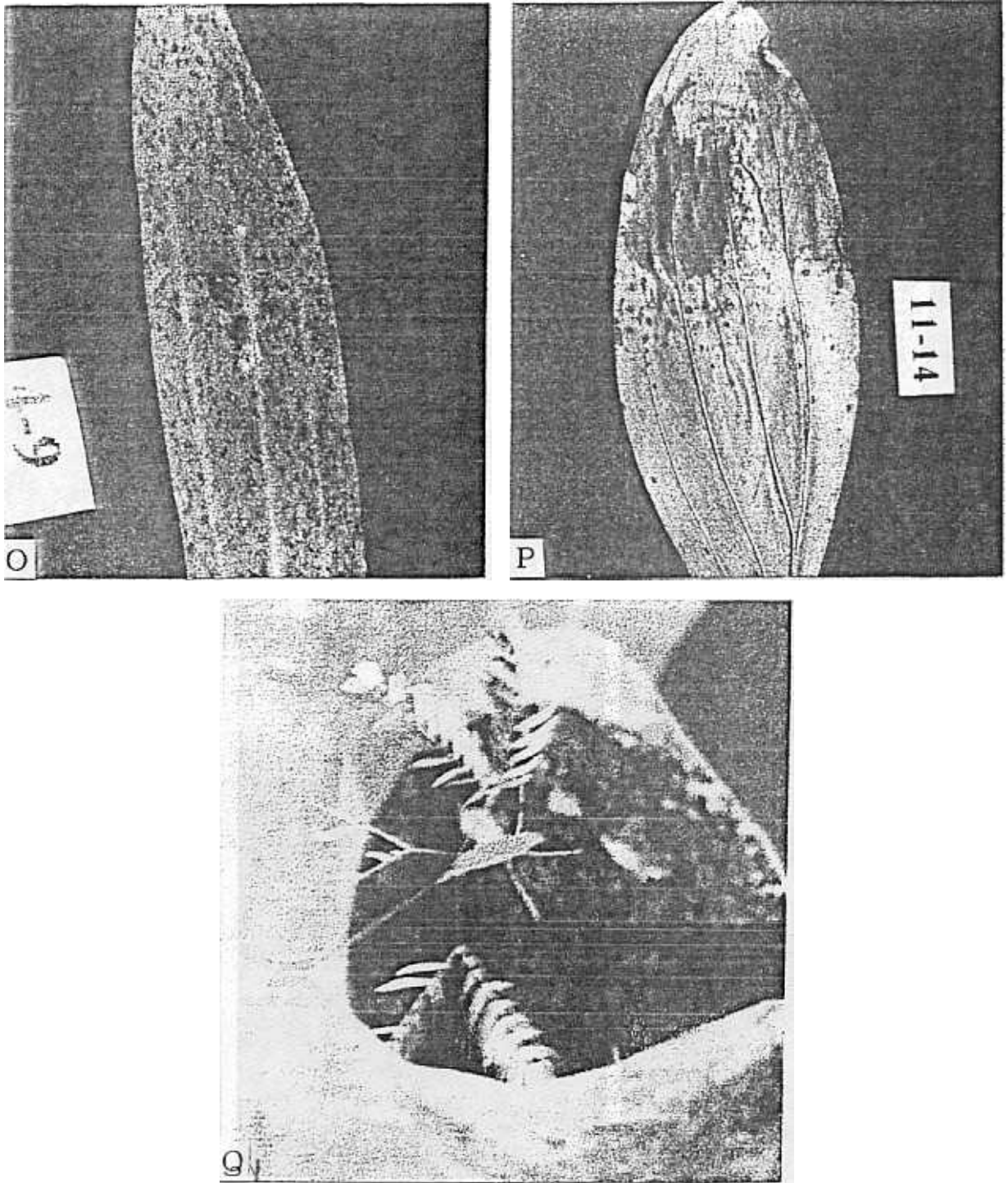


Fig. 18: Diseases of *Acacia mangium*. O, Unidentified foliar spot; P, Unidentified foliar spot; Q, A seedling affected with powdery mildew.

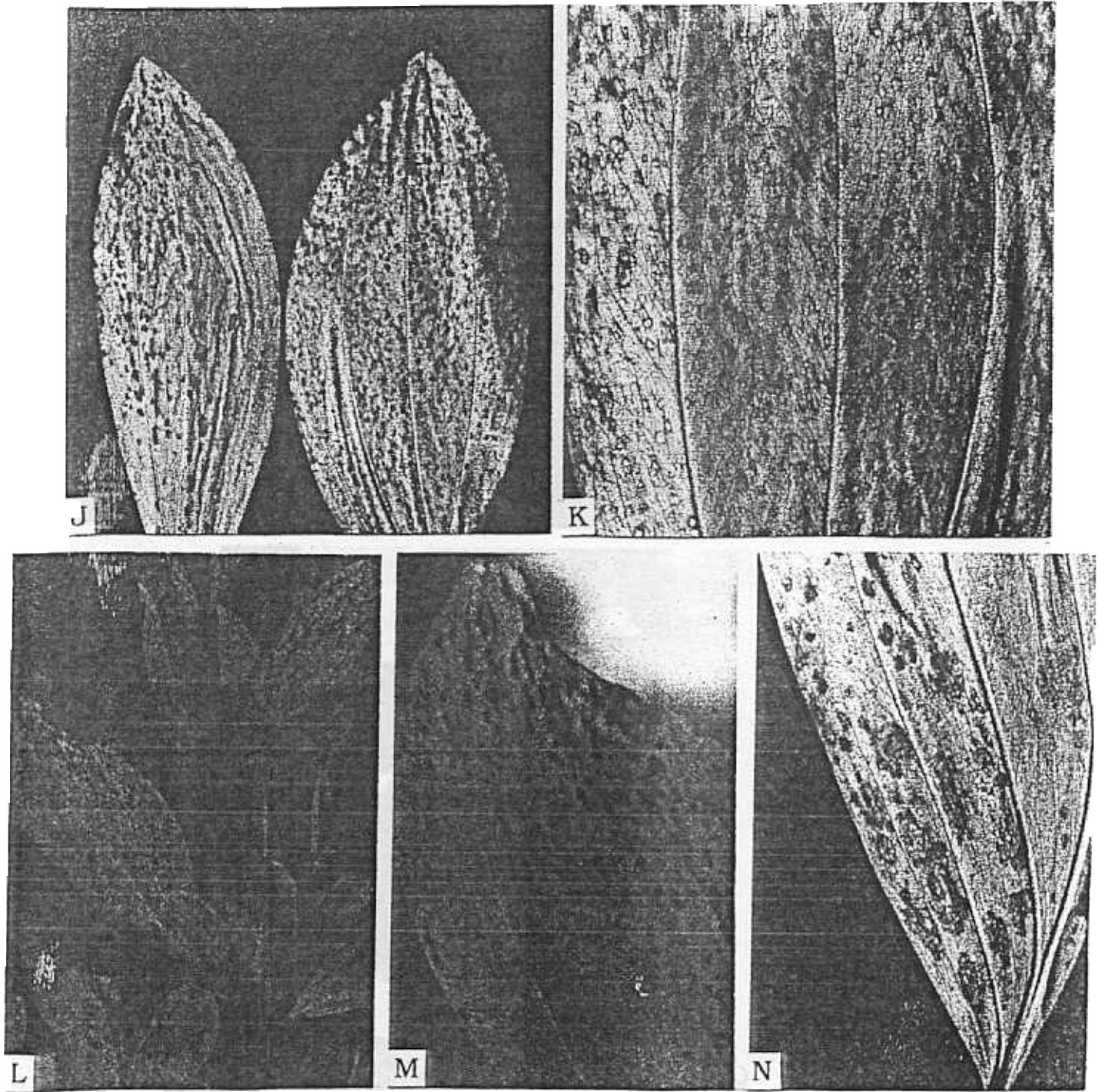


Fig. 17: Diseases of *Acacia mangium*. J, K, *Cercosporidium foliar spot*; L, M, N, *Alternaria foliar spot*.

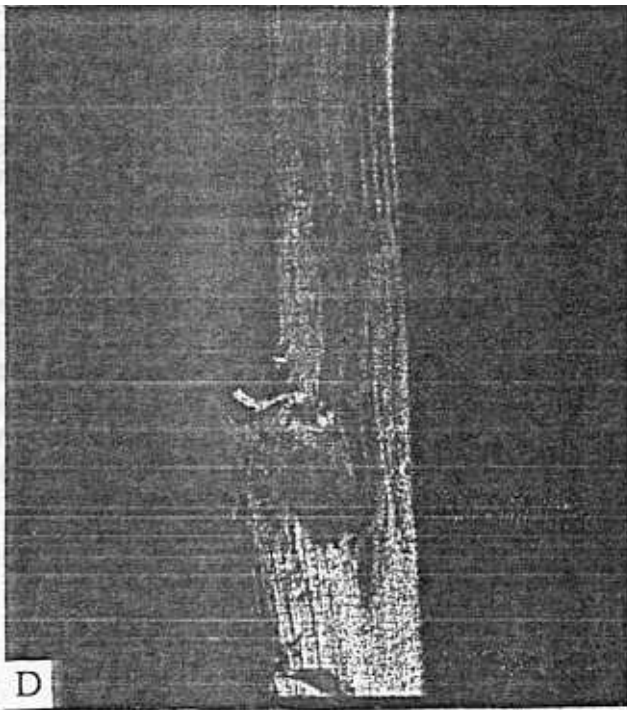
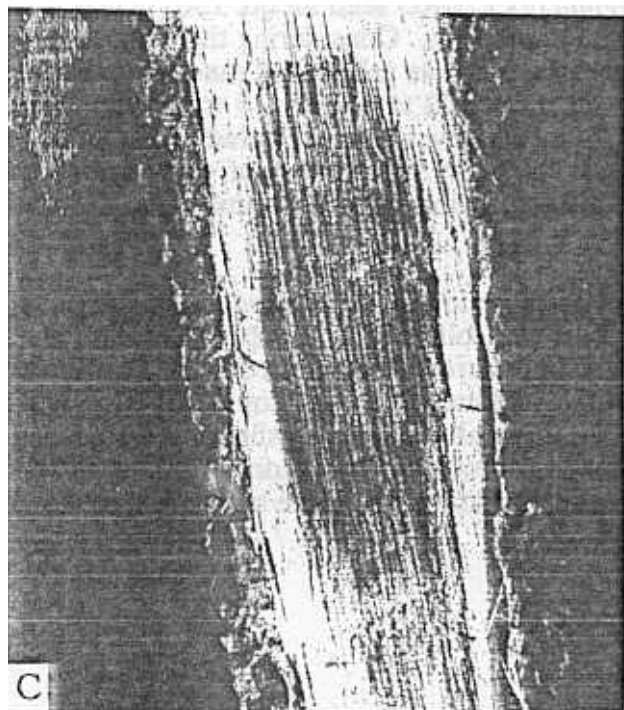
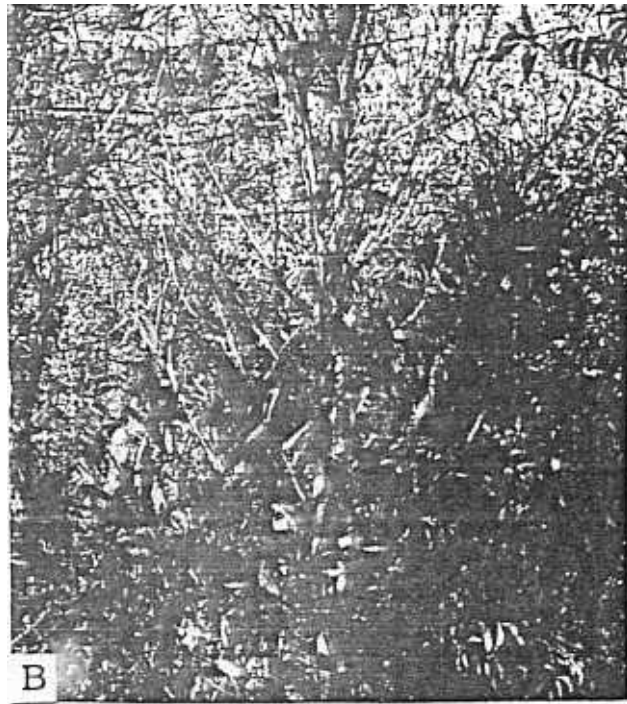


Fig. 19: Die-back of *Acacia mangium* caused by *Hendersonula* sp. A, Die-back of shoots in the upper crown accompanied by yellowing of phyllodes; B, Extensive die-back in upper crown and production of epicormic shoots; C, D, Infected branch split up to show the spread of infection from younger branches.

Symptoms: Numerous circular dark brown spots, 102 mm dia., appeared in the upper half of the lamina. The spots expanded and coalesced to form large necrotic area extending from one margin to other.

Causal organism: Unidentified; non-sporulating Hyphomycete.

5.3.3. Powdery mildew

Occurrence: Powdery mildew found to affect 2- to 3-month-old seedlings in KFRI nursery during January-February. The disease was widespread and very severe resulting in premature defoliation.

Symptoms: All the phyllodes were covered with whitish powdery mass on the upper surface. Gradually, the lower surface also got infected. In severe cases even the petioles and stem were covered with the whitish powdery mass.

Causal organism: *Oidium* sp.

5.3.4. Die-back

Occurrence: Extensive die-back of *A. mangium* (ex CSIRO seed lot no. 15677) was recorded in a species trial plot (1989) at Nallal, Hosekote (Karnataka). Considering the damage and disease severity, out of 380 trees a plot of 100 trees (10 x 10) was selected at random and assessed for the incidence and severity of the disease. Of these 100 trees only 46 trees were found to be healthy and the rest were in various stages of disease development, including the dead ones and dead and removed (Fig. 2). The figure shows a patchy distribution of the diseased trees. The disease was also recorded in 2-year old trees growing in the premises of a factory near Angamaly, Kerala.

Symptoms: The initial symptoms of die-back were yellowing of phyllodes and subsequent thinning of upper crown, including the top. This was followed by complete defoliation and die-back of branches and death of main stem in the upper crown. It resulted in the development of epicormic shoots giving bushy appearances to the affected trees with top dead. Slowly and gradually the infection proceeded downwards killing all the primary shoots and epicormic shoots. The process of killing of the main stem, development of epicormic shoots and death of epicormic shoots was repeated until the infection had killed the entire tree. No infection of roots was observed.

- Healthy (45)
- ♀ Dead (22)
- ⊗ Top dead (13)
- ▣ Side branches dead (14)
- ◆ Yellowing of leaves/ thinning of crown (1)
- Dead tree cut (4)

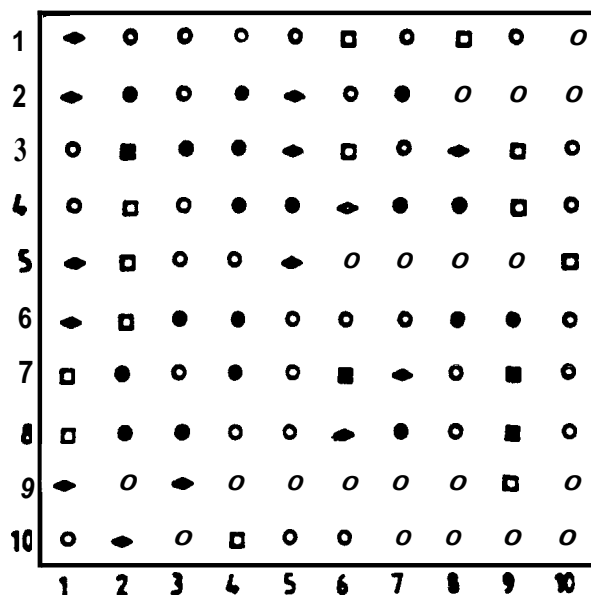


Fig. 20: Incidence and severity of dieback of *Acacia mangium* at Hosekote, Bangalore. Figure in bracket indicates the number of trees

Etiology: A close examination of the freshly affected trees showed that the infection was initiated in top one-fourth part of the crown. Initially, the younger branches got infected and showed die-back symptoms. From these branches the infection spread to the main stem as observed in many cases; complete girdling of tissues killed the upper plant part.

Causal organism: Consistently from the diseased branches and main stem *Hendersonula* sp. was isolated in pure culture.

Colony on PDA greyish black, effuse, appressed, reverse dark; conidiomata pycnidial, carbonaceous, black, eustromatic, synnematos, 1- to several per stroma, locules occurring at different levels in stroma; conidia extruded in cirri, at first 1-celled, hyaline later 3-4-celled pale brown, 16.8 x 5.6 μ .

53.5. Stem decay

Three different types of stem decay were recorded in *A. mangium*

1. Gliocladium stem decay

Occurrence: This disease was observed in a species trial plot (1990) at Sadivayal, Shiruvani (Tamil Nadu). Of the 420 trees planted, about 20 per cent of them had already died due to the disease.

Symptoms: The affected trees had a basal canker, characterised by appressed bark on one side. When the bark was removed and a cut was made, the stem showed typical browning due to decay. When the decay advanced and it girdled the stem completely the trees showed yellowing of phyllodes, defoliation and thinning of crown; such trees ultimately died. Partially affected trees had infestation by *Xyleborus* beetles in the form of minute holes in the living sapwood.

Etiology: It was not clear as to how the infection initiated. Due to the presence of the basal canker apparently the infection took place near the ground level. Decay was also observed around the holes drilled by *Xyleborus*, indicating that possibly the infection started from the insect tunnels. Since, root could not be observed, possibility of root infection could not be ruled out.

Causal organism: *Gliocladium* sp. was isolated from the decayed stem and decay around the insect holes.

Colony on PDA dull orangish, spreading, appressed reverse pale brownish; mycelium hyaline to pale, immersed, scanty; sporulation in concentric rings; spore masses produced in orangish yellow drops; conidiophores straight, septate, branched; phialides penicilloid, primary and secondary, apex centenulate, producing chains of conidia, conidia hyaline, oval, small, 3.45-4.6 μ x 2.3 μ .

2. Above ground stem decay through branch stubs

Occurrence: Widespread stem decay through branch stubs was observed in 1 ha plantation at Gangadharpur (West Bengal).

Symptoms: No external symptoms were visible. When the stubs were exposed, it showed browning extending by several centimetres in up and down direction in the sap and heartwood.

Etiology: The branches were lopped indiscriminately by the villagers for fire wood resulting in open injury through which the infection had taken place.

Causal organism: Consistently a Basidiomycete was isolated from all the decayed specimens.

3. Basal stem decay

Occurrence: Basal stem decay of *A. mangium* in a mixed planting with *A. auriculiformis* was observed at Khadalgobra; the latter species remain unaffected.

Symptoms: The affected tree had prominent decayed area near the ground level without any bark; roots remain unaffected. On exposing, it was found that the sapwood had become very soft and spongy with black and white mycelial growth. The crown showed die-back of shoots and thinning of crown.

Causal organism: Basidiomycete; spongy rot/white rot

5.3.6 Root decay

Occurrence: Root decay was observed at Khadalgobra mixed planting (1987) where out of 1200 trees only 200 were remaining. The area was subjected to water logging during July-December, hence the plants had been raised on mounds.

Symptoms: The affected trees had extensive die-back of shoots, especially in the upper crown, bushy growth of epicormic shoots appearing due to death of main leading shoot. The shoots also died as *drying* up of the main stem gradually advanced downwards. Roots of such trees were dying and showed typical decay symptoms. Feeder roots were decayed and turned greyish black and even some of the primary and secondary roots had greyish-black decay leading to the base of the stem.

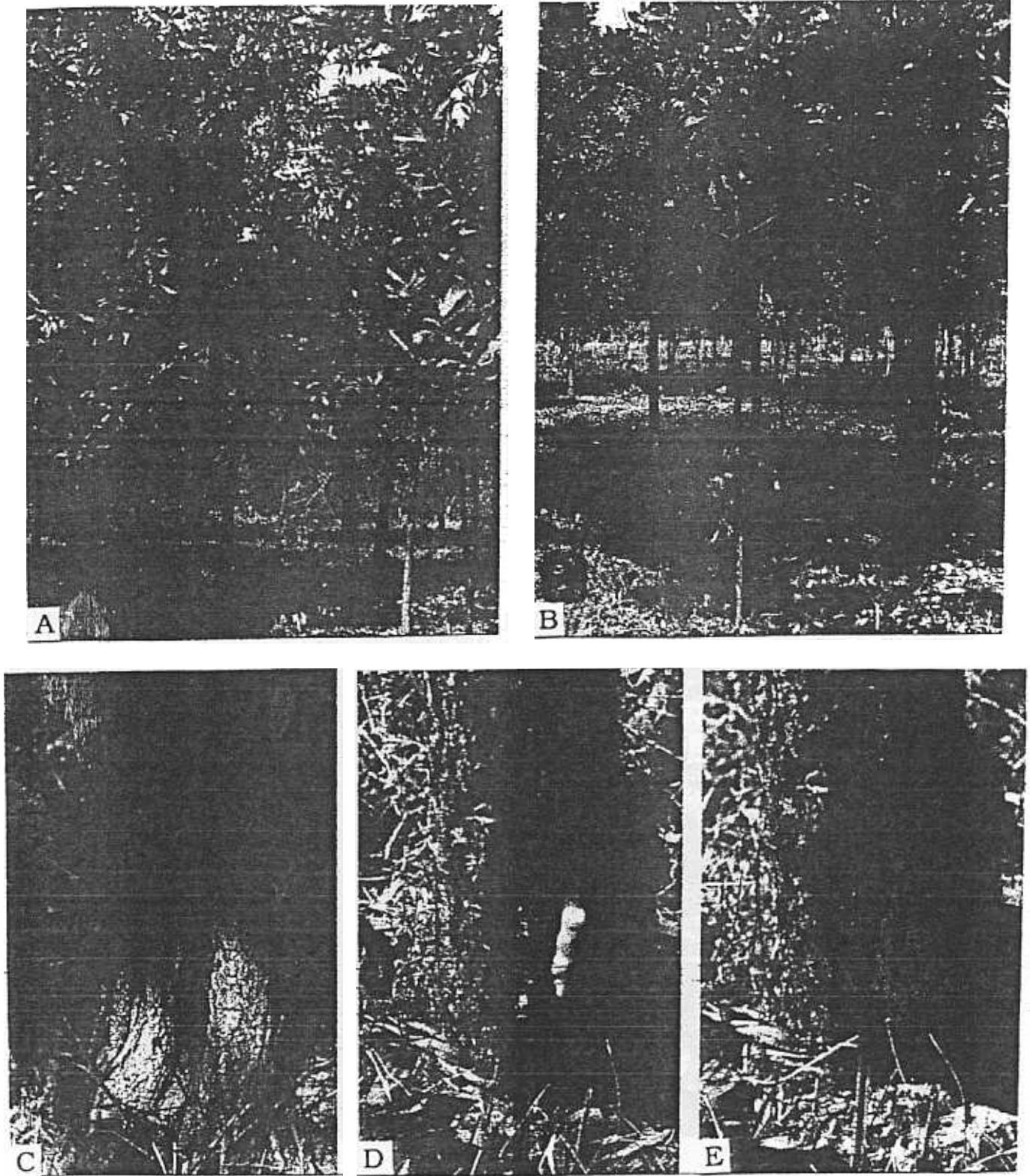


Fig. 21: Stem decay of *Acacia mangium* caused by *Gliocladium* sp. A, B, Death of isolated trees; C, Infected basal part of stem; D, Oozing of froth from the bottom; E, The area exposed to show the extent of decay.

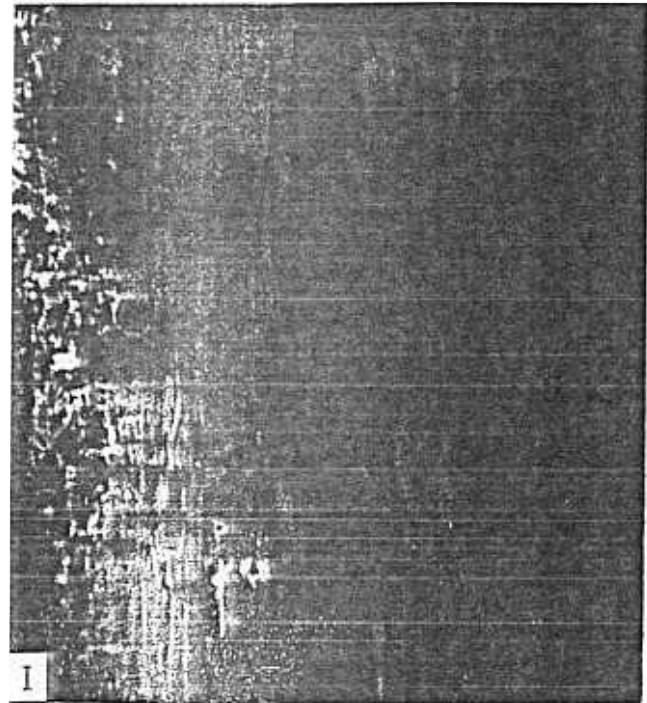
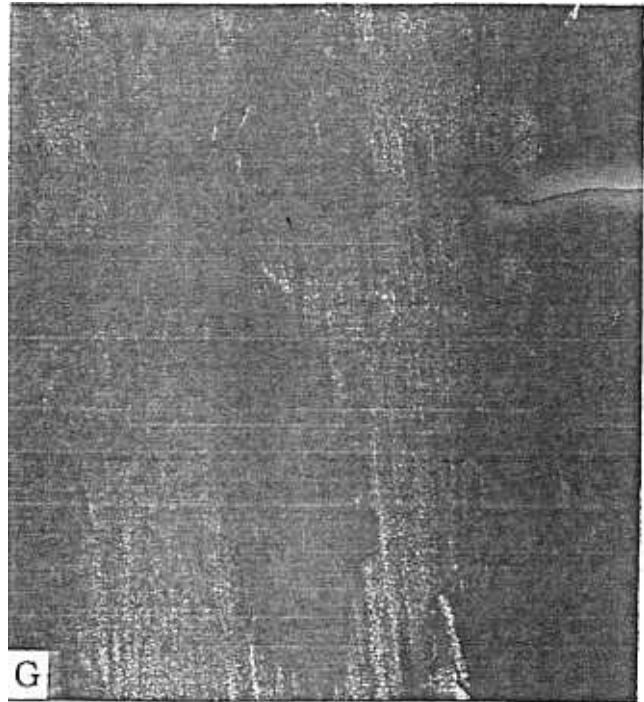
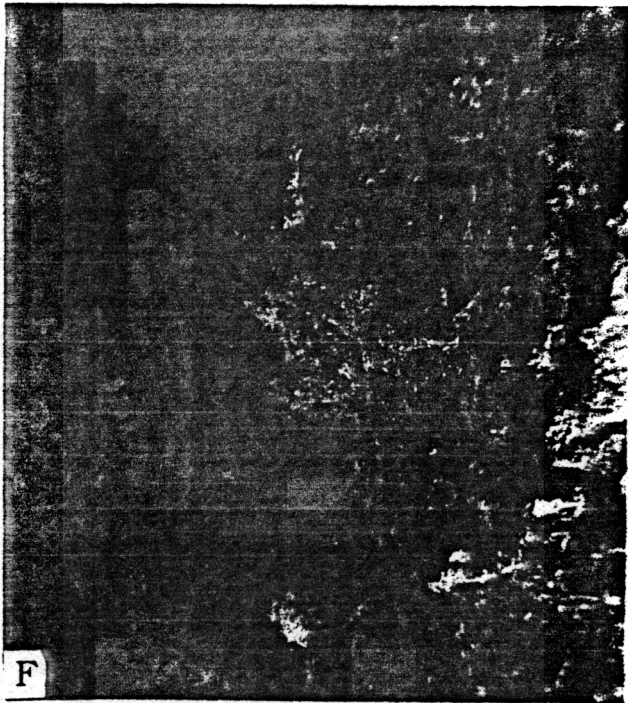


Fig. 22: Stem decay of *Acacia mangium* caused by *Gliocladium* sp. F, Stem affected with *Xyleborus* beetles. Note fresh mass of powder over the borer holes; G, The same area exposed to show decay in the stem and infection associated with borer holes; H, I, The affected stem exposed to show the extent of decay.

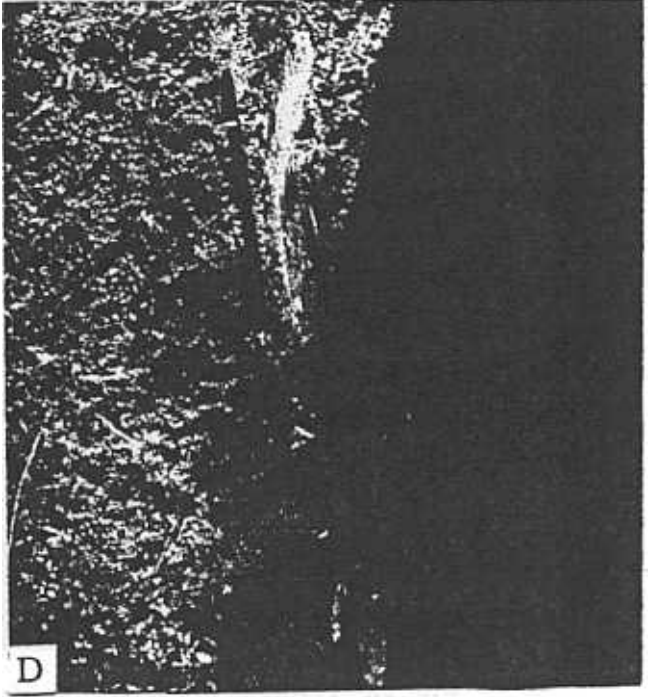
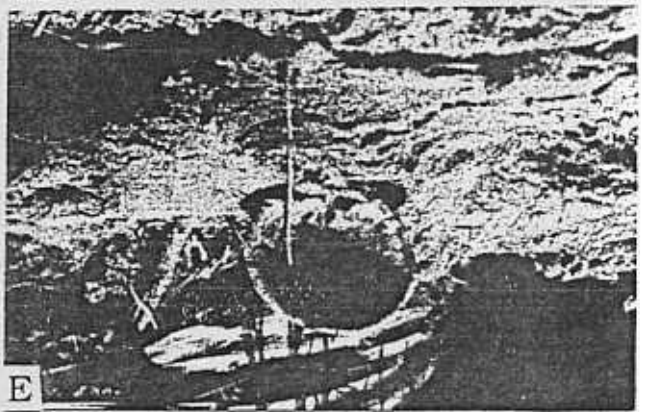
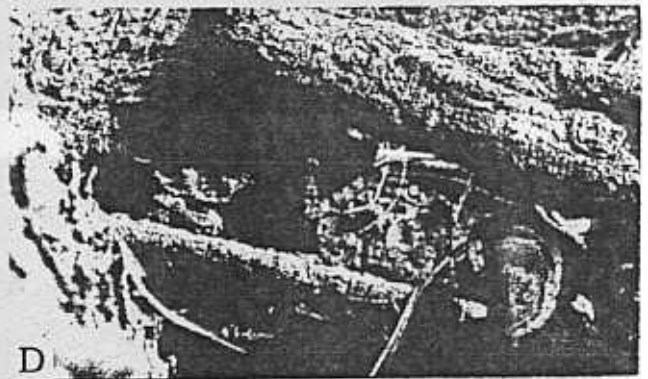
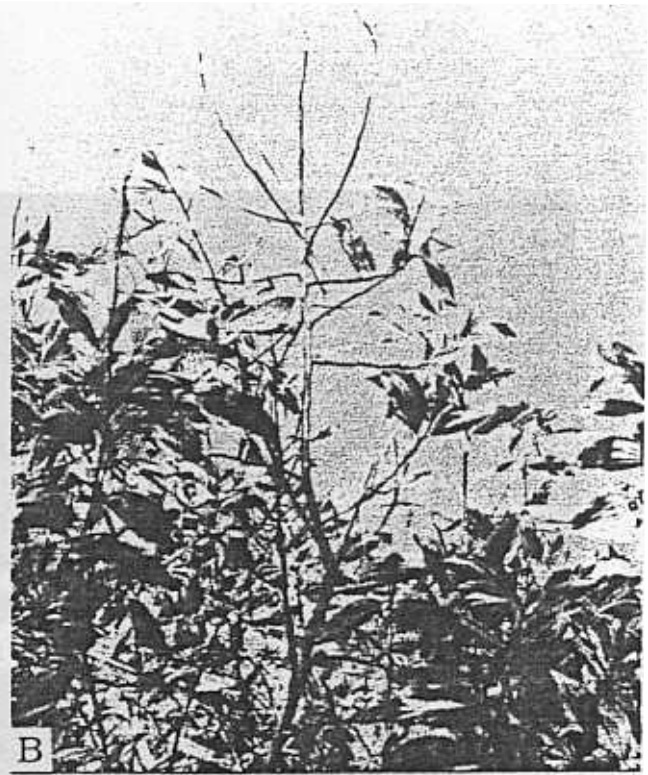
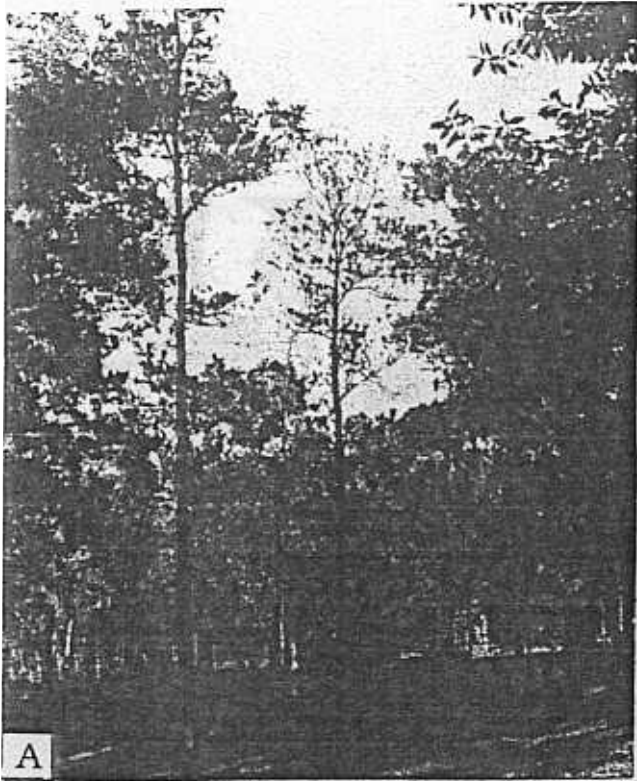


Fig. 23: Diseases of *Acacia mangium*. A, B, Stem decay associated with branch stubs; C, Extensive die-back of shoots; D, Decayed root system.



24: *Ganoderma* root rot of *Acacia mangium*. A, Affected plantation at Sapodiha (WB). Note thinning of crown; E shoots and yellowing of phyllodes in the upper crown trees; C, Root system exposed to show infected roots; D, E, Fruiting bodies of *Ganoderma lucidum* at the base of affected

trees in a
Die-back of
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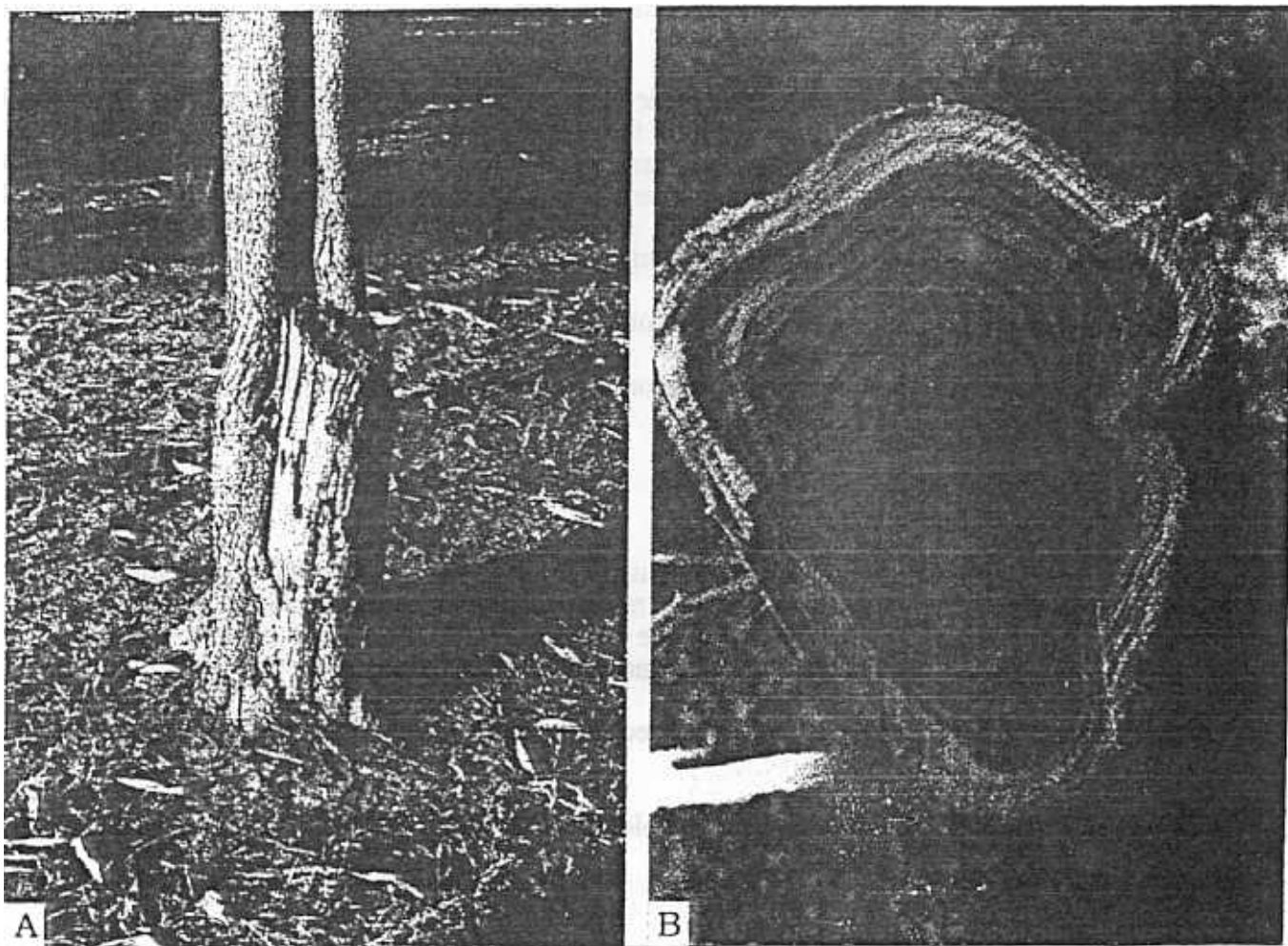


Fig Heart the *Acacia mangium* Decayed branch stub B Heart

Etiology: Possibly, water logging predisposed the decay initially in the feeder roots which later spread to other roots and stem.

Causal organism: Basidiomycete.

5.3.7. Root rot

Occurrence: The most serious disease of *A. mangium* was recorded generally in older plantations of *A. mangium* which had been converted into seed stands after removing inferior trees during 1993. These areas were Guchisola (1987), Sapodiha (1985) Kusumadhari (1985, 1986) and Manjigarh (1989) in West Bengal. The mortality due to root rot was minimum at Guchisola (<10 percent) and maximum at Kusumadhari (1985) where out of 238 trees counted during 1994 ca. 75 percent of them were already dead and removed at the time of survey. At Kusumadhari (1986) there were sixteen freshly dying or dead and standing trees. At Sapodiha, of the 77 standing trees 15 trees were apparently affected with root rot while at Manjigarh the mortality was also high as most of the trees in 1.5 ha seed stand showed symptoms of root rot. The disease was also recorded in 2-years old tree in the premises of factory at Angamaly, Kerala.

Symptoms: Typical symptoms of root rot were yellowing of phyllodes, premature defoliation and death of branches initially only in the upper crown and later throughout followed by epicormic shoots on dying mainstem of trees in patches. The affected trees showing different stages of symptoms were felled and studied for disease etiology. The stem remained unaffected and only the roots found affected with extensive browning. Fructifications of the causal organism were observed at the base of stem of living trees.

Causal organism: *Ganoderma lucidum* complex.

From the affected roots pure cultures of Basidiomycetous fungus were obtained; the cultures resembled *Ganoderma* cultures.

5.3.8. Heart rot

Occurrence: Heart rot was detected at Kusumadhari (1986) in West Bengal. Incidence of the disease could not be ascertained as it was not possible to cut trees in a seed stand. Considering the fact that the stubs of branches near the ground cut during 1993 to convert the plantation to seed stand were all decayed, possibly the incidence of heart rot will be very high.

Symptoms: In felled trees, rot was observed in the heart wood. The heart rot area was pale with dark zonation lines.

Etiology: The dead stubs decayed and colonised by wood rotting fungi possibly provided the entry points for decay fungus.

Causal organism: Basidiomycete.

Isolations from the infected heartwood yielded consistently a Basidiomycete with mycelium having clamp connections.

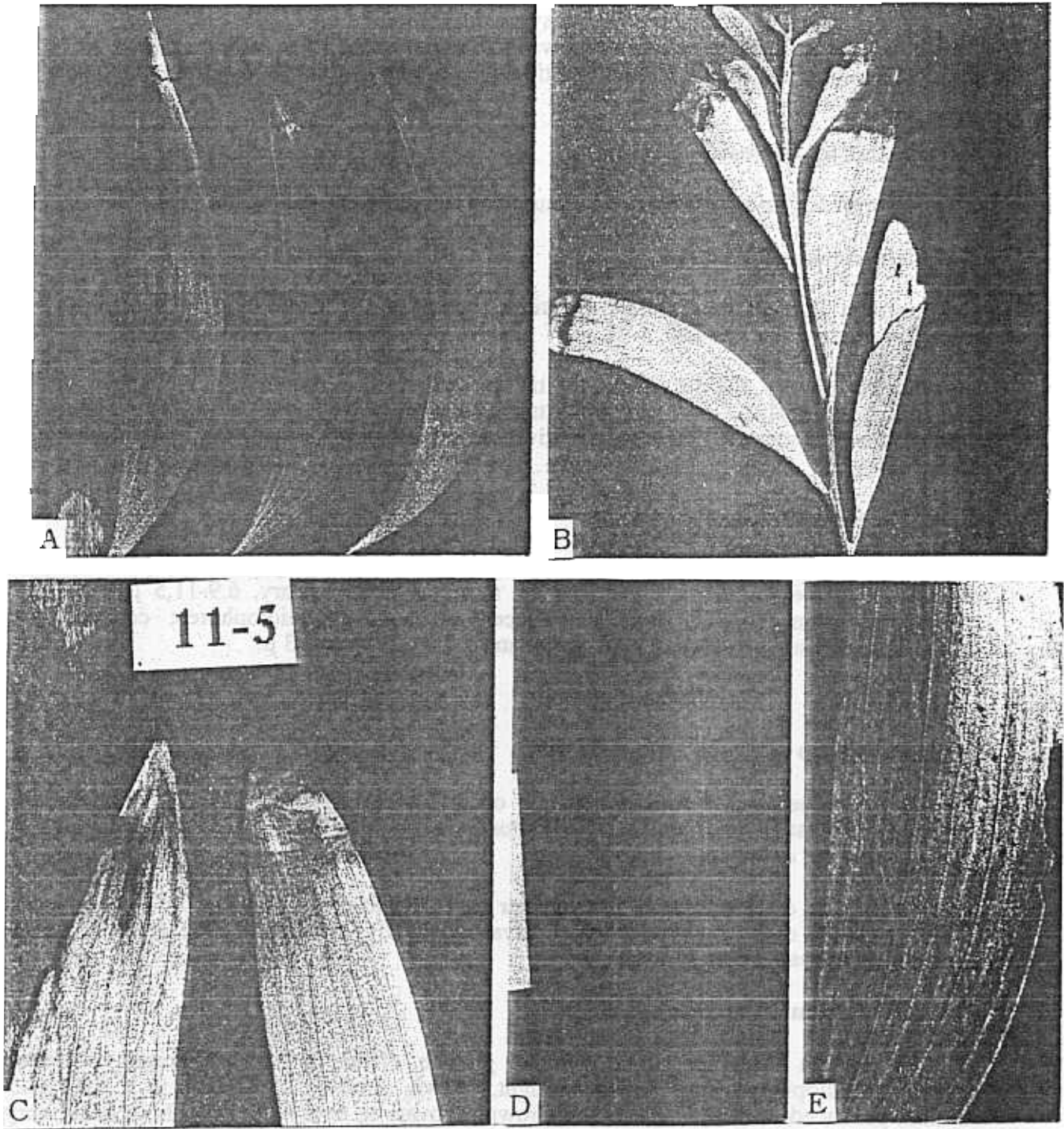


Fig. 26: Diseases of *Acacia auriculiformis*. A, *Colletotrichum* foliar tip necrosis; B, C, *Alternaria* foliar tip necrosis; D, Unidentified foliar spot; E, Unidentified foliar spot.

5.4. Diseases of *Acacia auriculiformis*

There were seven distinct disease symptoms recorded on *A. auriculiformis* with which 35 fungal organisms and one phytoplasma was found associated (Figs. 26-36). Based on symptoms there were numerous foliar diseases identifiable caused by similar or different pathogens.

5.4.1. Foliar tip necrosis

Necrosis of tip of phyllodes was caused by two different pathogens.

1. *Colletotrichum* tip necrosis

Occurrence: Though the disease was quite common in a roadside block plantation in Neyveli township, its severity was low.

Symptoms: Initially, the necrosis at the tip was brownish in colour which changed to greyish. The infection, localised at the tip of mature phyllodes, appeared as dull greyish necrotic area with dark brown margin. The necrosis advanced further down leaving behind the previous dark brown margin.

Causal organism: *Colletotrichum* sp.

Colony on PDA greyish brown, appressed, reverse dark greyish-black; sclerotia spherical to variable shapes, numerous, dark brown, terminal to intercalary, 6.9-11.5 μ x 4.6-6.9 μ ; conidiomata nonacervular, conidia produced on simple conidiophores; conidia straight, cylindrical, oblong, hyaline, aseptate, guttulate, 5.75-12.65 μ x 2.3 μ .

2. *Alternaria* tip necrosis

Occurrence: The disease was of common Occurrence in species trials (1995) at Dejuri and Dharampur (West Bengal) and Auroville (Pondicherry). It did not cause much damage to the phyllodes except at the tip.

Symptoms: The disease affected the younger phyllodes near the growing shoot. The infection at the tip caused dark tan necrosis which advanced slowly downwards. The growing margin of the necrosis appeared dark brown.

Causal organism: *Alternaria* sp.

Colony on PDA light olive green to greyish, effuse to floccose, round, restricted in growth; conidiophores light brown, straight, brown, septate, 29.9-116.4 μ x 4.03-11.5 μ ; conidia, produced in chains, olivaceous brown, obovate to oval with or without beak, varying sizes of beak; short beak conidia, transverse septa 1-8, longitudinal septa 1-2, 29.9-57.5 μ x 4.6-11.5 μ ; long beak conidia with 3-4 transverse and 1-2 longitudinal septa, 80.3-151.8 μ x 3.2-11.5 μ .

5.4.2. Foliar spots

Based on the morphology of the spots and causal organisms a total of thirty foliar spot diseases were identified in *A. auriculiformis*. These diseases are arranged considering the size of spots and the damage they cause to phyllodes.

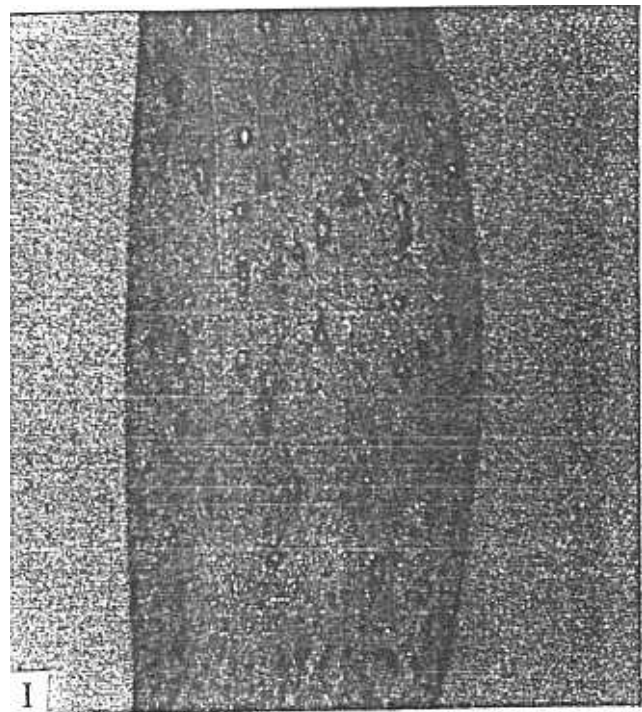
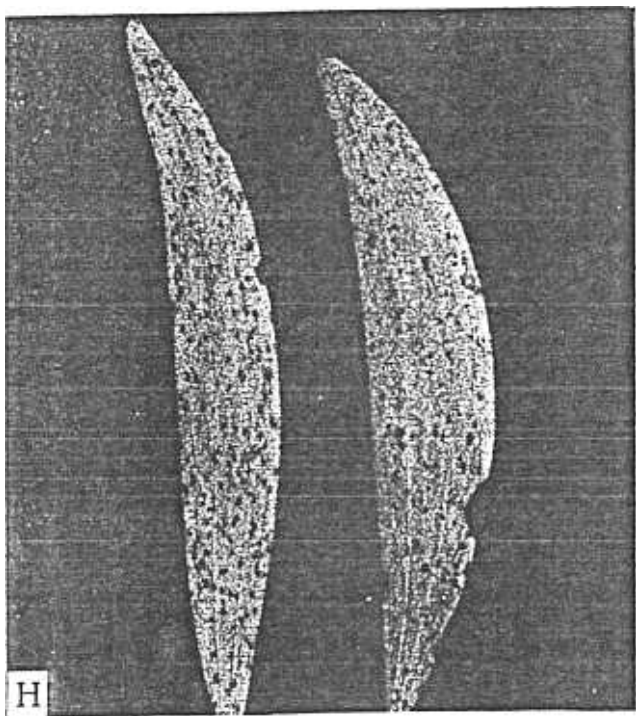
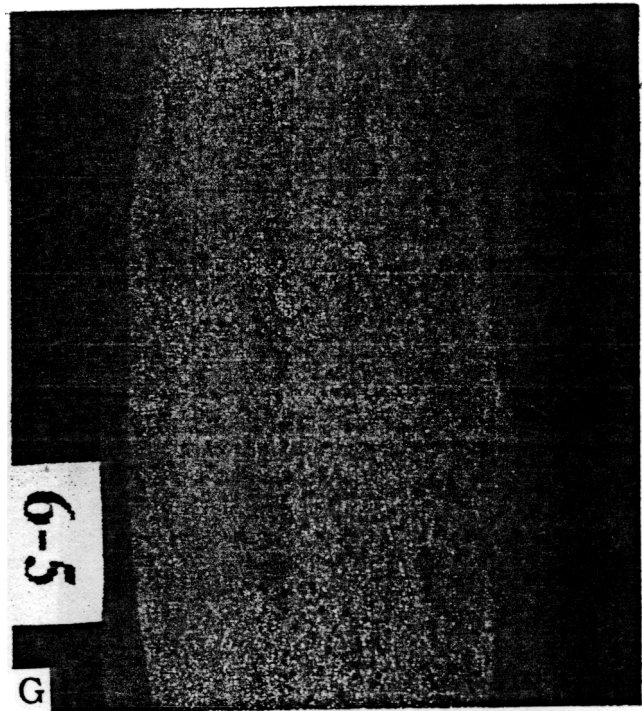
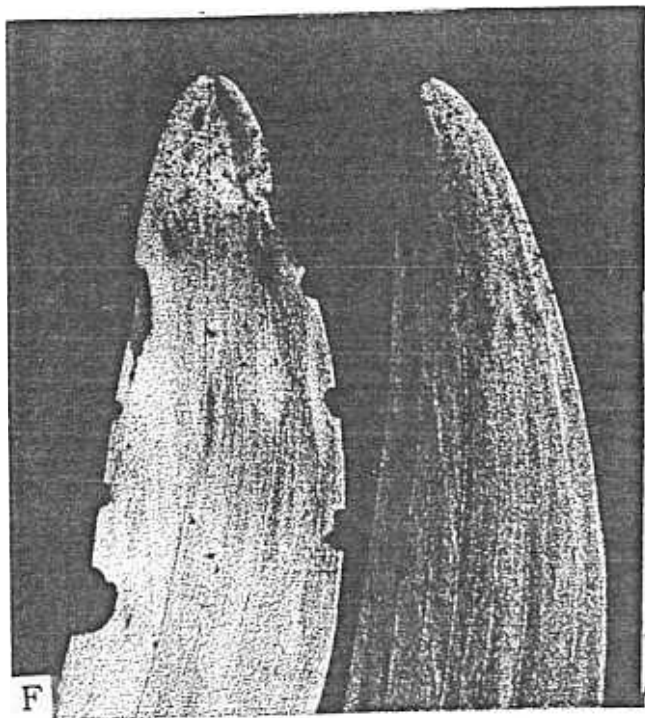
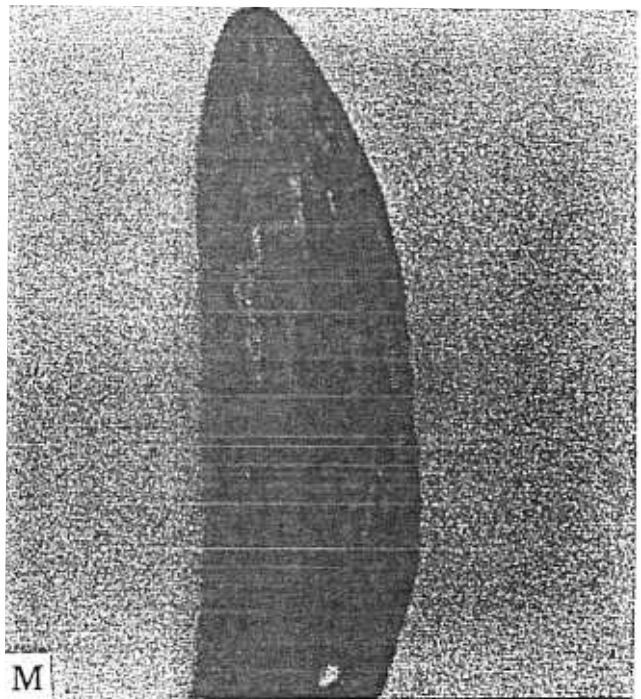
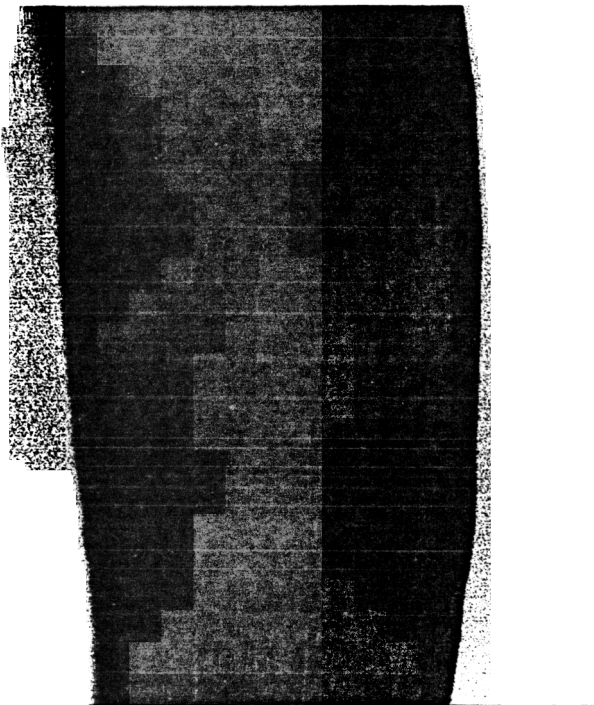
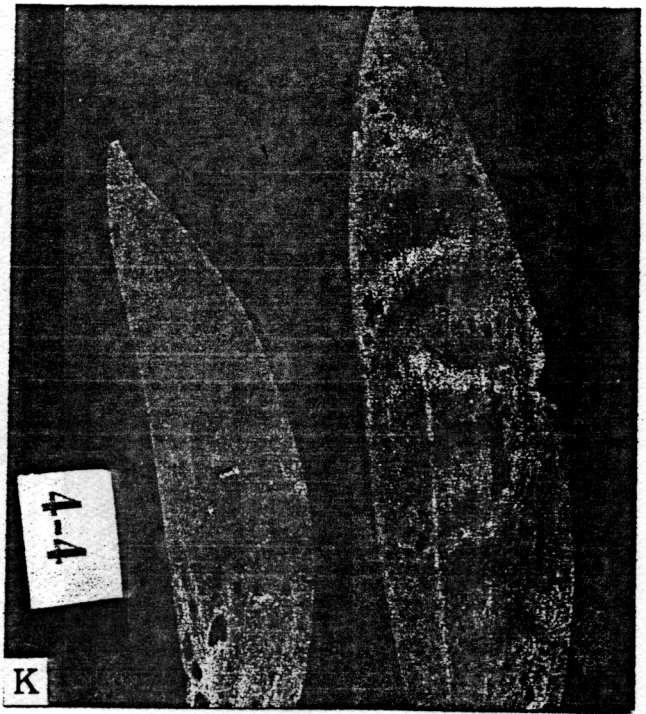
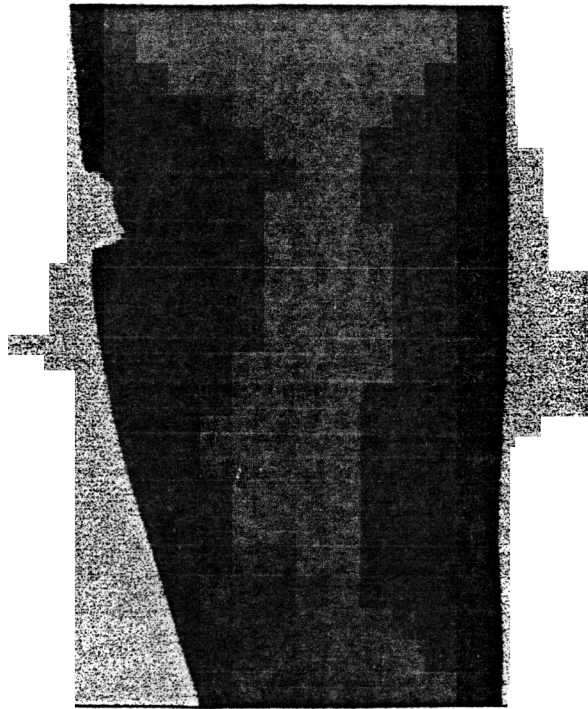


Fig. 27: Diseases of *Acacia auriculiformis*. F, Unidentified foliar spot; G, *Alternaria* foliar spot; H, *Colletotrichum* foliar spot; I, *Glomerella* foliar spot.



diseases *Phoma auriformis*. J, I identified foliar spot;
Phomopsis leaf spot; L, Pestalotiopsis leaf spot; M, Phoma
leaf spot.

1. Unidentified (1-4) foliar spot

Occurrence: The disease was recorded during September/October in 1-year-old experimental plantation at Ramavarmapuram, Trichur (Kerala). The incidence and severity of the infection were low.

Symptoms: The spots, light greyish with black margin and spherical to irregular in shape, were very minute (<1 mm) and found only on the upper surface.

Causal organism: Unidentified; non-sporulating.

2. Unidentified (5-2) Foliar spot

Occurrence: The disease was recorded on young as well as mature phyllodes in a spacement trial at Neyveli (Tamil Nadu). The incidence and severity were very low.

Table 11. Diseases of *A. auriculiformis* recorded in India

Disease	Causal organism	Locality	Disease status	
			Incidence	Severity
1. Foliar tip necrosis	i. <i>Colletotrichum sp.</i>	Neyveli,	C	L
	ii. <i>Altemaria sp.</i>	Dejuri, Auroville	C	L
2. Foliar spots	I. Unidentified(i)	RV Puram	R	L
	ii. Unidentified(ii)	Neyveli	O	L
	iii. Unidentified(iii)	"	R	L
	iv. <i>Altemaria sp.</i>	"	O	L
	v. <i>Colletotrichum sp.</i>	Hosekote, Mettupalayam, Jarakbande		
	vi. <i>Glomerella sp.</i>	Auroville	C	M
	vii. Unidentified	RV Puram	C	M
	viii. <i>Phomopsis sp.</i>	Mettupalayam	O	L
	ix. <i>Pestalotiopsis sp.</i>	RV Puram	O	L
	x. <i>Phoma sp.</i>	RV Puram	O	L
	xi. <i>Macrophomina sp.</i>	Auroville	O	L
	xii. Unidentified	Auroville	R	L
	xiii. Unidentified	Neyveli	O	L
	xiv. <i>Glomerella sp.</i>	"	C	M
	xv. <i>Altemaria sp.</i>	Dejuri	O	L
	xvi. <i>Phomopsis sp.</i>	Jarakbande	C	M
	xvii. Unidentified	Auroville	C	M
	xviii. <i>Colletotrichum sp.</i>	Mettupalayam, Auroville, RV puram	C	M
	xix. <i>Cylindrocladium scoparium</i>	RV puram	VC	M
	xx. Sooty mould Unidentified	Beede, Hosekote RV puram	VC	M
3. Powdery mildew	<i>Oidium sp.</i>	Thyranadur, Beede	VC	S
4. Shoot blight	Unidentified	RV puram	VC	S
5. Pod rot	<i>Fusicoccum sp.</i>	Neyveli	VC	M
6. Die-back	<i>Hendersonula sp.</i>	Jarakbande	C	S
7. Pink disease	<i>Corticium salmonicolor</i>	Trichur	C	M
8. Root rot	<i>Ganoderma</i>	RV puram, Trichur	O	L
			O	L
9. Witches broom	Phytoplasma	Calicut, Dejuri Beede	O	L

*WS, Widespread; VC, Very common; C, Common; O, Occasional; R, Rare
 **S, Severe; M, Medium; L, Low.

Symptoms: Dark greyish black, minute spots (<1 mm) were present on both the surfaces of phyllode. As the spots were not deep seated they were not visible on the under surface.

Causal organism: Unidentified, Sphaeropsidales/Ascomycete.

Colony on PDA dark greyish, velvety, restricted growth, reverse dark; mycelium, dark brown, septate; immersed; conidiomata pycnidial, ostiolate, astiole lined with thin walled large cells, hyaline, spherical, dark brown, long, finger like lobed, branched, convoluted; conidia hyaline, straight to slightly curved, oblong to reniform, eguttulate, non-septate, rarely 2-3 celled

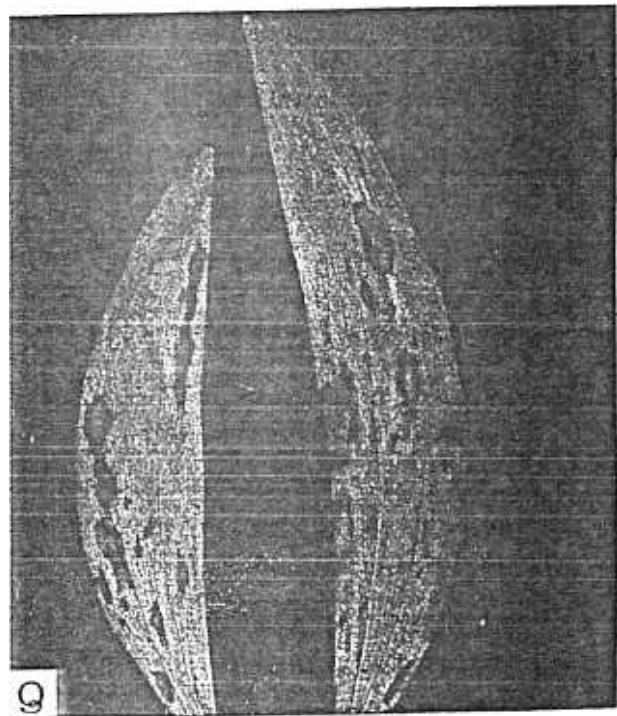
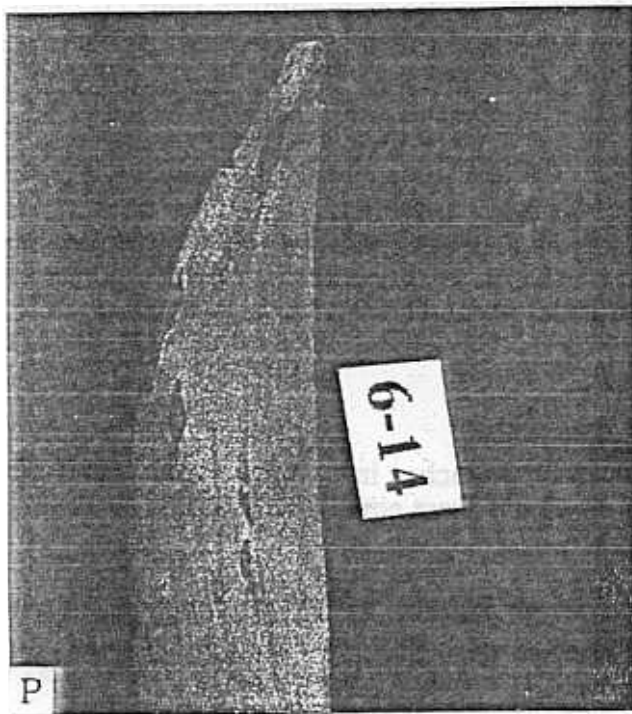
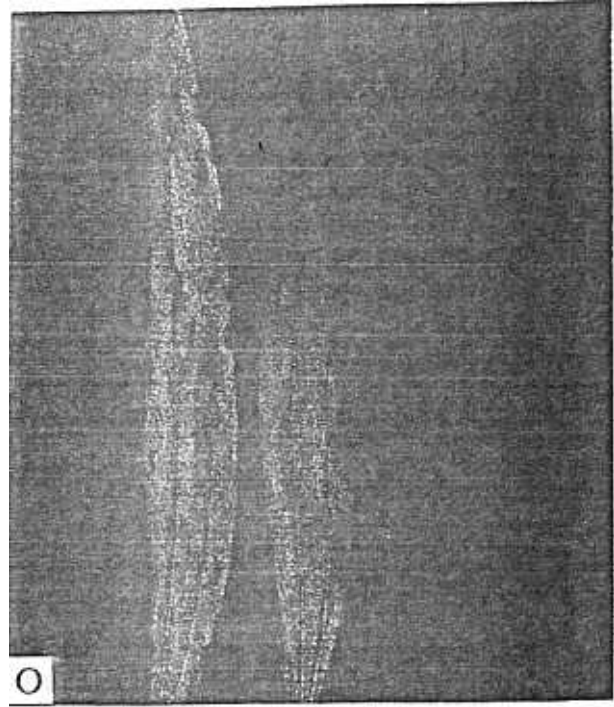
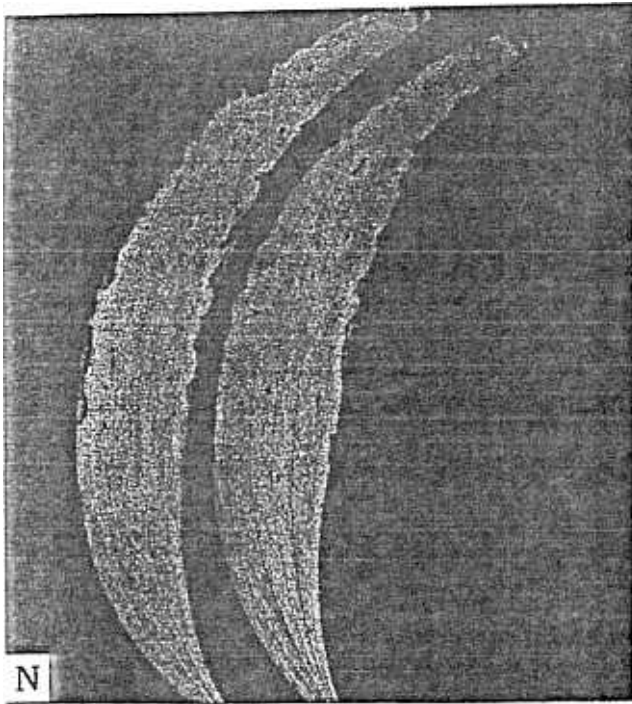


Fig. 29: Foliar diseases of *Acacia auriculiformis*. N., *Macrophomina* foliar spot; O, Unidentified foliar spot; P, Unidentified foliar spot; Q, *Glomerella* foliar spot.

(unequal cells), 16.1-23 μ x 4.6-6.3 μ ; conidia rarely with appendage like structure, possibly persistent conidiophores, hyaline, 9.2-54.5 μ long; same culture occasionally had ascocarps with asci; asci hyaline, elongated, thick walled at the tip, inoperculate, 80.5-115 μ x 6.9-9.2 μ , ascospores spherical to oval, hyaline, thick walled, possibly 8 per ascus.

3. Unidentified (5-3) foliar spot

Occurrence: This disease, found in Neyveli (Tamil Nadu), was recorded on young phyllodes of only a few trees.

Symptoms: Numerous dark coloured spots, < 1mm across, were localised at the tip of phyllode. Initially, the spot appeared only on the upper surface and only later the lower surface developed the spots.

Causal organism: Unidentified; non-sporulating Hyphomycete.

Colony on PDA dark greyish black, floccose; mycelium dark brown.

4. *Alternaria* foliar spot

Occurrence: The disease was recorded in an afforestation trial in a degraded rocky area at Auroville (Pondichery). The incidence and severity of this foliar spot were low.

Symptoms: The disease was characterised by small angular dark purplish spots (1-2 mm across) more on the upper surface of phyllodes. Only when some of the spots coalesced the spots could be seen on the lower surface.

Causal organism: *Alternaria* sp.

Colony on PDA dark, floccose, reverse dark; mycelium, dark brown, septate, highly branched; conidiomata spherical, ostiolate, beaked, sterile perithecia like structures observed, 179.2-280 μ ; conidia light brown produced on chains on simple dark brown conidiophores with short beak and 3-4 transverse and 1-2 longitudinal septa, 18-36 μ x 7.2-10.8 μ .

5. *Colletotrichum* foliar spot

Occurrence: The disease was common on lower branches in a species trial (1989) at Nallal, Hosekote (Karnataka). Young and mature phyllodes were equally affected. The incidence and severity of the disease were rated as medium.

Symptoms: Initially, the spots, dark brown in colour, were 1 mm across. These spots developed an elongated light greyish white area and appeared typical elliptical or spindle shaped. There were more spots on the upper surface than the lower. Most of the spots were of uniform size.

Causal organisms: *Colletotrichum* sp.

Colony on PDA light brown, effuse, reverse brownish; acervuli absent; conidia born on short conidiophores directly on the mycelium; sclerotia present, dark brown 12.5 x 6.9 μ ; conidia hyaline, elongate, cylindrical, oblong to narrowly oval, aseptate, guttulate, 9.2-13.8 μ x 2.3-3.45 μ .

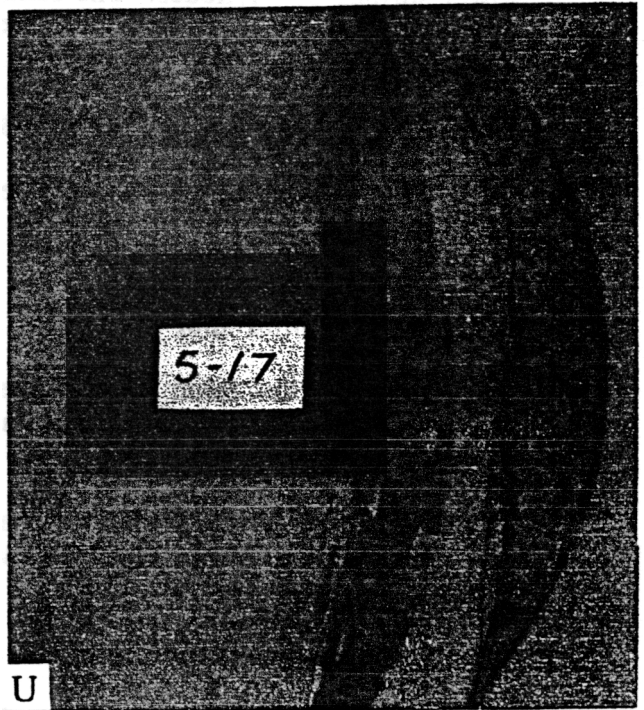
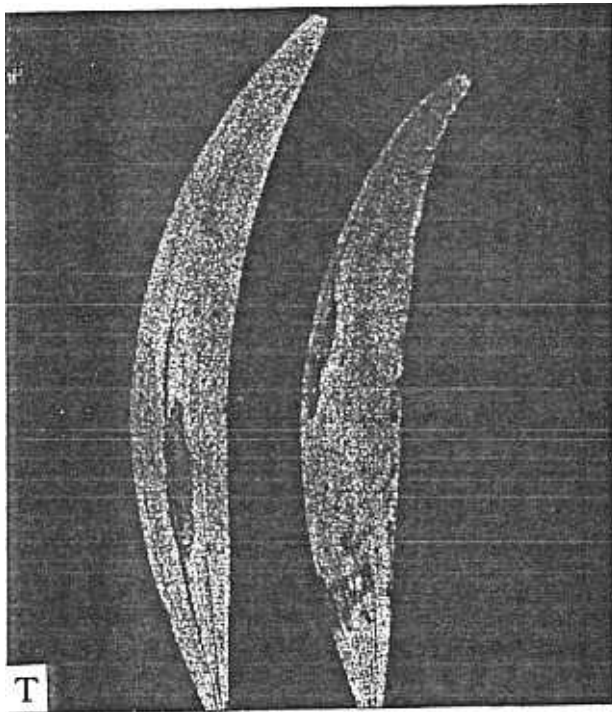
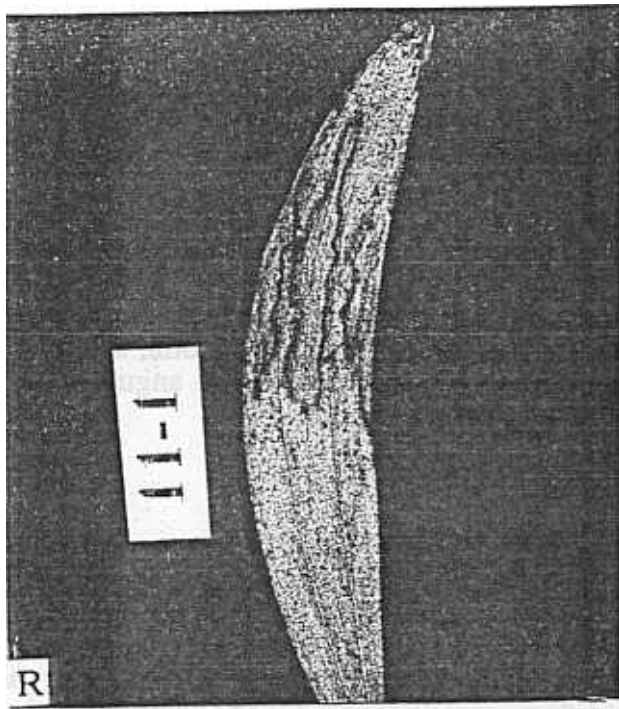


Fig. 30: Foliar diseases of *Acacia auriculiformis*. R, *Alternaria* foliar spot; S, *Phomopsis* foliar spot; T, Unidentified foliar spot; U, *Colletotrichum* foliar spot.

6. *Glomerella foliar spot*

Occurrence: The disease was recorded in an afforestation trial plot in a rocky degraded site in Auroville (Pondicherry). Though the disease was common, severe infection occurred only in a few trees; young and mature phyllodes were equally susceptible.

Symptoms: The disease was characterised by amphigenous, dark brownish black, oval to spindle shaped spots with silvery grey to light brownish grey centres. The adjacent spots coalesced to form larger spots.

Causal organism: *Glomerella* sp.

Colony on PDA initially dark brown turning greyish brown, lighter in the centre; reverse hyaline turns greyish black due to development of perithecia and sclerotia; sclerotia abundant, terminal to intercalary; perithecia, spherical, dark brown, wall textura angularis; conidiomata nonacervular, conidia borne directly on simple, short conidiophores.

7. Unidentified (1-9) foliar spot

Occurrence: The disease, recorded in a plantation at Ramavarmapuram, Trichur (Kerala), was observed only on mature phyllodes. The incidence and severity of the disease were low.

Symptoms: Initially, the spots appeared as black blotches, 2-3 mm across on either the upper or lower surface of phyllodes. The centre of these spots became silvery white with characteristic thread like growth radiating from the margin. Underneath the spots the tissue showed light greying in the centre with surrounding light brown tissue.

Causal organism: Unidentified; non-sporulating,

Colony on PDA white, floccose with greyish brown sectoring, reverse white to pale; no conidiomata observed.

8. *Phomopsis foliar spot*

Occurrence: This foliar spot disease was observed in a species trial plot (1986-87) at Mettupalayam (Tamil Nadu). The incidence and severity of the disease were very low as it occurred only in a few trees.

Symptoms: The amphigenous spots appeared spherical to elliptical dark brown to tan with a pale hollow. Smaller spots (1-2 mm across) coalesced to form irregular larger spots, measuring 3-4 mm across.

Causal organism: *Phomopsis* sp.

Colony on PDA white, mycelium sparse, corded, reverse pale brown; conidiomata pycnidial, black, carbonaceous, convoluted; conidia of two types: a- conidia, elliptical to spindle shaped, hyaline aseptate, guttulate, $6.9-10.35 \mu \times 2.3 \mu$; B-conidia filiform, hyaline, eguttulate $25.3-39.1 \mu \times 1.15 \mu$.

9. *Pestalotiopsis foliar spot*

Occurrence: The disease was recorded in a plantation at Ramavarmapuram, Trichur (Kerala). The incidence and severity of the disease were low.

Symptoms: The disease, mostly occurring on the upper surface of mature phyllodes, was characterised by reddish brown spots, similar to pock marks with depressed centre. On the lower surface the spots appeared as dark brown slightly raised tissues. These spots coalesced to give rise larger necrotic spots, especially near the tip region.

Causal organism: *Pestalotiopsis* sp.

Colony on PDA white, cottony, spreading, reverse pale; conidiomata acervular, dark; sporulation scanty; conidia dark brown, elliptical, spindle shaped, 4-septate, middle 3 cells brown, centre cell darker than others, end cells hyaline, $20.7-23 \mu \times 6.9 \mu$, apical cell conical with two filiform, spatulate occasionally branched, $13.8-25.3 \mu$ long appendage, basal cell truncate with a basal appendage $4.6-6.9 \mu$.

10. Phoma foliar spot

Occurrence: This spot disease was recorded in 1-year-old experimental plantation at Ramavarmapuram, Trichur (Kerala). Since the disease was observed only on a few trees, it had low incidence and severity.

Symptoms: The disease observed on the upper surface of young as well as moderately mature phyllodes in the middle crown of the tree, was characterised by elongated streak like silky white lesions upto 5-8 mm in length. Some of the lesions coalesced to give rise irregular shaped lesions. In severe cases the lesions also developed on the lower surface. Black dot like pycnidia were observed in the lesions.

Causal organism: *Phoma* sp.

Colony on PDA light brown, mycelium immersed, scanty; conidiomata pycnidial, thin walled, spherical, ostiolate; conidia, small, circular to oval, minute, light pale in colour.

11. Macrophomina foliar spot

Occurrence: The disease was recorded in a roadside block planting at Auroville (Pondicherry). The incidence and severity of the disease were low.

Symptoms: Dark brown to purplish brown amphigenous spots were produced on young as well as mature phyllodes. The spots, oval to elliptical to spindle shaped, 2-3 mm in length, were localised mostly at the margin; only a few spots developed on the lamina. When the spots joined, long irregular shaped lesions were produced.

Causal organism: *Macrophomina* sp.

Colony on PDA, effuse, dark greyish black; reverse dark, slow growing; mycelium branched, septate, dark brown, conidiomata pycnidial, eustromatic, separate or clustered, with thick dark brown wall, textura angularis, pseudo-sclerenchymatous, superficial in culture, scattered; conidia hyaline, aseptate, oval, guttulate with rounded ends, $11.5-13.8 \mu \times 4.02-4.6 \mu$.

12. Unidentified (5-16) foliar spot

Occurrence: Low incidence of this disease was recorded only in a few branches of 1-2 trees in Auroville.

Symptoms: The typical symptoms of the disease were dark brown spots, usually over the veins having distinct brown colour on the underside of the phyllode.

Causal organism: Unidentified; non-sporulating Hyphomycete .

13. unidentified (5-6) foliar spot

Occurrence: This disease was recorded in an espacement trial at Neyveli (Tamil Nadu) and roadside block plantation at Auroville (Pondicherry). The incidence and severity of the disease were very low.

Symptoms: The phyllodes had reddish brown elongated amhigeneous lesions, upto 1 cm long and 2-3 cm wide having irregular dark brown margins. Each phyllode had only a few spots (3-8 no.) due to their large size. Occasionally, these spots coalesced, especially near the tip or margins to form larger spots; sometimes fructifications were also observed over the lesions.

Causal organism: Unidentified.

14. *Glomerella* foliar spot

Occurrence: The spot disease, observed in a species trial plot at Jarakbande. Bangalore (Karnataka), had common occurrence and medium severity.

Symptoms: The typical symptoms of the disease were dark brown, irregular. large amphigenous spots with light greyish brown centre. The tissues around each spot were light yellowish. Such spots occurred mostly on mature phyllodes on the lower branches. Severely infected phyllodes defoliated prematurely.

Causal organism: *Glomerella* sp.

Colony on PDA white turning greyish, floccose, reverse light to dark grey; sclerotia abundant, light to dark brown thick walled, mostly terminal, occasionally intercalary, oval, spherical to clavate to irregular shaped 11.5-16.1 μ x 4.5-11.5 μ ; perithecia abundant, light to dark brown. spherical, 86.7-162.9 μ in dia.; conidiomata non-acervular. conidia borne on simple, short conidiophores; conidia, oblong, hyaline aseptate, guttulate, upper end obtuse, lower slightly pointed, 9.2-16.1 μ x 2.3-4.6 μ .

15. *Alternaria* foliar spot

Occurrence: This disease was recorded only at Dejuri (West Bengal) in a species trial (1995). The incidence and severity of the disease were low.

Symptoms: The spots were elongated interveinal brown coloured blotches with diffused margins. These coalesced to develop into large necrotic area which resulted in premature defoliation.

Causal organism: *Alternaria* sp.

Colony on PDA dark grey to olivaceous grey, floccose, reverse dark; conidia, borne terminally in chains, at times on geniculations at the side of conidiophores, septate, simple or branched, 115-159.5 μ x 4.6 μ conidia pale brown to dark brown, highly variable in shape, oval obclavate; shorter conidia, either in chains or singly, thick walled, smooth, vertical septa 0-3, oblique 0-1, constricted at the septum 9.2-22.6 μ x 6.9-11.5 μ longer conidia with long beak, transverse septa 1-18, 69.0-124.2 μ x 4.6-9.2 μ .

16. *Phomopsis foliar spot*

Occurrence: The disease was recorded on lower branches only at Jarakbande, Bangalore (Karnataka) in roadside trees of the research station. The incidence and severity were medium.

Symptoms: Initially dull light brown to light greyish brown amphigeneous spots, oval, ovate, upto 1 cm long with dark brown margin developed near the tip of phyllode. The necrotic spot enlarged and covered the tip causing necrosis of the tip as well covered upto half of the phyllode. Fructifications were found over the necrotic spots. Severely infected phyllodes defoliated prematurely.

Causal organism: *Phomopsis sp.*

Colony on PDA white turning dull light brown. appressed, reverse brownish; conidiomata pycnidial, scattered, dark, multilocular, convoluted; only δ -conidia present, hyaline, spindle shaped with pointed ends, guttulate, $4.6-11.5 \mu \times 1.725-2.3 \mu$.

17. Unidentified (5-14,6-14) foliar spot

Occurrence: This foliar spot was recorded from the roadside block amenity planting at Auroville (Pondicherry). The disease was of common occurrence with medium severity.

Symptom: The disease affected mostly younger phyllodes which had initially 2-3 cm long, dark reddish brown coloured necrotic lesions running lengthwise, mostly over the veins. These lesions enlarged lengthwise and coalesced to form long lesions running from tip to bottom of phyllode, such lesions were found either at the margins or on the lamina. Fructifications of the causal organism were observed in the necrotic lesions.

Causal organism: Unidentified; non-sporulating Hyphomycete.

18. *Colletotrichum foliar spot*

Occurrence: This disease was recorded at Mettupalayam (Tamil Nadu) in a species trial (1986-87), Auroville (Pondicherry) in afforestation trial and Ramavarmapuram (Kerala) in a plantation. At Ramavarmapuram, it was widespread on young regenerated seedlings as well as lower branches.

Symptoms: Mostly the lesions were localised along the margins. Initially dark brown amphigeneous lesions. 1-3 mm long, developed along the margins. These lesions enlarged, more lengthwise and coalesced to form one long lesion running throughout the length of phyllode. The lesion were greyish on the upper surface and dark brown on the lower surface. Fructifications of the causal organism were observed over the lesions. Severely infected leaves defoliated prematurely.

Causal organism: *Colletotrichum sp.*

19. *Cylindrocadium foliar spot*

Occurrence: This foliar spot was recorded during October, just after the rains, in a plantation at Ramavarmapuram, Trichur (Kerala). It was of common Occurrence on naturally regenerated seedlings and lower branches of trees. Severity was high in seedlings.

Symptoms: The disease was characterised by large reddish brown necrotic areas, usually along the margins and tip. The affected phyllodes defoliated prematurely.

Causal organism: *Cylindrocadium scoparium.*

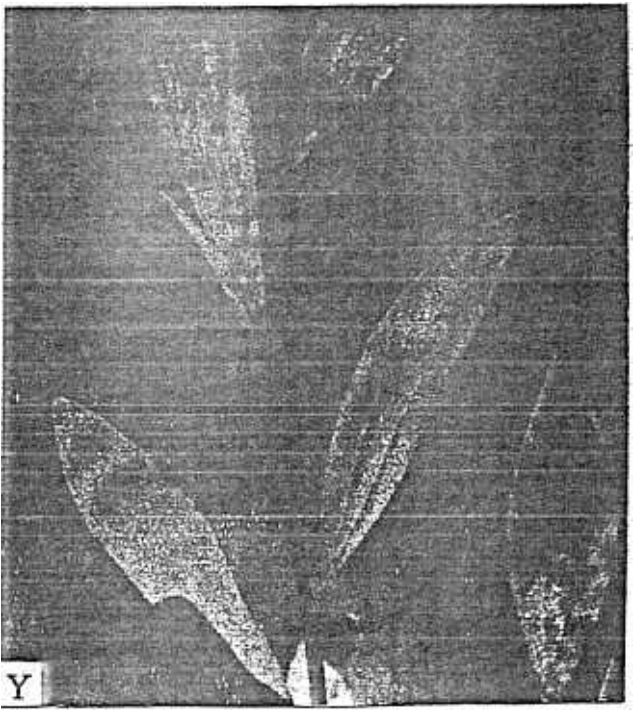
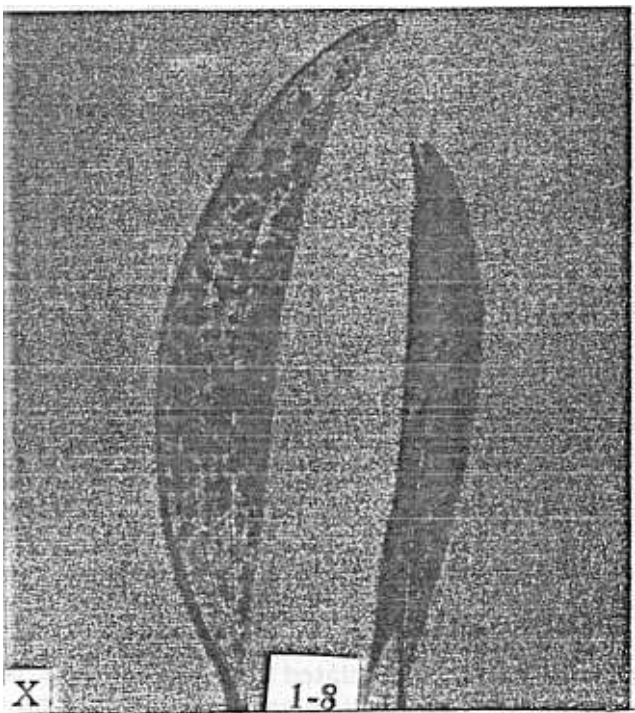
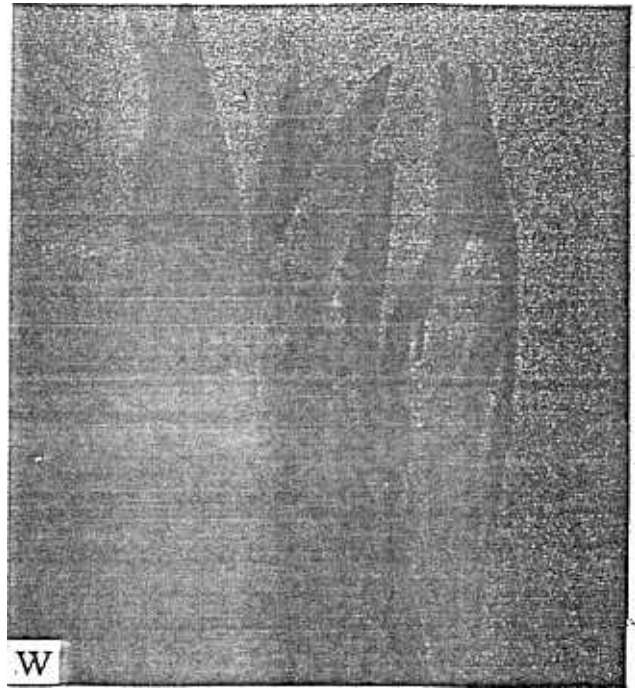


Fig. 31: Foliar diseases of *Acacia auriculiformis*. V,W, *Cylindrocladium* foliar spot; X, Sooty mould; Y, Powdery mildew.

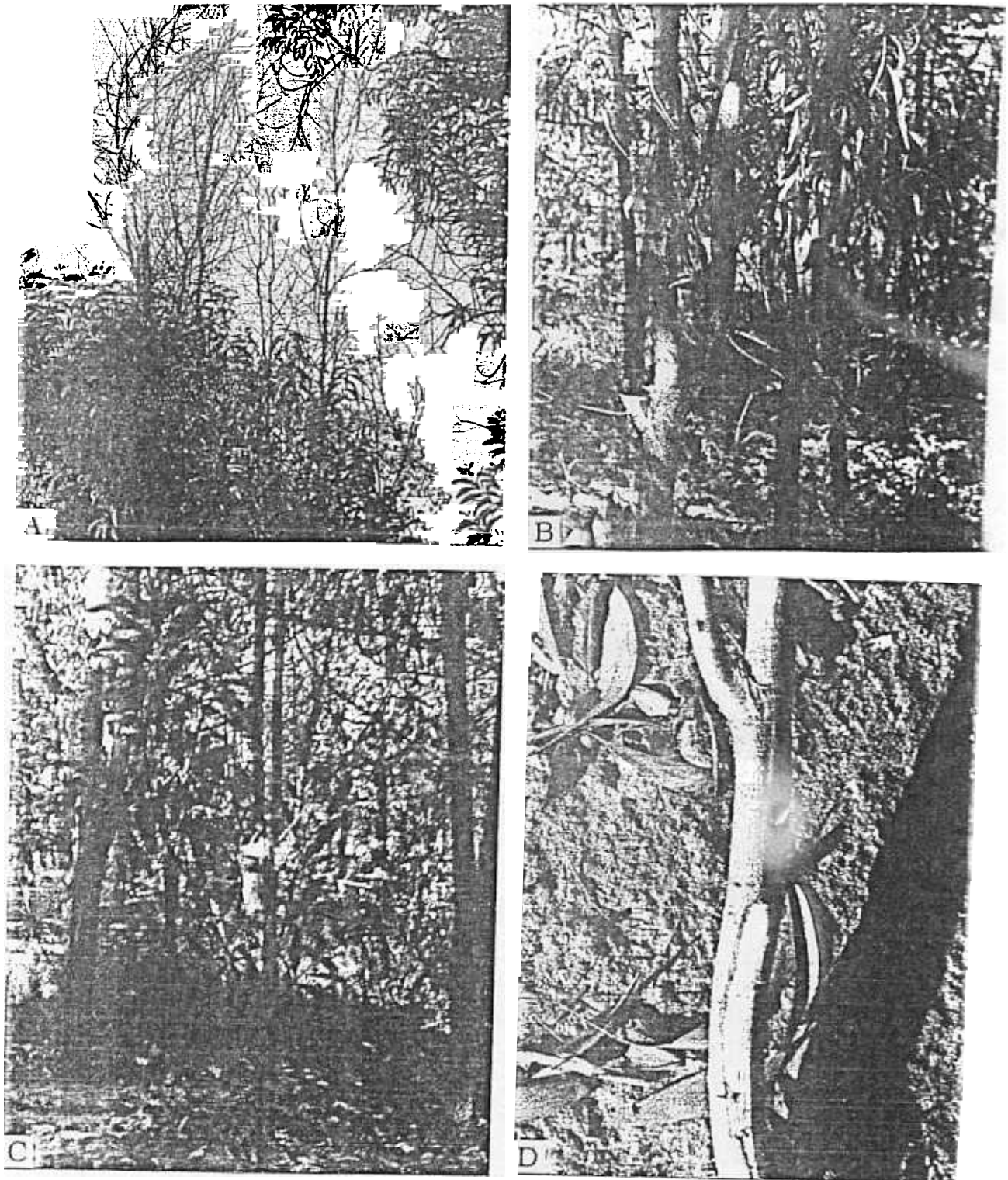


Fig. 32 Die-back of *Acacia auriculiformis* caused by *Hendersonula* sp. A, Extensive die-back in the upper crown; B, Repeated die-back of epicormic shoots; C, Production of epicormic shoots from the healthy stem; D, Canker (appressed area) associated with the die-back. Note grey coloured diseased bark with healthy bark on the right on the exposed area.

Symptoms: Dull purplish brown spots were seen on green pods, especially in the lower and middle parts of the crown. These spots coalesced to form large necrotic areas. The affected pods dried up and fell off prematurely. Seeds inside the pods were found to be shrivelled and brown in colour.

Causal organism: *Fusicoccum* sp.

Colony on PDA slow growing, effuse to floccose, reverse dark; mycelium dark, branched, septate; conidiomata pycnidial, eustromatic, synnematosus, mostly produced in clusters on a tuft of mycelium; pycnidia dark, thick walled, textura angularis; conidia hyaline, thin walled, aseptate, rounded ends and bulged in the middle, straight, eguttulate, cylindrical with truncate base, 23-27.6 μ x 4.6 μ .

5.4.6. Die-back

Occurrence: Die-back of *A. auriculiformis* was recorded in a species trial plantation at Jarakbande, Bangalore (Karnataka). The disease occurred in patches and ultimately killed the trees. The average incidence was estimated to be about 20-25 per cent (Fig.33).

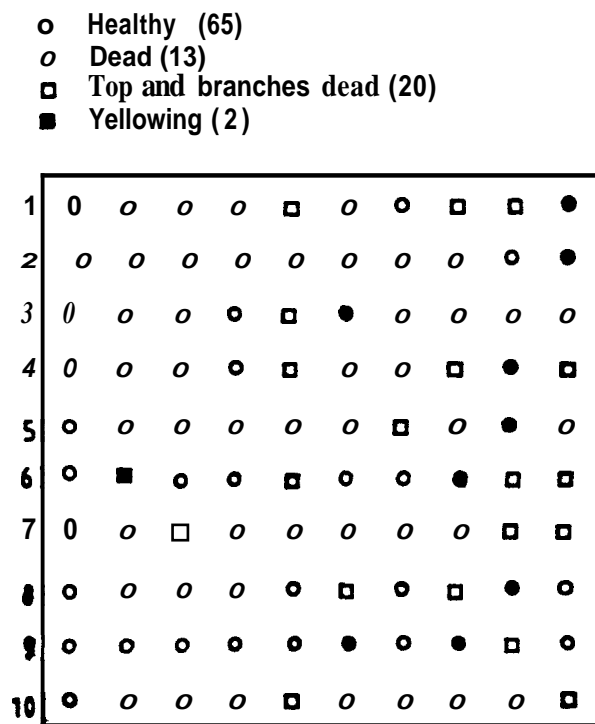


Fig. 33 Incidence and severity of die-back of *Acacia auriculiformis* at Jarakbande, Bangalore. Number in brackets is the number of trees.

Symptoms: Die-back of *A. auriculiformis* appeared to be similar to that of *A. mangium* at Nallal, Hosekote (Karnataka).

The infection occurred in the upper portion of the crown. Initially, young shoots got affected and killed and inturn the infection spread to the main stem. As a result of this, the main stem produced numerous epicormic shoots. As the infection moved downwards the epicormic shoots produced above died and fresh shoots were produced on the healthy part of

Colony on PDA reddish brown in the centre and light dull yellowish towards the periphery, cottony, fluffy; reverse dark brown; conidia produced in abundance, hyaline, cylindrical, 1-septate, rarely 3-septate, 32.2-41.4 μ x 2.3-4.6 μ ; sterile hyphae 80.5-179.4 μ long bearing globose vesicle 9.2- 11.5 μ .

20. Sooty mould

Occurrence: The sooty mould was quite common in plantations and species trials at Hosekote and Beede (Karnataka), Kottappara and Ramavarmapuram (Kerala). Infection of medium severity was observed at Beede.

Symptoms: The disease appeared in the form of superficial black irregular to round patches initially on the upper surface. Under warm and humid conditions these patches enlarged and coalesced to give rise to large patches. In severe cases the infection also extended to the lower surface. Severely infected phyllodes defoliated prematurely.

Causal organism: *Meliolles*.

5.4.3. Powdery mildew

Occurrence: In plantations, powdery mildew was recorded at Tyranadur and Beede (Karnataka) where 1-year-old plants of Springvale provenance were found to be very susceptible. In an assessment at Beede, the incidence of powdery mildew was 88 per cent. The phyllodes of all the affected trees were covered with white powdery mass and of these >10 per cent of the trees were severely affected.

Symptoms: Phyllodes of all the maturities were affected with powdery mildew, which was characterised by the presence of white powdery mass on the upper surface. In severe cases, the infection also extended to the lower surface. Severely infected phyllodes showed curling, puckering and browning and defoliated prematurely.

Causal organism: *Oidium* sp.

5.4. Shoot blight

Occurrence: Shoot blight was recorded in 1-year-old experimental plantation at Ramavarmapuram (Kerala) and Dharampur (West Bengal). At Dharampur the incidence was ca.30 per cent while at Ramavarmapuram >1 per cent.

Symptoms: The apical bud and 2-3 young phyllodes had blighted appearance as they turned blackish brown. The tip of other phyllodes just below the blighted ones showed tip necrosis.

Causal organism: *Phomopsis* sp.

Colony on PDA white turning dull with dark brown sectoring, appressed, reverse pale greyish; conidiomata pycnidial.

5.4.5. Pod rot

Occurrence: Pod rot was observed in a roadside block plantation at Neyveli (Tamil Nadu). The incidence of pod rot was quite high as a large number of immature pods were getting dried up and falling down.

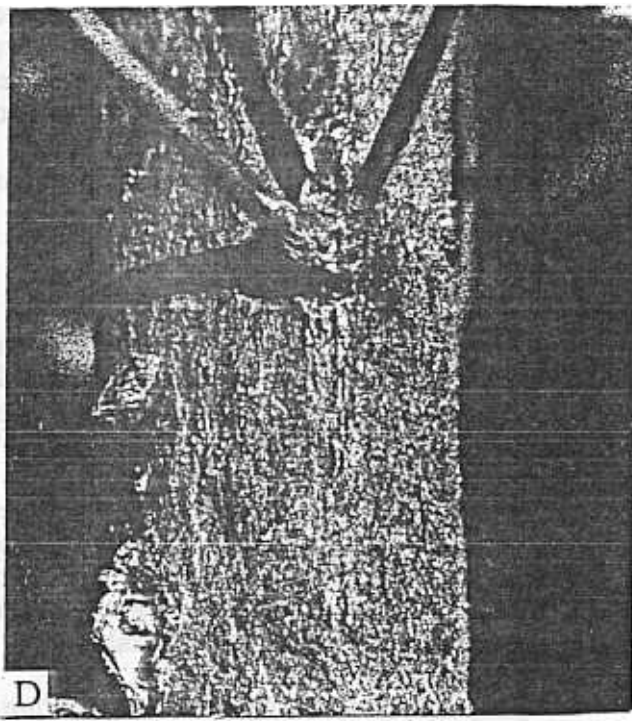
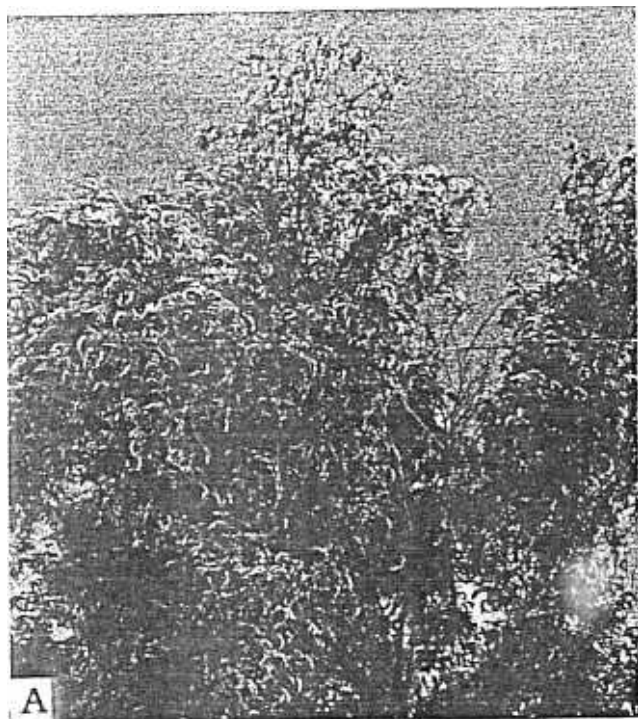


Fig. 34: Pink disease of *Acacia auriculiformis*. A, B, Death of branches in the upper crown; C, D, Development of numerous epicormic shoots, pustules and cobweb stages of pink disease.

stem. This process continued until the infection had killed the mainstem as well as all the side branches, thus ultimately killing the whole tree; the roots remain unaffected.

The main difference from the die-back of *A. mangium* was the greyish black colouration of the bark and sapwood, seen clearly after exposing it with a sharp knife.

Causal organism: *Hendersonula* sp.

Cultural characters were similar to that of isolate from *A. mangium*.

5.4.7. Pink disease

Occurrence: Pink disease of *A. auriculiformis* causing mostly branch death, occurred commonly in Kerala due to prevailing conducive micro- and macro-climatic conditions as well as presence of a large number of alternate hosts. The incidence of the disease was recorded in a plantation at Ramavarmapuram, Trichur (Kerala) and roadside strip plantation stretching for about 3 km along Trichur-Palghat highway. At Ramavarmapuram, the disease was more common (40-50 per cent) in trees at the periphery; average incidence was low (<10 per cent). In roadside plantation, the incidence was as high as 80 per cent, killing more than 2-3 top/side branches in the upper crown. Infection of the main stem, though observed occasionally was not common.

Symptoms: The typical symptoms were yellowing and wilting of phyllodes in a shoot followed by defoliation. Such dead shoots devoid of phyllodes were clear indication of pink disease. On the affected branches the fungus produced only the cobweb and pustule stages and no perfect or necator stages were observed. In the case of infection on the mainstem the sequence of symptoms were similar to that of the shoot.

Causal organism: *Corticium salmonicolor* Berk & Br.

5.4.8. Root rot

Occurrence: Root rot of *A. auriculiformis* was recorded at Ramavarmapuram, Trichur (Kerala) plantation (1989), Calicut University Campus (Kerala) and mixed plantation (1987) Arabari, Midnapur (West Bengal) in a block plantation. Except at Calicut where the incidence of dead trees was high, in other localities only a few trees were found to be affected.

Symptoms: The affected trees showed yellowing of phyllodes, thinning of crown due to premature defoliation followed by death of trees. The fructifications of the fungus were produced on the dead stem at the bottom of the tree just after the first showers in June and later these were attacked by insects and destroyed. On dead stems numerous fructifications developed during June- September.

Causal organism: *Ganoderma lucidum* complex.

5.4.9. Witches broom

Occurrence: A single tree affected by witches broom was recorded in 1993 experimental plantation. at Beede (Karnataka). The disease did not appear to be of common occurrence.

Symptoms: The affected tree was considerably stunted in growth as compared to nearby healthy trees. The size of phyllodes and internodes was reduced to a great extent. The shape of phyllodes near the shoot apex was transformed into needle like structures. The axillary buds

also had sprouted producing abnormally stunted shoots. This gave rise to the appearance of witches broom.

Causal organism: Possibly a phytoplasma.

6. DISCUSSION

Forest disease surveys are usually aimed at periodical or continuous surveillance of forests or plantations with the objective to detect or even predict outbreaks of disease and damage, and diagnose the cause with a view to suggest appropriate strategies to reduce the disease damage. The outcome of such surveys form the basis for assigning priorities for intensive research on specific disease problems. In this context the present disease survey, though not as exhaustive as done earlier by Sharma *et al.* (1985) in Kerala State, India, it provides very important information on the spectrum of diseases in four important *Acacia* species i.e., *A. aulacocarpa*, *A. crassicarpa*, *A. mangium* and *A. auriculiformis* in India and identifies the serious disease problems affecting them. Due to paucity of time it was not possible to visit all the southern states in India wherever exotic acacias have been introduced in a big way, nevertheless the disease survey fulfilled the objectives considering the number of disease were recorded during the survey. Since the effort was to record all the diseases encountered, whether of minor or major importance, a large number of disease could be recorded.

Maximum number of diseases were recorded on *A. auriculiformis* followed by *A. mangium*, *A. crassicarpa* and *A. aulacocarpa* (Table 12). Occurrence of large number of diseases on *A. auriculiformis* is possibly due to its susceptibility to diseases, in addition to its early introduction and large scale cultivation as compared to other species.

The survey recorded a number of new and interesting diseases. All the diseases recorded on *A. aulacocarpa* and *A. crassicarpa* are new records for India: In *A. mangium* except for *Glomerella* foliar spot and sooty mould all the diseases are first records whereas on *A. auriculiformis* except for five diseases (*Alternaria* foliar spot, *Phomopsis* foliar spot, *Colletotrichum* foliar spot, pink disease and *Ganoderma* root rot) the rest are new host records. *Exserohilum* foliar spot, earlier reported by Mohanan and Sharma (1984) from Madurai (Tamil Nadu) was not encountered during this survey, possibly due to seasonal differences in the time of survey.

It is quite interesting to note that all the *Acacia* species suffer more from foliar diseases than diseases of other plant parts. However, number of fungal genera involved are not many as different species of the same genus produce variable symptoms. The common genera associated with most of the foliar diseases are *Colletotrichum*, *Pestalotiopsis*, *Alternaria*, *Curvularia* and *Phomopsis*. In addition, there are several fungal isolates yet to be identified being non-sporulating in cultures. But if we consider the most damaging diseases than it is apparent that they are the diseases of stem and root as they result in mortality of trees.

Table 12. Number of diseases recorded and the most serious diseases on *A. aulacocarpa*, *A. crassicarpa*, *A. mangium* and *A. auriculiformis* in India during this survey

Plants parts affected	Total number of diseases and most damaging diseases(s)			
	<i>A. aulacocarpa</i>	<i>A. crassicarpa</i>	<i>A. mangium</i>	<i>A. auriculiformis</i>
Foliage	11, phomopsis Foliar spot	16; nil	17; Colletotrichum foliar spot, Pestalotiopsis foliar spot, Cercosporidium foliar spot	Powdery mildew Shoot blight
Stem	1; Branch canker	1; Basal stem canker and root decay	4; Die back	2; Die back
Root	1; Root decay		2; Root rot	1; Root rot
Total	13		23	28

In most of the species trials surveyed the mortality of *A. aulacocarpa* and *A. crassicarpa* is high due to root rot caused by unknown Basidiomycete. During the survey it was not possible to collect the fruit bodies of the causal organism as the dead trees, which may have developed the fruit bodies were not retained in the plots to maintain hygiene. However, in most cases the fructifications of macrofungi appear just after the initiation of rains 'during June/July and survive for a few months only as they are liable to be attacked by insects. Further surveys are needed to establish the identity of the causal organism so that appropriate management strategies may be evolved.

A. mangium the most damaging diseases recorded are root rot caused by *Ganoderma lucidum* complex in the State of West Bengal and die-back caused by *Hendersonula* in Karnataka and Kerala. *Ganoderma* root rot of *A. mangium* is considered to be a serious problem also in Papua New Guinea (Arentz, 1993). Considering the high mortality of trees in some of the seed stands, *Ganoderma* root rot in West Bengal appears to be more damaging and wide spread than heart rot in Malaysia. Further studies are needed immediately to understand the pathogen behaviour and etiology of the disease so that appropriate steps including search for disease resistance in different provenances, may be taken up before it is too late and cultivation of *A. mangium* is stopped.

Equally important and serious is the *Hendersonula* die-back of *A. mangium* discovered in Nallal Research Plot, Hosekote (Karnataka) which deserves immediate attention. It was quite curious to note that while *A. mangium* at Hosekote suffered heavily by die-back the adjacent plot of *A. auriculiformis*, an unknown provenance from CSIRO Australia was unaffected. However, at Jarakbande Research plot, some 40 km away only *A. auriculiformis* had die-back and adjacent *A. mangium* plot was unaffected. Considering the fact that the die-back of both the species is caused by the same pathogen, this behaviour could be due to host variation (provenances) or pathogen variation as the climatic conditions and soil are almost identical in these two locations.

Although *Ganoderma* root rot of *A. auriculiformis* has been recorded earlier from India and it causes mortality, the extent of damage is not so high as in the case of *A. mangium*. Possibly further surveys are required in other States such as Maharashtra, Orissa, Bihar as well where the species is grown in large scale.

7. CONCLUSION

The present disease survey has revealed that the four Australian *Acacia* species from potentially serious diseases, especially Ganoderma root rot of *A. mangium* in West Bengal and Hendersonula die-back of *A. mangium* and *A. auriculiformis* in Karnataka. Equal. are root decay of *A. aulacocarpa* and basal stem canker and root decay of *A. crassicarpa*. Furthermore, the survey shows the importance of species/provenance trials established in different parts of the country in assessing or evaluating the susceptibility of species/provenance to disease growing under identical condition, in addition to their performance. It is suggested to conduct further surveys in other states where species/provenance trials have been established to get a better picture of disease situation of Australian Acacias in India.

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