FUNGAL DISEASES OF CERTAIN MEDICINAL PLANTS IN KERALA

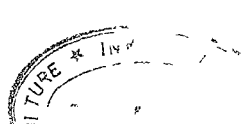
BY

S. SANKARANARAYANA SARMA

THESIS

Submitted in partial fulfilment of
the requirements for the degree of
MASTER OF SCIENCE IN AGRICULTURE
(Plant Pathology)

Department of Plant Pathology
COLLEGE OF AGRICULTURE
VELLAYANI, TRIVANDRUM
1988



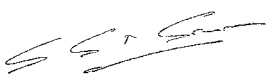
Dedicated to the memory of

my father

(Late) Mr. S.SANKARANARAYANAN

DECLARATION

I hereby declare that this thesis entitled "Fungal diseases of certain medicinal plants in Kerala" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.



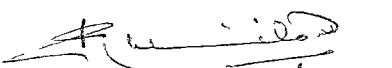
(S.SANKARANARAYANA SARMA)

College of Agriculture,
Vellayani,

1988.

CERTIFICATE

Certified that this thesis entitled "Fungal diseases of certain medicinal plants in Kerala" is a record of research done independently by Mr. S. SANKARANARAYANA SARMA under my guidance and supervision and that it has not formed the basis for the award of any degree, fellowship or associateship to him.



(K.I. WILSON)
Chairman
Advisory Committee
Professor and Head
Department of Plant Pathology

College of Agriculture,
Vellayani,

APPROVED BY

CHAIRMAN

Dr. K. I. WILSON

MEMBERS

1. Dr.M.CHANDRASEKHARAN NAIR

2. Mrs. G.PADMAKUMARY

3. Dr.S.RAMACHANDRAN NAIR

EXTERNAL EXAMINER

27/3/85

(K K N NAMBIAR)

ACKNOWLEDGEMENTS

The author wishes to place on record his deep sense of gratitude to

Dr.K.I.Wilson, Professor & Head, Department of Plant Pathology and Chairman of the Advisory Committee for suggesting the problem, guidance and help during this investigation and in the preparation of the thesis,

Dr.M.Chandrasekharan Nair, Professor of Plant Pathology, Mrs. G.Padmakumary, Associate Professor of Plant Pathology and Dr.S.Ramachandran Nair, Professor and Head, Department of Horticulture, members of the Advisor Committee for their helpful suggestions and criticism,

Dr(Mrs) P.Saraswathy, Professor of Agricultural Statistics and Mr. Ajith Kumar, Junior Programmer(Computer), Department of Agricultural Statistics, for the help in the statistical analysis of the data,

Dr.A.N.Namboodiri, Director, Dr.T.K.Abraham, Scientist and Mr.P.J.Mathew, Senior Scientific Assistant, Tropical Botanic Garden and Research Institute, Palode, and Dr.P.Lakshmi, Professor of Pharmacognosy, Post-Graduate cum Research Centre in Ayurveda, Poojappura, for the supply of necessary medicinal plants and helpful suggestions

Dr.B.C.Sutton, Head of the Identification and Taxonomic Services, Commonwealth Mycological Institute, England, for the identification of fungal cultures,

(contd..)

Dr.N.Saifudeen, Assistant Professor of Soil Science and Agricultural Chemistry for providing facilities of the Central Analytical Laboratory at the National Agricultural Research Project (S.R), Vellayani,

M/S. C.Gokulapalan and Babu George, Junior Assistant Professors of Plant Pathology for suggestions and help during the investigation,

and the staff and P.G. students of the Department of Plant Pathology for their whole hearted co-operation and encouragement.

S.SANKARANARAYANA SARMA

C O N T E N T S

LIST OF TABLES

(contd..)

LIST OF TABLES (Contd.)

LIST OF FIGURES

(contd..)

LIST OF FIGURES (Contd.)

LIST OF PLATES

(contd..)

LIST OF PLATES (Contd.)

INTRODUCTION

INTRODUCTION

Medicinal plants constitute a group of industrially important crops which provide appreciable income to the country by way of exports. Many beneficial drugs are derived directly from plants or from chemical blue-prints obtained from plant products. Over 400 species of plants are used for the commercial preparation of beneficial drugs. In India, the use of various parts of several medicinal plants to cure specific ailments has been in vogue from ancient times in our indigenous medicine. It is estimated that about 75 per cent of the people in the Third World countries still rely on herbal preparations.

In India, this group of crops did not receive the scientific attention they deserve until the Indian Council of Agricultural Research launched an All India Co-ordinated Project on Medicinal and Aromatic Plants. Even now the full potential of these crops has not been scientifically exploited.

Kerala is known to be a rich source of medicinal plants. Many of these occur in wild or semi-wild state in the State, with a rich genetic diversity. Due to the humid climatic conditions, the occurrence of diseases, particularly

fungal diseases, has become a major constraint in the commercial cultivation of medicinal plants in Kerala.

Based on the foregoing considerations and in view of the national priorities for the cultivation and utilization of medicinal plants, the present investigation has been undertaken with the following objectives:

1. Survey of the fungal diseases of important medicinal plants cultivated in Kerala.
2. Study the symptomatology of the diseases.
3. Study the morphology and pathogenicity of the pathogens.
4. *In vitro* evaluation of fungicides against fungi causing diseases in medicinal plants.

The results obtained are presented in this dissertation.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Acorus calamus Linn.

The first record of a fungal pathogen on this host in India was made by Rabenhorst (1878) who reported the occurrence of *Cryptosporium calami* on the leaves of *Acorus calamus* from Calcutta.

Rust caused by *Uromyces acori* was reported by Ramakrishnan and Rangaswami (1948) from Ooty. Later, Rangaswami *et al* (1970) reported *Uromyces sparganii* sub sp. *asiaticus* on this plant from Ooty.

Pandotra and Ganguly (1964a) reported *Ramularia aromatici* on the leaves of *A. calamus* from Jammu.

Gupta (1974) recorded *Stagonospora groveri* on *A. calamus* from Hissar.

Adhatoda beddomei Nees.

Dietel (1906) recorded *Chnoopsora butleri* on the leaves of *Adhatoda vasica* from Dehradun and Kumaon in U.P.

Sydow and Butler (1906) reported *Aecidium adhatodae* on the leaves of *A. vasica* from Dehradun.

Chona and Munjal (1955) reported *Septoria adhatodae* on this plant from New Delhi.

Chowdhury (1955) reported the occurrence of Cercospora adhatodae on the leaves of A. vasica from Assam.

Munjal and Gill (1962) reported a leaf spot of Adhatoda sp. caused by Corynespora cassiicola from Assam. Pavgi and Singh (1965) reported this fungus on the leaves of Adhatoda sp. from Kulu Valley in Himachal Pradesh. Pandotra and Ganguly (1964b) in their study on fungi on medicinal and aromatic plants in north west Himalayas, reported the incidence of a leaf spot of A. vasica caused by Phyllosticta vasicae.

Mukherjee and Kapoor (1969) recorded Rhytidhysterium rufulum and Didymosphaeria mulleri on the twigs of Adhatoda vasica from New Delhi. Further, they (Kapoor and Mukherjee, 1969) reported Nectria flavoviridis on the twigs of A. vasica from New Delhi.

Rangaswamy et al (1970) reported a leaf spot of A. vasica caused by Cercospora adhatodae from Mysore.

Shreemali (1972) reported Phoma vasicae on the twigs of A. vasica from Jodhpur in Rajasthan.

Manoharachary et al (1975) reported that Aspergillus sp., Alternaria alternata, Rhizopus arrhizus, Curvularia lunata (Cochliobolus lunatus), Penicillium sp., and

Sclerotium oryzae (Magnaporthe salvinii) were commonly present on the seeds of A. vasica in Hyderabad.

Roy (1976) reported the occurrence of Alternaria alternata, Chaetomium globosum, Colletotrichum capsici, Botryodiplodia theobromae, Nigrospora oryzae and Drechslera specifierum on A. vasica from Bhagalpur, U.P.

Gupta (1987) reported Periconia byssoides on the leaves of Adhatoda sp. from Gorakhpur, U.P.

No pathogenic fungus has been recorded on Adhatoda beddomei till date.

Asparagus officinalis Linn.

Cooke (1878) first roported the occurrence of Aspergillus phaeocephalus on the roots of Asparagus racemosus from Madras.

Sydow and Butler (1911) recorded Leptosphaeria indica on the fading leaves of this plant from Wynad.

Sydow and Mc Rae (1929) recorded Cercospora asparagi on the leaves and stem of A. officinalis.

A stem disease of A. officinalis caused by Phoma asparagi was reported by Keshwala (1936).

Thirumalachar (1947) recorded a rust disease of Asparagus sp. caused by Puccinia phyllocladiae from Mysore.

Marras and Servazzi (1971) have made a detailed study of the Fusarium diseases of A. officinalis occuring in Sardinia. These included diseases caused by F. oxysporum f.sp. asparagi, F. moniliforme (Gibberella fujikuroi) and F. roseum.

Shreemali (1973) reported the occurrence of Microdiplodia mimusopsidicola and Phomopsis aremariae on A. officinalis.

Sohi et al (1975) reported stem blight of A. officinalis caused by Phomopsis asparagi from Bangalore.

Kontaxis (1977) reported a rust of Asparagus sp., caused by Puccinia asparagi, from California, U.S.A.

Suzui (1978) made extensive studies on the ecology and control of asparagus violet root rot caused by Helicobasidium mompa in Japan.

Johnston et al (1979) reported Fusarium oxysporum f.sp. asparagi and F. moniliforme (Gibberella fujikuroi) as the cause of stem and crown rot and asparagus decline in New Jersey, U.S.A.

Saito et al (1980) made extensive studies on Sclerotium sp., the causal fungus of a root rot disease of esculent asparagus in Japan.

Purple spot, a disease of young asparagus spears, caused by Stemphylium vesicarium was reported by Lacy(1982) from East Lansing, U.S.A. The same pathogen was reported by Blancard et al (1984) from France.

Gindrat et al (1984) reported a severe leaf blight of Asparagus sp., caused by Stemphylium botryosum (Pleospora herbarum), from Nyon in Switzerland.

Tripathi (1985) reported Cercospora asparagi and Phomopsis asparagi on Asparagus sp. from Garhwal Hills, Srinagar.

Tu (1985), during investigations on the major disease of asparagus and their control in Taiwan, reported a leaf blight caused by Cercospora asparagi and stem blight caused by Phoma asparagi.

Catharanthus roseus G.Don.(=Vinca rosea Linn.)

Mundkur (1938) recorded Leveillula taurica on Vinca pusilla from Coimbatore, Tamil Nadu.

Maheskar (1967) recorded Colletotrichum sp. on the leaves and petiole of V. rosea from Poona, Maharashtra.

Singh et al (1967) reported a severe leaf spot of this host, caused by Myrothecium roridum.

Chakravarty et al (1976), in their investigations on the pathological problems in the cultivation of V. rosea,

described a damping-off caused by Pythium debaryanum and Sclerotium rolfsii from Kalyani, West Bengal.

Balasubramanian and Bhama (1977) reported a leaf spot disease of Catharanthus roseus, caused by Rhizoctonia solani, from Madras.

Janardhanan et al (1977) reported that nearly 80 per cent of Vinca rosea plants in the experimental plots of the Central Indian Medicinal Plants Organisation, Lucknow, were affected by a severe die-back disease, caused by Pythium butleri.

Keim (1977) reported a foliage blight of V. rosea from Southern California, caused by Phytophthora nicotianae var. parasitica.

Tiwari et al (1978) recorded twig blight and leaf spot diseases of Catharanthus roseus, caused by Colletotrichum dematium, Macrophomina phaseolina and Phyllosticta vincae-majoris, from Jabalpur, Madhya Pradesh.

Sridhar (1979) in his study on the fungal diseases of medicinal and aromatic plants reported a stem rot of Vinca rosea, caused by Sclerotium rolfsii, from Bangalore.

Rao and Pandey (1980) reported a shoot blight of this plant from Poona, Maharashtra, caused by Ophiobolus cathranthicola.

A leaf spot disease of Cathranthus roseus, caused by Colletotrichum gloeosporioides, was reported from Vellayani, Kerala, by Santhakumari (1980).

Padmakumary et al (1981) reported a leaf blight disease of C. roseus, caused by Fusarium oxysporum from Vellayani, Kerala.

A leaf spot diseases of C. roseus, caused by Alternaria alternata, was recorded from the National Botanic Research Institute, Lucknow (Goyal and Pathak,1982).

Narendrappa and Siddaramaiah (1985) recorded a wilt of C. roseus, caused by Fusarium udum var. cajani, from Dharwad, Karnataka.

Coscinium fenestratum Colebr.

There is no record of pathogenic fungi on Coscinium fenestratum.

Costus speciosus (Koenig.)Sm.

Salam et al (1958) recorded Piricularia sp. on the leaves of Costus speciosus from Hyderabad.

Rao (1964) reported Helicomina costi on the leaves of this plant from Hyderabad.

Mailum and Divinagracia (1969) reported that Phyllosticta zingiberi, the causal agent of leaf spot of ginger, can infect the leaves of C. speciosus also.

Gupta et al (1978) recorded a leaf blight disease of this plant from Lucknow, caused by Drechslera maydis, the imperfect state of Cochliobolus heterostrophus.

Thakur et al (1978) reported a rhizome rot of this medicinal plant from the Regional Research Laboratory, Jammu-Tawi, caused by Pythium spinosum.

A damping-off disease of C. speciosus, caused by Pythium butleri, was reported from Lucknow (Sattar et al 1979a). A leaf blight, caused by Phytophthora nicotianae var. nicotianae, was also reported by the authors(Sattar et al 1979b).

Kumar et al (1980) reported that the seed mycoflora of C. speciosus include Fusarium oxysporum, F. semitectum, F. equiseti, F. moniliforme var. subglutinans, F. fusaroides, Aspergillus niger, Penicillium chrysogenum, Phomopsis sp., Curvularia state of Cochliobolus lunatus, Chaetomium globosum, Gloeosporium sp. and Mucor circinelloides.

Thakur et al (1980) made a detailed study of a leaf blight of this plant, caused by Curvularia prasadii, from Jammu Tawi.

Shukla et al (1982) recorded a seedling blight, caused by Rhizoctonia solani, from Lucknow. A leaf spot caused by Drechslera rostrata was also reported by the authors (Shukla et al,1983)

Singh et al (1984) recorded a leaf spot caused by Phaeoisariopsis costusae from Gorakhpur.

Holostemma adakodien R.Br.

There is no record of any pathogenic fungus on Holostemma adakodien.

Plumbago indica (=P.rosea)Linn.

Rao (1965) in studies on the genus Phyllosticta in India, recorded Phyllosticta plumbaginicola on Plumbago zeylanica.

Ponnappa (1970a) reported Phyllostictina plumbaginis on the leaves of P. zeylanica, from Bangalore. Phyllosticta sp. and Pithomyces chartarum also were reported by the author (Ponnappa, 1970b).

Sharma and Agarwal (1974) in their studies on the fungi causing plant diseases at Jabalpur, Madhya Pradesh, recorded a leaf spot of P. zeylanica, caused by Alternaria plumbaginea.

No pathogenic fungus has been recorded on Plumbago indica.

Rauwolfia serpentina Benth. ex Kurz.

Ramakrishnan and Ramakrishnan (1950) reported the occurrence of Mycosphaerella rauwolfiae on the leaves of Rauwolfia serpentina in Walayar, Kerala.

Chandra (1955) recorded a leaf spot of this medicinal plant, caused by Alternaria sp., and a leaf blotch, caused by Cercospora sp. (Chandra, 1957) from Lucknow, U.P.

Mohanty and Addy (1957) reported Cercospora rauwolfiae, causing leaf spot of R. serpentina in Bhubaneswar, Orissa. Later, a target leaf spot, caused by Corynespora cassiicola, was also reported (Mohanty, 1958).

Ganguly and Pandotra (1962) reported a wilt caused by Fusarium sp.,leaf blight and bud rot caused by Alternaria tenuis, and a powdery mildew caused by Leveillula taurica, from Jammu and Kashmir. Janardhanan et al (1964) reported Fusarium oxysporum f. sp. rauwolfiae, causing wilt of R. serpentina in Jammu and Kashmir. A leaf spot disease, caused by Epicoccum nigrum, was recorded from Allahabad, U.P. (Srivastava, 1964).

Varadarajan (1964a) reported a leaf spot of Rauwolfia serpentina caused by Pellicularia filamentosa from Gujarat. An anthracnose caused by Colletotrichum gloeosporioides was also reported from Mexico (Varadarajan, 1964b). Later, he (Varadarajan, 1966) recorded a leaf spot and premature defoliation, caused by Curvularia lunata from Gujarat.

Biharilal and Tandon (1967) recorded a leaf spot disease of R. serpentina, caused by Colletotrichum capsici from Allahabad, U.P. Lele and Asha Ram (1968) studied a die-back disease of this plant caused by Colletotrichum dematium.

Padma and Mukherjee (1972) isolated Fusarium sp., Pestalotia monorhinca, Gliocladium roseo-griseum and Colletotrichum dematium from the rhizoplane of Rauwolfia serpentina.

Spilanthes acmella Linn.

Thirumalachar and Govindu (1954), during studies on the morphological and cytological characters of a bisporidial species of Endophyllum, recorded E. spilanthus on the leaves of Spilanthes acmella from Hebbal, Karnataka.

Ramakrishnan (1959) recorded Aecidium spilanthis, infecting the leaves of Spilanthes acmella in Valparai and Annamalai, Tamil Nadu.

Evaluation of fungicides

Hendrix et al (1947) was able to control mango anthracnose, caused by Colletotrichum gloeosporioides, by spraying copper fungicides such as Bordeaux mixture, Burgundy mixture, basic copper sulphate, cuprous oxide and copper oxychloride.

Tandon and Agarwala (1954) reported satisfactory control of die-back of guava plants, caused by Gloeosporium psidii, by the application of 3:3:50 Bordeaux mixture and 0.33 per cent Perenox.

Sijpesteijn and Janssen (1958) reported that Glomerella cingulata was found to be sensitive to 1:2 copper dimethyl dithiocarbamate.

Tandon and Singh (1968) found that mango anthracnose, caused by Colletotrichum gloeosporioides, could be effectively controlled by spraying the trees with Zineb or Bordeaux mixture (4:4:50). They reported that Bordeaux mixture (1:1:50), Fytolan (0.3 per cent) and Fungicopper (0.3 per cent) reduced the incidence of guava anthracnose, caused by Colletotrichum gloeosporioides (Tandon and Singh, 1969).

Mendoza (1977) reported that application of Daconil 75 WP, Dithane M-45 or Maneb at fruit-set and 10 days before harvest gave good control of Colletotrichum gloeosporioides, causing preharvest anthracnose of mango.

Abul Hasan et al (1978) recorded considerable inhibition of radial growth of Colletotrichum lagenarium with 0.3 per cent Dithane M-45 and 0.3 per cent Ziram.

Khanna and Chandra (1978), in their studies on leaf blight of Rosa indica and Cinnamomum camphora caused by Glomerella cingulata, obtained good control with Difolatan and Benlate.

In spraying trials, Mishra and Siradhana (1978) recorded effective control of Colletotrichum graminicolum causing anthracnose of sorghum, with Benlate, Difolatan and Bavistin.

Singh and Jain (1978) reported that Bavistin was the best among 14 fungicides tested by them, in inhibiting the linear growth of Colletotrichum lagenarium.

Solel and Oren (1978) reported that among the fungicides bioassayed against Colletotrichum gloeosporioides causing anthracnose of citrus fruits, Bordeaux mixture was the most effective copper compound; organic compounds like Captafol, Captan, Chlorothalonil, Maneb and Mancozeb were also very effective.

Chauhan et al (1980) reported that, in field spraying, best control of anthracnose of bottlegourd, caused by Colletotrichum lagenarium, was achieved with Difolatan, followed by Bavistin, Blitox and Dithane M-45 when sprayed at 0.2 per cent concentration of active ingredient.

In laboratory evaluation of fungicides, Karunakaran (1981) reported that Bordeaux mixture (5000 ppm), Fytolan (3000 ppm) and Dithane Z-78(3000 ppm) completely inhibited the growth of Colletotrichum gloeosporioides. In the field evaluation, he obtained considerable reduction in the percentage of leaf spot and twig blight of clove, shot-hole disease of nutmeg and die-back disease of cinnamon, all caused by Colletotrichum gloeosporioides, with Bordeaux mixture (1 per cent), Dithane Z-78 (0.3 per cent) and Fytolan (0.3 per cent).

Sindhan and Bose (1981) in their evaluation of fungicides against anthracnose of French bean, caused by Colletotrichum lindemuthianum, reported that Bavistin (0.075 per cent), Ziram (0.2 per cent) Dithane M-45 (0.2 per cent) and Blitox (0.2 per cent) reduced the disease incidence significantly over control.

Sohi and Rawal (1984) reported that in the field tests to control anthracnose of cowpea, caused by Colletotrichum lindemuthianum, Bavistin (0.2 per cent) was the best treatment. Dithane M-45 (0.2 per cent) also gave satisfactory control, whereas Blitox (0.5 per cent) was not at all effective.

Kumar and Srivastava (1985) reported that Colletotrichu graminicola, a seed-borne pathogen of pigeon pea, was

effectively controlled by treatment with Agrosan-GN, Bavistin, Difolatan, Captan, Vitavax and Dithane M-45.

Varadarajan (1966) recommended 2 to 3 sprayings with Bordeaux mixture during South-west monsoon for the control of leaf spot and premature defoliation of Rauwolfia serpentina, caused by Curvularia lunata.

In the laboratory evaluation of fungicides against Curvularia eragrostidis, causing leaf blight of pineapple, Saikia (1982) obtained complete inhibition of growth of the fungus with Cuman (1000 ppm). Blitox (4000 ppm) and Dithane M-45 (2000 ppm) also gave satisfactory inhibition of growth.

Zamorski and Bielska (1983) noted that under in vitro conditions, Captafol was highly toxic to Curvularia trifolii f.sp. gladioli.

Kumar and Srivastava (1985) reported that Curvularia pallescens, a seed-borne pathogen of pigeon pea, was effectively controlled by treatment with Agrosan-GN, Bavistin, Difolatan, Captan, Vitavax and Dithane M-45.

Thakur et al (1985) reported that, in laboratory evaluation of fungicides against Curvularia prasadii, causing leaf blight of Costus speciosus, Benomyl was the most effective fungicide, followed by Triforine. Copper oxychloride also gave encouraging results.

Newhall (1948) reported that spores of Diplodia theobromae from infected cocoa pods were effectively inhibited by Bordeaux mixture, Phygon, Zerlate, Yellow Cupracide and Fermate.

Laboratory studies by Srivastava and Tandon (1971) revealed that copper fungicides and dithiocarbamates were ineffective against isolates of Botryodiplodia theobromae causing fruit rot of citrus, guava, mango and sapodilla.

In the laboratory evaluation of fungicides against Diplodia natalensis, infecting guava fruits, Rajagopalan and Wilson (1972a) obtained 100 per cent inhibition of germination of single-celled spores of the fungus with 50 ppm Dithane M-45 in sterile, distilled water, whereas the double celled spores required 100 ppm of the above fungicide. Complete inhibition of growth was obtained at 3000 ppm of Dithane M-45. In field studies, they found Ziride to be the most effective fungicide against the disease (Rajagaopalan and Wilson, 1972b).

Prasad and Bilgrami (1973) reported that in in vitro trials, Ziram, Zerlate, Agrosan, Flit-406, Thiram, Betrocal and Sodium-o-phenate were effective against Botryodiplodia theobromae causing fruit rot of chillies. Eight proprietary copper fungicides, including Fytolan and Blue copper, were not effective against the fungus.

Singh et al (1977) recommended prophylatic treatment with a copper based fungicide for the control of twig blight and pod blackening of cocoa caused by Botryodiplodia theobromae.

Vijayan (1978) reported that Dithane M-45 (100 ppm) and Bavistin (200 ppm) caused 100 per cent inhibition of germination of single-celled spores of Botryodiplodia theobromae. Fytolan (200 ppm) also gave satisfactory inhibition. Bavistin (250 ppm) and Dithane M-45(1000 ppm) completely inhibited the radial growth of the fungus.

Vijayan and Wilson (1980) reported that Rovral, followed by Difolatan and Dithane M-45 gave good control of charcoal pod rot of cocoa, caused by Botryodiplodia theobromae.

Naseema (1981) obtained satisfactory inhibition of radial growth of Botryodiplodia theobromae with Dithane M-45 at 1000 ppm. Peterson (1981) reported that infection of new shoots of pines by Diplodia pinea was controlled by two applications of Bordeaux mixture (8:8:100) at 2 weeks interval.

Zengin (1978) reported that soil drenching of seed beds with 1 per cent Bordeaux mixture gave good control of damping-off of Capsicum caused by Fusarium sp.

Qadri et al (1982) reported that in in vitro trials, Bavistin at 0.1 per cent, Ziride, Difolatan and Dithane M-45 at 0.2 per cent concentrations inhibited the growth of Fusarium oxysporum. Blitox at 0.2 per cent concentration was not effective.

Nair and Menon (1983) recommended soil drenching of beds with 1 per cent Bordeaux mixture for the control of damping-off disease of cashew caused by Fusarium sp., Pythium sp., Phytophthora palmivora and Cylindrocladium scoparium.

Kalra and Sohi (1984) obtained considerable reduction in the growth of Fusarium oxysporum in culture medium incorporated with Difolatan and Dithane M-45 at 0.2 per cent concentrations.

Sharma and Jain (1984) reported that Dithane M-45 and Bavistin at 500 ppm concentrations were very effective in inhibiting the radial growth of Fusarium moniliforme, F. oxysporum f.sp. lini, F. oxysporum f.sp. zingiberi and F. oxysporum f.sp. udum on Potato dextrose agar medium.

Vrany et al (1984) reported that Bavistin (1000 ppm) completely inhibited the growth of Fusarium moniliforme on Potato dextrose agar medium.

MATERIALS AND METHODS

MATERIALS AND METHODS

Isolation of fungi from infected plants

Infected parts of the following medicinal plants were collected from College of Agriculture, Vellayani, Tropical Botanic Gardens & Research Institute, Palode and Post-Graduate cum-Research Centre in Ayurveda, Poojappura in Trivandrum District.

1. Acorus calamus Linn. (Family - Araceae)

English - Sweet flag

Malayalam - Vayambu, Vashampu

Dried rhizome of the plant is a tonic and carminative. It possesses emetic and antispasmodic properties. It produces beneficial results in cases of dyspepsia and chronic diarrhoea (Anon., 1948 and Nadkarni, 1954).

2. Adhatoda beddomei Nees. (Family - Acanthaceae)

Malayalam - Chittadalotakam.

It is a well known drug in the Ayurvedic and Unani systems of medicines and is recommended for a variety of ailments, such as bronchitis, asthma, fever and jaundice. The leaves and roots are antispasmodic and efficacious in coughs (Nadkarni, 1954).

3. Asparagus officinalis Linn. (Family - Liliaceae)

English - Common asparagus

Malayalam - Satavari

The plant is a demulcent, diuretic, laxative, cardiac sedative, tonic and aphrodisiac. Roots, ripe fruits (seeds) and the whole plant are used medicinally. Roots contain 'asparagin', which stimulates the kidneys. Roots are more diuretic than shoots. Root infusion is used against jaundice and congestive torpor of liver. The water in which asparagus has been boiled is good for the cure of rheumatism (Anon., 1948 and Nadkarni, 1954).

4. Catharanthus roseus G.Don.(= Vinca rosea Linn.) (Family - Apocyanaceae)

English - Periwinkle

Malayalam - Nithyakalyani, Ushamalari

The plant has been used as a remedy for disbetes in various parts of India and South Africa. The juice of the leaves is used against wasp stings. An infusion of the leaves is given in the treatment of menorrhagia. Extracts of the plants are used for the treatment of leukemia; the anti-leukemic activity resides in two alkaloids - leurosine and vincaleukoblastin, obtained from the roots (Nadkarni, 1954).

5. Coscinium fenestratum Colebr. (Family - Menispermaceae)

English - Tree turmeric

Malayalam - Maramanjal

Roots and stem of this plant are used medicinally. Root is a stomachic and tonic. It is found to be useful in debility, dyspepsia and fevers. It possesses antiseptic properties and is used for dressing wounds and ulcers. Decoction of the bark is used in the treatment of snake-bite (Anon., 1950 and Nadkarni, 1954).

6. Costus speciosus (Koenig.)Sm. (Family- Zingiberaceae)

Malayalam - Channakoova, Narunchana.

Roots of the plant are used as astringent, stimulant, anthelmintic and aphrodisiac. Also useful against catarrhal fevers, coughs, dyspepsia, skin diseases, worms and snake bites. It is a potent source of an important steroidal sapogenin-diosgenin, which is used as a basic material for the synthesis of cortisol steroid, sex hormones and oral contraseptive pills (Anon., 1950 and Nadkarni, 1954).

7. Holostemma adakodien R.Br. (Family - Asclepiadaceae)

Malayalam - Adakodien, Adapathiyan.

The roots of this plant are reported to possess cooling, alterative, tonic and lactative properties. Tuber of the plant is used as a galactogogue. Roots, made into a

paste, are applied in ophthalmia and orchitis. They are also used in diabetes, gonorrhoea, coughs and stomach-ache (Nadkarni, 1954 and Anon., 1959).

8. Plumbago indica (= P. rosea) Linn. (Family - Plumbaginaceae)

English - Rose-coloured lead wort.

Malayalam - Chuvannakoduveli, Chethikoduveli.

Roots of the plant are used as vesicant and stimulant; when tampered with little bland oil is used as an external application in rheumatism and paralytic affections. It is a powerful sialogogue, remedy for secondary syphilis and leprosy. The milky juice is useful in ophthalmia and scabies (Nadkarni, 1954 and Chopra et al, 1956).

9. Rauwolfia serpentina Benth. ex Kurz. (Family - Apocyanaceae

Malayalam - Sarpagandhi

Rauwolfia and its preparations are important as anti-hypertensives and as sedatives. It is employed for the relief of various central nervous system disorders, both psychic and motor, including anxiety states, excitement, maniachal behaviour associated with psychosis, schizophrenia, insanity, insomnia and epilepsy. Root extracts are used in the treatment of diarrhoea and dysentery, and also as an anthelmintic. The root is believed to stimulate uterine contraction and is recommended for use in child-birth in difficult cases (Nadkarni, 1954 and Anon., 1969).

10. Spilanthes acmella Linn. (Family - Compositae)

Malayalam - Akravu

Flowers are made into a tincture and used to relieve toothache. Seeds are used to produce salivation when the mouth is dry. Spilanthol, obtained from flowers, has strong local anaesthetic action (Nadkarni, 1954 and Anon., 1976).

The fungal pathogens were isolated from the diseased parts by routine mycological technique as described hereunder:

The infected parts were cut into small bits, washed thoroughly in distilled water, surface sterilized in 0.1 per cent mercuric chloride solution for one to three minutes, taken out and washed in three changes of sterile, distilled water. These bits were then placed on sterile potato dextrose agar (PDA) medium in 9 cm petridishes and incubated at room temperature (28 $\pm$ 2°C). When the fungal growth was visible, mycelial bits were transferred to PDA slants. The organisms were then purified by single spore isolation and maintained on PDA slants.

Pathogenicity tests

(i) Inoculation on leaves

For inoculation studies, six month old seedlings of the respective medicinal plants raised in pots were used.

The plants to be inoculated were kept in moist chamber, made out of large polythene bag, for 24 hours before inoculation.

The leaves were cleaned by swabbing with cotton wool dipped in 0.1 per cent mercuric chloride solution and then washed with sterile water. Slight injury was given to the leaves by gently puncturing with pins fixed on a cork disc. Inoculations were conducted by spraying spore suspensions of respective organisms, prepared in sterile water. A hand atomizer was used for spraying the spore suspension. The inoculated area was then covered with a small bit of cotton wool soaked in sterile water. Control plants were also maintained by spraying the punctured leaves with sterile water. The inoculated and control plants were covered with polythene bags for 48 to 72 hours in order to maintain high humidity. The polythene bags were then removed, and the test plants were kept under shade. Observations were taken 5 to 10 days after inoculation.

(ii) Inoculation on stem

Three months old plants were kept in moist chamber for 24 hours before inoculation.

The base of the stem near soil level was cleaned by wiping with cotton wool dipped in 0.1 per cent mercuric chloride solution and then washed with sterile water.

Injury to the cleaned portion of the stem was given by puncturing with a sterilized needle. A sporulating culture bit of the fungus was then placed on the injured portion of the stem, and was covered with moist cotton wool. The inoculated plants were then covered with polythene bags to provide high humidity. Control plants were also maintained similarly. The polythene bags were removed 72 hours after inoculation and the plants were kept under shade. Observations were taken 9 to 10 days after inoculation.

(iii) Reisolation of the pathogens from artificially inoculated plant parts

The pathogens were reisolated from lesions produced by artificial inoculations and compared with the original cultures.

Symptomatology

Symptomatology was studied in detail by observing the development of lesions in naturally infected plants in the field as well as in the artificially inoculated ones.

Morphology of the pathogens

The morphological characters of the patnogens were studied by growing them in slide culture as described by Riddel (1950).

Sterile agar medium was poured into sterilized petidishes in a thin layer and after solidifcation, blocks of 6 mm square and 2 mm thickness were cut out using a sterile scalpel. One such square was placed at the centre of each sterile glass slide and each of the four sides of the agar block was inoculated with small bits of the respective organism obtained from seven day old cultures grown on PDA. A cover slip was placed on the top of the inoculated agar and the slides were placed in moist petridish chambers (Petridish with wet filter paper in the bottom on which two glass rods kept as support for the slides). These were then incubated at room temperature for two to three days or more, depending on the growth of the organism. After this, the coverslip was lifted gently, a drop of 95 per cent alcohol was placed in the centre and before drying, the coverslip was mounted on another slide using lactophenol. The square of the agar was removed from the culture slide and another mount was prepared by placing a coverslip without any disturbance to the fungal growth on the slide. The slides were then examined and the morphological characters of the pathogens studied.

Growth on different media

The following six media were used to study their comparative effect on the radial growth and sporulation of the organisms:

1. Coon's agar
2. Czapek's Dox agar
3. Oatmeal agar
4. Potato dextrose agar
5. Richard's agar
6. Sabouraud's agar

The composition of the media are given in Appendix-I.

Each medium was prepared in conical flasks, sterilized by autoclaving at 1.05 kg/cm^2 for 20 minutes, and poured in sterilized petridishes at the rate of 15-20 ml in each. The media were then inoculated with 5 mm diameter mycelial discs taken from actively growing PDA culture of the respective fungus. Three replications were maintained for each treatment. The inoculated petridishes were incubated at room temperature (28 $\pm$ 2°C). Observations were taken when the growth of the fungus in any one of the treatment reached the edge of the petridish.

In vitro evaluation of fungicides

The following fungicides were used for laboratory evaluation:

Fungicide	Active ingredient
1. Bordeaux mixture	- Copper sulphate-lime-mixture.
2. Carbistin	- 2-(Methoxy-carbamoyl) benzimidazole.
3. Cuman L	- Zinc dimethyl dithiocarbamate
4. Dithane M-45	- Zinc ion and manganese ethylene-bisdithiocarbamate
5. Foltaf	- Cis-N(1,1,2,2- tetrachloroethyl)thio)-4 Cyclohexene-1,2-dicarboximide.
6. Fytolan	- Copper oxychloride-50% metallic copper.

(i) Inhibition of spore germination

Spores obtained from 10 days old petridish cultures of the fungus grown on Czapek's Dox agar medium were used to assess the effect of fungicides on the spore germination of the fungi. Spore suspension was prepared in sterile, distilled water. The concentration was adjusted to 50 to 60 spores when a drop of spore suspension was examined under the low power of a microscope. The fungicidal solutions were prepared in sterile, distilled water in double the concentration as that required for the experiment. Equal volumes of the fungicidal solution and spore suspension were mixed and two drops of the same were placed on sterile, clean, grease-free glass slides placed in petridish moist chambers and incubated at room temperature. Observations were taken at 6 and 24 hours after incubation. The per cent inhibition of spore germination, based on 20 microscopic fields, was calculated.

(ii) Inhibition of radial growth

The inhibitory effect of fungicides on the radial growth of the organisms on solid medium was studied by 'poisoned food technique' described by Zentmyer (1955).

The required quantity of fungicide was added to 50 ml of sterilized Czapek's Dox agar medium, mixed well, and poured into three sterilized petridishes at the rate of 15 ml per dish. The dishes were then inoculated with 5 mm diameter mycelial discs taken from seven day old culture of the respective fungus. One culture disc was placed at the centre of each petridish. Suitable controls were also maintained. The petridishes were incubated at room temperature ($28 \pm 2^{0}C$). Observations on the radial growth of the fungi were recorded when the growth of the organism in control completely covered the petridish. Per cent inhibition of growth was calculated using the following formula:

$$\text{Per cent inhibition} = \frac{(C - T)}{C} \times 100$$

Where, C = radial growth in control

and T = radial growth in treatment.

RESULTS

RESULTS

The following fungal diseases were noticed on medicinal plants during the investigation:

Host and disease	Causal organism	Location
I. *Acorus calamus*		
1. Leaf rust	*Uromyces sparganii* ssp. *asiaticus*	TBGRI,Palode*
II. *Adhatoda beddomei*		
1. Leaf spot	*Colletotrichum gloeosporioides*	TBGRI and PGRC,Poojappura**
2. Leaf rust	*Puccinia* sp.	TBGRI
III. *Asparagus officinalis*		
1. Stem rot	*Fusarium moniliforme* var. *intermedium*	TBGRI
IV. *Catharanthus roseus* (= *Vinca rosea*)		
1. Leaf spot	*Colletotrichum gloeosporioides*	TBGRI, PGRC and AGC*** Vellayani.
2. Leaf spot	*Curvularia clavata*	AGC
V. *Coscinium fenestratum*		
1. Leaf blight	*Colletotrichum gloeosporioides*	TBGRI

Host and disease	Causal organism	Location
VI. *Costus speciosus*		
1. Leaf spot	*Curvularia lunata*	TBGRI
VII. *Holostemma adakodien*		
1. Leaf spot	*Botryodiplodia theobromae*	TBGRI
VIII. *Plumbago indica* (= *P. rosea*)		
1. Leaf spot	*Colletotrichum gloeosporioides*	TBGRI and PGRC
IX. *Rauwolfia serpentina*		
1. Anthracnose	*Colletotrichum gloeosporioides*	TBGRI and PGRC
X. *Spilanthes acmella*		
1. Leaf blight	*Colletotrichum capsici*	TBGRI and PGRC

*TBGRI - Tropical Botanic Garden and Research Institute, Palode.

**PGRC - Post-Graduate cum-Research Centre in Ayurveda, Poojappura.

*** AGC - College of Agriculture, Vellayani.

SYMPTOMATOLOGY

I. Acorus calamus Linn.

1. Leaf rust - C.O. Uromyces sparganii Clinton & Peck.ssp asiaticus Parmelee & Savile.

The symptoms appeared as characteristic rust pustules on the leaves. The pustules are very prominent on the upper surface of the leaf. The sori are small, roundish and brown coloured. The number of pustules on the leaves varied from a few to many. These pustules consisted of golden brown, single-celled uredospores of the fungus appearing as powdery masses. In severe infections, the leaves withered resulting in defoliation of the plant.

II. Adhatoda beddomei Nees.

1. Leaf spot - C.O. Colletotrichum gloeosporioides (Penz.) & Penz & Sacc.

The symptoms appeared initially as minute brown coloured dots on the leaves. These dots gradually enlarged and appeared as oblong or oval lesions with dark brown irregular margin. Severely affected leaves withered and dropped down.

2. Leaf rust - C.O. Puccinia sp.

Pale spots initially appear on the under surface of the leaves. In advanced stages of infection, prominent cup-shaped, rusty pustules measuring 3 to 10 mm in diameter developed on the lamina. The convex lower surface of the pustules was

Plate 1. Leaf rust of *Acorus calamus* caused by *Uromyces sparganii* ssp. *asiaticus*.

Plate 2. Leaf spot of *Adhatoda beddomei* caused by *Colletotrichum gloeosporioides*.

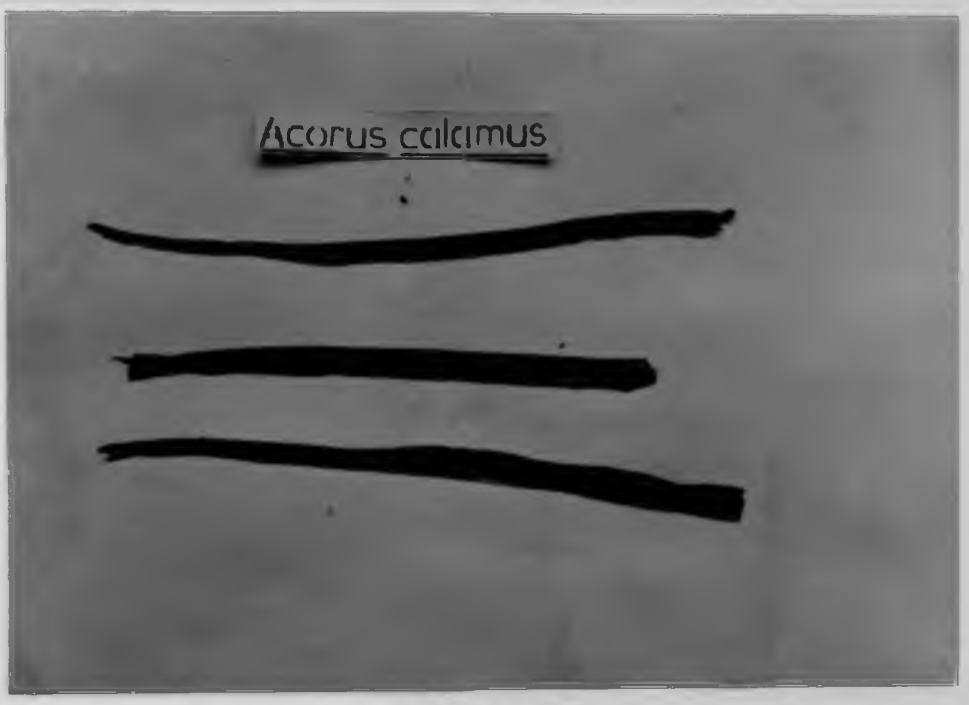


PLATE 1

PLATE 2

encrusted with spore masses which appeared black in colour. The corresponding area on the upper surface of the leaves was smooth and chlorotic. In severe cases of infection, the leaves turned yellow and dropped in large numbers.

III. Asparagus officinalis Linn.

1. Stem rot - C.O. Fusarium moniliforme var. intermedium Neish & Leggett.

The first noticed symptom was the yellowing and wilting of the growing stalk. Elliptical, reddish brown lesions were produced on the stem near the soil level. One or more lesions may be produced on the stem. These enlarged causing decay of the internal tissues, resulting in the death of the plant.

IV. Catharanthus roseus G.Don.(=Vinca rosea Linn.)

1. Leaf spot - C.O. Colletotrichum gloeosporioides (Penz.) Penz & Sac.

The symptoms initiated as minute, water-soaked spots on the leaves, mostly prominent on the upper surface. As the spots enlarged, these became papery white in the centre with well defined dark brown margin. The well developed spots were round in shape and measured upto 3 mm in diameter.

2. Leaf spot - C.O. Curvularia clavata Jain

The symptoms initiated as small, brown, pin-head shaped dots on the leaves. These later enlarged and became dull brown coloured and irregular in shape. In severe cases of infection, defoliation was also observed.

Plate 3. Leaf rust of *Adhatoda beddomei* caused by *Puccinia* sp.

Plate 4. Stem rot of *Asparagus officinalis* caused by *Fusarium moniliforme* var. *intermedium*.

PLATE 3

PLATE 4

Plate 5. Leaf spot of *Catharanthus roseus* caused by *Colletotrichum gloeosporioides*.

Plate 6. Leaf spot of *Catharanthus roseus* caused by *Curvularia clavata*.

PLATE 5

PLATE 6

V. Coscinium fenestratum Colebr.

1. Leaf blight - C.O. Colletotrichum gloeosporioides (Penz.) Penz. & Sacc

The disease initially manifested as small, circular or oval, brown specks scattered over the leaf surface. These specks gradually enlarged and developed into distinct spots with light brown or ashy-grey centre, surrounded by dark brown margin. The size of the spots varied from 1.5 to 3.5 mm in diameter. The spots are surrounded by yellow halo. The adjoining spots coalesced to form irregular necrotic patches, causing blighting of the leaves.

VI. Costus speciosus (Koenig.) Sm.

1. Leaf spot - C.O. Curvularia lunata (Wakker) Boedijn

The symptoms initiated as small, greyish-brown spots with dark brown margin on the leaves. As the spots enlarged, yellow halo could be noticed around them. As the disease advanced, the centre of the spots became papery and got blown off, producing shot-holes on the leaves.

VII. Holostemma adakodien R.Br.

1. Leaf spot - C.O. Botryodiplodia theobromae Pat.

The disease initiated on the leaves as very small spots with ashy-grey centre and dark brown margin. As the disease advanced the centre of the spots became papery and got blown off, forming shot-holes.

Plate 7. Leaf blight of *Coscinium fenestratum* caused by *Colletotrichum gloeosporioides*.

Plate 8. Leaf spot of *Costus speciosus* caused by *Curvularia lunata*.

PLATE 7

PLATE 8

VIII. Plumbago indica (= P. rosea) Linn.

1. Leaf spot - C.O. Colletotrichum gloeosporioides (Penz) Penz.& Sacc. (Glomerella cingulata (Stonem.)Spauld.&Schrenk.)

The symptoms initiated as small brown specks on the leaves. These originated mostly from the tip or margin. The spots then enlarged in size, became almost circular in shape with grayish-brown centra and dark brown margin. Tha siza of the spots varied from 2 to 8 mm in diameter. As the leaves matured, the centra of the spots became papery and dropped off, producing shot-hole symptom. In severe cases of infection, defoliation was also noticed.

IX. Rauwolfia serpentina Benth. ex Kurz.

1. Anthracnosa-C.O. Colletotrichum gloeosporioides (Penz.) Penz & Sacc.

Tha symptoms initiated as small, circular, water-soaked lesions on tha leaves. Thase lesions later enlarged in size, became circular to irregular with sunken centre and raised margin. The size of the lesions varied from 5 to 10 mm in diameter. As the disease advanced, these lesions coalesced resulting in withering and drying of the leaves. Shot-hole symptoms were also seen on some leaves.

X. Spilanthes acmella Linn.

1. Leaf blight - C.O. Colletotrichum capsici (Sydow) Butler & Bisby.

The symptoms initiated as small brown spots which originated mostly from the tip or margin of the leaves.

Plate 9. Leaf spot of *Holostemma adakodien* caused by *Botryodiplodia theobromae*.

Plate 10. Leaf spot (and shot-hole) of *Plumbago indica* caused by *Colletotrichum gloeosporioides*.

PLATE 9

PLATE 10

Plate 11. Anthracnose of *Rauwolfia serpentina* caused by *Colletotrichum gloeosporioides*.

Plate 12. Leaf blight of *Spilanthes acmella* caused by *Colletotrichum capsici*.

PLATE 11

PLATE 12

The spots are generally surrounded by yellow halo. As the disease advanced, the spots enlarged in size and coalesced forming larger lesions. In severe cases of infection, the leaves dried and dropped off.

MORPHOLOGICAL CHARACTERS

1. Colletotrichum gloeosporioides (Penz.) Penz. & Sacc. (on Adhatoda beddomei)

Hyphae of the fungus are branched, septate and hyaline. The fungus produces acervuli in the culture medium. Acervuli are globose, dark and setate. Setae are 3 to 5 septate, dark brown in colour, tapering towards the apex and measure 96.8 to 126.4 μ x 3 to 5 μ in size. Conidiophores are nonseptate and hyaline. Conidia are single-celled, hyaline, straight, cylindrical with blunt ends and measure 10.3 to 17.2 μ x 2.6 to 3.4 μ in size.

2. Colletotrichum gloeosporioides (Penz.) Penz & Sacc (on Catharanthus rose

Hyphae are branched, septate and hyaline. Conidiophores are non-septate and hyaline. Conidia are single-celled, hyali straight, cylindrical with blunt ends and measure 12.0 to 20. x 3.4 to 5.2 μ in size.

3. Colletotrichum gloeosporioides Penz. (on Coscinium fenestratum)

The fungus produces profusely branched, septate and hyaline hyphae. Conidiophores are non-septate and hyaline.

Conidia are single-celled, hyaline, straight, cylindrical with blunt ends and measure 10.3 to 17.2 μ x 2.4 to 3.4 μ in size.

4. Colletotrichum gloeosporioides (Penz) Penz. & Sacc. (Glomerella cingulata (Stonem.) Spauld. & Schrenk.) (on Plumbago indica)

Hyphae of the fungus are branched, septate and hyaline. The fungus produces large number of acervuli in the culture medium. Acervuli are globose, dark brown to black and setate. Setae are 3 to 5 septate, dark brown, tapering towards the apex and measure 86.8 to 118.3 μ x 3.0 to 5.0 μ in size. Conidiophores are nonseptate and hyaline. Conidia are single-celled, hyaline, straight, cylindrical with blunt ends and measure 12.2 to 17.4 μ x 3.0 to 4.0 μ in size.

The fungus produces flask-shaped, dark brown to black perithecia in old cultures. The perithecia measure 142.0 to 268.0 μ in breadth and upto 326.4 μ in height. Asci are 58.7 to 64.3 μ x 10.6 to 13.4 μ in size. Ascospores are initially single-celled, become two celled at maturity, slightly curved and measure 13.2 to 22.6 μ x 3.4 to 5.1 μ in size.

5. Colletotrichum gloeosporioides (Penz.) Penz & Sacc (on Rauwolfia serpentina

Hyphae of the fungus are branched, septate and hyaline. The fungus produces numerous disc-shaped, setate acervuli in

Fig.1.

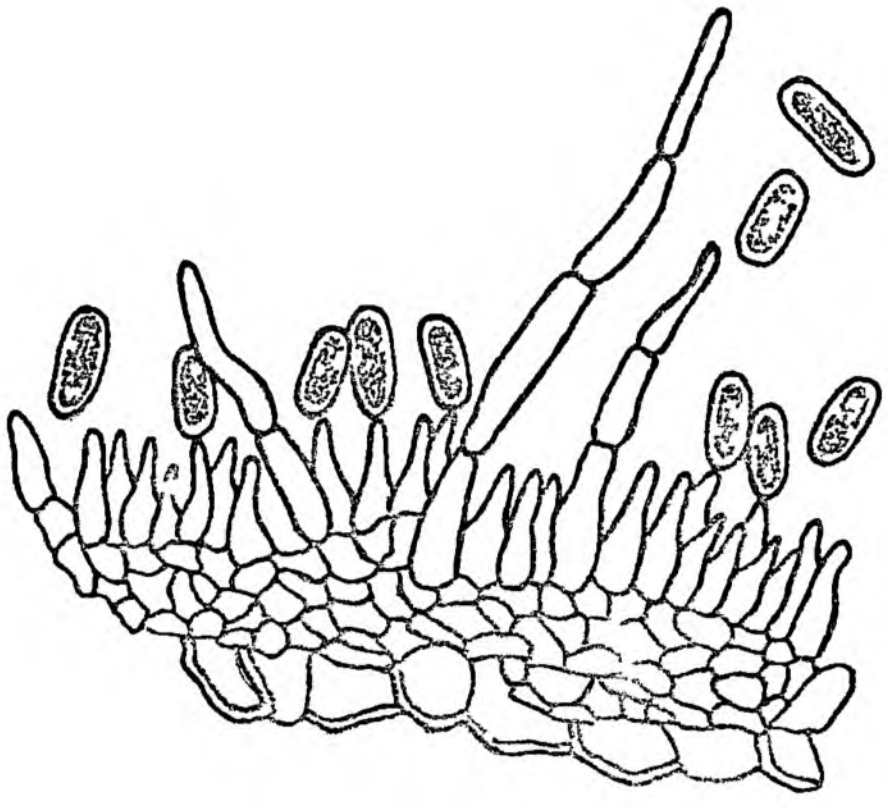
a. Acervulus of *Colletotrichum gloeosporioides* isolated from *Adhatoda beddomei*

b. Conidia of *Colletotrichum gloeosporioides* (*Adhatoda beddomei* isolate)

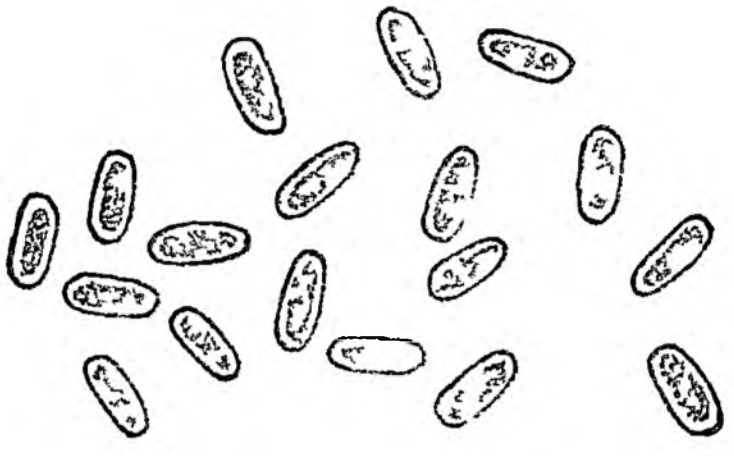
c. Conidia of *C. gloeosporioides* (*Catharanthus roseus* isolate)

d. Conidia of *C. gloeosporioides* (*Coscinium fenestratum* isolate)

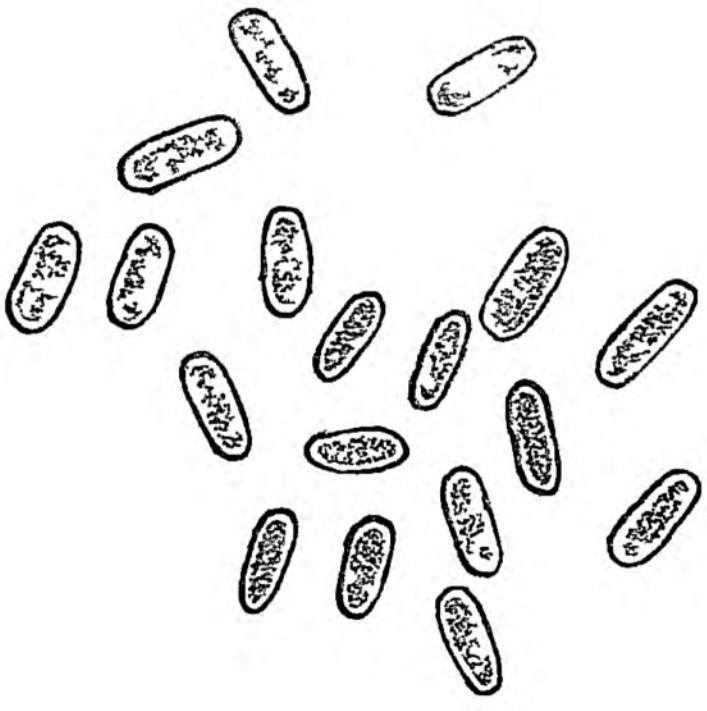
FIG 1



a



b



c

d

50μm

Fig. 2.

a. Conidia of *Colletotrichum gloeosporioides* (*Plumbago indica* isolate)

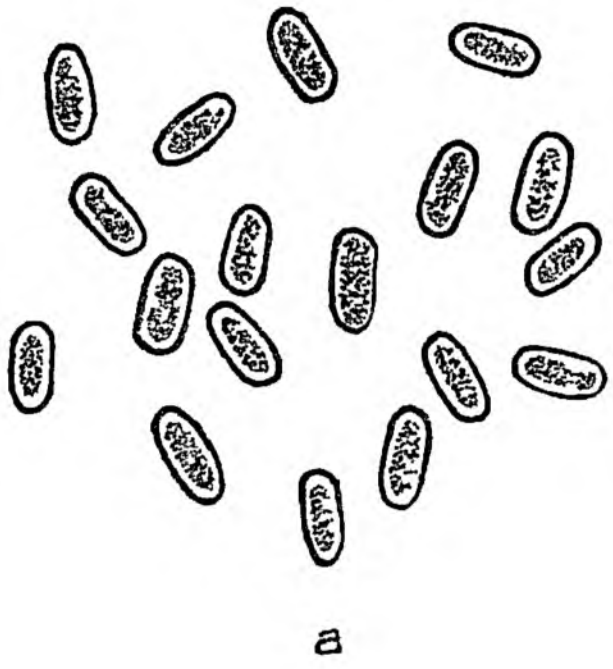
b. Conidia of *C. gloeosporioides* (*Rauwolfia serpentina* isolate)

c. Perithecium of *Glomerella cingulata* (*Plumbago indica* isolate)

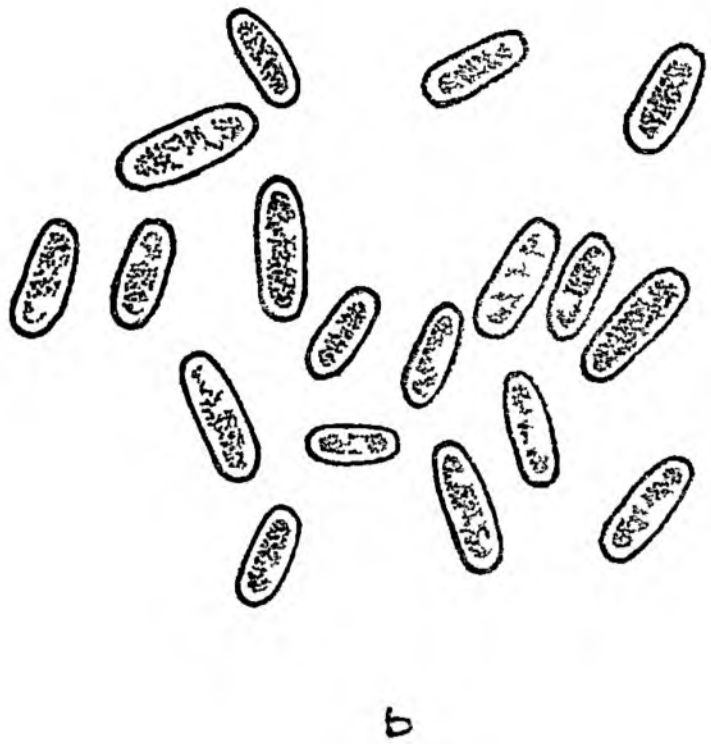
d. Ascus of *Glomerella cingulata*

e. Ascospores of *G. cingulata*

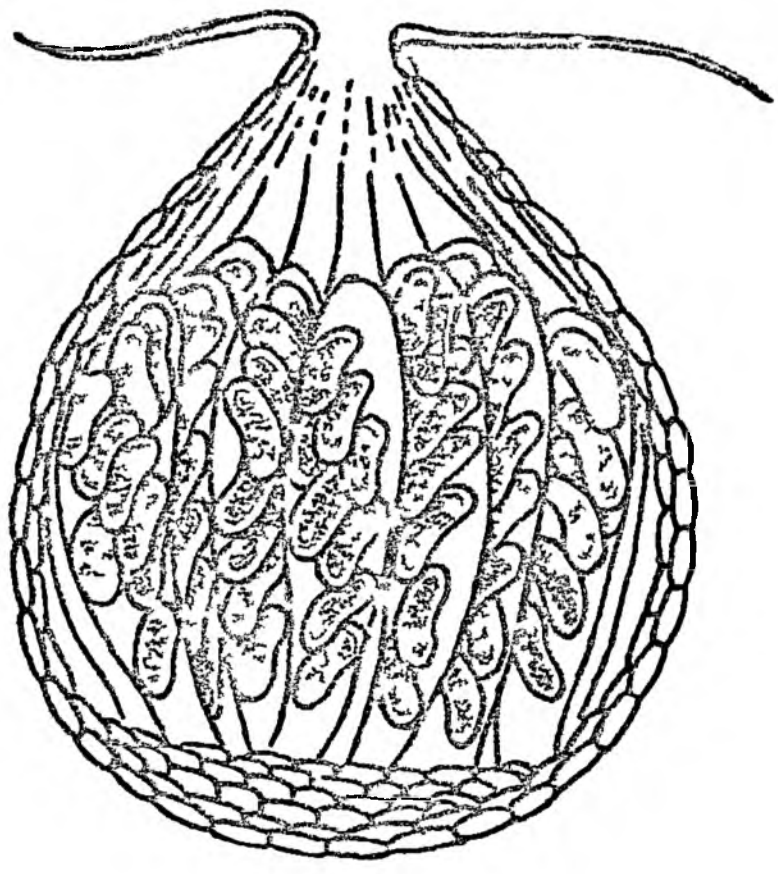
FIG 2



a



b



c

d

e

50 μm

Table 1. Comparative morphological characters of five isolates of Colletotrichum gloeosporioides from medicinal plants.

Host	Growth and sporulation on Potato dextrose agar.	Conidial measurements (μ)	
		Range (L x B)	Average (L x B)
Adhatoda beddomei	Colony greyish white with entire margin. Mycelium subaerial. Sporulation-poor	10.3 - 17.2 x 2.6 - 3.4	14.1 x 2.9
Catharanthus roseus	Colony dull white with entire margin. Mycelium subaerial. Sporulation-fair	12.0 - 20.0 x 3.4 - 4.2	15.6 x 4.1
Coscinium fenestratum	Colony dull white with entire margin. Mycelium cottony. Sporulation-good	10.3 - 17.2 x 2.4 - 3.4	14.2 x 2.9
Plumbago indica	Colony greyish white with entire margin. Mycelium subaerial. Sporulation-fair	12.2 - 17.4 x 3.0 - 4.0	15.2 x 3.4
Rauwolfia serpentina	Colony dull white with entire margin. Mycelium cottony. Sporulation-good	12.6 - 18.4 x 2.8 - 4.1	15.8 x 3.6

the culture medium. Setae are 3 to 5 septate, dark brown, tapering towards the apex and measuring 90.2 to 122.4 μ x 3.4 to 4.7 μ in size. Conidiophores are non-septate and hyaline. Conidia are single-celled, hyaline, straight, cylindrical with blunt ends and measure 12.6 to 18.4 μ x 2.8 to 4.1 μ in size.

6. Colletotrichum capsici (Sydow) Butler & Bisby (on Spilanthes acmella)

Hyphae are branched, septate and hyaline. The fungus produces numerous globose and setate acervuli on the culture medium. Setae are 3 to 4 septate, dark brown, tapering towards the apex and measure 132.2 to 196.4 μx 3.4 to 5.1 μ in size. Conidiophores are septate and hyaline. Conidia are single-celled, falcate with tapering ends, with a prominent oil globule and measure 12.0 to 24.0 μ x 4.2 to 4.8 μ in size.

7. Curvularia clavata Jain (on Catharanthus roseus)

Hyphae of the fungus are branched, septate and dark brown in colour. Conidiophores are septate and dark brown in colour. Conidia are 3- septate, dark brown to black, symmetrical and clavate. End cells of the conidia are paler than the middle ones. Conidia measure 12.0 to 20.6 μx 5.2 to 6.9 μ in size.

Plate 13. Acervuli of *Colletotrichum capsici*.

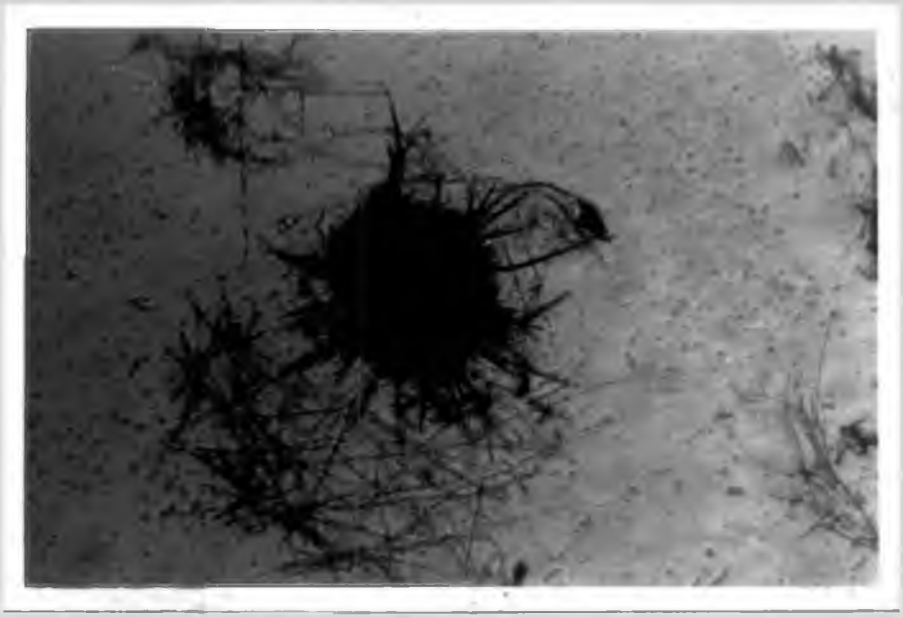


PLATE 13

8. Curvularia lunata (Wakker)Boedijn (on Costus speciosus)

Hyphae are branched, septate and dark brown in colour. Conidiophores are septate and dark brown in colour. Conidia are 3-septate, dark brown to black in colour and curved. End cells of the conidia are paler than the middle ones. The conidia measure 10.3 to 20.6 μ x 6.2 to 6.9 μ in size.

9. Botryodiplodia theobromae Pat.(on Holostemma adakodien)

Hyphae of the fungus are branched, septate and dark chocolate brown in colour. The fungus produces numerous pycnidia in the culture medium. Pycnidia are globular and black in colour. The pycnidiospores are initially one-celled, hyaline, smoothwalled and granular. On maturity, the spores become bicelled, pale brown in colour and measure 17.2 to 24.0 μ x 10.3 to 15.4 μ in size. Most of the bi-celled spores show longitudinal striations with a slight constriction at the septum.

10. Fusarium moniliforme var. intermedium Neish & Leggett (on Asparagus officinalis)

Hyphae of the fungus are branched, septate and hyaline. The fungus produces only micro-conidia in the culture medium. The conidia are single-celled, hyaline, egg-shaped and measure 5.1 to 8.5 μ x 1.7 to 3.4 μ in size.

Fig. 3.

a. Conidia of Colletotrichum capsici

b. Micro-conidia of Fusarium moniliforme var. intermedium

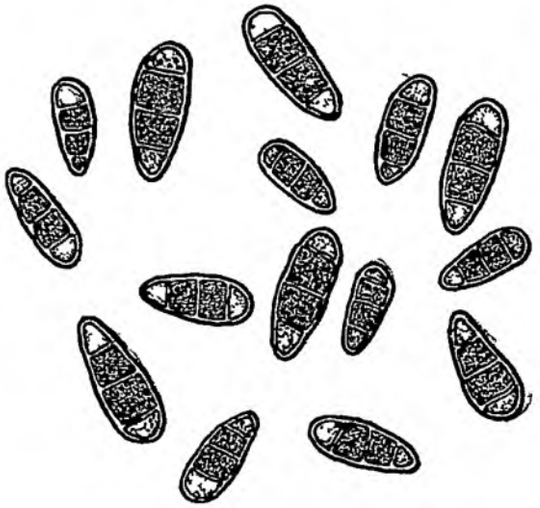
c. Conidia of Curvularia clavata

d. Conidia of Curvularia lunata

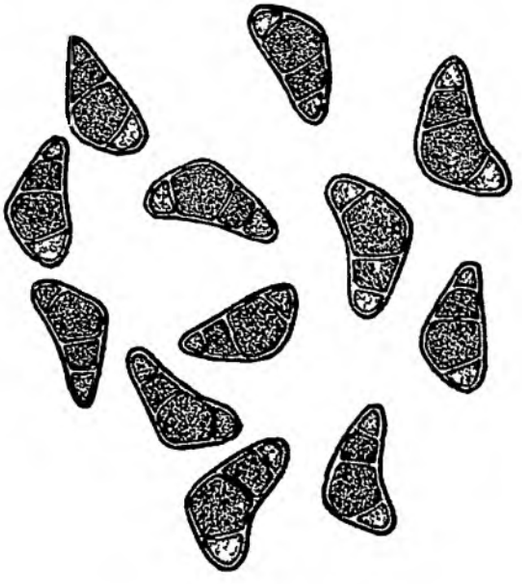
FIG 3

a

b



c



d

50 μm

Fig. 4.

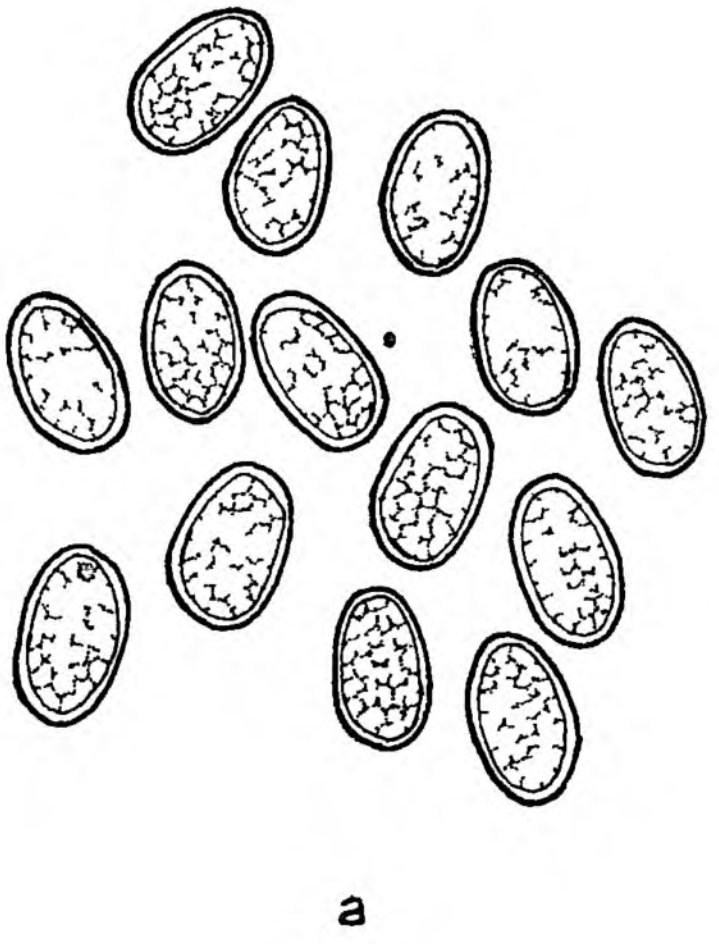
a. Pycnidiospores of *Botryodiplodia theobromae* (Single-celled spores)

b. Pycnidiospores of *B. theobromae* (Double-celled spores)

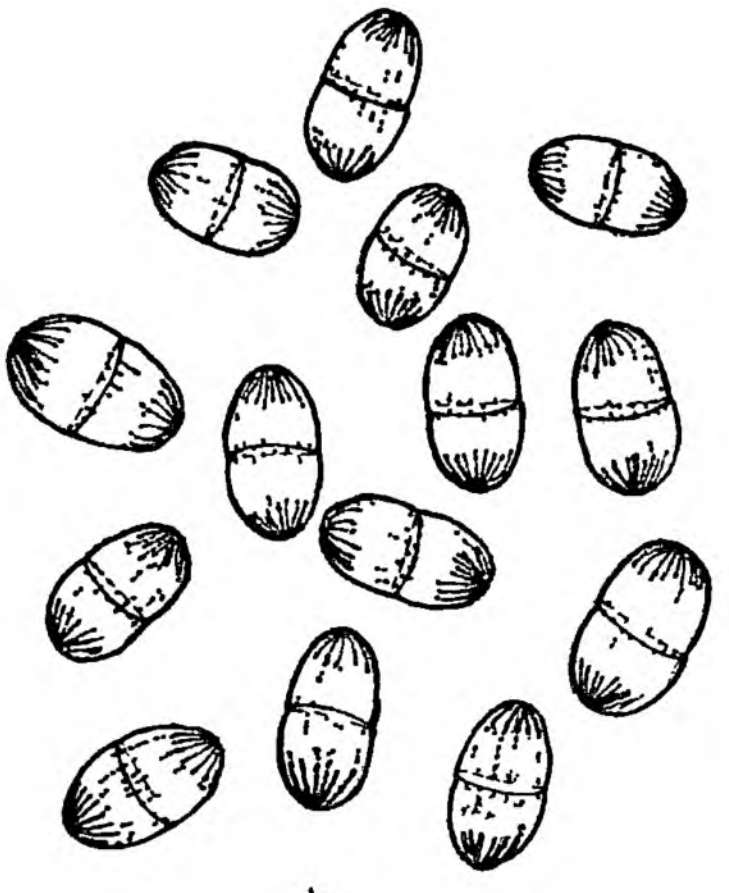
c. Uredospores of *Uromyces sparganii* ssp. *asiaticus*

d. Teliospores of *Puccania* sp.

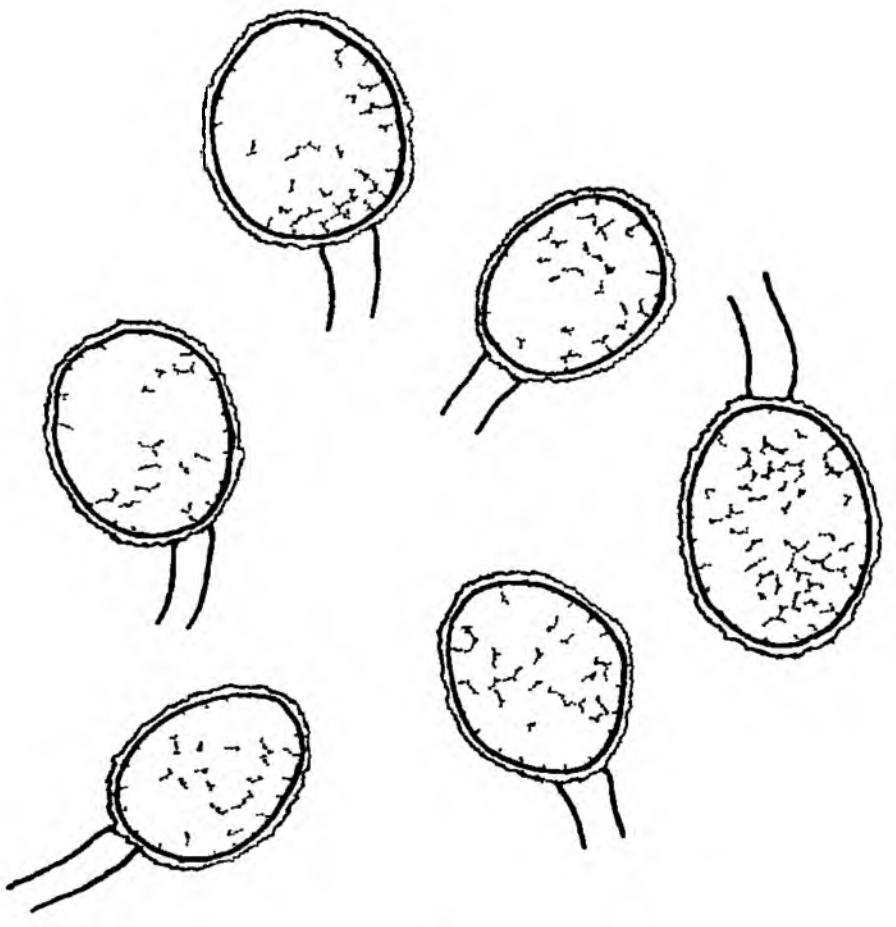
FIG 4



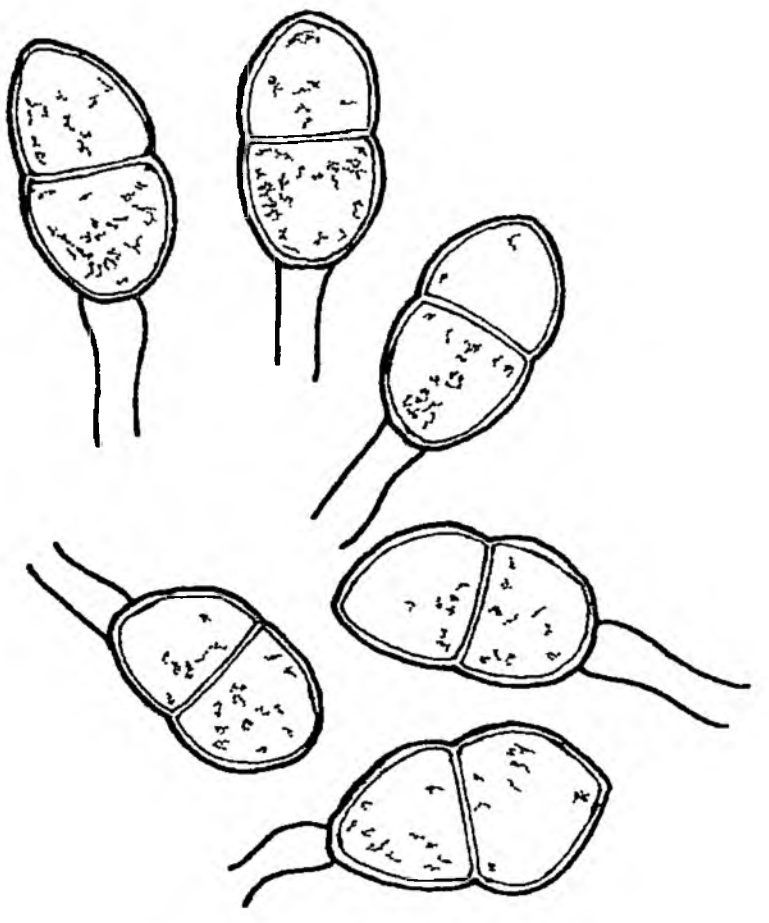
a



b



c



d

50 µm

11. Uromyces sparganii Clinton & Peck. ssp. asiaticus Parmelee & Saville (on Acorus calamus)

The fungus produces numerous rust pustules on the leaf, especially on the upper surface. Uredospores are stalked, single-celled, globoid, echinulate and golden-brown in colour. The uredospores measure 27.4 to 30.1 μ x 24.0 to 27.4 μ in size.

12. Puccinia sp. (on Adhatoda beddomei)

The fungus produces numerous teliosori on the under surface of the leaves. The rust sori are absent on the upper surface. Teliospores are stalked, two-celled with slight constriction at the septum, tapering towards the apex, smooth, reddish-brown in colour and measure 30.9 to 41.2 μ x 13.7 to 20.6 μ in size.

PATHOGENICITY

All the fungi (except Uromyces sparganii ssp. asiaticus and Puccinia sp.) were found to be pathogenic to their respective host plants when inoculated under artificial conditions. Symptoms as those observed in nature were produced within 6 to 10 days after inoculation.

When the five isolates of Colletotrichum gloeosporioides obtained from Adhatoda beddomei, Catharanthus roseus, Coscinium fenestratum, Plumbago indica and Rauwolfia serpentina were

Cross-inoculated, it was noticed that these isolates were cross-infective. The isolate from R. serpentina was found to be the most virulent, while that from A. beddomei the least.

GROWTH AND SPORULATION ON CULTURE MEDIA

(i) Colletotrichum gloeosporioides

Czapek's-Dox agar was found to be the best medium for the growth and sporulation of the fungus, followed by Richard's and Potato dextrose agar. Statistical analysis of the data showed that these three media do not differ significantly. Sabouraud's agar was found to be the least effective medium for the growth and sporulation of the fungus (Table 2).

(ii) Colletotrichum capsici

Best growth and sporulation of the fungus was obtained on Czapek's-Dox agar, and this medium was statistically superior to all other media tested. Though Sabouraud's agar was found to be the poorest medium for the growth of the fungus, this medium was found to be statistically on par with Potato dextrose agar and Coon's agar (Table 3).

(iii) Curvularia clavata

Czapek's-Dox agar and Oatmeal agar were found to be favouring good growth and sporulation of the fungus, followed

Table 2. Growth and sporulation of *Colletotrichum gloeosporioides* (Rauwolfia isolate) on different culture media

Sl. No.	Medium	*Mean colony diameter (mm)	Colony characters
1.	Coon's agar	78.00	Colony dull white, cottony with entire margin. Fair sporulation.
2.	Czapek's-Dox agar	90.00	Colony dull white, cottony. Mycelium subaerial. Good sporulation.
3.	Oatmeal agar	82.33	Colony dull white, thin with entire margin. Fair sporulation.
4.	Potato dextrose agar	88.33	Colony dull white, cottony with entire margin. Good sporulation.
5.	Richard's agar	89.00	Colony dull white, cottony with entire margin. Mycelium subaerial. Good sporulation.
6.	Sabouraud's agar	66.00	Colony dull white, thin with slightly wavy margin. Fair sporulation.

* Average of three replications.

FIG 5 GROWTH OF *Colletotrichum glaeosporioides* ON DIFFERENT CULTURE MEDIA

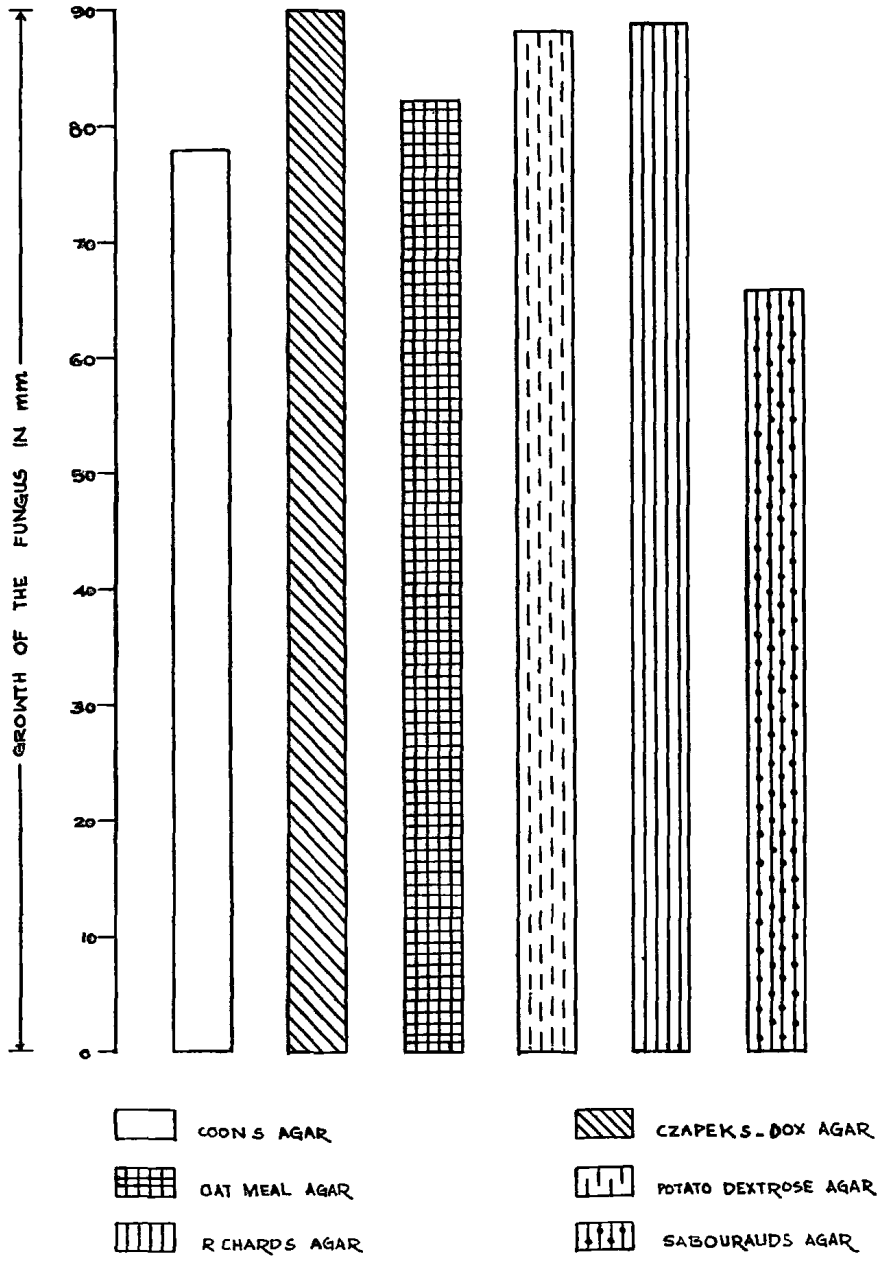


Table 3. Growth and sporulation of Colletotrichum capsici on different culture media

Sl. No.	Medium	*Mean colony diameter (mm)	Colony characters
1.	Coon's agar	72.33	Colony greyish-white. Mycelium subaerial with slightly wavy margin. Fair sporulation.
2.	Czapek's-Dox agar	90.00	Colony greyish-white. Mycelium subaerial. Good sporulation.
3.	Oatmeal agar	73.33	Colony greyish-white.Mycelium subaerial with wavy margin. Good sporulation.
4.	Potato dextrose agar	72.67	Colony greyish-white. Mycelium subaerial with entire margin. Good sporulation.
5.	Richard's agar	82.33	Colony greyish-white. Mycelium subaerial with entire margin. Good sporulation.
6.	Sabouraud's agar	68.67	Colony greyish-white. Mycelium subaerial with entire margin. Fair sporulation.

* Average of three replications.

FIG 6 GROWTH OF *Colletotrichum capsici* ON DIFFERENT CULTURE MEDIA

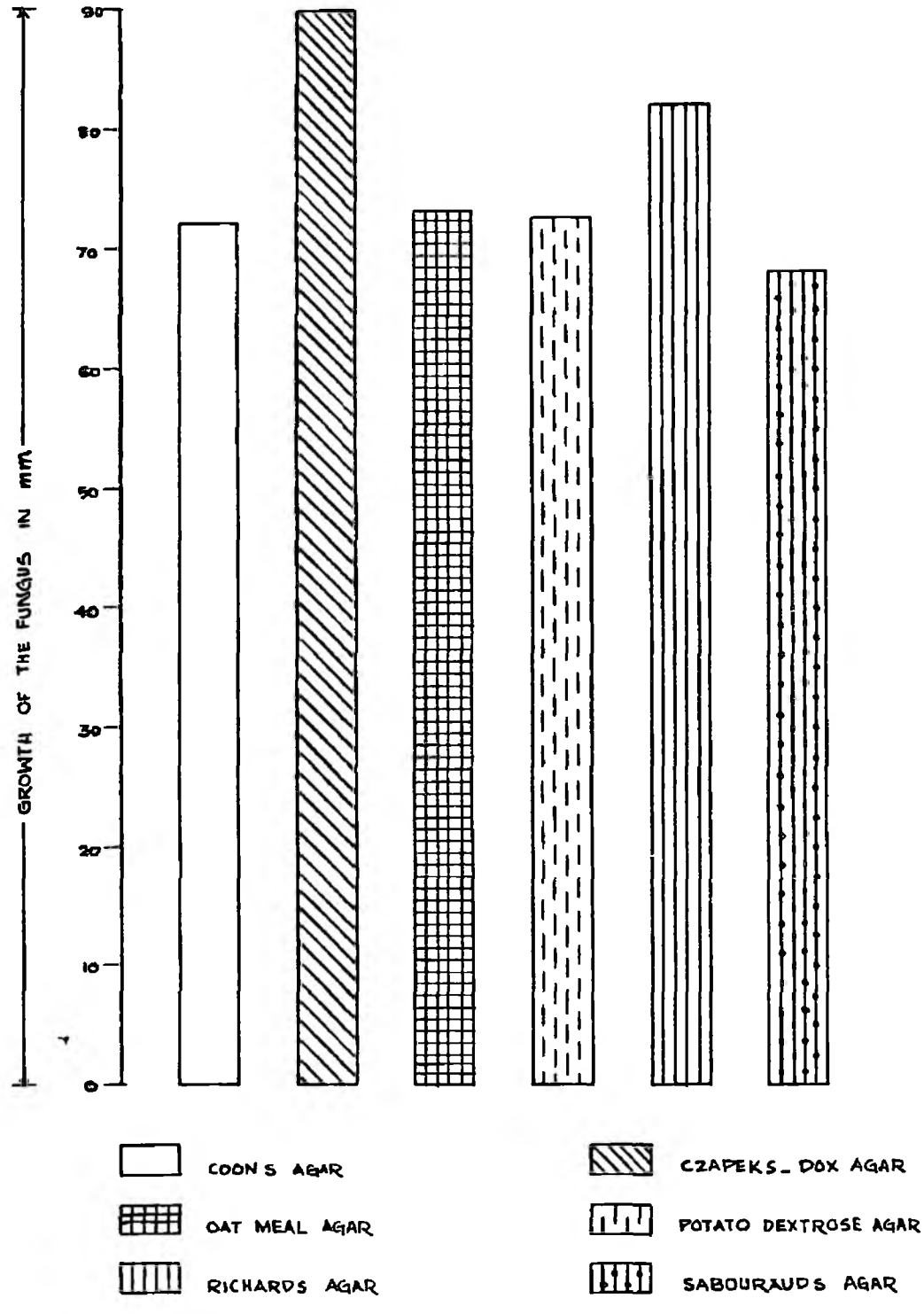
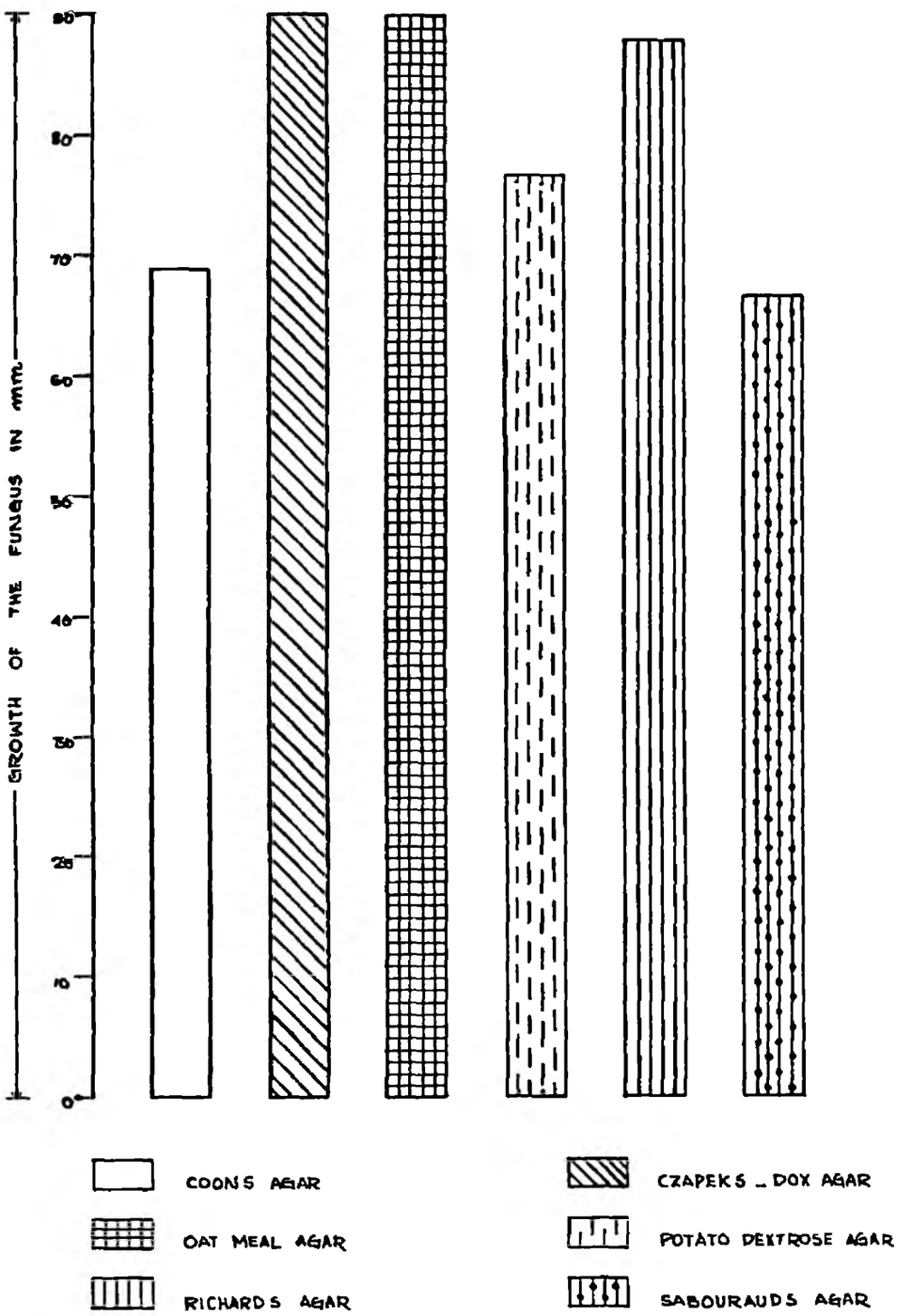


Table 4. Growth and sporulation of *Curvularia clavata* on different culture media

Sl. No.	Medium	*Mean colony diameter (mm)	Colony characters
1.	Coon's agar	68.67	Colony sooty black. Mycelium sub aerial with slightly wavy margin. Fair sporulation.
2.	Czapek's-Dox agar	90.00	Colony greyish-white at the margin and dark coloured at the centre. Mycelium sub aerial. Good sporulation.
3.	Oatmeal agar	90.00	Colony greyish-white at the margin and dark coloured at the centre. Mycelium sub aerial. Good sporulation.
4.	Potato dextrose agar	76.67	Colony sooty black.Mycelium sub aerial with wavy margin. Fair sporulation.
5.	Richard's agar	88.00	Colony greyish-white at the margin and dark coloured at the centre. Mycelium sub aerial with entire margin. Good sporulation.
6.	Sabouraud's agar	66.67	Colony sooty black.Mycelium sub aerial with wavy margin. Fair sporulation.

* Average of three replications.

FIG 7 GROWTH OF *Curvularia clavata* ON DIFFERENT CULTURE MEDIA



by Richard's agar. Statistical analysis of the data showed that these three media were on par in supporting the growth of the fungus. Growth of the fungus on Sabouraud's agar was the poorest though it was found to be statistically on par with Coon's agar (Table 4).

(iv) Curvularia lunata

Czapek's-Dox agar, Oatmeal agar and Richard's agar were found to be equally effective for the growth and sporulation of the fungus, and were significantly superior to all other media tested. Sabouraud's agar and Coon's agar were found to be least effective for the growth of the fungus (Table 5).

(v) Botryodiplodia theobromae

Czapek's-Dox agar, Oatmeal agar and Potato dextrose agar supported good growth and sporulation of the fungus. Sabouraud's agar was found to be the poorest medium (Table 6).

(vi) Fusarium moniliforme var. intermedium

Very good growth and sporulation of the fungus was obtained on Czapek's-Dox agar and Richard's agar, followed by Coon's agar. These three media were significantly superior to other media tested. Oatmeal agar produced only very little growth and sporulation (Table 7).

Table 5. Growth and sporulation of Curvularia lunata on different culture media

Sl. No.	Medium	*Mean colony diameter (mm)	Colony characters
1.	Coon's agar	70.33	Colony black. Mycelium sub aerial with wavy margin. Fair sporulation.
2.	Czapek's-Dox agar	90.00	Colony black at the centre and greyish-white at the margin. Mycelium sub aerial. Good sporulation.
3.	Oatmeal agar	90.00	Colony black at the centre and grevish-white at the margin. Mycelium sub aerial. Good sporulation.
4.	Potato dextrose agar	78.67	Colony sooty black.Mycelium growing as a puffy mass in the centre. Fair sporulation.
5.	Richard's agar	90.00	Colony black at the centre and greyish-white at the margin. Mycelium sub aerial. Good sporulation.
6.	Sabouraud's agar	68.67	Colony black. Mycelium sub aerial with wavy margin. Fair sporulation.

* Average of three replications.

FIG 8 GROWTH OF *Curvularia lunata*

ON DIFFERENT CULTURE MEDIA

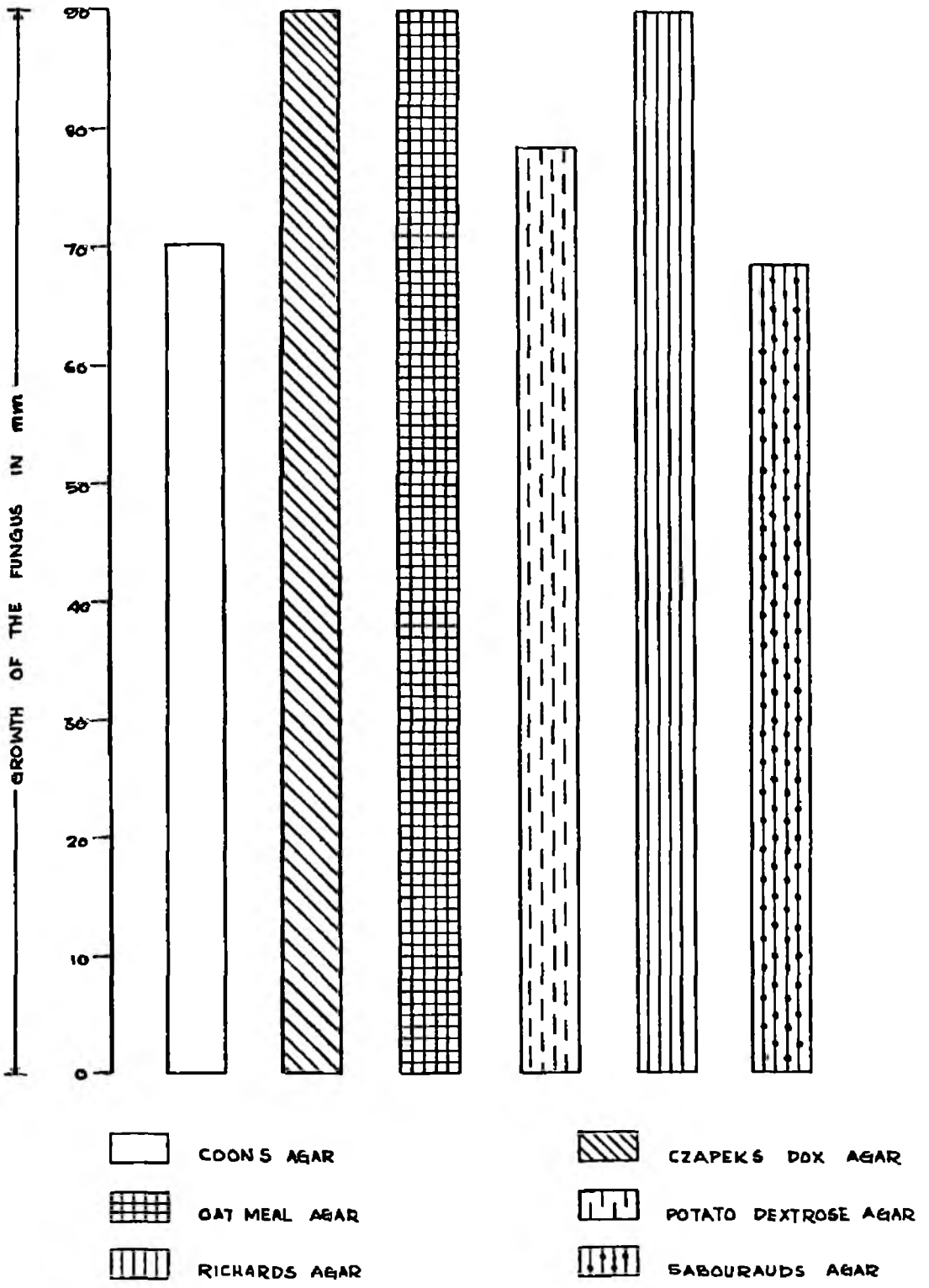


Table 6. Growth and sporulation of Botryodiplodia theobromae on different culture media

Sl. No.	Medium	*Mean colony diameter (mm)	Colony characters
1.	Coon's agar	81.00	Colony greyish white.Mycelium sub aerial with entire margin. Fair sporulation.
2.	Czapek's Dox agar	90.00	Colony greyish white. Mycelium sub aerial. Good sporulation.
3.	Oatmeal agar	90.00	Colony dark grey at the centre and light grey towards the margin. Mycelium aerial. Good sporulation.
4.	Potato dextrose agar	90.00	Colony grey coloured with light grey margin. Mycelium aerial. Good sporulation.
5.	Richard's agar	83.33	Colony whitish. Mycelium sub aerial with slightly wavy margin. Fair sporulation.
6.	Sabouraud's agar	73.33	Colony whitish, appearing as a thin layer over the medium with entire margin. Fair sporulation.

* Average of three replications.

FIG 9 GROWTH OF *Botryodiplodia theobromae* ON DIFFERENT CULTURE MEDIA

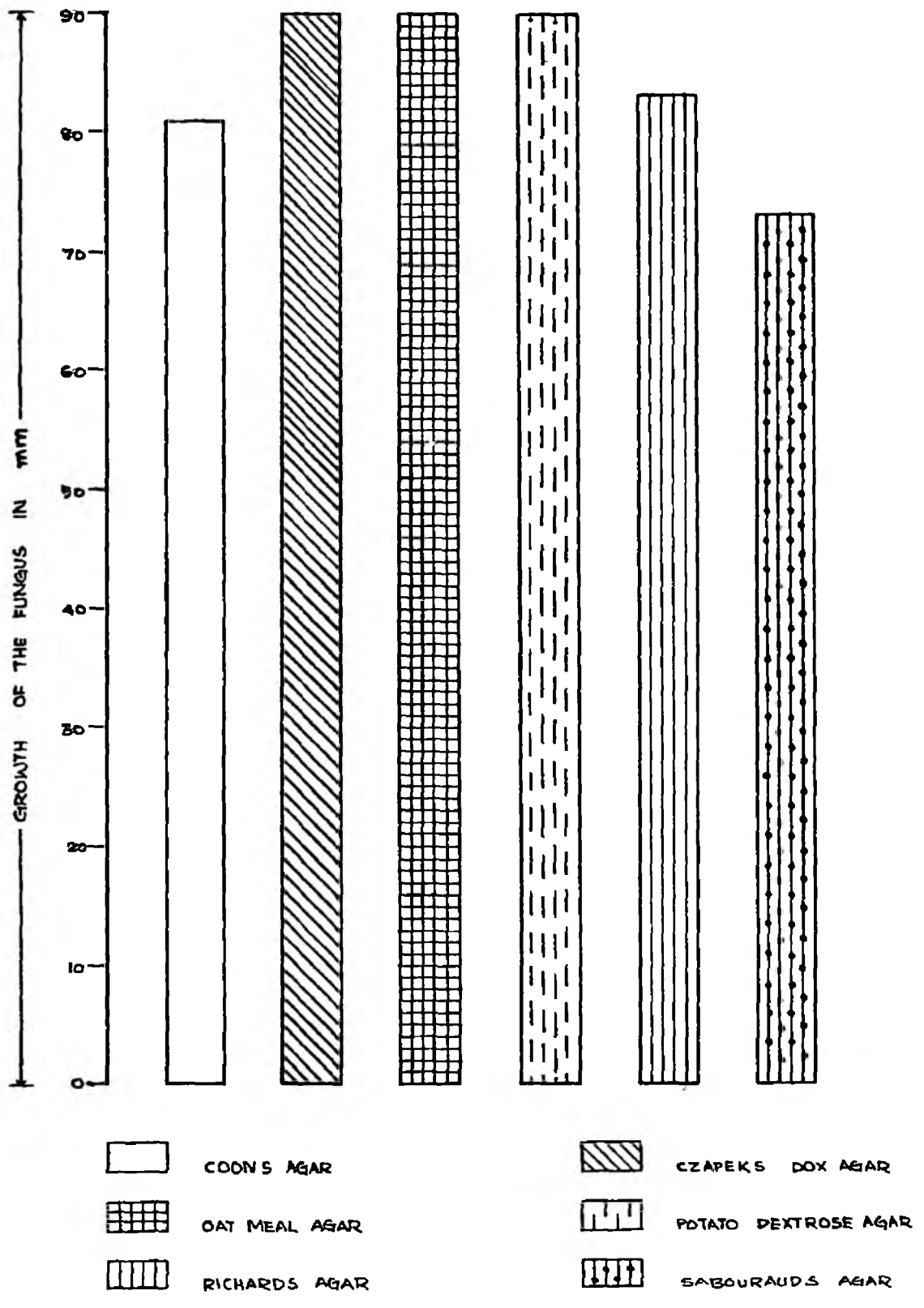
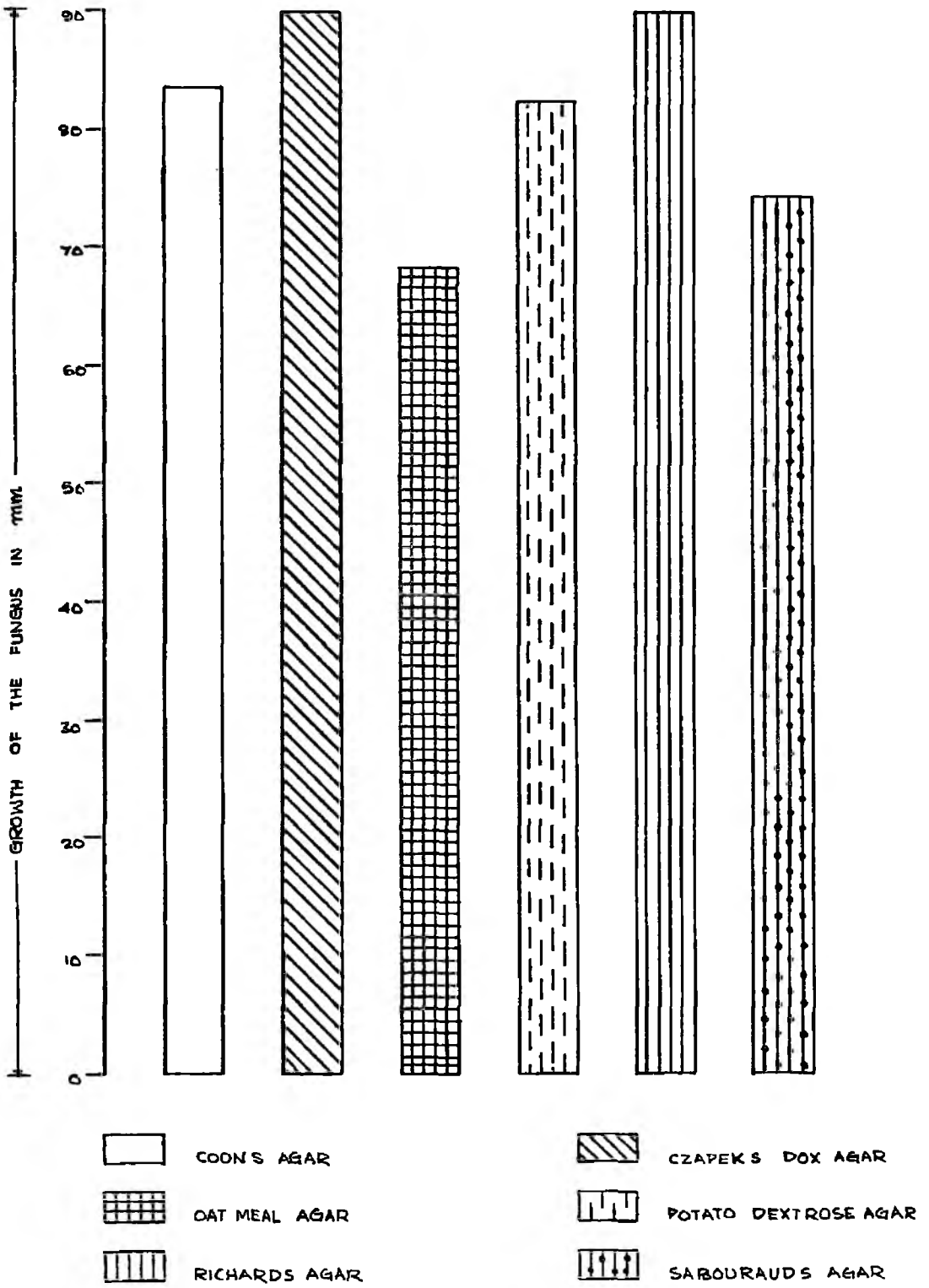


Table 7. Growth and sporulation of Fusarium moniliforme var. intermedium on different culture media

Sl. No.	Medium	*Mean colony diameter (mm)	Colony characters
1.	Coon's agar	86.67	Colony snowy white at the margin and pinkish in the centre. Good sporulation.
2.	Czapek's-Dox agar	90.00	Colony snowy white. Mycelium sub aerial. Good sporulation.
3.	Oatmeal agar	68.33	Colony pinkish white, appearing as a thin layer over the medium. Poor sporulation.
4.	Potato dextrose agar	82.67	Colony snowy white at the margin and slightly pink coloured at the centre. Fair sporulation.
5.	Richard's agar	90.00	Colony snowy white. Mycelium sub aerial. Good sporulation.
6.	Sabouraud's agar	74.33	Colony white coloured, appearing as a thin layer over the medium. Fair sporulation.

* Average of three replications.

FIG 10 GROWTH OF *Fusarium moniliforme* var *intermedium* ON DIFFERENT CULTURE MEDIA



IN VITRO EVALUATION OF FUNGICIDES

A. Inhibition of spore germination

(i) Colletotrichum gloeosporioides

Bordeaux mixture, Dithane M-45 and Foltaf caused cent per cent inhibition of spore germination at 6 and 24 hours after incubation. In the above three fungicides, complete inhibition was obtained even at 50 ppm concentration, except in the case of Bordeaux mixture, wherein only 98.4 per cent inhibition was noticed when observations were taken at 24 hours after incubation. Cuman L at 200 ppm concentration also caused complete inhibition of spore germination. Fytolan was found to have the least inhibitory effect on the spore germination of the fungus. The data are presented in Table 8.

(ii) Colletotrichum capsici

Bordeaux mixture, Cuman L, Dithane M-45 and Foltaf caused cent per cent inhibition at 6 and 24 hours after incubation. In the above four fungicides, complete inhibition of spore germination was obtained even at 50 ppm concentration, except in the case of Cuman L, wherein only 95.2 per cent inhibition was noticed at 24 hours after incubation. Carbistin at 200 ppm also caused complete inhibition. Fytolan was found to be the least effective fungicide. The data are presented in Table 9.

Table 8. Effect of different fungicides on the spore germination of *Colletotrichum gloeosporioides* (*Rauwolfia* isolate)

Sl. No.	Treatment	Per cent inhibition of spore germination after					
		6 hours			24 hours		
		50 ppm	100 ppm	200 ppm	50 ppm	100 ppm	200 ppm
1.	Bordeaux mixture	100.0	100.0	100.0	98.4	100.0	100.0
2.	Carbistin	89.4	96.8	100.0	84.6	90.4	98.7
3.	Cuman L	92.4	100.0	100.0	89.8	97.6	100.0
4.	Dithane M-45	100.0	100.0	100.0	100.0	100.0	100.0
5.	Foltaf	100.0	100.0	100.0	100.0	100.0	100.0
6.	Fytolan	62.4	76.7	82.3	58.7	69.9	78.8
7.	Control	4.0	4.0	4.0	2.3	2.3	2.3

Table 9. Effect of different fungicides on the spore germination of *Colletotrichum capsici*

Sl. No.	Treatment	Per cent inhibition of spore germination after					
		6 hours			24 hours		
		50 ppm	100 ppm	200 ppm	50 ppm	100 ppm	200 ppm
1.	Bordeaux mixture	100.0	100.0	100.0	100.0	100.0	100.0
2.	Carbistin	94.2	100.0	100.0	92.2	98.6	100.0
3.	Cuman L	100.0	100.0	100.0	95.2	100.0	100.0
4.	Dithane M-45	100.0	100.0	100.0	100.0	100.0	100.0
5.	Foltaf	100.0	100.0	100.0	100.0	100.0	100.0
6.	Fytolan	86.8	90.2	94.6	83.4	87.8	92.2
7.	Control	4.5	4.5	4.5	2.5	2.5	2.5

(iii) Curvularia clavata

Foltaf caused cent per cent inhibition of spore germination at 50 ppm concentration, whereas Bordeaux mixture could effect cent per cent inhibition only when observations were taken at 6 hours after incubation. However, Boardeaux mixture at 100 ppm and Dithane M-45 at 200 ppm caused complete inhibition of spore germination at 6 and 24 hours after incubation. Among the fungicides tested, Carbistin was found to be the least effective. The data are presented in Table 10.

(iv) Curvularia lunata

Foltaf (50 ppm), Bordeaux mixture (100 ppm) and Dithane M-45 (200 ppm) caused cent per cent inhibition of spore germination of the fungus. Cuman L and Fytolan, at 200 ppm concentrations, effected complete inhibition only at 6 hours after incubation. Among the fungicides tested, Carbistin was found to be the least effective. The data are presented in Table 11.

(v) Botryodiplodia theobromae

Bordeaux mixture, Dithane M-45 and Foltaf caused cent per cent inhibition of germination of single-celled spores of the fungus. In the above three fungicides, complete inhibition was obtained even at 50 ppm concentration, except in the case of Bordeaux mixture, wherein only

Table 10. Effect of different fungicides on the spore germination of *Curvularia clavata*

Sl. No.	Treatment	Per cent inhibition of spore germination after					
		6 hours			24 hours		
		50 ppm	100 ppm	200 ppm	50 ppm	100 ppm	200 ppm
1.	Bordeaux mixture	100.0	100.0	100.0	94.8	100.0	100.0
2.	Carbistin	32.4	47.2	50.5	29.2	37.3	42.1
3.	Cuman L	75.6	94.4	100.0	71.6	88.2	98.4
4.	Dithane M-45	91.4	100.0	100.0	89.2	97.8	100.0
5.	Foltaf	100.0	100.0	100.0	100.0	100.0	100.0
6.	Fytolan	86.8	94.4	100.0	81.2	89.8	97.6
7.	Control	7.0	7.0	7.0	5.0	5.0	5.0

Table 11. Effect of different fungicides on the spore germination of *Curvularia lunata*

Sl. No.	Treatment	Per cent inhibition of spore germination after					
		6 hours			24 hours		
		50 ppm	100 ppm	200 ppm	50 ppm	100 ppm	200 ppm
1.	Bordeaux mixture	100.0	100.0	100.0	93.5	100.0	100.0
2.	Carbistin	34.5	46.8	51.7	28.2	34.7	41.3
3.	Cuman L	73.8	92.3	100.0	70.5	86.0	98.0
4.	Dithane M-45	89.3	98.5	100.0	86.2	94.6	100.0
5.	Foltaf	100.0	100.0	100.0	100.0	100.0	100.0
6.	Fytolan	88.5	94.6	100.0	82.3	91.4	98.2
7.	Control	8.0	8.0	8.0	6.0	6.0	6.0

96.8 per cent inhibition was noticed when observations were taken at 24 hours after incubation. Carbistin at 200 ppm concentration also caused complete inhibition. Fytolan was found to have the least inhibitory effect on the germination of single-celled spores of the fungus. The data are presented in Table 12.

In the case of double-celled spores, Foltaf effected cent per cent inhibition of germination at 50 ppm concentration whereas Dithane M-45 could effect cent per cent inhibition only when observations were taken at 6 hours after incubation. Bordeaux mixture (200 ppm) and Dithane M-45 (100 ppm) also caused complete inhibition of spore germination. Here too, Fytolan was found to be the least effective fungicide. The data are presented in Table 13.

(vi) Fusarium moniliforme var. intermedium

Bordeaux mixture, Dithane M-45 and Foltaf caused cent per cent inhibition of spore germination. These fungicides were effective even at 50 ppm concentration. Cuman L at 200 ppm concentration also caused complete inhibition of spore germination. Fytolan was found to be the least effective fungicide. The data are presented in Table 14.

Table 12. Effect of different fungicides on the spore germination of Botryodiplodia theobromae (Single-celled spores)

Sl. No.	Treatment	Per cent inhibition of spore germination after					
		6 hours			24 hours		
		50 ppm	100 ppm	200 ppm	50 ppm	100 ppm	200 ppm
1.	Bordeaux mixture	98.0	100.0	100.0	96.8	100.0	100.0
2.	Carbistin	79.0	91.2	100.0	73.4	87.1	100.0
3.	Cuman L	74.5	83.6	93.4	72.4	81.4	90.1
4.	Dithane M-45	100.0	100.0	100.0	100.0	100.0	100.0
5.	Foltaf	100.0	100.0	100.0	100.0	100.0	100.0
6.	Fytolan	56.0	72.3	92.5	50.4	66.2	88.4
7.	Control	6.0	6.0	6.0	4.5	4.5	4.5

Table 13. Effect of different fungicides on the spore germination of Botryodiplodia theobromae (Double-celled spores)

Sl. No.	Treatment	Per cent inhibition of spore germination after					
		6 hours			24 hours		
		50 ppm	100 ppm	200 ppm	50 ppm	100 ppm	200 ppm
1.	Bordeaux mixture	92.1	100.0	100.0	85.6	96.5	100.0
2.	Carbistin	62.4	83.4	96.8	60.2	76.0	93.2
3.	Cuman L	63.3	72.2	81.8	61.1	67.6	78.1
4.	Dithane M-45	100.0	100.0	100.0	92.6	100.0	100.0
5.	Foltaf	100.0	100.0	100.0	100.0	100.0	100.0
6.	Fytolan	32.6	54.3	58.6	30.4	48.7	65.3
7.	Control	8.0	8.0	8.0	6.0	6.0	6.0

Table 14. Effect of different fungicides on the spore germination of *Fusarium moniliforme* var. *intermedium*

Sl. No.	Treatment	Per cent inhibition of spore germination after					
		6 hours			24 hours		
		50 ppm	100 ppm	200 ppm	50 ppm	100 ppm	200 ppm
1.	Bordeaux mixture	100.0	100.0	100.0	100.0	100.0	100.0
2.	Carbistin	86.8	94.3	100.0	82.7	92.1	98.2
3.	Cuman L	88.0	94.0	100.0	81.2	92.0	100.0
4.	Dithane M-45	100.0	100.0	100.0	100.0	100.0	100.0
5.	Foltaf	100.0	100.0	100.0	100.0	100.0	100.0
6.	Fytolan	68.6	76.9	86.9	64.1	70.9	82.1
7.	Control	8.0	8.0	8.0	4.5	4.5	4.5

B. Inhibition of growth (Poisoned food technique)

(i) Colletotrichum gloeosporioides

Complete inhibition of growth of the fungus was obtained on Czapek's-Dox agar medium containing 2500 ppm Bordeaux mixture, 500 ppm Carbistin, 2000 ppm Cuman L and 1000 ppm Dithane M-45. Foltaf and Fytolan could not effect complete inhibition even at the highest concentration tested (Table 15).

(ii) Colletotrichum capsici

Complete inhibition of growth of the fungus was obtained on the medium containing 2500 ppm Bordeaux mixture, 250 ppm Carbistin and 2000 ppm each of Cuman L, Dithane M-45 and Fytolan. Foltaf could not effect complete inhibition of growth even at the highest concentration tested (Table 16).

(iii) Curvularia clavata

Growth of the fungus was completely inhibited by 2500 ppm Bordeaux mixture and 2000 ppm each of Cuman L and Dithane M-45. Carbistin, Foltaf and Fytolan were not able to cause complete inhibition of the mycelial growth of the fungus even at the highest concentration tested. Carbistin exhibited the least inhibitory effect on the growth of the fungus (Table 17).

Table 15. Effect of different fungicides on the radial growth of *Colletotrichum gloeosporioides* (*Rauwolfia* isolate) (poisoned food technique)

Sl. No.	Treatment	Concentration of fungicide (ppm)	*Mean colony diameter (mm)	Percentage inhibition over control $\frac{(C - T)}{C} \times 100$
1.	Bordeaux mixture	2500	0.00	100.00
		5000	0.00	100.00
		10000	0.00	100.00
2.	Carbistin	250	4.67	94.81
		500	0.00	100.00
		1000	0.00	100.00
3.	Cuman L	1000	16.33	81.86
		2000	0.00	100.00
		3000	0.00	100.00
4.	Dithane M-45	1000	0.00	100.00
		2000	0.00	100.00
		3000	0.00	100.00
5.	Foltaf	1000	14.33	84.08
		2000	12.33	86.30
		3000	8.33	90.74
6.	Fytolan	1000	42.67	52.59
		2000	35.33	60.74
		3000	30.33	66.30
7.	Control	-	90.00	

* Average of three replications

FIG II EFFECT OF FUNGICIDES ON THE GROWTH OF *Colletotrichum gloeosporioides* ON SOLID MEDIUM

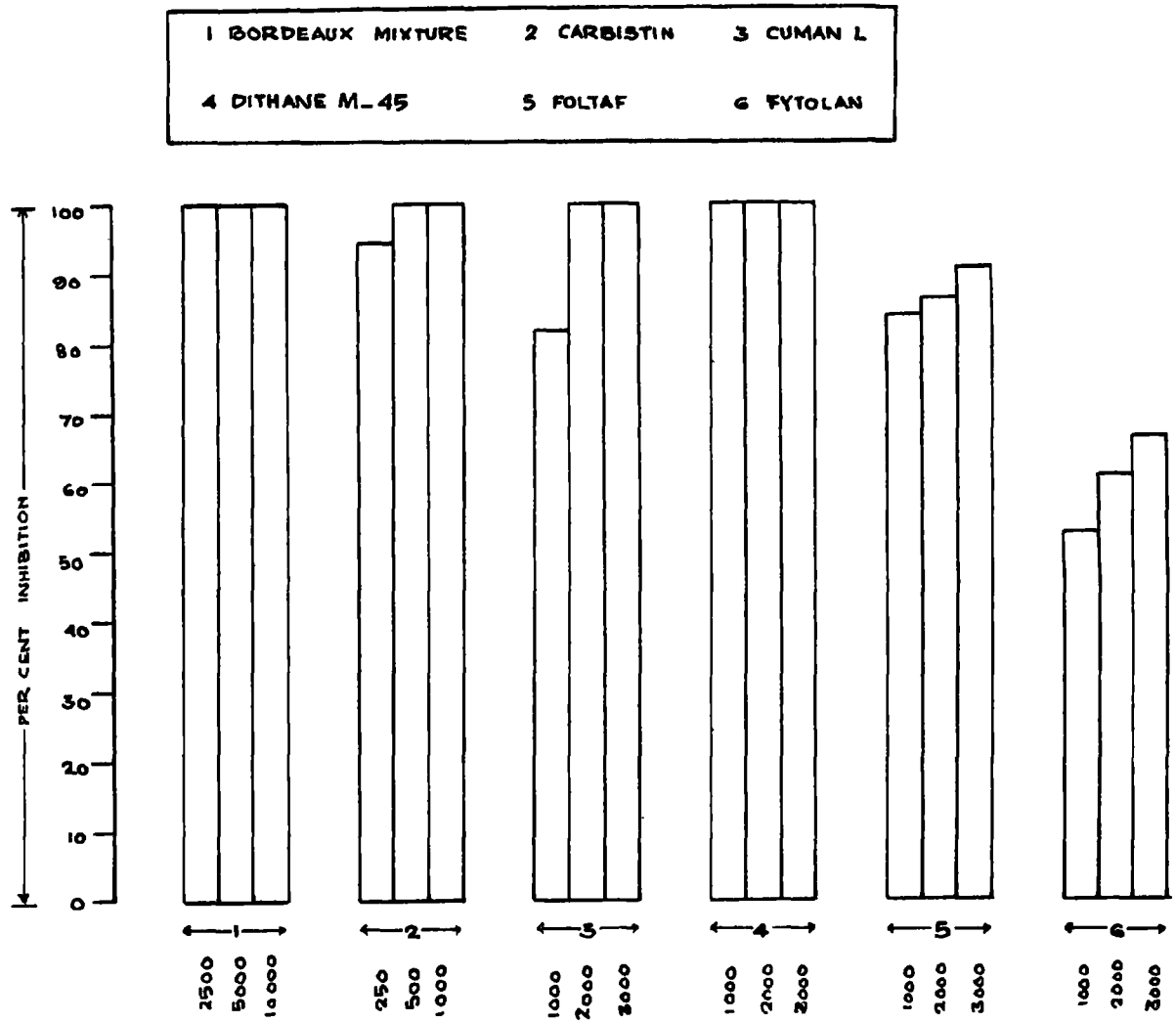


Plate 14. Effect of Bordeaux mixture on the growth of Colletotrichum gloeosporioides on Czapek's-Dox agar.

Plate 15. Effect of Lithane M-45 on the growth of Colletotrichum gloeosporioides on Czapek's-Dox agar.

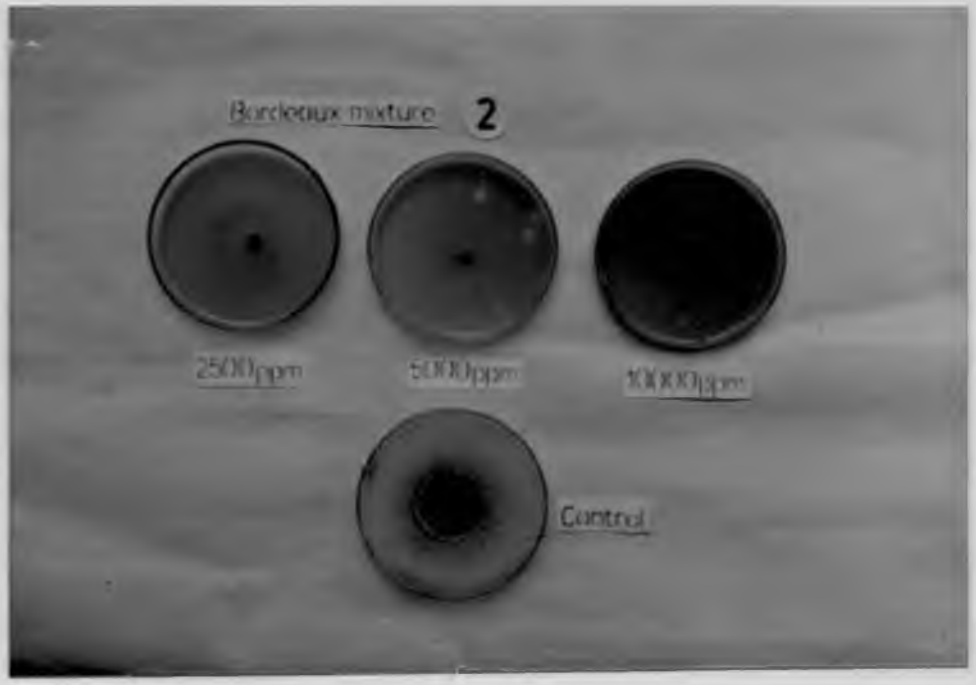


PLATE 14

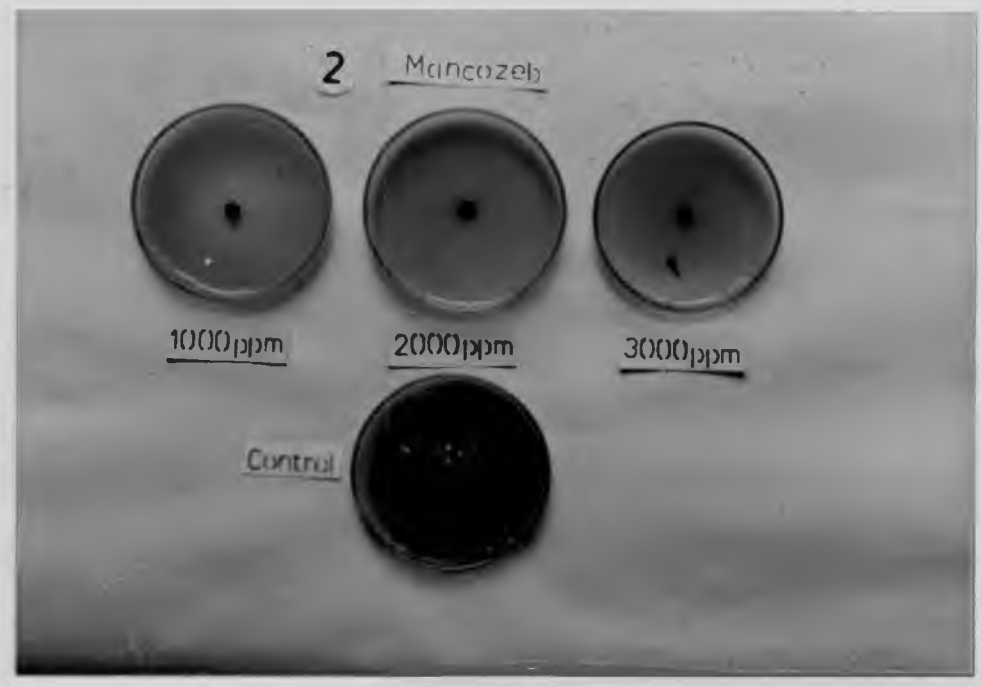


PLATE 15

Table 16. Effect of different fungicides on the radial growth of Colletotrichum capsici (poisoned food technique)

Sl. No.	Treatment	Concentration of fungicide (ppm)	*Mean colony diameter (mm)	Percentage inhibition over control $(\frac{C-T}{C}) \times 100$
1.	Bordeaux mixture	2500	0.00	100.00
		5000	0.00	100.00
		10000	0.00	100.00
2.	Carbistin	250	0.00	100.00
		500	0.00	100.00
		1000	0.00	100.00
3.	Cuman L	1000	9.33	89.63
		2000	0.00	100.00
		3000	0.00	100.00
4.	Dithane M-45	1000	9.00	90.00
		2000	0.00	100.00
		3000	0.00	100.00
5.	Foltaf	1000	14.67	83.70
		2000	11.67	87.03
		3000	7.67	91.48
6.	Fytolan	1000	7.67	91.48
		2000	0.00	100.00
		3000	0.00	100.00
7.	Control	-	90.00	-

* Average of three replications

FIG 12. EFFECT OF FUNGICIDES ON THE GROWTH OF *Colletotrichum capsici* ON SOLID MEDIUM

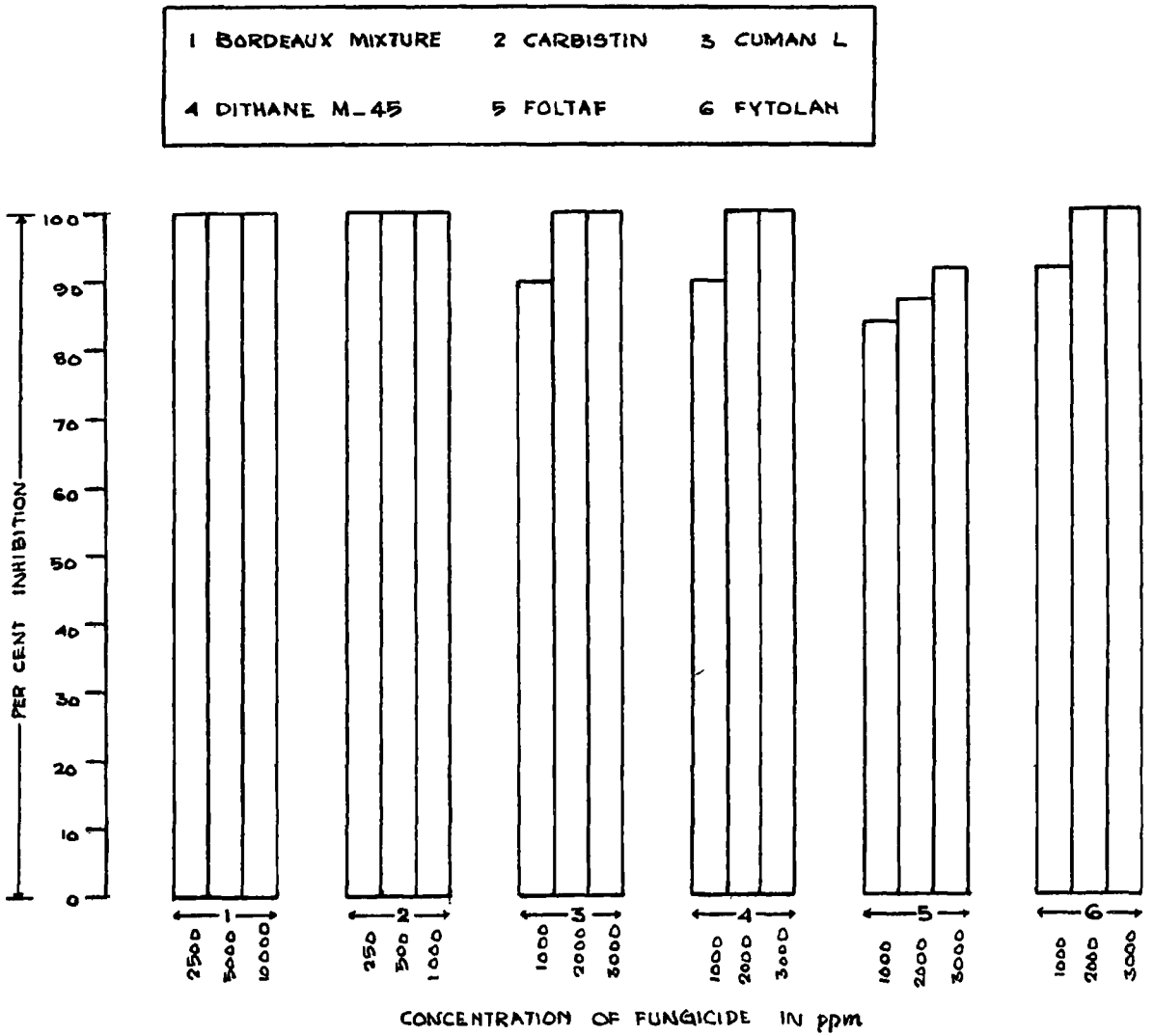


Plate 16. Effect of Bordeaux mixture on the growth of *Colletotrichum capsici* on Czapek's-Dox agar.

Plate 17. Effect of Carbistin on the growth of *Colletotrichum capsici* on Czapek's-Dox agar.

PLATE 16

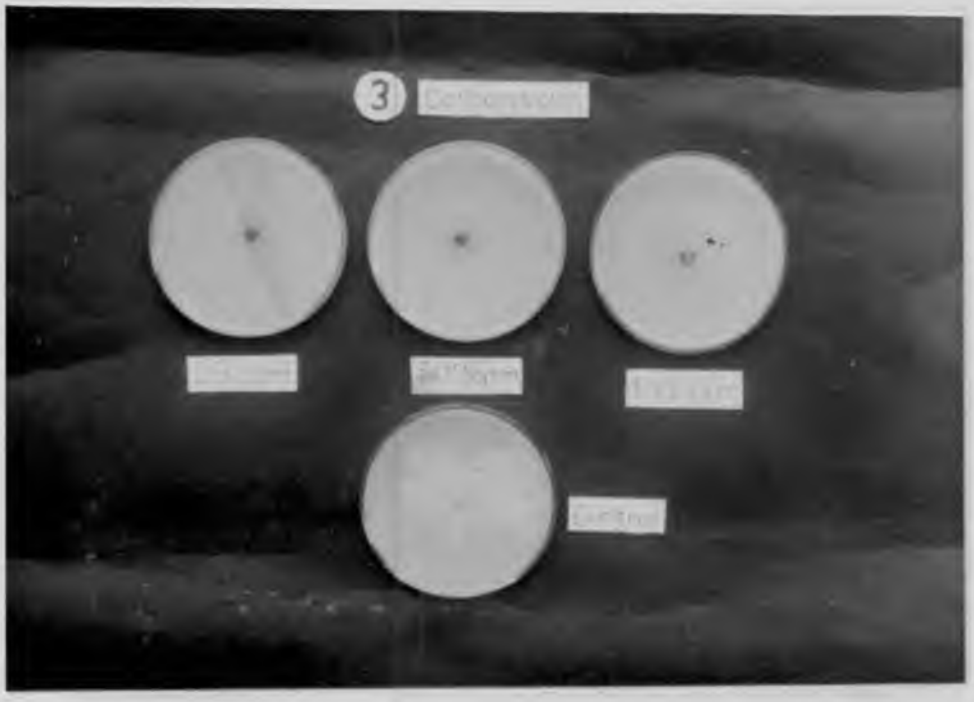


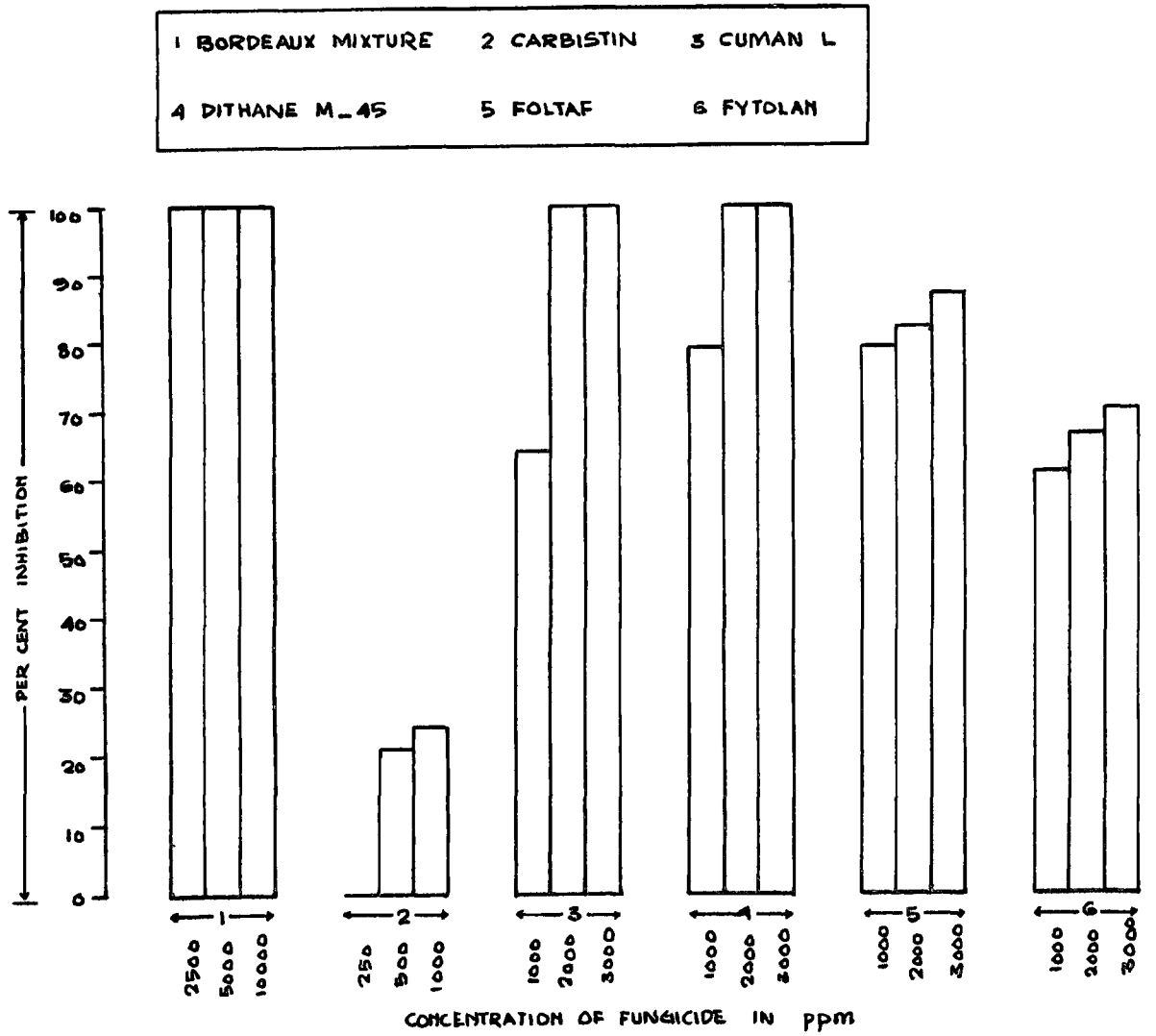
PLATE 17

Table 17. Effect of different fungicides on the radial growth of *Curvularia clavata* (poisoned food technique)

Sl. No.	Treatment	Concentration of fungicide (ppm)	*Mean colony diameter (mm)	Percentage inhibition over control $\frac{(C - T)}{C} \times 100$
1.	Bordeaux mixture	2500	0.00	100.00
		5000	0.00	100.00
		10000	0.00	100.00
2.	Carbistin	250	90.00	0.00
		500	71.33	20.74
		1000	68.33	24.08
3.	Cuman L	1000	32.67	63.70
		2000	0.00	100.00
		3000	0.00	100.00
4.	Dithane M-45	1000	19.33	78.52
		2000	0.00	100.00
		3000	0.00	100.00
5.	Foltaf	1000	18.67	79.26
		2000	16.00	82.22
		3000	11.67	87.03
6.	Fytolan	1000	35.33	60.74
		2000	30.33	66.30
		3000	27.33	69.63
7.	Control	-	90.00	-

* Average of three replications

FIG 13 EFFECT OF FUNGICIDES ON THE GROWTH OF *Curvularia clavata* ON SOLID MEDIUM



(iv) Curvularia lunata

Complete inhibition of the growth of the fungus was obtained at 2500 ppm Bordeaux mixture, 2000 ppm Cuman L and 3000 ppm Dithane M-45. Carbistin, Foltaf and Fytolan could not effect complete inhibition of growth of the fungus even at the highest concentration tested. Carbistin was the least effective of all the fungicides tested (Table 18).

(v) Botryodiplodia theobromae

Growth of the fungus was completely inhibited by 2500 ppm Bordeaux mixture, 250 ppm Carbistin and 1000 ppm Dithane M-45. Cuman L, Foltaf and Fytolan were not able to effect complete inhibition of mycelial growth of the fungus even at 3000 ppm concentration. Fytolan was the least effective fungicide (Table 19).

(vi) Fusarium moniliforme var. intermedium

Complete inhibition of growth of the fungus was obtained on the medium containing 2500 ppm Bordeaux mixture, 250 ppm Carbistin, 2000 ppm Cuman L, 1000 ppm Dithane M-45 and 3000 ppm Foltaf. Fytolan could not effect complete inhibition of mycelial growth even at 3000 ppm concentration (Table 20).

Table 18. Effect of different fungicides on the radial growth of Curvularia lunata (poisoned food technique)

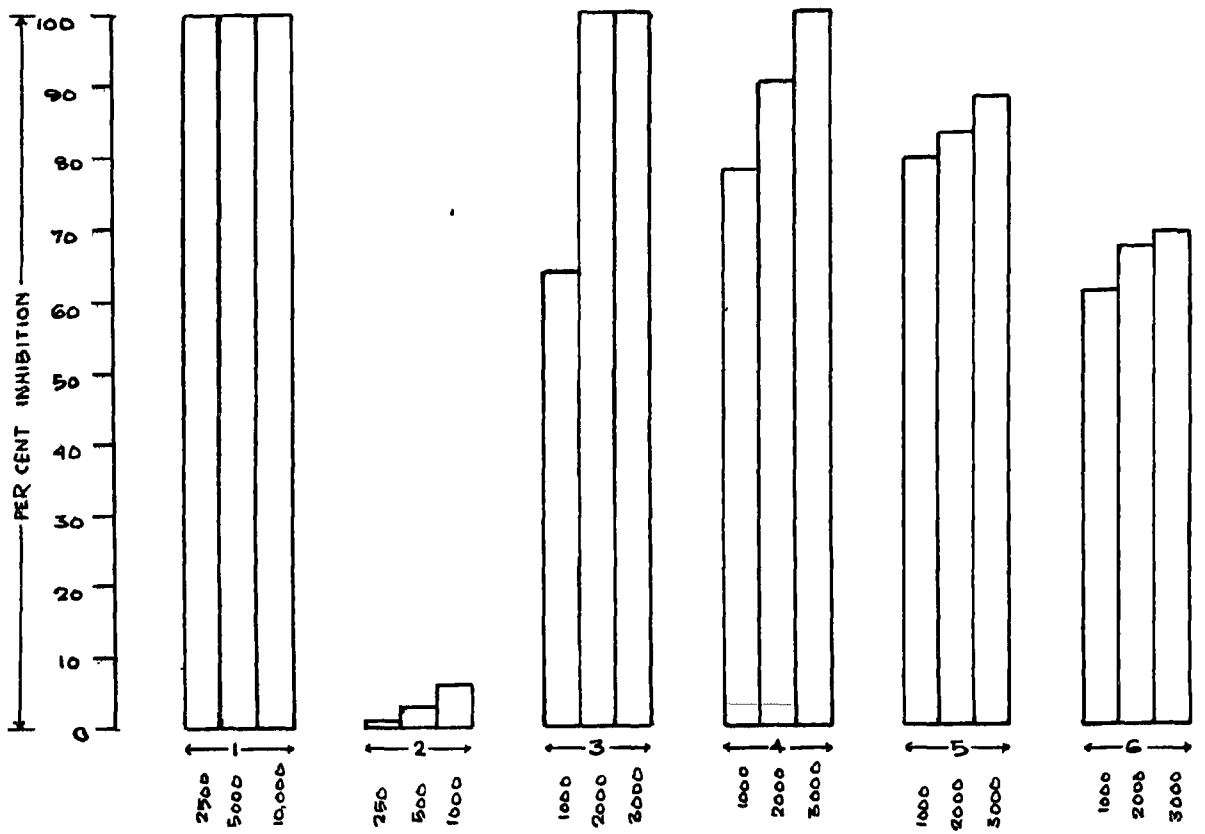
Sl. No.	Treatment	Concentration of fungicide (ppm)	*Mean colony diameter (mm)	Percentage inhibition over control $\frac{(C - T)}{C} \times 100$
1.	Bordeaux mixture	2500	0.00	100.00
		5000	0.00	100.00
		10000	0.00	100.00
2.	Carbistin	250	89.00	1.11
		500	87.00	3.33
		1000	84.33	6.30
3.	Cuman L	1000	32.33	64.08
		2000	0.00	100.00
		3000	0.00	100.00
4.	Dithane M-45	1000	19.67	78.14
		2000	8.67	90.37
		3000	0.00	100.00
5.	Foltaf	1000	18.33	79.63
		2000	15.33	82.97
		3000	11.00	87.78
6.	Fytolan	1000	35.33	60.74
		2000	30.00	66.67
		3000	28.00	68.89
7.	Control	-	90.00	-

* Average of three replications

FIG 14 EFFECT OF FUNGICIDES ON THE GROWTH OF *Curvularia lunata*

ON SOLID MEDIUM

1 BORDEAUX MIXTURE	2 CARBISTIN	3 CUMAN L
4 DITHANE M-45	5 FOLTAF	6 FYTOLAN



CONCENTRATION OF FUNGICIDE IN ppm

Plate 18. Effect of Bordeaux mixture on the growth of Curvularia clavata on Czapek's-Dox agar.

Plate 19. Effect of Bordeaux mixture on the growth of Curvularia lunata on Czapek's-Dox agar.

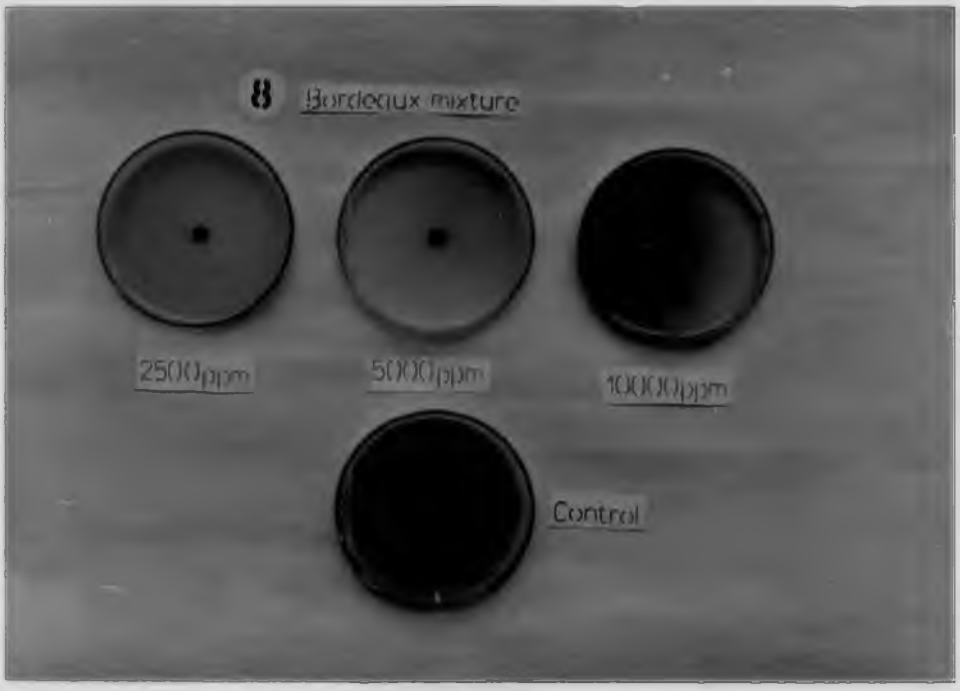


PLATE 18

PLATE 19

Table 19. Effect of different fungicides on the radial growth of Botryodiplodia theobromae (poisoned food technique)

Sl. No.	Treatment	Concentration of fungicide (ppm)	*Mean colony diameter (mm)	Percentage inhibition over control $\frac{(C - I)}{C} \times 100$
1.	Bordeaux mixture	2500	0.00	100.00
		5000	0.00	100.00
		10000	0.00	100.00
2.	Carbistin	250	0.00	100.00
		500	0.00	100.00
		1000	0.00	100.00
3.	Cuman L	1000	14.33	84.08
		2000	9.33	89.63
		3000	4.33	95.19
4.	Dithane M-45	1000	0.00	100.00
		2000	0.00	100.00
		3000	0.00	100.00
5.	Foliaf	1000	20.00	77.77
		2000	15.00	83.33
		3000	10.67	88.14
6.	Fytolan	1000	51.67	42.59
		2000	41.67	53.70
		3000	21.67	75.92
7.	Control	-	90.00	-

* Average of three replications

FIG 15 EFFECT OF FUNGICIDES ON THE GROWTH OF *Botryodiplodia theobromae* ON SOLID MEDIUM

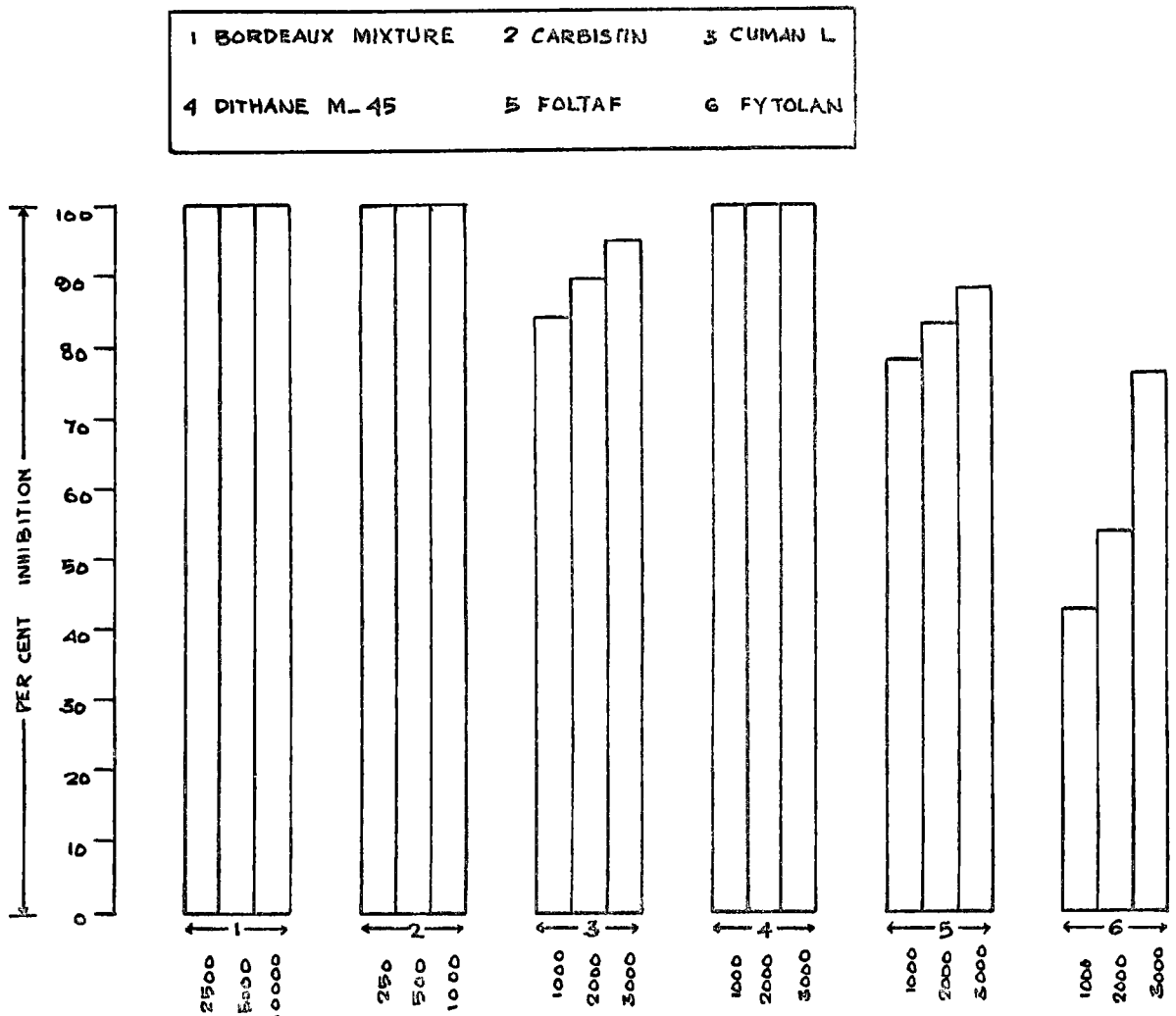


Plate 20. Effect of Bordeaux mixture on the growth of Botryodiplodia theobromae on Czapek's-Dox agar.

Plate 21. Effect of Carbistin on the growth of Botryodiplodia theobromae on Czapek's-Dox agar.

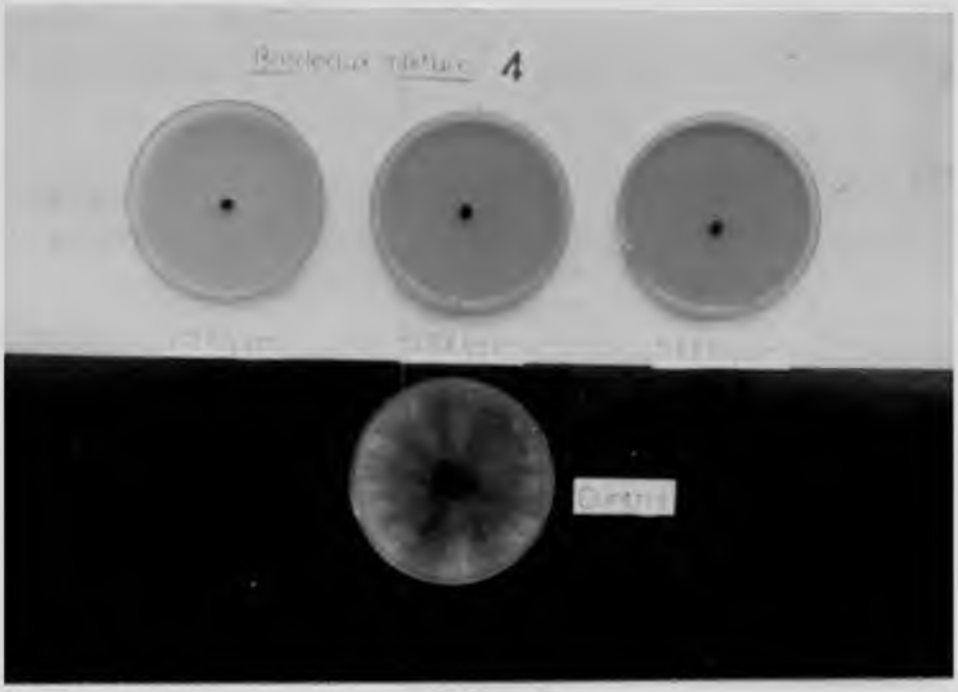


PLATE 20

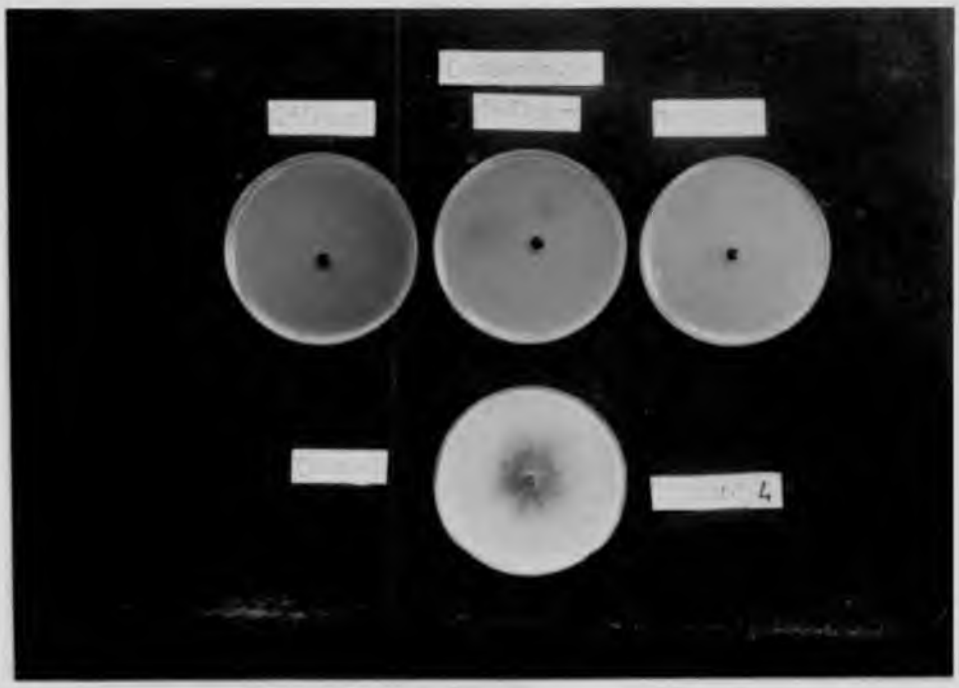


PLATE 21

Table 20. Effect of different fungicides on the radial growth of Fusarium moniliforme var. intermedium (poisoned food technique)

Sl. No.	Treatment	Concentration of fungicide (ppm)	*Mean colony diameter (mm)	Percentage inhibition over control $\frac{(C-T)}{C} \times 100$
1.	Bordeaux mixture	2500	0.00	100.00
		5000	0.00	100.00
		10000	0.00	100.00
2.	Carbistin	250	0.00	100.00
		500	0.00	100.00
		1000	0.00	100.00
3.	Cuman L	1000	18.67	79.26
		2000	0.00	100.00
		3000	0.00	100.00
4.	Dithane M-45	1000	0.00	100.00
		2000	0.00	100.00
		3000	0.00	100.00
5.	Foltaf	1000	32.67	63.70
		2000	22.67	74.81
		3000	0.00	100.00
6.	Fytolan	1000	30.67	65.92
		2000	25.33	71.86
		3000	19.67	78.14
7.	Control	-	90.00	-

* Average of three replications.

FIG 16 EFFECT OF FUNGICIDES ON THE GROWTH OF *Fusarium moniliforme* var *intermedium* ON SOLID MEDIUM

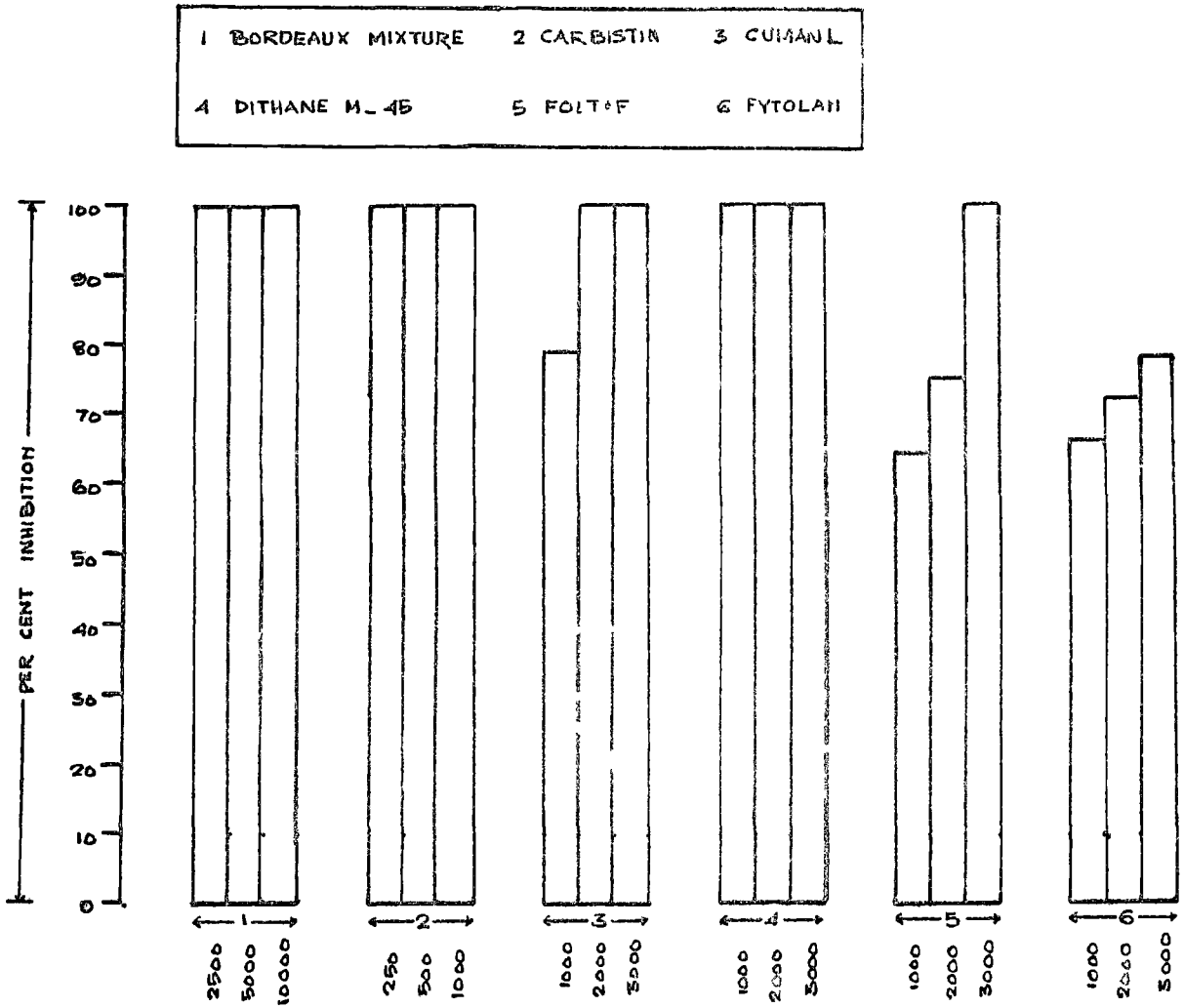


Plate 22. Effect of Dithane M-45 on the growth of *Botryodiplodia theobromae* on Czapek's-Dox agar.

Plate 23. Effect of Bordeaux mixture on the growth of *Fusarium moniliforme* var. *intermedium* on Czapek's-Dox agar.

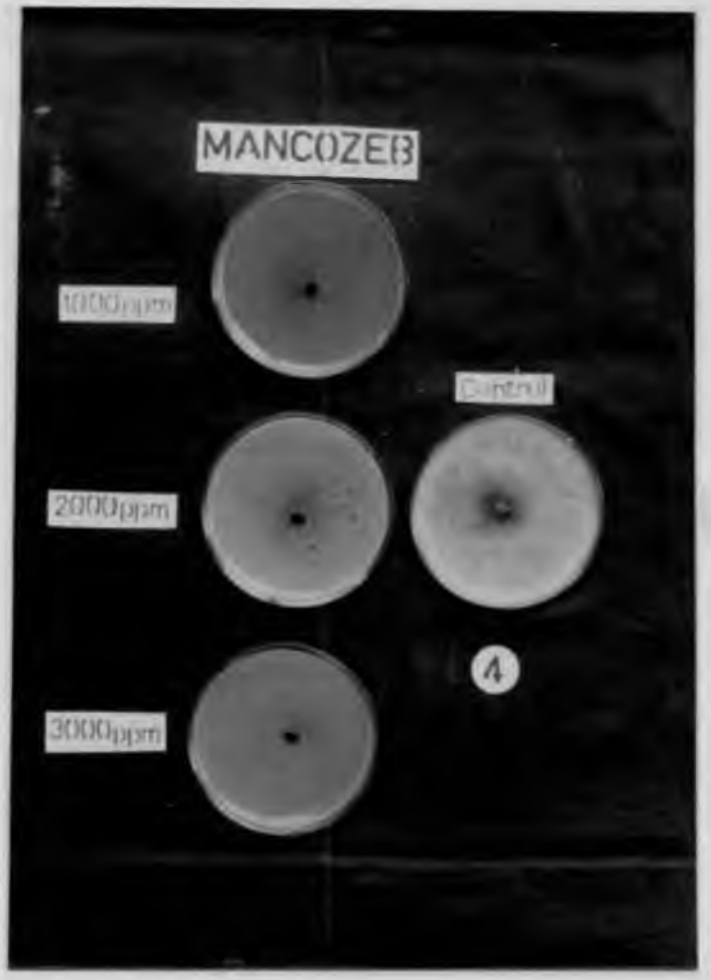


PLATE 22

PLATE 23

Plate 24. Effect of Carbistin on the growth of *Fusarium moniliforme* var. *intermedium* on Czapek's-Dox agar.

Plate 25. Effect of Dithane M-45 on the growth of *Fusarium moniliforme* var. *intermedium* on Czapek's-Dox agar.

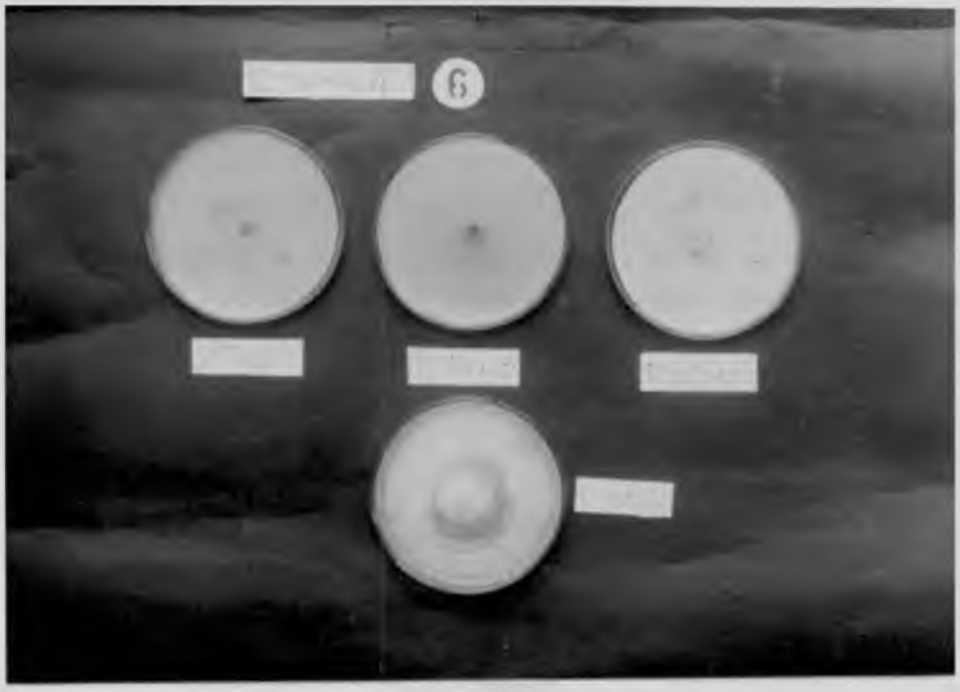


PLATE 24

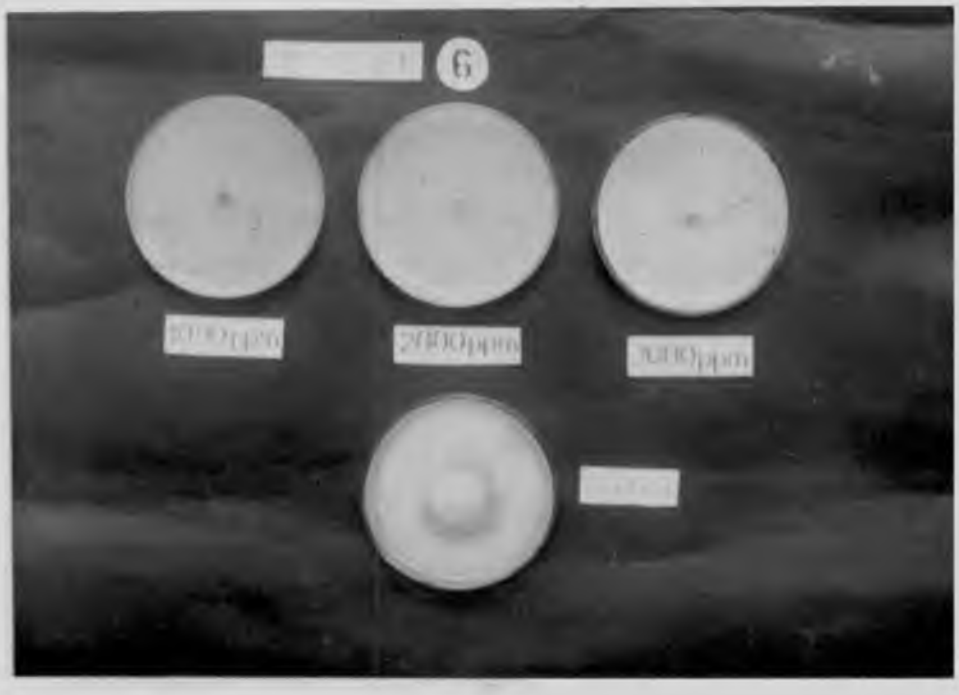


PLATE 25

DISCUSSION

DISCUSSION

Diseases have been recognised as one of the major constraints in the commercial cultivation of medicinal plants. A survey of the fungal diseases of certain medicinal plants in the College of Agriculture, Vellayani, Tropical Botanic Garden and Research Institute, Palode and Post-graduate-cum-Research Centre in Ayurveda, Poojappura, yielded the following:

I. *Acorus calamus* Linn.

1. *Leaf rust*: C.O. - *Uromyces sparganii* Clinton & Peck.ssp. *asiaticus* Parmelee & Savile (IMI No.322536).

The fungus has been reported on this host from Ootacamund Tamil Nadu (Rangaswami *et al*. 1970). There is no record of this fungus from Kerala State.

II. *Adhatoda beddomei* Nees.

1. *Leaf spot*: C.O. - *Colletotrichum gloeosporioides* (Penz) Penz. & Sacc. (IMI No.322533).

Roy (1976) reported *Colletotrichum capsici* on *Adhatoda vasica* from Bhagalpur, U.P. However, the present report is a new host record for *C. gloeosporioides*.

2. *Leaf rust*: C.O. - *Puccinia* sp. (IMI No.322535).

This is a new host record for the pathogen in our country

III. Asparagus officinalis Linn.

1. Stem rot: C.O. - Fusarium moniliforme var. intermedium Neish & Leggett (IMI No.322530).

Marras and Servazzi (1971) and Johnston et al (1979) have reported Fusarium moniliforme (Gibberella fujikuroi) on this host from Sardinia and New Jersey respectively. F. moniliforme var. intermedium has not been reported on A. officinalis.

IV. Catharanthus roseus G.Don. (= Vinca rosea Linn.)

1. Leaf spot : C.O. - Colletotrichum gloeosporioides (Penz.) Penz & Sacc

The morphological characters of the pathogen agreed with those described by Von Arx (1957), Mordue (1971) and Sutton (1980). Santhakumari (1980) reported C. gloeosporioides on this host from Vellayani, Kerala.

2. Leaf spot: C.O. - Curvularia clavata Jain (IMI No.322531).

The fungus has not been recorded on C. roseus.

V. Coscinium fenestratum Colebr.

1. Leaf blight: C.O. - Colletotrichum gloeosporioides (Penz.) Penz & Sacc (IMI No.322526).

The present report is a new host record for the pathogen.

VI. Costus speciosus (Koenig.) Sm.

1. Leaf spot: C.O. - Curvularia lunata (Wakker) Boedijn. (IMI No. 324535).

Kumar et al (1980) reported Curvularia lunata as a seed-borne pathogen of this plant from Lucknow. Thakur et al

(1980) reported a leaf blight of Costus speciosus caused by Curvularia prasadii from Jammu-Tawi. The present report is a new host record for Curvularia lunata from Kerala.

VII. Holostemma adakodien R.Br.

1. Leaf spot: C.O. - Botryodiplodia theobromae Pat. (IMI No.322528).

There is no record of this fungus on H. adakodien from India.

VIII. Plumbago indica (= P. rosea) Linn.

1. Leaf spot: C.O. - Colletotrichum gloeosporioides (Penz.) Penz. & Sacc. (Glomerella cingulata (Stonem.) Spauld & Schrenk.)(IMI No.322529).

This is a new host record for the pathogen.

IX. Rauwolfia serpentina Benth. ex Kurz.

1. Anthracnose: C.O. - Colletotrichum gloeosporioides (Penz.) Penz & Sacc (IMI No.322532).

Varadarajan (1964b) has earlier observed anthracnose of this plant in Mexico, caused by C. gloeosporioides Penz. There is no record of this fungus on R. serpentina in India.

X. Spilanthes acmella Linn.

1. Leaf blight: C.O. - Colletotrichum capsici (Sydow) Butler & Bisby (IMI No.322527).

This is a new host record for C. capsici.

Specific identity of the above fungi was provided by the Commonwealth Mycological Institute, England (Sutton, 1988).

The pathogenicity of all the fungi (except Uromyces sparganii ssp. asiaticus and Puccinia sp.) was proved by artificial inoculation on their respective host plants. Symptoms similar to those observed under natural conditions, were produced within 3 to 10 days after inoculation.

Cross inoculation studies with the five isolates of Colletotrichum gloeosporioides obtained from Adhatoda beddomei, Catharanthus roseus, Coscinium fenestratum, Plumbago indica and Rauwolfia serpentina revealed that all the isolates are cross infective. Of the five isolates, the one from R. serpentina was found to be the most pathogenic, producing typical symptoms within 2 to 3 days of inoculation, and the one from A. beddomei the least, requiring upto 6 days to produce symptoms.

All fungi isolated were found to grow well on the culture media tested. However, variations were observed in the nature and extent of growth and sporulation on different media.

Czapek's-Dox agar was found to be the best medium for the growth and sporulation of Colletotrichum gloeosporioides followed by Richard's agar and Potato dextrose agar. C. gloeosporioides has been reported to grow well on Potato dextrose agar and Oatmeal agar (Wilson and Jose, 1966).

They found Oatmeal agar to be very good for the sporulation of the fungus. Purkayastha and Sen Gupta (1975) reported that Richard's agar and Czapek's-Dox agar supported good growth and sporulation of C. gloeosporioides. Santhakumari (1980) obtained good growth of fungus on Czapek's-Dox agar and Potato dextrose agar. Best growth and abundant sporulation was obtained on Richard's medium.

Colletotrichum capsici favoured Czapek's-Dox agar the most for its growth and sporulation. Richard's agar also gave good growth and sporulation. Though the growth of the fungus on Oatmeal agar and Potato dextrose agar were much less than in Richard's agar, the sporulation on these media was good. Sehgal et al (1965) and Tripathi and Beniwal (1977) obtained good growth and sporulation of C. capsici on Potato dextrose agar. Chatrath and Raychaudhuri (1968) and Malati Majumdar and Bineeta Sen (1974) reported Oatmeal agar to be a good medium for the sporulation of C. capsici.

The growth and sporulation of Curvularia clavata was best on Czapek's-Dox agar, followed by Oatmeal agar and Richard's agar. In the case of Curvularia lunata, Czapek's-Dox agar, Oatmeal agar and Richard's agar were found to be equally good for the growth and sporulation. Chand and Verma (1968) obtained good growth and sporulation of Curvularia lunata on Potato dextrose agar, Oatmeal agar,

Czapek's-Dox agar and Richard's agar. Singh (1971) reported good growth and sporulation of C. ovoidea on Oatmeal agar.

Czapek's-Dox agar, Oatmeal agar and Potato dextrose agar were found to be equally effective in promoting good growth and sporulation of Botryodiplodia theobromae. Czapek's-Dox agar, Oatmeal agar, Potato dextrose agar and Richard's agar have been reported to be good for the growth of B. theobromae (Siradhana and Jain, 1962; Alasoadura, 1970; Rao et al, 1971; Vijayan and Wilson, 1980).

Very good growth and sporulation of Fusarium moniliforme var. intermedium was obtained on Czapek's-Dox agar and Richard's agar, followed by Coon's agar. Potato dextrose agar, Richard's agar and Czapek's-Dox agar have been reported to be good for the growth and sporulation of Fusarium oxysporum f. niveum (Jhamaria, 1972). Singh and Singh (1975) reported very good growth and sporulation of F. moniliforme on Czapek's-Dox agar. Gopinath et al (1984) and Khune et al (1984) reported Potato dextrose agar to be a good medium for the growth of F. moniliforme, but the sporulation on this medium was poor.

In general, Sabouraud's agar was found to be a poor medium for the growth and sporulation of the above fungi.

Spore germination of Colletotrichum gloeosporioides was completely inhibited by Dithane M-45 and Foltaf even at 50 ppm concentration, whereas 100 ppm of Bordeaux mixture and 200 ppm of Cuman L were required to effect cent per cent inhibition. Of the six fungicides tested, Fytolan was the least effective, causing only 82.3 and 78.8 per cent inhibition respectively at 6 and 24 hours after incubation even at the highest concentration tested (200 ppm). Complete inhibition of radial growth of the fungus was obtained on Czapek's-Dox agar containing 2500 ppm Bordeaux mixture, 500 ppm Carbistin, 2000 ppm Cuman L and 1000 ppm Dithane M-45. Foltaf and Fytolan could not effect complete inhibition even at 3000 ppm.

In the case of Colletotrichum capsici, Bordeaux mixture, Dithane M-45 and Foltaf at 50 ppm concentration caused complete inhibition of spore germination. Carbistin, (200 ppm) and Cuman L (100 ppm) also caused complete inhibition. Carbistin at 100 ppm concentration could effect cent per cent inhibition only at 6 hours after incubation. Here also, Fytolan was found to be the least effective fungicide in inhibiting the spore germination. Complete inhibition of growth was obtained with 2500 ppm Bordeaux mixture, 250 ppm Carbistin and 2000 ppm each of Cuman L, Dithane M-45 and Fytolan. Foltaf could not completely inhibit the growth even at 3000 ppm.

Abul Hasan et al (1978) recorded considerable inhibition of radial growth of Colletotrichum lagenarium with 0.3 per cent Dithane M-45 and Ziram. Lima et al (1978) reported orthodifolatan to be toxic to C. gloeosporioides in in vitro evaluation. Singh and Jain (1978) found that Bavistin was a good fungicide in inhibiting linear growth of C. lagenarium. Santhakumari (1980) obtained cent per cent inhibition of spore germination of C. gloeosporioides with 5000 ppm Blitox. Karunakaran (1981) obtained complete inhibition of growth of C. gloeosporioides with 5000 ppm Bordeaux mixture and 3000 ppm each of Fytolan and Dithane Z-78 in solid medium. Narain and Panigrahi (1971) reported good inhibition of conidial germination of C. capsici with Ziram, even at a concentration of 5 ppm.

Germination of spores of Curvularia clavata was completely inhibited by 50 ppm Foltaf, whereas Bordeaux mixture and Dithane M-45 required 100 ppm and 200 ppm respectively. However, Bordeaux mixture (50 ppm), Cuman L (200 ppm), Dithane M-45 (100 ppm) and Fytolan (200 ppm) completely inhibited the spore germination when observations were taken at 6 hours after incubation. Carbistin was found to be the least effective fungicide in inhibiting spore germination of the fungus. Radial growth of fungus was completely inhibited by 2500 ppm Bordeaux mixture and 2000 ppm

each of Cuman L and Dithane M-45. Foltaf and Fytolan could not cause complete inhibition even at 3000 ppm. Carbistin was the least effective fungicide against the growth of the fungus.

Complete inhibition of spore germination of Curvularia lunata was obtained with 100 ppm Bordeaux mixture, 200 ppm Dithane M-45 and 50 ppm Foltaf. Bordeaux mixture (50 ppm), Cuman L (200 ppm) and Fytolan (200 ppm) could effect cent per cent inhibition of spore germination only when observations were taken at 6 hours after incubation. Here also, Carbistin was found to be the least effective fungicide. Growth of the fungus on Czapek's-Dox agar was completely inhibited with 2500 ppm Bordeaux mixture, 2000 ppm Cuman L and 3000 ppm Dithane M-45. Foltaf and Fytolan were not very effective. Here also, Carbistin was the least effective fungicide.

Saikia (1982) obtained complete inhibition of growth of Curvularia eragrostidis with Cuman (1000 ppm), Blitox (4000 ppm) and Dithane M-45 (2000 ppm). Zamorski and Bielska (1983) noted that captafol was highly toxic to Curvularia trifolii f.sp. gladioli. Edington et al (1971) reported that with the exception of Torula herbarum, all members of Porosporae (of which Curvularia is a member) of the class-Deuteromycetes are insensitive to Benomyl. Donald Erwin (1973)

reported that dark-spored members of Deuteromycetes are insensitive to Benomyl. Ved Ram and Dharam Vir (1986) observed that benzimidazole fungicides like Benomyl, Thiabendazole and Carbendazim played some role in the acceleration of rotting of banana fruits caused by Curvularia lunata. This indicated that these fungicides are not effective in checking the growth and other activities of the fungus.

Bordeaux mixture (100 ppm), Carbistin (200 ppm) and Dithane M-45 and Foltaf each at 50 ppm concentrations caused cent per cent inhibition of germination of single-celled spores of Botryodiplodia theobromae. Complete inhibition of germination of double-celled spores could be obtained only with 200 ppm Bordeaux mixture, 100 ppm Dithane M-45 and 50 ppm Foltaf. Bordeaux mixture (100 ppm) and Dithane M-45 (50 ppm) could effect complete inhibition of germination of double-celled spores only when observations were taken at 6 hours after incubation. Of the six fungicides tested, Fytolan was found to have the least inhibitory effect on the germination of both single-celled and double celled spores. Radial growth of the fungus on Czapek's-Dox agar was completely inhibited by 2500 ppm Bordeaux mixture, 250 ppm Carbistin and 1000 ppm Dithane M-45. Cuman L, Foltaf and Fytolan could not cause complete inhibition of growth even at 3000 ppm.

Of the fungicides tested, Fytolan was the least effective.

Bordeaux mixture has been found effective in inhibiting the spore germination of Diplodia theobromae (Newhall, 1948). Rajagopalan and Wilson (1972a) obtained cent per cent inhibition of germination of single-celled and double-celled spores of Diplodia natalensis with Dithane M-45 at 50 ppm and 100 ppm concentrations respectively, while the radial growth of the fungus was completely inhibited by 3000 ppm Dithane M-45. Prasad and Bilgrami (1973) observed that Fytolan and Blue Copper were not effective against Botryodiplodia theobromae. Naseema (1981) obtained good inhibition of growth of B. theobromae with 1000 ppm Dithane M-45. Vijayan and Wilson (1985) obtained cent per cent inhibition of germination of single-celled spores of B. theobromae with 50 ppm Difolatan, 100 ppm Dithane M-45 and 200 ppm Bavistin, while the growth of the fungus on solid medium was completely inhibited by 250 ppm Bavistin and 1000 ppm Dithane M-45.

Conidial germination of Fusarium moniliforme var. intermedium was completely inhibited by 50 ppm each of Bordeaux mixture, Dithane M-45 and Foltaf. Cuman L (200 ppm) also caused cent per cent inhibition. Carbistin (200 ppm) effected complete inhibition only when observations were taken at 6 hours after incubation. Fytolan was the least effective among the fungicides tested. Complete inhibition

of radial growth of the fungus on Czapek's-Dox agar was obtained with 2500 ppm Bordeaux mixture, 250 ppm Carbistin, 2000 ppm Cuman L, 1000 ppm Dithane M-45 and 3000 ppm Foltaf. Fytolan caused only 78.14 per cent inhibition of growth even at 3000 ppm concentration.

Bavistin (0.1 per cent) and Ziride, Difolatan and Dithane M-45(0.2 per cent) have been reported to inhibit the radial growth of Fusarium oxysporum, while Blitox (0.2 per cent) was not effective (Qadri et al,1982). Growth of F. oxysporum was found to be considerably reduced on solid medium containing 0.2 per cent Difolatan and Dithane M-45 (Kalra and Sohi, 1984). Sharma and Jain (1984) reported that Dithane M-45 and Bavistin (500 ppm) were very effective in inhibiting the radial growth of Fusarium moniliforme. Vrany et al (1984) obtained cent per cent inhibition of growth of F. moniliforme on Potato dextrose agar containing 1000 ppm Bavistin.

The present investigation revealed the presence of a number of fungi causing diseases of economically important medicinal plants grown in Kerala. Some of these diseases occur in a very severe form due to the warm and humid conditions particularly prevalent in our State. Out of the twelve diseases recorded, eleven are new to Kerala, of which eight are new records for the country.

The results of laboratory evaluation of fungicides indicate that Foltaf is a very promising fungicide in inhibiting the spore germination of all the fungi tested during the present study, even at a concentration of 50 ppm. In regard to the inhibition of growth of these fungi, Bordeaux mixture, Cuman L and Dithane M-45 were found to be more effective. Carbistin was also found to be very effective in inhibiting the spore germination as well as radial growth of all the fungi, except Curvularia clavata and C. lunata. A suitable fungicide for the control of fungal diseases of medicinal plants can be selected from among the above promising ones after conducting necessary field trials.

SUMMARY

SUMMARY

A survey of fungal diseases of medicinal plants in three localities of Trivandrum district, viz. College of Agriculture, Vellayani, Tropical Botanic Garden and Research Institute, Palode and Post-graduate-cum-Research Centre in Ayurveda, Poojappura, yielded the following twelve diseases on ten medicinal plants:

1. Leaf rust of Acorus calamus Linn. caused by Uromyces sparganii Clinton & Peck. ssp. asiaticus Parmelee & Savile

2.* Leaf spot of Adhatoda beddomei Nees. caused by Colletotrichum gloeosporioides (Penz.) Penz. & Sacc.

3.* Leaf rust of Adhatoda beddomei Nees. caused by Puccinia sp.

4.* Stem rot of Asparagus officinalis Linn. caused by Fusarium moniliforme var. intermedium Neish & Leggett

5. Leaf spot of Catharanthus roseus G.Don (= Vinca rosea Linn.) caused by Colletotrichum gloeosporioides (Penz.) Penz & Sacc

6.* Leaf spot of Catharanthus roseus G.Don. caused by Curvularia clavata Jain

7.* Leaf blight of Coscinium fenestratum Colebr. caused by Colletotrichum gloeosporioides (Penz.) Penz & Sacc.

8. Leaf spot of Costus speciosus (Koenig.) Sm. caused by Curvularia lunata (Wakker) Boedijn

9.* Leaf spot of Holostemma adakodien R.Br. caused by Botryodiplodia theobromae Pat.

10.* Leaf spot of Plumbago indica (=P.rosea) Linn. caused by Colletotrichum gloeosporioides (Penz) Penz. & Sacc. (Glomerella cingulata (Stonem.) Spauld. & Schrenk.)

11. Anthracnose of Rauwolfia serpentina Benth.ex Kurz. caused by Colletotrichum gloeosporioides (Penz.) Penz. & Sacc

12.* Leaf blight of Spilanthes acmella Linn. caused by Colletotrichum capsici (Sydow) Butler & Bisby

Of the above, eight diseases (marked with asterisk) are new records from our country. Except the leaf spot of Catharantnus roseus caused by C. gloeosporioides, all the diseases are new records from Kerala.

The pathogenicity of all the fungi (except Uromyces sparganii ssp. asiaticus and Puccinia sp.) was proved by artificial inoculation on the respective host plants.

Cross inoculation studies with isolates of Colletotrichum gloeosporioides from five hosts, showed that they are cross infective. The isolate from Rauwolfia

serpentina was found to be the most virulent while the one from Adhatoda beddomei the least.

Morphological characters of the fungi isolated were studied by slide culture technique.

Variations were observed in the growth and sporulation of the fungi on different media. Czapek's-Dox agar and Richard's agar were found to be very good for the growth and sporulation of all the fungi tested, followed by Oatmeal agar and Potato dextrose agar, except for Fusarium moniliforme var. intermedium which exhibited poor growth on Oatmeal agar. Sabouraud's agar was found to be a poor medium for all the fungi.

The experiment to study the in vitro effect of six fungicides on spore germination revealed that cent per cent inhibition of Colletotrichum gloeosporioides, C. capsici, Curvularia clavata, Curvularia lunata, Botryodiplodia theobromae (Single celled and double celled spores) and Fusarium moniliforme var. intermedium could be obtained with Foltaf at 50 ppm concentration. Spore germination of Colletotrichum gloeosporioides was inhibited by 100 ppm Bordeaux mixture, 200 ppm Cuman L and 50 ppm Dithane M-45 also. Bordeaux mixture (50 ppm), Carbistin (200 ppm),

Cuman L (100 ppm) and Dithane M-45 (50 ppm) caused complete inhibition of spore germination of C. capsici.

Spore germination of Curvularia clavata and Curvularia lunata could be completely inhibited by 100 ppm Bordeaux mixture and 200 ppm Dithane M-45. Cent per cent inhibition of germination of single celled spores of Botryodiplodia theobromae was obtained with 100 ppm Bordeaux mixture, 200 ppm Carbistin and 50 ppm Dithane M-45. Germination of double-celled spores of B. theobromae was completely inhibited by 200 ppm Bordeaux mixture and 100 ppm Dithane M-45. Complete inhibition of spore germination of Fusarium moniliforme var. intermedium was obtained with 50 ppm Bordeaux mixture, 200 ppm Cuman L and 50 ppm Dithane M-45. Fytolan was comparatively less effective against the spore germination of most of the above fungi.

Radial growth of Colletotrichum gloeosporioides on Czapek's-Dox agar was completely inhibited by 2500 ppm Bordeaux mixture, 500 ppm Carbistin, 2000 ppm Cuman L and 1000 ppm Dithane M-45. Growth of Colletotrichum capsici was completely inhibited by 2500 ppm Bordeaux mixture, 250 ppm Carbistin and 2000 ppm each of Cuman L, Dithane M-45 and Fytolan. Growth of Curvularia clavata was completely

inhibited by 2500 ppm Bordeaux mixture and 2000 ppm each of Cuman L and Dithane M-45. Complete inhibition of Curvularia lunata was obtained with 2500 ppm Bordeaux mixture, 2000 ppm Cuman L and 3000 ppm Dithane M-45. Radial growth of Botryodiplodia theobromae was completely inhibited by 2500 ppm Bordeaux mixture, 250 ppm Carbistin and 1000 ppm Dithane M-45. Complete inhibition of growth of Fusarium moniliforme var. intermedium was obtained with 2500 ppm Bordeaux mixture, 250 ppm Carbistin, 2000 ppm Cuman L, 1000 ppm Dithane M-45 and 3000 ppm Foltaf. Fytolan exerted the least inhibitory effect on the growth of the above fungi.

REFERENCES

REFERENCES

Abul Hasan, Abrar Khan, M., Wajid Khan, Abdul Rashid and Saxena, S.K. (1978). Chemical control of anthracnose of Coccinia cardifolia incited by Colletotrichum lagenarium. Pesticides, 12: 31-33.

*Alasoadura, S.O. (1970). Culture studies on Botryodiplodia theobromae Pat. Mycopath.et Mycol. appl., 42: 153-160.

Anon. (1948). The wealth of India, Vol. I. Council of Scientific and Industrial Research, New Delhi. 253 pp.

Anon. (1950). The wealth of India, Vol. II. Council of Scientific and Industrial Research, New Delhi. 427 pp.

Anon. (1959). The wealth of India, Vol. V. Council of Scientific and Industrial Research, New Delhi. 332 pp.

Anon. (1969). The wealth of India, Vol. VIII. Council of Scientific and Industrial Research, New Delhi. 394 pp.

Anon. (1976). The wealth of India, Vol. X. Council of Scientific and Industrial Research, New Delhi. 591 pp.

Balasubramanian, R. and Bhama, K.S. (1977). A new leaf spot disease of Catharanthus roseus in India. Indian Phytopath., 30: 556-557.

Biharilal and Tandon, R.N. (1967). Some new leaf spot diseases caused by Colletotrichum-II. Proc. Nat. Acad. Sci., 37 B: 283-290.

* Blancard, D., Piquemal, J.P. and Gindrat, D. (1984). Stemphylium disease of asparagus. Revue Horticole, No.248: 27-30.

Chakravarty, D.K., Khatua, D.C. and Das, T.K. (1976). Pathological problems in the cultivation of Vinca rosea. Indian Agriculturist, 20: 289-295.

Chand, J.N. and Verma, P.S. (1968). A leaf spot disease of Cyamopsis tetragonoloba caused by Curvularia lunata in India. Indian Phytopath., 21: 239-240.

Chandra, V. (1955). Leaf spot disease of Rauwolfia serpentina Benth. Sci. & Cult., 21: 208-210.

Chandra, V. (1957). Leaf blotch disease of Rauwolfia serpentina Benth. Sci. & Cult., 23: 99.

Chatrath, M.S. and Raychaudhuri, S.P. (1968). Nuclear condition of conidia of Colletotrichum capsici. Indian Phytopath., 21: 464-466.

Chauhan, M.S., Tripathi, N.N., Duhan, J.C. and Virk, K.S. (1980). Efficacy of some systemic and non-systemic fungitoxicants for the control of anthracnose of bottlegourd. Pesticides, 14: 20-21.

Chona, B.L. and Munjal, R.L. (1955). Notes on miscellaneous Indian fungi-II. Indian Phytopath., 8: 184-198.

Chopra, R.N., Nayar, S.L. and Chopra, I.C. (1956). Glossary of Indian Medicinal plants. Council of Scientific and Industrial Research, New Delhi. 330 pp.

*Chowdhury, S. (1955). Notes on fungi of Assam-I. Lloydia, 18: 82-87.

*Cooke, M.C. (1878). Some Indian fungi. Grev., 6: 117-118.

*Dietel, P. (1906). Uber Chnoopsora eine neve Uridineen Gatung. Ann. Mycol., 4: 421-423.

Donald, C.Erwin (1973). Systemic fungicides: Disease control, translocation and mode of action. Ann.Rev. Phytopath., 11: 389-412.

Edington, L.V., Khew, K.L. and Barron, G.L. (1971). Fungitoxic spectrum of Benzimidazole compounds. Phytopathology, 61: 42-44.

Ganguly, D. and Pandotra, V.R. (1962). Some of the commonly occurring diseases of important medicinal and aromatic plants in Jammu and Kashmir. Indian Phytopath., 15: 50-54.

*Gindrat, D., Varady, C. and Neury, G. (1984). Asparagus: a new leaf disease caused by Stemphyllum species. Revue Suisse de Viticulture d' Arboriculture et d' Horticulture, 16: 81-85.

Gopinath, A., Shekara Shetty, H. and Safeeulla, K.M. (1984). Infection and establishment of Fusarium moniliforme in sorghum seedlings. Indian Phytopath., 37: 132-136.

Goyal, R. and Patnak, N.C. (1982). A new leaf spot disease of Catharanthus roseus (L.) G.Don from India. New Botanist, 9: 31-32.

Gupta, B.K. (1987). New hosts of fungi from India. Indian Phytopath., 40: 122.

Gupta, M.L., Janardhanan, K.K. and Husain, A. (1978). A leaf blight of Costus speciosus caused by Drechslera maydis. Indian Phytopath., 31: 243-245.

Gupta, P.L. (1974). Parasitic fungi on medicinal plants from India-II. Some pycnidial and perithecial forms. Mycopath.et mycol. Appl., 54: 127-130.

*Hendrix, J.W., Matsuura and Kikuta, K. (1947). Fungicide investigations. Rept. Hawaii Agric. Exp. Sta., 1944-'46 : 104-107.

Janardhanan, K.K., Ganguly, D. and Husain, A. (1964). Fusarium wilt of Rauwolfia serpentina. Curr. Sci., 33: 313.

Janardhanan, K.K., Gupta, M.L. and Husain, A. (1977). Pythium die-back, a new disease of Catharanthus roseus. Indian Phytopath., 30: 427-428.

Jhamaria, S.L. (1972). Nutritional requirements of Fusarium oxysporum f. niveum. Indian Phytopath., 25: 29-32.

Johnston, S.A., Springer, J.K. and Lewis, G.D. (1979). Fusarium moniliforme as a cause of stem and crown rot of asparagus and its association with asparagus decline. Phytopathology, 69: 778-780.

Kalra, J.S. and Sohi, H.S. (1984). Efficacy of different fungicides against Alternaria tenuis Auct. and Fusarium oxysporum Schl. ex Fries under in vitro conditions. Research Bulletin of Punjab University, 35: 99-102.

Karunakaran, P. (1981). Etiology and control of the diseases of major tree spices (Clove, Nutmeg and Cinnamon) in Kerala. Ph.D. Thesis, Kerala Agricultural University, Vellanikkara.

Keim, R. (1977). Foliage blight of periwinkle in Southern California. Plant Dis. Reptr., 61: 182-184.

Keshwala, K.F. (1936). A Phoma disease of Asparagus. Ind. J. Agric. Sci., 6: 800-802.

Khanna, K.K. and Chandra, S. (1978). Control of leaf blight of Rosa indica and Cinnamomum camphora caused by Glomerella cingulata. Indian J. Mycol. & Pl.Path., 7: 176-177.

Khune, N.N., Kurhekar, D.K., Raut, J.G. and Wangikar, P.D. (1984). Stalk rot of sorghum caused by Fusarium moniliforme. Indian Phytopath., 37: 316-317.

Kontaxis, D.G. (1977). Epiphytotic of rust on asparagus in Imperial Valley, California. Plant Dis. Reptr.,61: 503.

Kumar, K. and Srivastava, S.S.L. (1985). Fungi associated with pigeon pea seeds, their effect and control. Indian J. Plant Path., 3: 53-56.

Kumar, S., Sattar, A., Singh, K.P. and Husain, A. (1980). Seed-mycoflora of Costus speciosus. Indian J. Mycol. & Pl. Path., 10: 101-102.

Lacy, M.L. (1982). Purple spot: a new disease of young asparagus spears caused by Stemphylium vesicarium. Plant Dis.,66: 1198-1200.

Lele, V.C. and Asha Ram. (1968). Die-back disease of Rauwolfia serpentina Benth. caused by Colletotrichum dematium (Pers.ex.Fr.) Grove. Indian Phytopath., 21: 349-350.

*Lima, J.A. Dea., Menezes, M., Karam, M.Deq., Oliveira, V.Dep. and Rodrigues, M.G.R. (1978). Toxic effect of some fungicides on C. gloeosporioides Penz. , causal agent of cashew anthracnose. Fitossanidade, 1: 62-66.

Maheskar, V.G. (1967). A new disease of Vinca rosea from India. Plant Dis. Reptr., 51: 480-481.

*Mailum, N.P. and Divinagracia, G.G. (1969). Leaf spot of ginger in Philippines. Philipp. Agric., 53: 202-217.

Malati Majumdar and Bineeta Sen (1974). Studies on induction of sporulation in mycelial cultures of some pathogenic species of Colletotrichum. Indian Phytopath., 27: 149-154.

Manoharachary, C., Rama Rao, P., Venkateshwarlu, K. and Raghuvee Rao, P. (1975). Seed mycoflora of some oil seeds, vegetable and medicinal plants. New Botanist, 2: 132-134.

*Marras, F. and Sevazzi, O. (1971). Fusarium diseases of Asparagus (A. officinalis L.) Studi sassar. Sez. 3, 18: 211-228.

Mendoza, N.S. (1977). Pre-harvest anthracnose control in mango. Philippine Phytopathology, 13: 50-53.

Mishra, A. and Siradhana, B.S. (1978). Chemical control of anthracnose of sorghum. Indian Phytopath., 31: 225-227.

Mohanty, N.N. (1958). Target spot of Rauwolfia serpentina Benth. Sci. & Cult., 24: 608-609.

Mohanty, N.N. and Addy, S.K. (1957). Cercospora leaf spot of Rauwolfia serpentina Benth. Curr. Sci., 26: 289-290.

Mordue, M. (1971). Descriptions of Pathogenic fungi and Bacteria. C.M.I.Sheet No.315. Commonwealth Mycological Institute, Kew, Surrey, U.K.

*Mukherjee, K.G. and Saroj Kapoor, S (1969). Fungi of Delhi-V-Some interesting loculoascomycetes. Ceska Mycol., 23: 256-261.

Mundkur, B.B. (1938). Fungi of India- Supplement-I. I.C.A.R. Sci. Monograph, 12: 54 pp.

Munjal, R.L. and Gill, H.S. (1962). Some dematiaceous Hyphomycetes from India-I. Indian Phytopath., 15: 269-279.

Nadkarni, A.K. (1954). Indian Materia Medica, Vol. I. Popular Book Depot, Bombay. 1319 pp.

Nair, M.C. and Menon, M.R. (1983). Diseases of crop plants of Kerala. Kerala Agricultural University, Vellanikkara, Kerala. 277 pp.

Narain, A. and Panigrahi, C. (1971). Efficacy of some fungicidal compounds to control C. capsici in vitro and in vivo. Indian Phytopath., 24: 593-596.

Narendrappa, T. and Siddaramaiah, A.L. (1985). A new wilt of Catharanthus roseus. Plant Path. Newsletter, College of Agriculture, Dharwad, 3: 20.

Naseema, A. (1981). Seed mycoflora of some vegetables in Kerala. M.Sc.(Ag)Thesis, Kerala Agricultural University, Vellanikkara.

Newhall, A.G. (1948). Research at Turrialba on cocoa diseases. Cocoa Inf. Bull., 7: 7.

Padma, R. and Mukherjee, K.G. (1972). Fungi on the root region of Rauwolfia serpentina Benth. and R. canescens. Indian Phytopath., 25: 104-107.

Padmakumary, G., Suharban, M., Nair, M.C., Reghunath, B.R. and Nair, G.S. (1981). A new leaf blight disease of Catharanthus roseus (L.)G.Don. Agric. Res. J. Kerala, 19: 145.

Pandotra, V.R. and Ganguly, D. (1964,a). Fungi on medicinal and aromatic plants in N.W. Himalayas-II. Mycopath.et Mycol. Appl., 22: 59-68.

Pandotra, V.R. and Ganguly, D. (1964,b). Fungi on medicinal and aromatic plants in N.W. Himalayas-III. Mycopath.et Mycol. Appl., 27: 106-116.

Pavgi, M.S. and Singh, U.P. (1965). Parasitic fungi from North India-V. Mycopath. et Mycol. Appl., 27: 89-95.

Peterson, G.W. (1981). Control of Diplodia and Dothistroma blights of pines in urban environment. Journal of Arboriculture, 7: 1-5.

Ponnappa, K.M. (1970,a). Phyllostictina plumbaginis sp. nov. Mycologia, 62: 395-397.

Ponnappa, K.M. (1970,b). Some interesting fungi. Proc. Ind. Acad. Sci., 71 B:66-77.

Prasad, S.S. and Bilgrami, K.S. (1973). Investigations on the diseases of litchi-II. Influence of temperature and humidity on the decay of fruits caused by nine virulent pathogens. Indian Phytopath., 26: 517-522.

Purkayastha, R.P. and Sen Gupta, M. (1975). Studies on Colletotrichum gloeosporioides inciting anthracnose of Jute. Indian Phytopath., 28: 454-458.

Qadri, S.M.H., Srivastava, K.J., Bhonde, S.R., Pandey, U.B. and Bhagchandani, P.M. (1982). Fungicidal bioassay against some important pathogens of onion. Pesticides, 16: 11-16.

*Rabenhorst, L. (1878). Fungi europaei exsicacti. Hedw. 17: 31-47.

Rajagopalan, B. and Wilson, K.I. (1972,a). In vitro evaluation of fungicides against Diplodia natalensis. Indian J. Microbiol., 12: 100-103.

Rajagopalan, B. and Wilson, K.I. (1972,b). Diplodia natalensis causing dry rot of guava fruits in South India. Plant Dis. Reptr., 56: 323-324.

Ramakrishnan, T.S. (1959). Notes on fungi from South India-VII. Proc. Ind. Acad.Sci., 49B : 124-128.

Ramakrishnan, T.S. and Ramakrishnan, K. (1950). Additions to fungi of Madras- IX. Proc. Ind. Acad. Sci., 32B: 205-214.

Ramakrishnan, T.S. and Rangaswami, G. (1948). Uromyces acori Ramakr. and Rangaswami sp. nov. on Acorus calamus L. Curr. Sci.,17: 240-241.

Rangaswami, G., Seshadri, V.S. and Lucy Channamma, K.A. (1970). Fungi of South India, Univ. Agric. Sci., Bangalore. 193 pp.

Rao, K.S.N., Sreekantiah, K.R. and Rao, T.N.R. (1971). Post harvest infection of coconut kernel by Botryodiplodia theobromae and a note on the hydrolytic enzymes secreted by the fungus. Indian Phytopath., 24: 815-819.

Rao, V.G. (1964). A new fruit spot of Anona squamosa from India. Plant Dis. Reptr., 48: 399-400.

*Rao, V.G. (1965). The genus Phyllosticta in India. Sydowia, 19: 117-120.

Rao, V.G. and Pandey, A. (1980). An undescribed species of Ophiobolus Riess. on periwinkle. Sci. & Cult., 46: 295-296.

Riddel, R.W. (1950). Slide cultures. Mycologia, 42: 265-270.

Roy, A.K. (1976). Some new records of fungi on medicinal plants. Curr. Sci., 45: 464.

Saikia, A.K. (1982). Laboratory evaluation of fungicides against leaf blight of pineapple. Pesticides, 16: 38.

*Saito, I., Suzui, T. and Baba, T. (1980). Fine structure of septal pore apparatus in Sclerotium sp., the causal fungus of a root rot disease of esculent asparagus. Trans. Mycol. Soc. Japan, 21: 187-192.

Salam, M.A., Rao, P.N. and Rao, P.R. (1958). The new records of fungi imperfecti on Zingiberaceae. Indian Phytopath., 11: 122-125.

Santhakumari, P. (1980). Studies on the fungal diseases of ornamental plants. M.Sc. (Ag)thesis, Kerala Agricultural University, Vellanikkara.

Saroj Kapoor and Mukherjee, K.G. (1969). Fungi of Delhi-VIII. Two unrecorded members of Hypocreales. J. Ind. Bot. Soc., 48: 255-257.

Sattar, A., Alam, M., Singh, K.P. and Husain, A. (1979,a). Damping-off of Costus speciosus caused by Pythium butleri. Indian Phytopath., 32: 615-616.

Sattar, A., Alam, M., Singh, K.P. and Husain, A. (1979,b). Phytophthora leaf blight of Costus in India. Indian J. Mycol. & Plant Path., 9: 81.

Sehgal, S.P., Deshpande, A.L. and Shrivastava, U.S. (1965). A new disease of coriander caused by Colletotrichum capsici (Syd.) Butler & Bisby from India. Curr. Sci., 34: 89-90.

Sharma, N.D. and Agarwal, G.P. (1974). Fungi causing plant diseases at Jabalpur, M.P. - XVI. J. Ind. Bot. Soc., 53: 76-82.

Sharma, N.D. and Jain, A.C. (1984). In vitro evaluation of fungicides against some Fusarium spp. Pesticides, 18: 37-38.

Shreemali, J.L. (1972). Two new pathogenic fungi causing diseases of Indian medicinal plants. Indian J. Mycol. & Plant Path. 2: 120-121.

Shreemali, J.L. (1973). Sphaeropsidean fungi obtained from Indian Phylloclades. Indian Phytopath., 26: 56-62.

Shukla, R.S., Kumar, S., Singh, K.P. and Husain, A. (1982). Seedling blight of Costus speciosus caused by Thanatephorus cucumeris. Indian Phytopath., 35: 539-540.

Shukla, R.S., Kumar, S., Singh, K.P. and Husain, A. (1983). A new leaf spot disease of Costus speciosus caused by Drechslera rostrata in India. Indian Phytopath., 36: 571-573.

Sijpesteijn, A.K. and Janssen, M.J. (1958). Fungitoxic action of 8- hydroxyquindine, Pyridine N-oxide 2- thiol and sodium dialkyl dithiocarbamates and their copper compounds. Nature, 180: 550.

Sindhan, G.S. and Bose, S.K. (1981). Evaluation of fungicides against anthracnose of French bean caused by Colletotrichum lindemuthianum. Indian Phytopath., 34: 325-329.

Singh, A.K., Singh, S.K. and Kamal (1984). A new species of Phaeoisariopsis Febr. Curr. Sci., 53: 876-877.

Singh, B.P. (1971). A new record of Curvularia ovoidea on the leaves of chilli. (Capsicum annuum). Indian Phytopath., 24: 388-389.

Singh, D.V., Singh, R.S. and Srivastava, H.S. (1967). Myrothecium leaf spot of Vinca rosea. Sci. & Cult., 33: 70-71.

Singh, R.B. and Jain, J.P. (1978). Bioassay of different systemic and non-systemic fungicides against anthracnose of bottlegourd caused by Colletotrichum lagenarium. Indian J. Mycol. & Plant Path. 8: 125-126.

Singh, R.S. and Narendra Singh (1975). An observation on the association of Fusarium moniliforme with sugarcane wilt. Indian Phytopath., 28: 271-272.

Singh, S., Pandey, P.C. and Misra, B.M. (1977). Twig blight and pod blackening of cocoa (Theobroma cacao Linn.) Indian Forester, 103: 483-485.

Siradhana, B.S. and Jain, A.C. (1962). Botryodiplodia fruit-rot of papaya. Sci. & Cult., 28: 185-186.

Sohi, H.S. and Rawal, R.D. (1984). Studies on the efficacy of various fungicides for the control of anthracnose of cowpea caused by Colletotrichum lindemuthianum. Pesticides, 18: 33-34.

Sohi, H.S., Ullasa, B.A. and Sokhi, S.S. (1975). Stem blight of Asparagus officinalis caused by Phomopsis asparagi (Sacc.) Bubak. Curr. Sci., 44:722-723.

Solel, Z. and Oren, Y. (1978). Laboratory and field evaluation of fungicides to control anthracnose stain of citrus fruit. Phytoparasitica, 6: 59-64.

Sridhar, T.S. (1979). Fungal diseases of medicinal and aromatic plants-I. Stem rot of Vinca rosea. Sci. & Cult., 45: 127-128.

Srivastava, H.P. (1964). Some new leaf spot fungi. Proc. Nat. Acad. Sci., 34 B: 188-196.

Srivastava, M.P. and Tandon, R.N. (1971). Efficiency of certain fungicides and an antibiotic against 4 isolates of Botryodiplodia theobromae. Indian Phytopath., 24: 396-397.

Sutton, B.C. (1980). The Coelomycetes. Commonwealth Mycological Institute, Kew, Surrey, England. 696 pp.

Sutton, B.C. (1988). Personal communication.

*Suzui, T. (1978). Studies on the ecology and control of asparagus violet root rot caused by Helicobasidium mompa Tanaka. Research Bull. Hokkaido Nat. Agric. Expt. Sta. No.122: 87-165.

*Sydow, H. and Butler, E.J. (1906). Fungi Indiae Orientalis Pars-I. Ann. Mycol., 4: 424-425.

*Sydow, H. and Butler, E.J. (1911). Fungi Indiae Orientalis Pars-III. Ann. Mycol., 9: 372-421.

*Sydow, H. and Mc Rae, W. (1929). Hyphomycetes Indiae Orientalis. Ann. Crypt. Exot., 2: 262-271.

Tandon, I.N. and Singh, B.B. (1968). Control of mango anthracnose by fungicides. Indian Phytopath., 21: 212-216.

Tandon, I.N. and Singh, B.B. (1969). Studies on anthracnose of guava and its control. Indian Phytopath., 22: 322-326.

Tandon, R.N. and Agarwala, B.K. (1954). Pathological studies of Gloeosporium psidii causing die-back of guavas. Proc. Ind. Acad. Sci., 40 B: 102-108.

Thakur, R.N., Pandotra, V.R. and Sastry, K.S.M. (1980). Studies on Curvularia leaf blight of Costus speciosus. Indian J. Mycol. & Plant Path., 10: 117-118.

Thakur, R.N., Pandotra, V.R., Singh, P. and Sastry, K.S.M. (1985). Studies on screening of five selected fungicides for the control of three pathogens causing diseases of three drug yielding plants. International J. Tropical Plant Diseases, 3: 91-92.

Thakur, R.N., Singh, P. and Sastry, K.S.M. (1978). Occurrence of Pythium rhizome rot of Costus speciosus. Indian J. Mycol. & Plant Path., 8: 229.

Thirumalachar, M.J. (1947). Some noteworthy rusts-II. Mycologia, 39: 231-248.

Thirumalachar, M.J. and Govindu, H.C. (1954). Morphological and Cytological studies of a bisporidial species of Endophyllum. Bot. Gaz., 115: 388-391.

*Tiwari, D.P., Lodh, A.R. and Jacob, A.I. (1978). Diseases of Catharanthus roseus (=Vinca rosea) in Jabalpur, M.P. Nat. Acad. Sci. Letters, 1: 163-164.

Tripathi, H.S. and Beniwal, S.P.S. (1977). Anthracnose of urdbean caused by Colletotrichum capsici. Indian Phytopath., 30: 273-274.

Tripathi, K.C. (1985). Diseases of asparagus in Garhwal Hills. Indian J. Forestry, 8: 236.

*Tu, C.C. (1985). Major diseases of asparagus and their control in Taiwan. Proceedings of the Sixth International Asparagus Symposium, 168-180 pp.

Varadarajan, P.D. (1964,a) Pellicularia leaf spot of Rauwolfia serpentina Benth. under cultivation. Curr. Sci., 33: 503-504.

Varadarajan, P.D. (1964,b). Anthracnose disease of Rauwolfia serpentina Benth. caused by Colletotrichum gloeosporioides Penz. Curr. Sci., 33: 564-565.

Varadarajan, P.D. (1966). Leaf spot and premature defoliation of Rauwolfia serpentina Benth. under cultivation caused by Curvularia lunata (Wakker) Boedijn. Indian Phytopath., 19: 298-299.

Ved Ram and Dharam Vir (1986). Efficacy of fungicides-xxxvi. Relative evaluation of various post-harvest chemical treatments against spoilage of banana fruits caused by Curvularia lunata. Indian Phytopath., 39: 594-595.

Vijayan, M. (1978). Charcoal pod rot of cocoa (Theobroma cacao L.) and its control. M.Sc.(Ag.)Thesis, Kerala Agricultural University, Vellanikkara.

Vijayan, M. and Wilson, K.I. (1980). Charcoal pod rot of cocoa. Indian Cocoa, Arecanut and Spices J. 3: 61-63.

Vijayan, M. and Wilson, K.I. (1985). Laboratory evaluation of fungicides against Botryodiplodia theobromae Pat. causing charcoal pod rot of cocoa. Proc. Ann. Conference Soc. Mycol. & Plant Path., Udaipur, 16-19 April, 1985.

Von Arx, J.A. (1957). Die Arten der.Gattung Colletotrichum Cda. Phytopath. Z., 29: 413-468.

Vrany, J., Sastry, K.S.M., Thakur, R.N. and Singh, P. (1984). Experiments on comparative efficacy of Daconil 2787-W-75 against four plant pathogenic fungi. Pesticides, 18: 39-40.

Wilson, K.I. and Jose, P.C. (1966). Leaf blight of Plumeria acutifolia Poir. Indian Phytopath., 19: 389.

*Zamorski, C. and Bielska, E. (1983). Curvularia trifolii (Kauffm.)Boed.f.sp. gladioli parmelee & Luttrell., a Glodiolus pathogen new to Poland. Acta Agrobotanica, 36: 135-144.

*Zengin, H. (1978). Control trials against damping-off of seedlings in the Marmara region. Zirai Mucadele Arastirma Yilligi, 12: 122.

Zentmeyer, G.A. (1955). A laboratory method of testing soil fungicides with Phytophthora cinnamomi, as test organism. Phytopathology, 45: 398-404.

* original not seen.

APPENDICES

APPENDIX I

COMPOSITION OF CULTURE MEDIA

Coon's agar

Sucrose	- 7.20 g
Dextrose	- 3.60 g
Magnesium sulphate	- 1.23 g
Potassium dihydrogen phosphate	- 2.72 g
Potassium nitrate	- 2.02 g
Agar agar	- 20.00 g
Distilled water	- 1000.00 ml

Czapek's-Dox agar

Sucrose	- 30.00 g
Sodium nitrate	- 2.00 g
Potassium dihydrogen phosphate	- 1.00 g
Magnesium sulphate	- 0.50 g
Potassium chloride	- 0.50 g
Ferrous sulphate	- 0.01 g
Agar agar	- 20.00 g
Distilled water	- 1000.00 ml

Oatmeal agar

Oatmeal	- 30.00 g
Agar agar	- 20.00 g
Distilled water	- 1000.00 ml

(contd..)

Potato dextrose agar

Pealed and sliced potato	- 200.00 g
Dextrose	- 20.00 g
Agar agar	- 20.00 g
Distilled water	- 1000.00 ml

Richard's agar

Sucrose	- 50.00 g
Potassium nitrate	- 10.00 g
Potassium dihydrogen phosphate	- 5.00 g
Magnesium sulphate	- 2.50 g
Ferric chloride	- 0.02 g
Agar agar	- 20.00 g
Distilled water	- 1000.00 ml

Sabouraud's agar

Glucose	- 40.00 g
Peptone	- 10.00 g
Agar agar	- 20.00 g
Distilled water	- 1000.00 ml

APPENDIX II

Analysis of variance table

(i) Growth of *Colletotrichum gloeosporioides* on different media

Source	SS	df	MS	F calculated	F at 0.05 level	F at 0.01 level
Total	1323.61	17				
Treatment	1274.27	5	254.85	61.98**	3.11	5.06
Error	49.33	12	4.11			

CD for comparison - 3.61

** Significant at 5 per cent and 1 per cent level

(ii) Growth of *Colletotrichum capsici* on different media

Source	SS	df	MS	F calculated	F at 0.05 level	F at 0.01 level
Total	1028.44	17				
Treatment	959.10	5	191.82	83.19**	3.11	5.06
Error	69.33	12	5.77			

CD for comparison = 4.28

** Significant at 5 per cent and 1 per cent level

(iii) Growth of *Curvularia clavata* on different media

Source	SS	df	MS	F calculated	F at 0.05 level	F at 0.01 level
Total	1772.00	17				
Treatment	1744.00	5	348.80	149.48**	3.11	5.06
Error	28.00	12	2.33			

CD for comparison = 2.72

** Significant at 5 per cent and 1 per cent level

(iv) Growth of *Curvularia lunata* on different media

Source	SS	df	MS	F calculated	F at 0.05 level	F at 0.01 level
Total	1571.60	17				
Treatment	1541.60	5	308.32	123.32**	3.11	5.06
Error	30.00	12	2.50			

CD for comparison = 2.82

** Significant at 5 per cent and 1 per cent level

(v) Growth of *Botryodiplodia theobromae* on different media

Source	SS	df	MS	F calculated	F at 0.05 level	F at 0.01 level
Total	694.28	17				
Treatment	686.94	5	137.38	224.73**	3.11	5.06
Error	7.33	12	0.61			

CD for comparison = 1.39

** Significant at 5 per cent and 1 per cent level

(vi) Growth of *Fusarium moniliforme* var. *intermedium* on different media.

Source	SS	df	MS	F calculated	F at 0.05 level	F at 0.01 level
Total	1184.00	17				
Treatment	1157.33	5	231.46	104.17**	3.11	5.06
Error	26.66	12	2.22			

CD for comparison = 2.65

** Significant at 5 per cent and 1 per cent level

APPENDIX III

Analysis of variance table

(i) Effect of different fungicides on the growth of Colletotrichum gloeosporioides on solid medium (poisoned food technique)

Source	SS	df	MS	F calculated	F at 0.05 level	F at 0.01 level
Total	12441.75	53				
Treatment	12429.09	17	731.12	2079.63**	1.92	2.52
Error	12.65	36	0.35			

CD for comparison = 0.98

** Significant at 5 per cent and 1 per cent level

(ii) Effect of different fungicides on the growth of Colletotrichum capsici on solid medium (poisoned food technique)

Source	SS	df	MS	F calculated	F at 0.05 level	F at 0.01 level
Total	4614.03	53				
Treatment	4605.71	17	270.92	1173.32**	1.92	2.52
Error	8.31	36	0.23			

CD for comparison = 0.79

** Significant at 5 per cent and 1 per cent level

(iii) Effect of different fungicides on the growth of Curvularia clavata on solid medium (Poisoned food technique)

Source	SS	df	MS	F calculated	F at 0.05 level	F at 0.01 level
Total	35560.36	53				
Treatment	35546.14	17	2090.95	5294.01**	1.92	2.52
Error	14.22	36	0.39			

CD for comparison = 1.04

** Significant at 5 per cent and 1 per cent level

APPENDIX III (Contd.)

(iv) Effect of different fungicides on the growth of Curvularia lunata on solid medium (Poisoned food technique)

Source	SS	df	MS	F calculated	F at 0.05 level	F at 0.01 level
Total	40059.60	53				
Treatment	40006.49	17	2353.23	1595.19**	1.92	2.52
Error	53.10	36	1.47			

CD for comparison = 2.03

** Significant at 5 per cent and 1 per cent level

(v) Effect of different fungicides on the growth of Botryodiplodia theobromae on solid medium (poisoned food technique)

Source	SS	df	MS	F calculated	F at 0.05 level	F at 0.01 level
Total	13673.22	53				
Treatment	13589.28	17	799.37	342.84**	1.92	2.52
Error	83.94	36	2.33			

CD for comparison = 2.53

** Significant at 5 per cent and 1 per cent level

(vi) Effect of different fungicides on the growth of Fusarium moniliforme var. intermedium on solid medium(Poisoned food technique)

Source	SS	df	MS	F calculated	F at 0.05 level	F at 0.01 level
Total	12294.16	53				
Treatment	12281.34	17	722.43	2029.85	1.92	2.52
Error	12.81	36	0.35			

CD for comparison = 0.98

** Significant at 5 per cent and 1 per cent level

FUNGAL DISEASES OF CERTAIN MEDICINAL PLANTS IN KERALA

BY

S. SANKARANARAYANA SARMA

ABSTRACT OF THE THESIS
Submitted in partial fulfilment of
the requirements for the degree of
MASTER OF SCIENCE IN AGRICULTURE
(Plant Pathology)

Department of Plant Pathology
COLLEGE OF AGRICULTURE
VELLAYANI, TRIVANDRUM
1988

ABSTRACT

A survey was conducted in three localities of Trivandrum district, viz. College of Agriculture, Vellayani, Tropical Botanic Garden and Research Institute, Palode and Post-Graduate-cum-Research Centre in Ayurveda, Poojappura, to study the fungal diseases of ten important medicinal plants. Colletotrichum gloeosporioides, C. capsici, Curvularia clavata, Curvularia lunata, Botryodiplodia theobromae, Fusarium moniliforme var. intermedium, Uromyces sparganii ssp. asiaticus and Puccinia sp. were found infecting the plants.

The above fungi, except Uromyces sparganii ssp. asiaticus and Puccinia sp. were isolated in pure culture and pathogenicity to their respective host plant established by artificial inoculation. The effect of five artificial culture media on the growth and sporulation of the pathogens was studied. Czapek's-Dox agar and Richard's agar were found to be favouring good growth and sporulation of all the fungi.

Cross inoculation studies with the isolates of Colletotrichum gloeosporioides from five medicinal plants revealed that they are able to infect each others host plant. The isolate from Rauwolfia serpentina was found to be

the most virulent pathogen, while the one from Adhatoda beddomei the least.

In vitro assay of six fungicides revealed that Bordeaux mixture, Cuman L, Dithane M-45 and Foltaf are very effective in inhibiting the spore germination of the test fungi. Carbistin was also effective against the fungi, except Curvularia clavata and Curvularia lunata.

Bordeaux mixture, Cuman L and Dithane M-45 were very effective in inhibiting the radial growth of the fungi on Czapek's-Dox agar. Carbistin, though effective against most of the test fungi, could not inhibit the growth of Curvularia clavata and Curvularia lunata.