STUDIES ON THE LEAF SPOT DISEASES OF OIL PALM (*Elaeis guineensis* Jacq) IN KERALA

BY

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THESIS

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DECLARATION

I hereby declare that this thesis entitled "STUDIES ON THE LEAF SPOT DISEASES OF OIL PALM (*Elaeis guineensis* Jacq.) 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, associateship, fellowship or other similar title of any other University or Society.

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CERTIFICATE

Certified that this thesis entitled "STUDIES ON THE LEAF SPOT DISEASES OF OIL PALM (*Elaeis guineensis* jacq.) IN KERALA" is a record of research work done independently by Mr. Thomas John under my guidance and supervision and that it has not formed the basis for the award of any degree, fellowship or associateship to him.

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INTRODUCTION

INTRODUCTION

Oil palm is a native of West Africa. The major oil palm growing countries are Malaysia, Indonesia, Papua, New Guinea, Nigeria, Ivory Coast, Republic of Zaire and Costa Rica. Malaysia and Indonesia are the two important palm oil exporting countries and their contribution to the world markets are seventy three and ten per cents respectively.

Oil palm was introduced in to India during the last century at the National Botanical gardens, Calcutta. The first effort in introducing and popularising the cultivation of oil palm on a systematic basis was made by the Government of Kerala at Thodupuzha, where a research station on oil palm was set up in 1960. Commercial cultivation of oil palm on a large scale was started in India by Oil palm India Ltd., which has 3705 hecteres under oil palm at present in Kerala. The success of oil palm cultivation in Kerala has shown that it can play an important role in reducing edible oil deficits and saving substantial foreign exchange, if it is cultivated in suitable areas adopting all scientific management practices.

Though oil palm in India has not so far been affected by any deadly disease, a few diseases like bunch failure, spear rot, anthracnose in nursery etc. have been recorded. Large number of leaf spot diseases have been observed resulting in heavy loss of nursery plants as well as of adult palms. No systematic effort has been made so far in this State to study the various leaf spot diseases of oil palm. Although informations relating to the actual loss caused by various leaf spot diseases of oil palm are scarce, the damage caused by these diseases are of great economic importance. Many leaf spot pathogens attack and reduce the yield of this crop considerably. Hence, inorder to make the cultivation of this crop a success and to increase its production, it is absolutely essential to have a full understanding of these diseases.

The objectives of the present investigation are therefore, to identify the leaf spot diseases affecting oil palm in Kerala, to determine their etiology, to study the symptomatology and also to evaluate the effectiveness of various fungicides in controlling the major diseases.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The occurrence of various leaf spot diseases has been reported from different oil palm growing countries. However, the information regarding the leaf spot diseases in Kerala is scarce. The leaf spot diseases caused by species of Bipolaris, Botryodiplodia, Colletotrichum, Curvularia, Fusarium and Phoma are described below.

Bipolaris

A leaf spot disease on oil palm seedlings caused by an unidentified species of Bipolaris was reported from Malaya. (Thompson, 1939). Thereafter reports in different spp. of Helminthosporium from various countries have been made (Bull, 1954; Dupriez and Bredas, 1957; Johnston, 1959; Turner and Bull, 1968; Trafton and Washburn, 1969). A survey conducted by Turner (1971) in Sumatra also confirmed the presence of Helminthosporium in oil palm nursery.

A leaf spot disease on adult palms caused by Bipolaris was reported from Malaysia (McIntosh, 1951), Drechslera halodes var. elaeicola from Zaire (Kovachich, 1954) and Drechslera rostrata from Malaysia (Williams and Liu, 1976).

Buckley and Allen (1951) described the etiology of the leafspot caused by Helminthosporium sp. Kovachich (1957) reported that H. halodes and other Helminthosporium spp. causing leaf spot of oil palm survived on the weed Sareophyrninum arnoldianum, a collateral host of the pathogen.

Jimenez and Reyes (1977) observed that the leaf disease due to Helminthosporium sop. developed on leaf wounds caused by insects.

Fungicidal evaluation

Turner (1969) reported that Thiram, Mancozeb and Ferbam gave good control of Helminthosporium leaf spot caused by H. halodes and H. rostratum.

Swamy and Urs (1978) observed that Bavistin (Carbendazim) and Blitox (Copper oxychloride) were effective against H. (Drechslera) sacchari in vitro.

Nakov, Boshnakov and Angelov (1979) observed that Difolatan (Captafol), Ziram and Dithane M-45 (Mancozeb) were effective against H. allii.

Dwivedi and Shukla (1983) reported that Drechslera halodes was sensitive to Thiram, Cuman L, Ferbam, Zineb, Captan and Aureofungin.

Botryodiplodia

A leaf spot disease of oil palm caused by Botryodiplodia theobromae on the foliage of oil palm seedlings was noticed from Ivory Coast, (Ravise, 1965), from Peninsular Malaysia (Turner and Bull, 1968).

Turner (1971) reported from Sumatra that leaf disease caused by Botryodiplodia was common.

Williams and Liu (1976) reported that leaf disease caused by B. palmarum was severe on oil palm seedlings.

Alibert (1944) and Hughes (1953) reported the leaf disease due to B. theobromae on adult palms.

Robertson (1956) stated that Botryodiplodia sp. normally affects the distal parts of the leaves, where small clear spots first developed, later the colour changed to brown and spots enlarged and were surrounded by a pale brown halo.

Robertson (1956) described an isolate of B. palmarum as follows.

Spores produced inside the pycnidium were hyaline, non-septate, and measured 18 x 10 µm. After extrusion they became biseptate or triseptate and were brown in colour.

Fungicidal evaluation

Rajagopalan and Wilson (1972a) observed that Zirida was the most effective fungicide in reducing the percentage of guava fruits infected with Diplodia natalensis.

Rajagopalan and Wilson (1972b) obtained 100 per cent inhibition of germination of single celled spores of Diplodia natalensis with 50 ppm Dithane M-45 whereas the double celled spores required 100 ppm of the above fungicide. Complete inhibition of growtn was obtained at 3000 ppm of Dithane M-45.

Chakrabarti and Nandi (1976) reported inhibition of the growth of B. theobromae with Aureofungin in vitro.

Successful control of Cocoa pod rot caused by B. theobromae by Bavistin (250 ppm) and Dithane M-45 (1000 ppm) has been reported (Vijayan, 1978).

Naseema (1981) in her studies with B. theobromae showed that Dithane M-45 (Mancozeb) at 1000 ppm inhibited the radial growth of the fungus.

Agarwal et al., (1982) reported that Aureofungin at 100 ppm inhibited the growth of B. theobromae causing mandarin fruit rot, in vitro.

Srivastava and Tandon (1971) in their in vitro studies showed that copper fungicides and dithiocarbamates were ineffective against the isolates of B. theobromae causing fruit rot of citrus, guava, mango and sapodilla.

Colletotrichum

A species of Colletotrichum causing leaf spot disease on oil palm was recorded by Staner (1929) from Belgian Congo. Glomerlla cingulata was reported from Malaya by Mc Intosh (1951), Colletotrichum sp. was reported from Peninsular Malaysia by Jagoe and Heath (1954), Glomerella cingulata was reported by Williams (1969), C. gloeosporioides was reported from Combodia by Punnee Soonthronpoot (1969).

Leaf spot disease of oil palm caused by C. capsici was reported from Malaya by Thompson (1940), Glomerella cingulata was reported from Belgian Congo by Kovachich (1957), from Nigeria by Turner (1971) and Glomerella sp. was isolated by Williams and Liu (1976).

The etiology and symptomatology of one type of anthracnose disease of oil palm seedlings caused by C.gloeosporioides was reported from West Africa (Anonymous, 1955). Robertson (1956) described the symptomatology of the leaf spot of oil palm seedlings caused by Glomerella cingulata. He stated

that Glomerella attack appears as small brown water soaked spots developing between veins. In culture Glomerella spores were 12 x 6 µm in size, thick walled and hyaline; perithecia were flask shaped with a small neck, the ascus had a pore and contained eight ascospores, which germinated readily.

Fungicidal evaluation.

Eikelenboom (1964) found that Glomerella cingulata was a sensitive organism for Zineb, Thiram, Captan and Thiophenyl tin acetate.

Kothari and Bhatnagar (1966) showed the inhibition of spore germination of C. capsici with Ferbam even at the lowest concentration tried (2 ppm). He reported the total inhibition of spore germination with Fytolan and Dithane Z-78 at 64 and 128 ppm, respectively. Narain and Panigrahi (1971) showed that Aureofungin at 50 ppm was effective in restricting the conidial germination of C. capsici. Gupta (1974) reported that Aureofungin at one ppm concentration gave complete inhibition of spore germination of C. piperatum. Om Gupta and Nema (1978) found that Ziram and Fytolan at 1000 ppm reduced the growth of C. papayae. Khanna and Chandra (1978) in their studies on the control of leaf blight of Rosa indica and Cinnamomum camphora caused by Glomerella

cingulata found that the best control was given by Difolatan (Captafol) and Benlate (benomyl) in the laboratory tests with detached leaves.

Solel and Oren (1978) observed that, among the fungicides bioassayed against C. gloeosporioides (Glomerella cingulata) causing anthracnose of citrus fruit, Bordeaux mixture was the most effective fungicide, potent organic compounds were Captafol, Captan, Clorothalonil, Maneb and Mancozeb.

Karunakaran (1981) in his studies on the control of the diseases of major tree spices caused by C. gloeosporioides found that Bordeaux mixture, Fytolan and Dithane 2-78 gave complete inhibition of mycelial growth and spore germination of the fungus.

Field evaluation of Fungicides

Okiogo (1978) found that coffee berry disease caused by Colletotrichum gloeosporioides (Glomerella cingulata) could be controlled effectively by spraying Captafol. Mishra and Siradhana (1978) reported that best control against C. graminicolum (C. graminicola).was given by Benomyl, Difolatan (Captafol) and Bavistin (Carbendazim). Solel and Oren (1978) in their studies to control anthracnose of citrus

fruit caused by C. gloeosporioides (Glomerella cingulata) reported that effective field control was achieved even with one prophylactic treatment with copper containing fungicides and Bordeaux mixture was found to be the most effective copper compound.

Madaan and Grover (1979) in their trial in controlling leaf antracnose and fruit scab caused by C. lagenarium found that Difolatan (Captafol) and Blitox (Copper oxychloride) gave good control.

Chauhan et al., (1980) in their studies to control of anthracnose of bottlegourd caused by C. lagenarium with Bavistin, Blitox, Dithane M-45 and Difolatan found that best control was achieved with Difolatan (Captafol) followed by Bavistin (Carbendazim).

Kotze et al., (1981) showed that in Pre harvest field tests Captafol and copper oxychloride reduced the incidence of anthracnose caused by C. gloeosporioides (G. cingulata) lesions on avocado fruit.

Sindhan and Bose (1981) in their studies to control anthracnose of french bean caused by C. lindemuthianum found that Benlate (benonyl), Bavistin (Carbendazim), Ziram and Vitavax gave good control.

Sohi and Rawal (1984) in their studies to control anthracnose or Cowpea caused by C. lindemuthianum found that Benomyl and Bavistin (Carbendazim) performed best and reduced the yield losses from 42.9% to 4.9% and 3.2%, respectively.

Curvularia

A leafspot disease of oil palm seedlings caused by Curvularia sp. was reported from Malaysia (Heath, 1955, Turner and Bull, 1968, Anon, 1976). From Sumatra, Williams, 1969, Turner, 1971 reported a leaf disease caused by C. eragrostidis, Cochliobolus geniculatus (formerly C.geniculata), Cochliobolus heterostrophus, C. eragrostidis (also as C. maculans). C. fallax, unidentified Curvularia spp. were recorded by Ellis (1971). C. eragrostidis and C. fallax were recorded from peninsular Malaysia by Williams and Liu (1976).

A leaf disease of oil palm was recorded from Honduras by Kovachich (1956), C. lunata was reported from Asia by Williams (1969), C. pallescens and C. prasadii were reported from Asia, C. fallax, C. oryzae from Africa (Common wealth Mycological Institute (1970), Curvularia spp. especially C. eragrostidis reported from Malaysia by Turner and Gillbanks (1974), Curvularia sp. from Colombia by Genty et al.,

(1975), C. fallax and C. lunata var. aeria reported from Malaysia by Williams and Liu (1976), C. eragrostidis was reported from Bangladesh by Khisa and Choudhury (1986).

Johnston (1959) described the etiology and symptomatology of the leafspot of oil palm seedling caused by C. maculans in detail. Pillai (1969) described the seedling blight of oil palm caused by C. eragrostidis from Malaya. He stated that the pathogen first reaches the plant as airborne spores which under suitable conditions germinate and initiate infection.

Fungicidal evaluation

Saikia (1982) found that Cuman L at 1000 ppm and Aureofungin at 2000 ppm completely inhibited the growth of C. eragrostidis. Blitox 50 (copper oxychloride) at 4000 ppm and Dithane M-45 at 2000 ppm also gave good control. Zamorski and Bielska (1983) reported the in vitro effect of Captafol against C. trifolii. Kumar and Srivastava (1985) found that C. pallescens and C. graminicola were sensitive to Bavistin (Carbendezim), Difolatan 80 w (Capatafol), Captan and Dithane M-45 (Mancozeb).

Heath (1958) reported that leaf blight of oil palm caused by Curvularia sp. was controlled by spraying with copper fungicide. Coleman (1958) showed that for controlling

seedling blight of oil palm caused by Curvularia sp. Captan gave best result. Turner (1967) reported that Copper oxychlorids and Dithane M-45 were effective against C. sragrostidis attacking oil palm seedling. Grewal and Payak (1978) in their studies on the control of Curvularia leaf spot of maize caused by C. pallescens found that the best control was given by Difolatan (Capatafol).

Fusarium

Many workers have reported Fusarium species such as Fusarium sp. from Sierra Leone (Deighton, 1933), F. oxysporum and F. solani from Malaya (Thompson, 1940), F. balbigenum var. tracheiphilum from Congo (Heim and Banchy, 1949), F. solani from Nigeria (Waterston, 1953), Fusarium sp. from Ivory coast (Lue, 1953) from Malaysia (Heath, 1958), F. moniliforme from Nigeria (Bull, 1954), F. equiseti from peninsular Malaysia (Johnston, 1962) and F. acuminatum, F. avenaceum, F. moniliformae, F. semitectum, F. sertectum var. majus, F. solani (Common Wealth Mycological Institute, 1970) causing leaf diseases of oil palm. Kovachich (1953), Bull (1954) and Turner (1971) isolated Fusarium sp. from oil palm seedlings from Belgian Congo, Nigeria and Malaysia respectively. F. lateritium was reported from Sabah (Williams and Liu, 1976), F. oxysporum, F. solani from Nigeria (Espinoza et al., 1977)

and F. oxysporum f.sp. elaeidis from Ivory Coast (Meunier et al., 1979) causing leaf diseases of oil palm seedlings. Kovacnich (1957) reported from Belgian Congo a leaf disease caused by Fusarium sp. He stated that re-inoculation with Fusarium isolates produced faint chlorotic speckling in some test plants.

Fungicidal evaluation

Turner (1968) reported that Thiram effectively controlled the spear rot of oil palm caused by F. oxysporum and F. solani. Khanna and Chandra (1977) reported that Aureofungin was effective against F. moniformae and F. roseum only at high concentration (2000 ppm). Zengin (1978) found that Bordeaux mixture at 1 per cent concentration gave 53.3 per cent control of dampingoff disease of Capsicum caused by Fusarium spp.

Costache et al., (1979) in their studies on the integrated control of tomato wilt caused by F. oxysporum f. sp. lycopersici found that Bavistin 50 wp (Carbendazim) at 0.05 - 0.1 per cent gave good control.

Kumar and Srivastava (1985) found that F. semitectum was sensitive to Bavistin (Carbendazim), Difolatan 80 w (Captafol), Captan and Dithane M-45 (Mancozeb).

Phoma

Phoma sp. causing leaf spot disease of oil palm was reported by Williams and Liu (1976) from Malaysia and from Common Wealth Mycological Institute (1970).

A leaf spot disease of oil palm caused by Phomopsis elaeidis was reported (Punithalingam, 1974, Anon, 1976).

Fungicidal evaluation

Khazaradze (1957) reported that the disease infection by Phomopsis diospyri was arrested by application of Bordeaux mixture one per cent.

Rao and Agarwal (1976) in their studies to control of fruit rot of Gauva caused by Phomopsis destructum found that Aureofungin gave 100 per cent inhibition at 100 ppm.

Rao and Agarwal (1977) in their trial in controlling fruit rot of Guava by Phomopsis destructum found that Blitox and Cuman gave good control.

Rebenko et al., (1978) found that a dangerous disease of Grapevine caused by Phomopsis viticola could be controlled effectively by spraying the vine with Bordeaux mixture.

Mansk et al., (1981) reported that Phomopsis spp. were sensitive to Difolatan (Captafol).

Lal et al., (1981) observed that Bavistin and Difolatan were effective against Phomopsis natsume, causing soft rot of ber, in vitro.

MATERIALS AND METHODS

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I. Survey on the occurrence of various leaf spot diseases of oil palm

A quarterly survey was carried out for a period of one year in the oil palm growing areas of Palode, Anchal, Thodupuzha and Kulathupuzha to identify the various leaf spot diseases affecting oil palm. Attempts were made to isolate all the pathogens associated with the diseased specimens and to establish their pathogenicity following Koch's postulates. The extent of damage caused by the various leaf spot diseases were recorded.

II. Isolation of various pathogens from oil palm

The diseased specimens of oil palm were collected from nursery seedlings at Palode, Anchal, Thodupuzha and Kulathupuzha for isolation of the pathogens. The fungal pathogens were isolated from the diseased leaves by routine mycological techniques as described hereunder:

The infected parts were cut into small bits and washed thoroughly in distilled water. The pieces were then surface sterilized in 0.1 per cent mercuric chloride solution for one to three minutes, taken out, re-washed in two to three changes of sterilized distilled water.

These pieces were then plated on Potato Dextrose Agar (PDA) medium and then incubated at room temperature ($28 \pm 3^{\circ}C$) when the fungal growth was visible, mycelial bits were transferred to PDA slants. The organisms were purified by single spore culture and maintained on PDA slants by periodical subculturing.

III. Inoculation studies

A. Inoculation of seedlings

Two year old plants of oil palm raised in pots were used for the experiment. The plants to be inoculated were kept under an atmosphere of high percentage of relative humidity for 24 hours before inoculation.

Inoculations were conducted by spraying spore suspensions prepared from the respective organisms and also by placing the culture bits consisting of mycelium and spores. Inoculation with the culture bits were conducted by placing a small piece of inoculum on the surface of healthy leaves. The inoculum was then covered with a piece of moist cotton wool to maintain a high percentage of relative humidity.

In both the methods of inoculations, purified seven day old cultures of the respective organisms were used.

Inoculations were made on the injured and uninjured leaves. Injury was made by puncturing with a sterilized needle. A hand atomizer was used for spraying the spore suspensions.

In both the methods, the inoculated and control plants were covered with polythene bags for different periods, depending upon the weather conditions, moistened inside, to provide high percentage of relative humidity. After incubation for 12 to 72 hours, the polythene bags were removed, allowed the disease to develop under natural conditions and observations recorded.

B. Inoculation of detached leaves

Detached healthy leaves, free from infection, were collected, surface sterilized by wiping with cotton dipped in 0.1 per cent mercuric chloride solution and then washed repeatedly with sterile distilled water. Inoculations were done by spraying spore suspensions and by placing culture bits. Conidial suspensions of the respective organisms were sprayed uniformly on both the sides of the leaves. Inoculations with culture bits of the organisms were carried out by placing them on the surface of the detached leaves. Inoculations were done with and without injury.

All the inoculated and uninoculated leaves were incubated in petridish moist chambers for different periods

to maintain high percentage of relative humidity. Observations were recorded periodically.

IV. Re-isolation of the pathogen from the inoculated leaves

The pathogens were re-isolated from the artificially produced lesions by following koch's postulates. The organisms so isolated were purified by single spore isolation techniques. The morphological and cultural characters of the pathogens re-isolated from the artificially produced lesions were studied and compared with the original isolates.

V. Symptomatology of various leaf spot diseases

Symptomatology of the various leaf spot diseases were studied in decail by observing the symptom development in the naturally infected plants in the field as well as in the artificially inoculated plants.

The following observations were recorded.

(a) Symptom development under natural condition.
(b) Variations in symptom development.
(c) Pattern of symptom development in the artifically inoculated plants.
(d) Incubation period for the initiation of symptoms in the artificially inoculated plants under different methods of inoculation.
(e) Occurrence and extent of damage.

VI. Morphology of the pathogen

The morphology of the various fungal pathogens isolated were studied by growing them on PDA. The morphological characters of mycelium, asexual and sexual fruiting bodies, colony colour, intensity of sporulation, measurements of various structures etc., were studied.

VII. Evaluation of fungicides

A. In vitro evaluation of fungicides against the pathogens

The comparative efficacy of the following seven fungicides were tested under laboratory conditions at different concentrations as shown below:

Name of fungicide	Concentration in ppm
1. Aureofungin sol (N-Methyl-p-amino aceto phenone-mycosamine heptane)	100, 150, 200
2. Bavistin (2 (Methoxy-Carbamoyl)-benzimidazole)	250, 500, 1000
3. Bordeaux mixture (Copper sulphate-lime mixture)	2500, 5000, 10000
4. Cuman L (Zinc dimethyl dithio carbamate)	1000, 2000, 3000

5. Dithane M-45 (Zinc ion and manganese ethylene bisdithiocarbamate)	1000, 2000, 3000
6. Foltaf (Cis-N-(1,1,2,2-tetrachloro-ethyl)thio)-4 cyclohexene 1,2-dicarboximide)	1000, 2000, 3000
7. Fytolan (Copper oxychloride-50 per cent metallic copper)	1000, 2000, 3000

The effect of different fungicides on the inhibition of radial growth of pathogens on solid media was tested by the 'poisoned food technique'.

The required quantity of fungicides were added to 50 ml of sterilized PDA medium to get the required concentration, mixed well, and poured into sterilized petridishes at the rate of 15 ml per dish. The dishes were inoculated with the respective culture discs of 5 mm diameter, cut out from the seven day old cultures of the different pathogens. The culture discs were placed at the centre of each petridish. Controls consisted of unamended PDA medium inoculated with the culture discs in the same way. All the petridishes were incubated at room temperature (28 ± 3°C). Observations on the radial growth of the fungus was recorded when the growth of the organism on the control plates was

completely covered. Per cent inhibition of growth of the different isolates of the pathogen over control was calculated by the following formula.

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

where C = radial growth in control.

T = radial growth in treatment

VIII. Field evaluation of promising fungicides against leaf spot of oil palm caused by Colletotrichum gloeosporioides

Of the various leaf spot diseases studied during the course of the present investigation, the leaf spot diseases caused by Colletotrichum gloeosporioides was observed as a major disease of economic importance. Considering the high phytotoxic effect of copper on oil palm, the use of Bordeaux mixture was not tried in field trial as a control measure though it is effective in in vitro studies. Hence the efficacy of the following four promising fungicides were tested under field conditions for the control of the above disease at the concentrations noted below:

Name of fungicide	Concentration (Percentage)
1. Bavistin (2 (Methoxy-Carbamoyl)-benzimidazole)	0.1
2. Dithane M-45 (Zinc ion - and manganese ethylene bis dithiocarbamate	0.2

3. Difolatan (Cis-N-(1,1,2-2 tetra chloro ethyl)thio)4-cyclo hexene-1,2, dicarboximide) 0.2

4. Cuman L (Zinc dimethyl dithiocarbamate) 0.2

In laboratory studies these four fungicides were found more effective against Colletotrichum gloeosporioides.

The trial for the control of leaf spot of oil palm was conducted at the College of Agriculture, Vellayani.

Twenty oil palm seedlings of two year old having maximum disease severity were selected for the trial. In the trial a randomised replicated field trial was laid out with one set of control. There were five treatments including control. Each treatment was replicated four times.

The plants selected at random were sprayed with the fungicide at an interval of 15 days. Three sprayings were given. The intensity of the leaf spot disease was recorded before the spraying to work out the disease severity. The disease intensity of the newly emerged leaves were recorded to calculate the per cent efficacy of each fungicide. The intensity of the disease at each observation was calculated using the following score chart.

Grade	Disease intensity	Description
0	0	No spots
1	5 - 10 per cent	1 2 - 10 spots
2	10 - 25 per cent	10 or more spots
3	26 - 50 per cent	Half of the leaf area infected.
4	51- 75 per cent	Half to three fourth of the leaf area infected.
5	76 and above	Almost complete infection of leaf.

All the leaves of the plants under each treatment were observed and the intensity of the disease was recorded. The disease index for each treatment was calculated from the observations.

$$D.I = \frac{\text{Sum of grades of each leaf}}{\text{Total number of leaves}}$$

The results were compared with the control plants which received no spray. The disease incidence scores of treated oil palm were adjusted for the pre treatment score and analysis of co-variance was done.

RESULTS

RESULTS

I. Survey on the occurrence of various leaf spot diseases of oil palm

A survey at three months interval was undertaken in the oil palm growing areas of Palode, Anchal, Kulathupuzha and Thodupuzha to identify the various leaf spot diseases affecting oil palm. A regular survey was carried out for one year in different plantations and the extent of damage caused by leaf spot diseases was recorded. Attempts were also made to isolate all the pathogens associated with the diseased specimens and to establish their pathogenicity following Koch's postulates.

During the course of the survey, six leaf spot diseases were recorded. (Table 1). It is seen that leaf spot caused by Colletotrichum gloeosporioides occurs as a major pathogen in all the localities infecting the majority of the oil palm seedlings surveyed.

Table-1

Extent of damage and causal organisms of different leaf spotdiseases of oil palm

Location	Frequency of observations	Causal organism	Extent of damage
1. Plantations at Kulathupuzha and Anchal	1	Bipolaris hawaiiensis	Severe in nurseries and young palms in mainfield during rainy season.
2. Plantations at Palode and Thodupuzha	2	Botryodiplodia theobromae	Found in nurseries and isolated adult palms in main field throughout the year.
3. Plantations at Palode, Anchal, Thodupuzha and Kulathupuzha	4	Colletotrichum gloeosporioides	Severe in nurseries and adult palms in mainfield during monsoon season.
4. Plantations at Palode, Anchal, Thodupuzha and Kulathupuzha	2	Curvularia geniculata	Severe in nurseries during rainy season.
5. Plantations at Palode and Thodupuzha	1	Fusarium pallidoroseum	Severe in nurseries during rainy season.
6. Plantation at Palode	1	Phoma sorghina	Observed in nurseries during rainy season.

II. Symptomatology

(1) Leaf spot disease caused by Bipolaris hawaiiensis

The symptoms on the leaves appeared on the spear or youngest opened fronds as small, pale green spots. Gradually, these spots enlarged and attained a size of 10-45 mm in diameter. The centre of the spots turned brown and was surrounded by pale yellow halo. (Plate-1).

(2) Leaf spot disease caused by Botryodiplodia theobromae

The attack due to this fungus was seen on the distal end of the leaf. The lesions appeared as small clear spots initially, later turned dark brown in colour. Gradually these spots increased in size with age and were surrounded by pale yellow halo. The adjacent spots coalesced, developed into necrotic patches, covering nearly the entire leaflet. (Plate-2).

(3) Leaf spot disease caused by Colletotrichum gloeosporioides

The symptoms appeared initially as small brown dots all over the leaf lamina. The spots gradually enlarged in size with circular to irregular brown border and were surrounded by pale yellow halo. The adjoining spots eventually coalesced and formed irregular necrotic patches. Infected patches showed the presence of acervuli as evidenced by slight raising of the epidermis from the underlying tissues.

Plate-1

Leaf spot disease caused by *Bipolaris hawaiiensis*.

Plate-2

Leaf spot disease caused by *Botryodiplodia theobromae*.


7

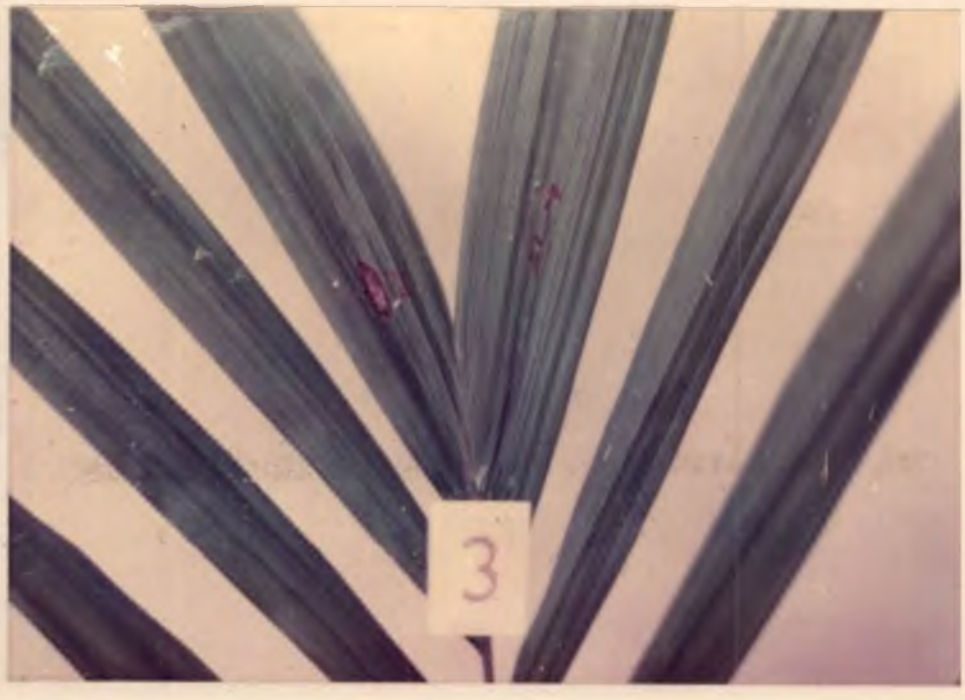

3

Plate-3

Leaf spot disease caused by *Colletotrichum gloeosporioides*.

Plate-4

Leaf spot disease caused by *Curvularia geniculata*.


1


6

Infection was observed on both young as well as older leaves in plants of all ages, viz., from seedlings in the nursery to the bearing palms in plantations. However, seedlings in the nursery were more susceptible to the disease. The leaves showed drying as a result of coalescence of lesions (Plate-3).

(4) Leaf spot disease caused by Curvularia geniculata

Yellow spots visible on both surfaces of the leaf is the initial symptom of the disease. These spots gradually enlarged in size along and between the veins to form circular or irregular spots with light brown centre and reddish brown margin. The number of spots varied from 7 to 30 per leaflets. Isolated spots, when fully developed, reached up to 7-8 mm in length. The adjoining spots eventually coalesced and caused blighting of the leaves (Plate-4).

(5) Leaf spot disease caused by Fusarium pallidoroseum

Presence of minute spots surrounded by yellow halo is the first symptom of the disease. The spots enlarged gradually to form irregular necrotic patches. The centre of such patches turned brown in colour. Later the centres of the patches dried out and were dropped to the ground (Plate-5).

(6) Leaf spot disease caused by Phoma sorghina

The initial symptoms appeared as small dots, which soon enlarged to attain a size of 9 to 30 mm in diameter. The

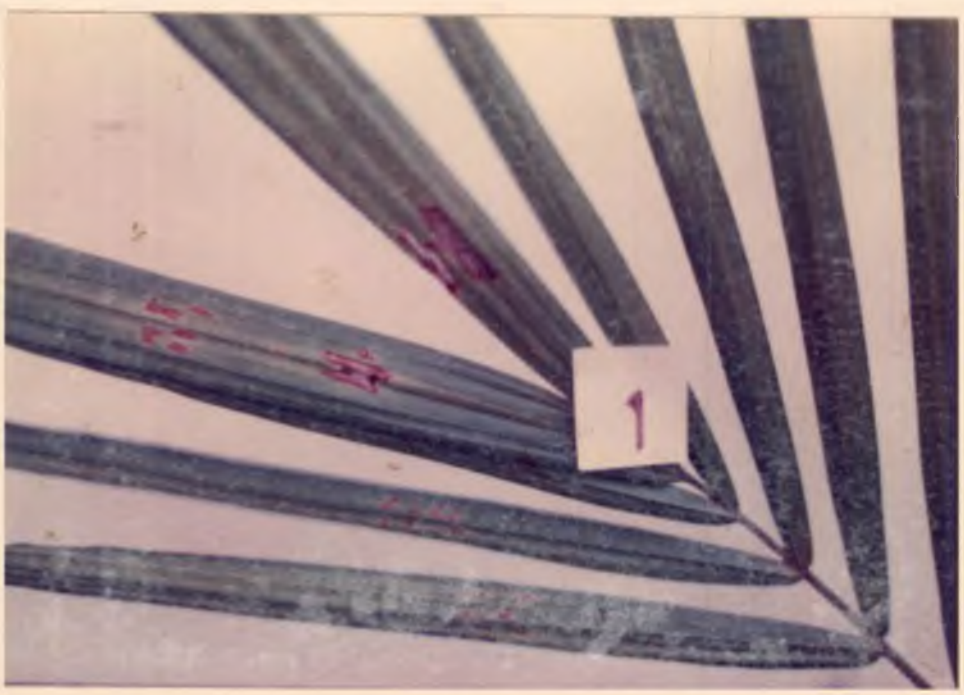
Plate-5

Leaf spot disease caused by *Fusarium pallidoroseum*.

Plate-6

Leaf spot disease caused by *Phoma sorghina*.


5


1

centre of the spots turned brown. The leaves showed drying as a result of coalescence of lesions (Plate-6).

III. Etiology of different leaf spot diseases

(1) Bipolaris hawaiiensis (M.B.Ellis) Uchida and Aragaki (Herb. IMI Number 322541)

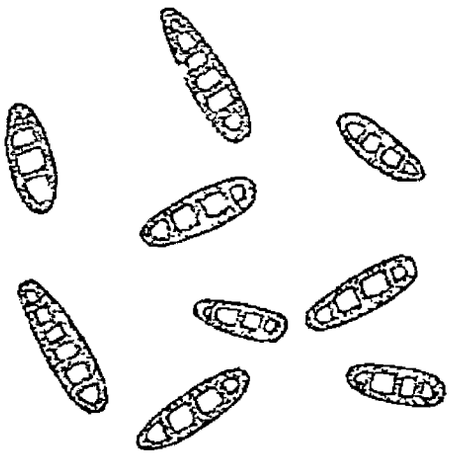
The organism was isolated into pure culture using potato dextrose agar medium following standard methods. The culture was then purified following single spore isolation.

The mycelium of the fungus is branched, septate and brown in colour. Conidiophores are septate and light brown coloured. Conidia are straight, oblong, rounded at the ends and pale to red brown in colour. They are 4 to 6 septate and measured 12 to 37 µm x 5 to 11 µm in size (Fig. 1a).

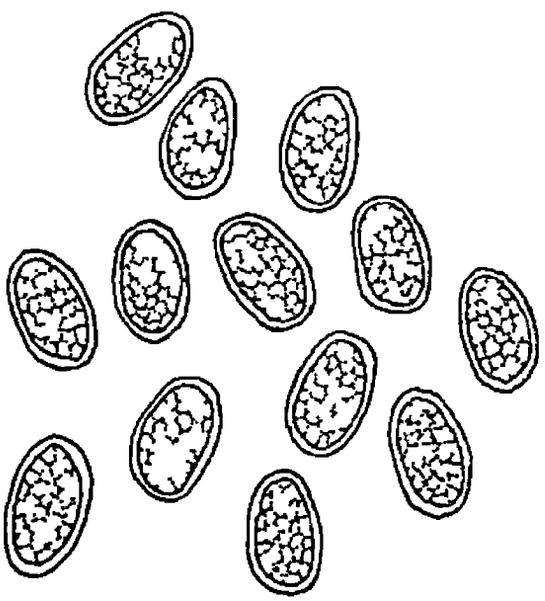
(2) Botryodiplodia theobromae Pat. (Herb. IMI Number 322539)

The causal organism was isolated on potato dextrose agar medium, purified by single spore isolation and maintained on PDA slants.

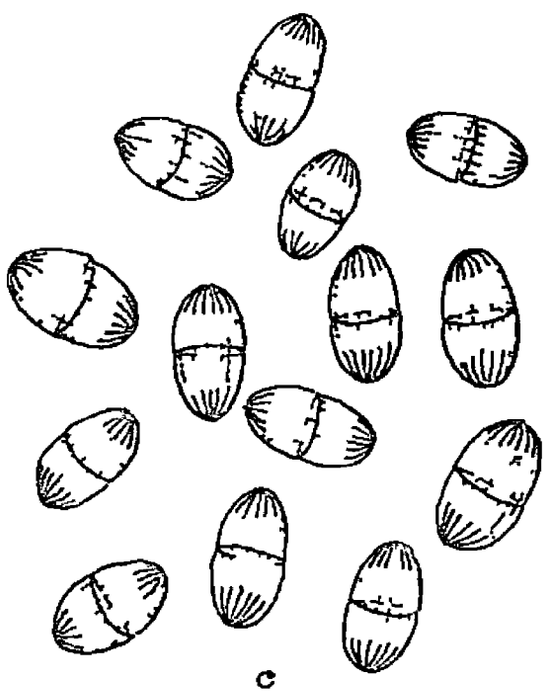
The mycelium of the fungus is branched, septate and chocolate brown coloured. The fungus produced globular to pyriform black coloured pycnidia in culture. The pycnidiospores are initially single celled, hyaline, smooth walled and granular. On maturity, the spores become pale brown



a



b



c

50 µm

and bicelled, measuring 20.9 to 27.2 µm x 12.2 to 16.1 µm. Most of the bicelled spores showed longitudinal striations with a slight transverse groove at the septum (Fig. 1b and c).

(3) Colletotrichum gloeosporioides (Penz.) Penz. and Sacc. (Glomerella cingulata) (Stonem.) Spauld and Schrenk. (Herb IMI Number 322537)

Isolation of the causal organism was made on potato dextrose agar medium, purified by single spore isolation and maintained on PDA slants.

The fungal mycelium is branched, septate and hyaline. Fungus produced dark, globose, setate acervuli on the infected leaf surface as well as in culture. Setae were 3-5 septate, dark brown, tapering at the apex and measured 96 to 118 µm x 4.3 to 6.5 µm in size.

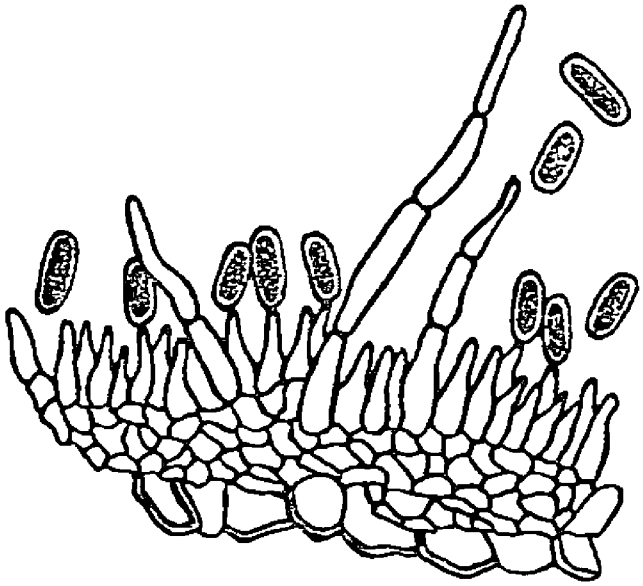
Conidiophores are nonseptate and hyaline. Conidia are single celled hyaline, straight, cylindrical with blunt ends and measured 12 to 16 µm x 4 to 6 µm in size.

In old cultures flask shaped, dark brown to black perithecia, measuring 132.4 to 284.8 µm in diameter and upto 313.2 µm tall, were observed. Asci were 58.3 to 64.5 µm x 12.1 to 13.2 µm. Ascospores were single celled initially and became two celled at maturity, slightly curved and

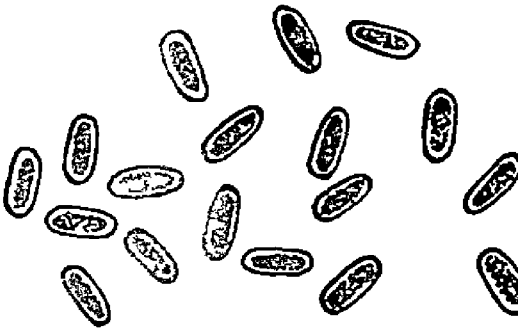
Fig.2 a. Acervulus or Colletotrichum gloeosporioides.
b. Conidia of Colletotrichum gloeosporioides.

Fig.2 c. Perithecium of Glomerella cingulata.
d. Ascus of Glomerella cingulata.
e. Ascospores of Glomerella cingulata.

FIG 2



a



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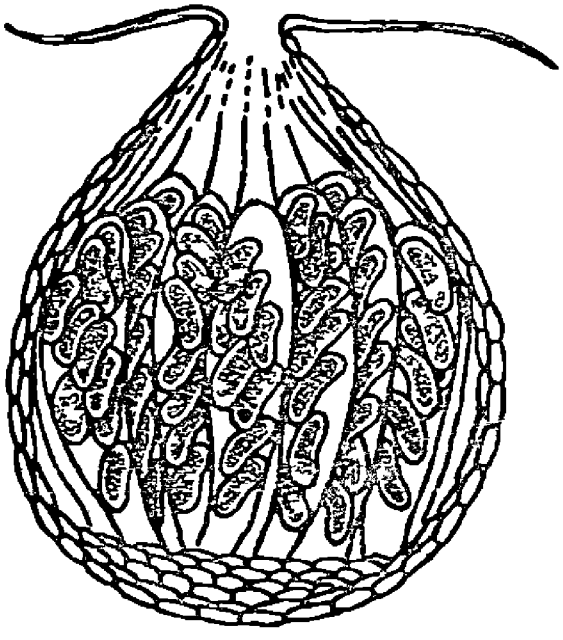
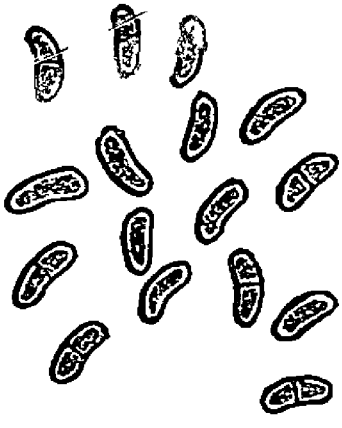


c

d



e

50 μm

measured 13.4 to 18.8 x 3.4 to 5.1/um. The perfect stage is Glomerella cingulata (Fig. 2 a to e).

(4) Curvularia geniculata (Tracy and Earle) Boedijn (Herb IMI number 322538)

The causal organism was isolated on potato dextrose agar medium, purified by single spore isolation and maintained on PDA slants.

The mycelium of the fungus is branched, septate, and dark brown in colour. Conidiophores are septate and dark brown in colour. Conidia are 3-4 septate, dark brown, distinctly geniculate and measured 16 to 24/um x 8.5 to 10.2/um. End cells of the conidia are paler than the middle ones (Fig. 3a).

(5) Fusarium pallidoroseum (Cooke) Sacc. (Herb IMI Number 322540)

Isolation was made by using potato dextrose agar medium and maintained on PDA slants after purification by single spore isolation.

The fungus produced two types of conidia viz. macroconidia and microconidia. Macro conidia were sickle shaped 3-5 septate and measured 13.7 to 24.0/um x 2.0 to 5.5/um. Micro conidia were single celled, egg shaped, hyaline and

measured 4 to 16 µm x 2 to 4 µm. The mycelium of the fungus was branched, septate and hyaline (Fig. 3b and c).

(6) *Phoma sorghina* (Sacc) Boerema *et al.*

(Hero IMI Number 322542)

The causal organism was isolated on potato dextrose agar medium, purified by single spore isolation and maintained on PDA slants.

Conidia are ellipsoid, single celled and measured 4 to 5 µm x 2 to 2.5 µm. The mycelium of the fungus is branched, septate and hyaline. Colonies are fluffy with characteristic white to salmon pink tinges or areas. (Fig. 3d).

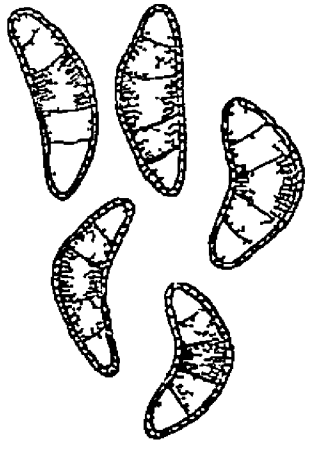
Pathogenicity studies

Inoculation of leaves of oil palm

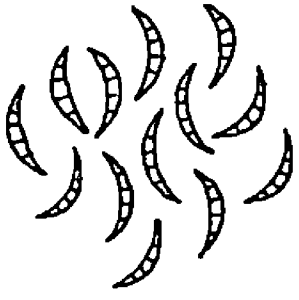
(1) *Bipolaris hawaiiensis*

Pathogenicity of the organism was confirmed by artificial inoculation on attached/detached oil palm leaves. Successful infection was obtained on injured leaves when inoculated with the spore suspension and culture bits of the organism. Initial symptoms of the disease appeared in 4-5 days when sprayed with the spore suspension and in 5-6 days when inoculated with culture bits. On the uninjured leaves the symptoms were initiated in 5 to 6 days of inoculation.

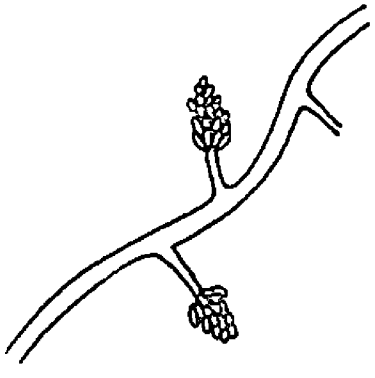
FS 3



a



b



c

d

50 µm

Table-2

Pathogenicity of Bipolaris hawaiiensis

Sl. No.	Method of inoculation	Injured leaves		Uninjured leaves	
		Percentage infection	Incubation period (days)	Percentage infection	Incubation period (days)
1.	Inoculation with spore suspension on the leaves of oil palm seedlings.	60	4-5	40	5-6
2.	Inoculation with spore suspension on the detached leaves.	80	4-5	50	5-6
3.	Inoculation with culture bits on the leaves of oil palm seedlings.	50	5-6	40	5-6
4.	Inoculation with culture bits on the detached leaves.	60	5-6	50	5-6

The percentage infection ranged from 50 to 80 in the injured leaves while in uninjured leaves it was only 40 to 50 per cent. (Table 2).

(2) Botryodiplodia theobromae

Pathogenicity was confirmed by artificial inoculation. Inoculation of the leaves, both injured and uninjured, with the spore suspension and culture bits of the organism, developed infection. Ininjured attached and detached leaves infection appeared in 2 to 3 days when inoculated with the spore suspension and 3 to 4 days when inoculated with the culture bits. In uninjured leaves infection appeared in 4-5 days. The percentage infection was higher in injured leaves than uninjured leaves (Table 3).

(3) Colletotrichum gloeosporioides

Both injured and uninjured leaves inoculated with spore suspension/culture bits of the organism developed infection. In injured attached and detached leaves, infection appeared in 2 to 3 days when inoculated with the spore suspension and 3-4 days when inoculated with culture bits. However, in uninjured leaves infection appeared only within 5 to 6 days of inoculation. The percentage infection was higher in injured (80 to 100) than uninjured leaves (10-40) (Table 4).

Table-3

Pathogenicity of Botryodiplodia theobromae

Sl. No.	Method of inoculation	Injured leaves		Uninjured leaves	
		Percentage infection	Incubation period (days)	Percentage infection	Incubation period (days)
1.	Inoculation with spore suspension on the leaves of oil palm seedlings.	70	2-3	..	..
2.	Inoculation with spore suspension on the detached leaves.	90	2-3	..	..
3.	Inoculation with culture bits on the leaves of oil palm seedlings.	60	3-4	20	4-5
4.	Inoculation with culture bits on the detached leaves.	80	3-4	10	4-5

Table-4

Pathogenicity of Colletotrichum gloeosporioides

Sl. No.	Method of inoculation	Injured leaves		Uninjured leaves	
		Percentage infection	Incubation period (days)	Percentage infection	Incubation period (days)
1.	Inoculation with spore suspension on the leaves of oil palm seedlings.	90	2-3	10	5-6
2.	Inoculation with spore suspension on the detached leaves.	100	2-3	30	5-6
3.	Inoculation with culture bits on the leaves of oil palm seedlings.	80	3-4	20	5-6
4.	Inoculation with culture bits on the detached leaves.	100	3-4	40	5-6

(4) Curvularia geniculata

Both injured as well as uninjured leaves inoculated with spore suspension and culture bits of the organism developed infection. In injured attached and detached leaves infection appeared in 2-3 days when inoculated with the spore suspension, while when inoculated with culture bits the period was 3-4 days. In the uninjured leaves symptoms appeared in 4-5 days. Percentage infection was higher in injured than uninjured leaves (Table 5).

(5) Fusarium pallidoroseum

When inoculated with the spore suspension and culture bits of the organism, the injured detached and attached leaves showed initial symptoms in 4 to 6 days of inoculation. The percentage infection ranged from 60 to 80 in injured leaves. No symptom was visible in uninjured attached and detached leaves under both the methods of inoculation (Table 6).

(6) Phoma sorghina

Inoculation with the spore suspension caused lesions in 2 to 3 days in the injured attached and detached leaves. In injured attached leaves the period was 3-4 days, while in injured detached leaves it was 2-3 days when inoculated with the culture bits of the organism. The percentage infection ranged from 90 to 100 per cent in injured leaves and 30 to 50 per cent in uninjured leaves (Table 7).

Table-5

Pathogenicity of Curvularia geniculata

Sl. No.	Method of inoculation	Injured leaves		Uninjured leaves	
		Percentage infection	Incubation period (days)	Percentage infection	Incubation period (days)
1.	Inoculation with spore suspension on the leaves of oil palm seedlings.	80	2-3	20	4-5
2.	Inoculation with spore suspension on the detached leaves.	100	2-3	30	4-5
3.	Inoculation with culture bits on the leaves of oil palm seedlings.	70	3-4	30	4-5
4.	Inoculation with culture bits on the detached leaves.	90	3-4	50	4-5

Table-6

Pathogenicity tests with Fusarium pallidoroseum

Sl. No.	Method of inoculation	Injured leaves		Uninjured leaves	
		Percentage infection	Incubation period (days)	Percentage infection	Incubation period (days)
1.	Inoculation with spore suspension on the leaves of oil palm seedlings.	70	4-5	..	..
2.	Inoculation with spore suspension on the detached leaves.	80	4-5	..	..
3.	Inoculation with culture bits on the leaves of oil palm seedlings.	60	5-6	..	..
4.	Inoculation with culture bits on the detached leaves.	70	5-6	..	..

Table-7

Pathogenicity tests with Phoma sorghina

Sl. No.	Method of inoculation	Injured leaves		Uninjured leaves	
		Percentage infection	Incubation period (days)	Percentage infection	Incubation period (days)
1.	Inoculation with spore suspension on the leaves of oil palm seedlings.	100	2-3	30	3-4
2.	Inoculation with spore suspension on the detached leaves.	100	2-3	40	3-4
3.	Inoculation with culture bits on the leaves of oil palm seedlings.	90	3-4	40	4-5
4.	Inoculation with culture bits on the detached leaves.	100	2-3	50	3-4

A in vitro study

Results of in vitro evaluation of common fungicides by poisoned food technique

(1) Bipolaris hawaiiensis

Results revealed that Bordeaux mixture and Dithane M-45 were the most effective fungicides as they did not allow the fungus to grow at all even in the least concentration tested. There was no growth in the highest concentration of Cuman L also. (Table 8). Foltaf was also effective as the per cent inhibition over control in 3000, 2000 and 1000 ppm were 95, 93 and 90 per cent respectively. The lower concentrations (2000 and 1000 ppm) of Cuman L inhibited growth over control considerably (88 and 77 per cent respectively). Aureofungin sol was also an effective treatment as the growth inhibition in 200, 150 and 100 ppm were 85, 83 and 75 per cent, respectively. The highest concentration 3000 and 2000 ppm of Fytolan also reduced the growth considerably (79 and 70 per cent, respectively). The lowest concentration of Fytolan (1000 ppm) growth inhibition was only 59 per cent. Among the various fungicides tested Bavistin was the least effective one (Fig. 4, Plate 7-13).

All concentrations of Bordeaux mixture, Dithane M-45 and Cuman L 3000 ppm were very effective as cent per cent

Table-8

Effect of different fungicides on the radial growth of Bipolaris hawaiiensis in solid media (poisoned food technique)

Sl. No.	Treatment	Concentration of fungicides (in ppm)	*Mean colony diameter (mm)	Per cent inhibition over control (C-T×100/C)
1.	Aureofungin sol (N-Methyl-p-amino aceto phenone-mycosamine heptane)	100	22.67	74.82
		150	15.67	82.59
		200	13.67	84.82
2.	Bavistin (2(Methoxy-carbamoyl)-benzimidazole)	250	80.67	10.35
		500	71.67	20.37
		1000	63.67	29.25
3.	Bordeaux mixture	2500	0.0	100.00
		5000	0.0	100.00
		10000	0.0	100.00
4.	Cuman L (Zinc dimethyl-dithio carbamate)	1000	20.33	77.42
		2000	11.00	87.79
		3000	0.0	100.00
5.	Dithane M-45 (Zinc ion and manganese ethylene bis-dithiocarbamate)	1000	0.0	100.00
		2000	0.0	100.00
		3000	0.0	100.00
6.	Foltaf (Cis-N-(1,1,2,2-tetrachloroethyl thio)4-cyclohexane-1, 2-dicar-boximide)	1000	8.67	90.38
		2000	6.67	92.59
		3000	4.67	94.82
7.	Fytolan (Copper oxychloride-50 per cent metallic copper)	1000	36.67	59.26
		2000	26.67	70.37
		3000	19.00	78.89
8.	Control	..	90.00	..

* Average of three replications

CD for comparison = 1.08

Significant at 5% and 1% level

FIG 4 EFFECT OF DIFFERENT FUNGICIDES ON THE GROWTH OF *Bipolaris hawaiiensis*

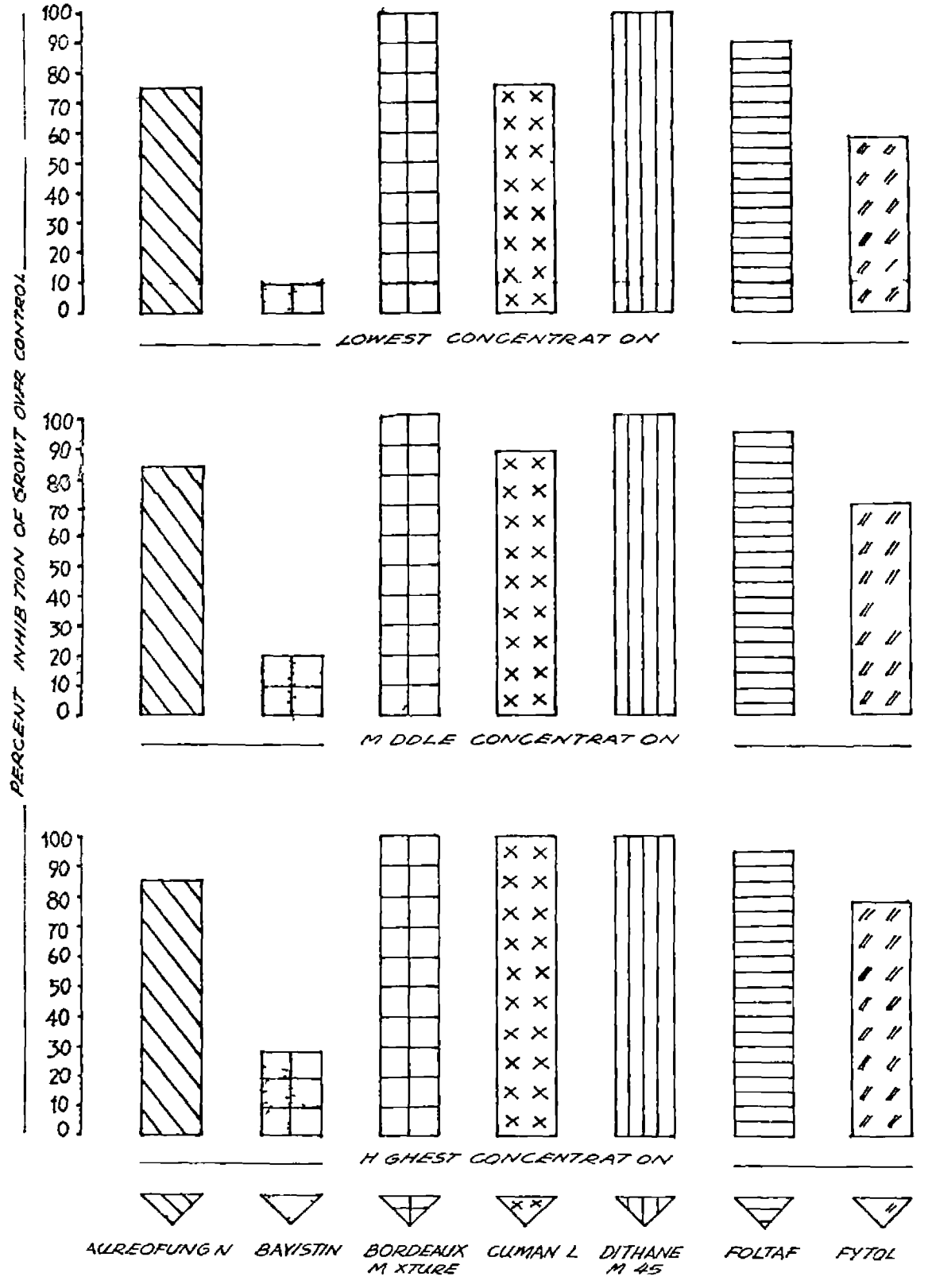
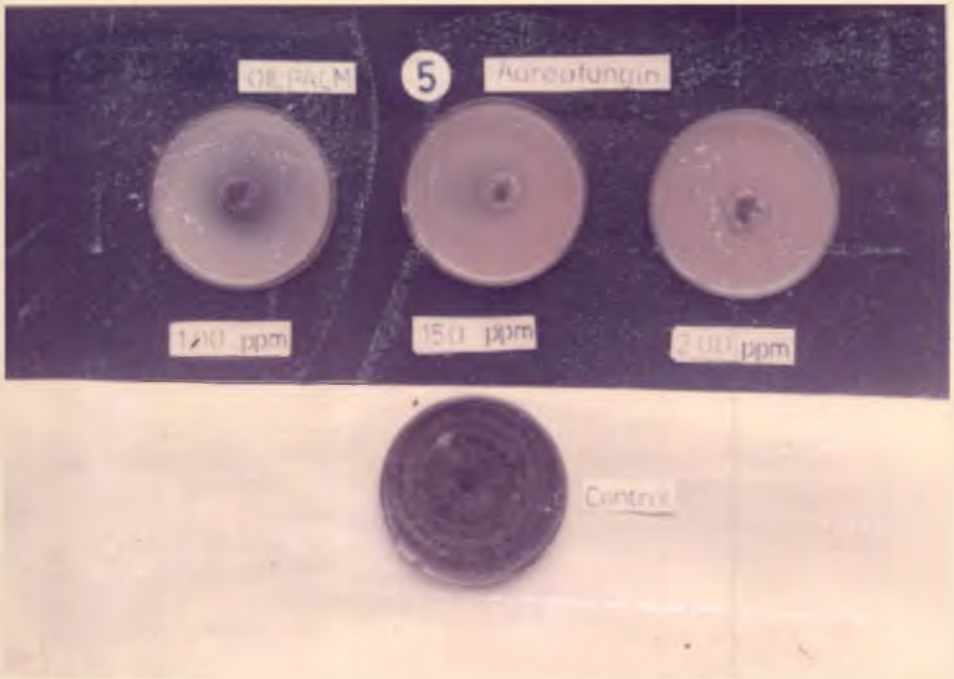


Plate-7

Effect of Aureofungin sol on the growth of *Bipolaris hawaiiensis*

Plate-8

Effect of Carbendazim on the growth of *Bipolaris hawaiiensis*.


OIL PALM
5
Aureofungin
150 ppm
Control

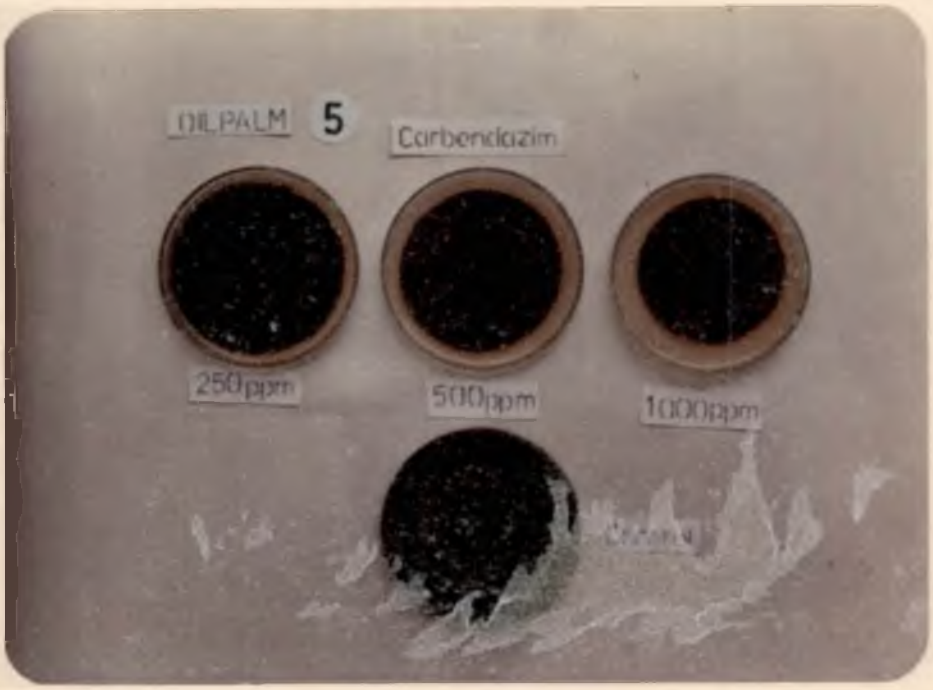
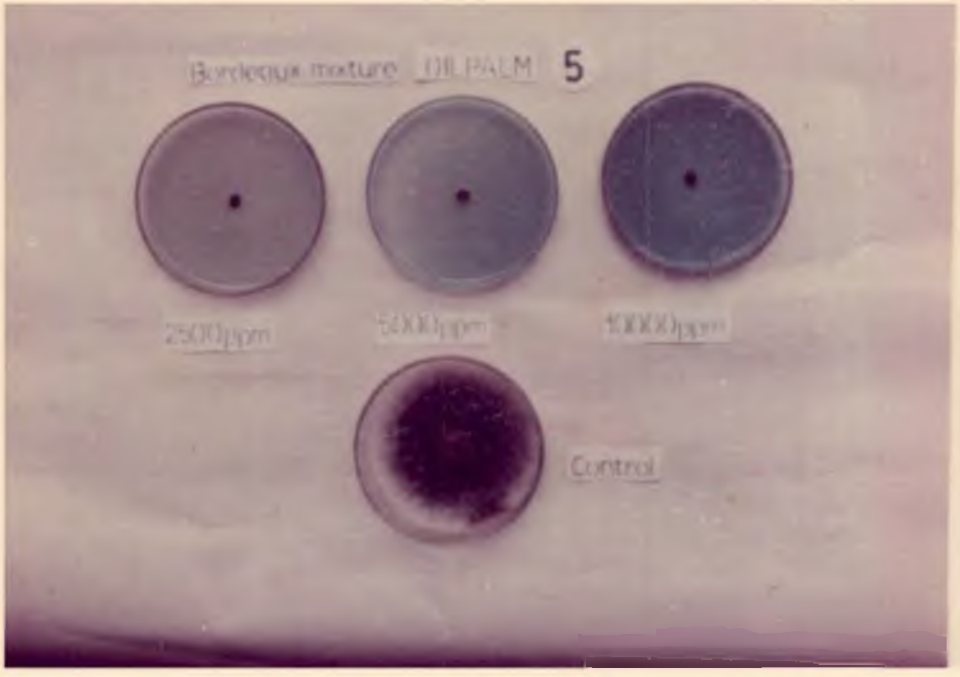

OIL PALM
5
Carbendazim
250ppm
500ppm
1000ppm

Plate-9

Effect of Bordeaux mixture on the growth of *Bipolaris hawaiiensis*.

Plate-10

Effect of Miram on the growth of *Bipolaris hawaiiensis*.


Bordeaux mixture
DILPALM
5
2500 ppm
5000 ppm
10000 ppm
Control

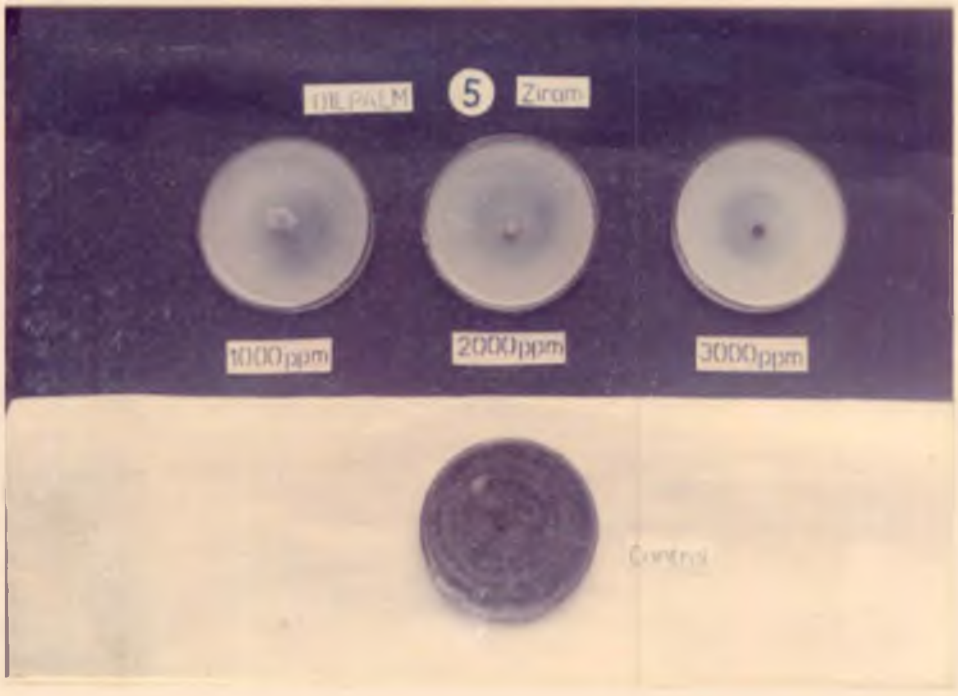
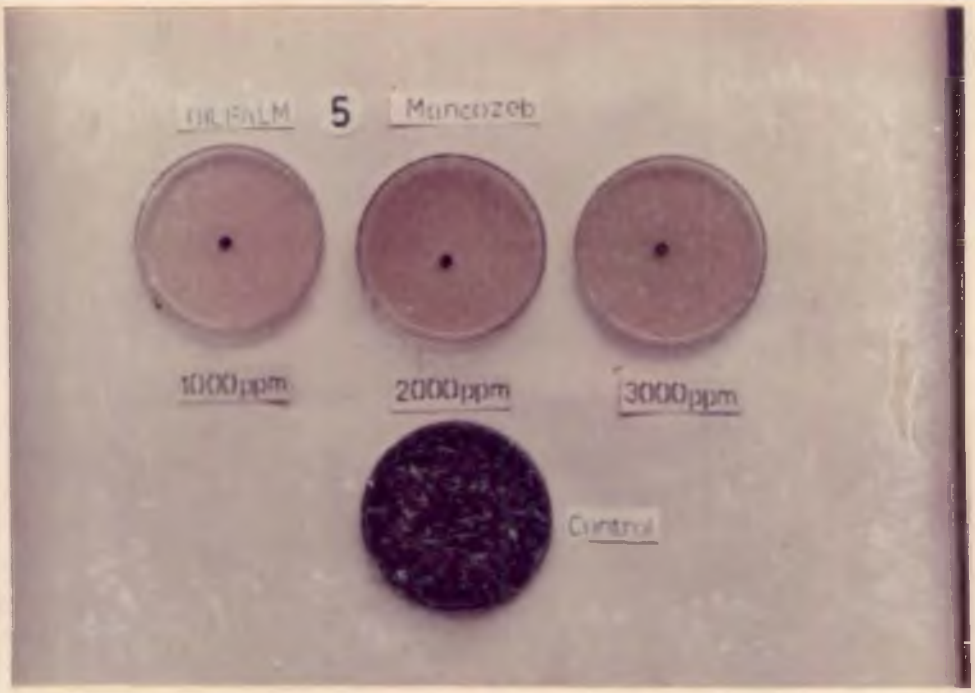

DILPALM
5
Ziram
1000 ppm
2000 ppm
3000 ppm
Control

Plate-11

Effect of Mancozeb on the growth of *Bipolaris hawaiiensis*

Plate-12

Effect of Captafol on the growth of *Bipolaris hawaiiensis*


DR.PALM
5
Mancozeb
1000ppm
2000ppm
3000ppm
Control

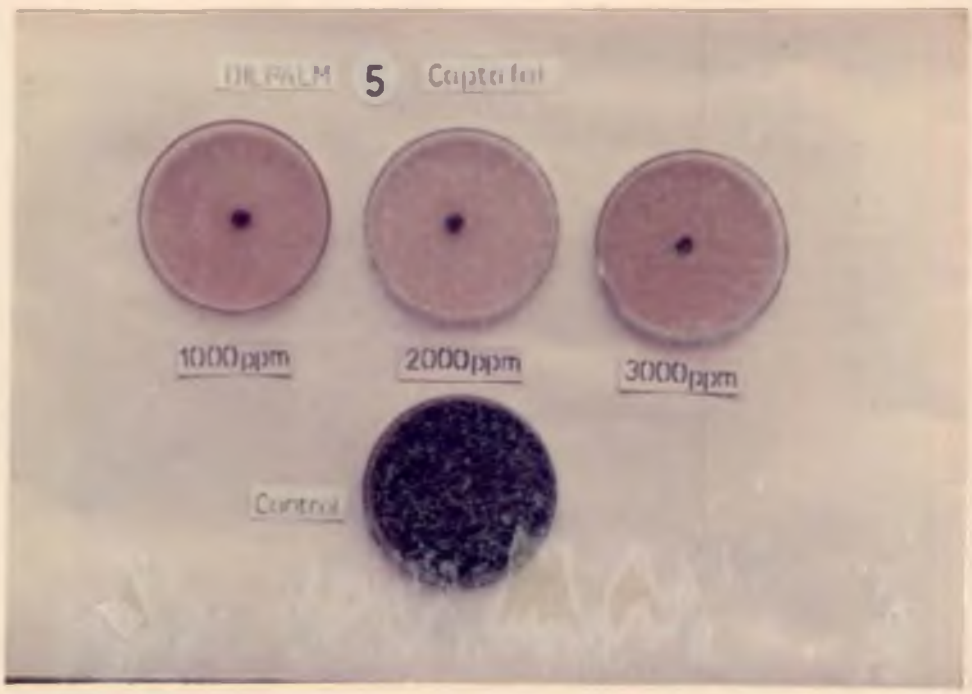
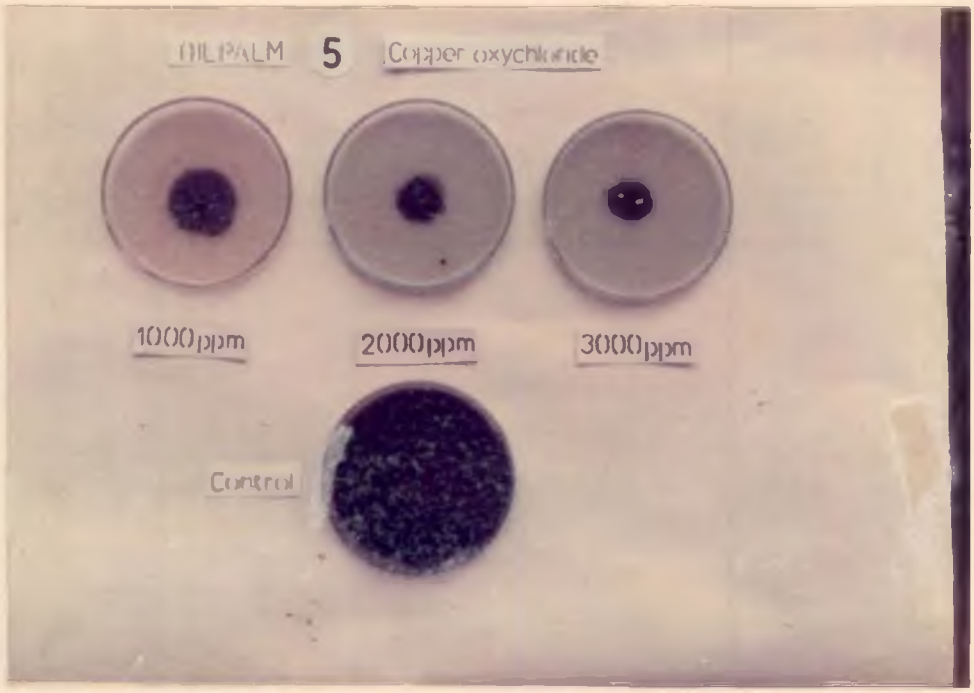

DR.PALM
5
Captafol
1000ppm
2000ppm
3000ppm
Control

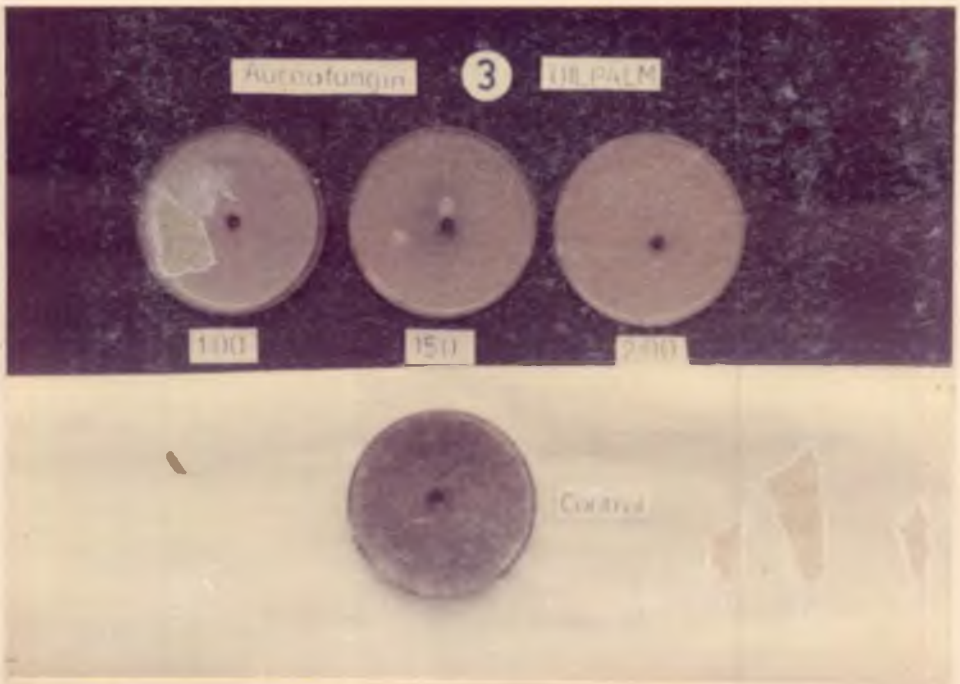
Plate-13

Effect of Copper oxychloride on the growth of *Bipolaris hawaiiensis*.

Plate-14

Effect of Aureofungin sol on the growth of *Botryodiplodia theobromae*.


OILPALM
5
Copper oxychloride
1000ppm
2000ppm
3000ppm
Control


Aureofungin
3
OILPALM
100
150
Control

inhibition over control were obtained in the treatments. Foltaf (3000, 2000 and 1000 ppm) were superior to other treatments. Cuman L @ 2000 ppm was superior to the remaining treatments, viz. 100, 150 and 200 ppm of Aureofungin sol and 1000 ppm of the same fungicide. Pytolan and Bavistin were not effective as the growth inhibition was very poor.

(2) Botryodiplodia theobromae

The results of the effect of various fungicides on the radial growth of the pathogen showed that cent per cent inhibition of growth of the isolate was observed with Dithane M-45 at all concentrations as well as in 2000 and 3000 ppm of Pytolan, 500 and 1000 ppm of Bavistin and at 1000 ppm of Bordeaux mixture (Table 9).

Aureofungin sol was also effective as the per cent inhibition over control in 200, 150 and 100 ppm were 94, 91 and 89 per cent respectively. The lower concentration (250 ppm) of Bavistin inhibited growth over control considerably (92 per cent). In Cuman L 3000 ppm the growth inhibition was 96 per cent. Bordeaux mixture 5000 and 2500 ppm also inhibited the growth considerably (88 and 79 per cent respectively). The higher concentrations of Foltaf 3000 and 2000 ppm were effective as the per cent

inhibition over control were 78 and 69 per cent respectively. In the lowest concentration (1000 ppm) of Fytolan the growth inhibition was 79 per cent. The lowest concentration of Foltaf and Cuman L (each at 1000 ppm) were found to be not effective as the per cent inhibition were only 54 and 40 per cent respectively (Fig. 5, Plate 14-19).

All concentrations of Dithane M-45, Bavistin (500 ppm), Bordeaux mixture 10,000 ppm and Fytolan (2000 ppm) were very effective as cent per cent inhibition over control was obtained. There was no significant difference between the treatments with Cuman L 3000 ppm Aureofungin sol 200 and 150 ppm and Bavistin 250 ppm. These treatments were superior to the remaining treatments. Bordeaux mixture 5000 ppm was next in the order of merit. Foltaf (3000 ppm), Bordeaux mixture 2500 ppm and Fytolan 1000 ppm were not significantly different. They were superior to other treatments viz. 2000 and 1000 ppm Foltaf and 2000 and 1000 ppm Cuman L. Foltaf and Cuman L 1000 ppm each were not effective, as the growth inhibition was very poor.

(3) Colletotrichum gloeosporioides

Complete inhibition of growth of the fungus was obtained on the medium containing 10,000 ppm Bordeaux mixture, 1000 ppm each of Bavistin and Dithane M-45 and 2000

Table-9

Effect of different fungicides on the radial growth of Botryodiplodia theobromae on solid media (poisoned food technique)

Sl. No.	Treatment	Concentration of fungicides (in ppm)	*Mean colony diameter (mm)	Per cent inhibition over control (C-Tx100)/C
1.	Aureofungin sol (N-Methyl-p-amino acato phenone-mycosamine heptane)	100	9.67	89.26
		150	7.67	91.48
		200	5.67	93.70
2.	Bavistin (2(Methoxy-carbamoyl)-benzimidazole)	250	7.33	91.86
		500	0.00	100.00
		1000	0.00	100.00
3.	Bordeaux mixture	2500	18.67	79.26
		5000	11.00	87.79
		10000	0.00	100.00
4.	Cuman L (Zinc dimethyl-dithio carbamate)	1000	54.33	39.62
		2000	31.00	65.56
		3000	5.00	96.28
5.	Dithane M-45 (Zinc ion and manganese ethylene bis-dithiocarbamate)	1000	0.0	100.00
		2000	0.0	100.00
		3000	0.0	100.00
6.	Foltaf (Cis-N-(1,1,2,2-tetrachloroethyl thio)4-cyclohexane-1, 2-dicar-boximide)	1000	41.67	53.71
		2000	28.00	68.90
		3000	18.33	79.80
7.	Fytolan (Copper oxychloride-50 per cent metallic copper)	1000	19.0	78.90
		2000	0.0	100.00
		3000	0.0	100.00
8.	Control	..	90.0	..

* Average of three replications

CD for comparison = 3.97

Significant at 5% and 1% level

FIG 5 EFFECT OF DIFFERENT FUNGICIDES ON THE GROWTH OF *Botryodiplodia theobromae*

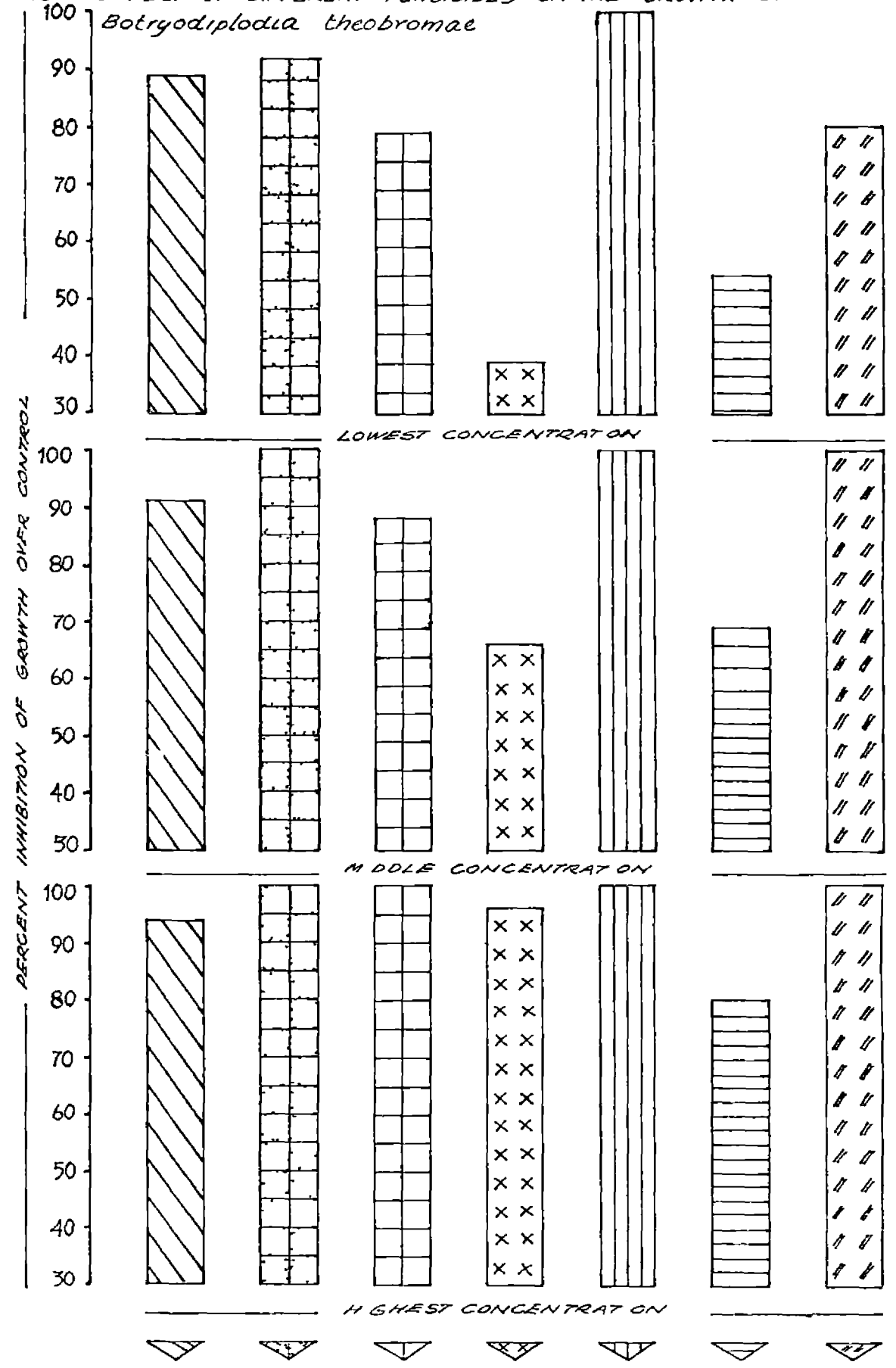
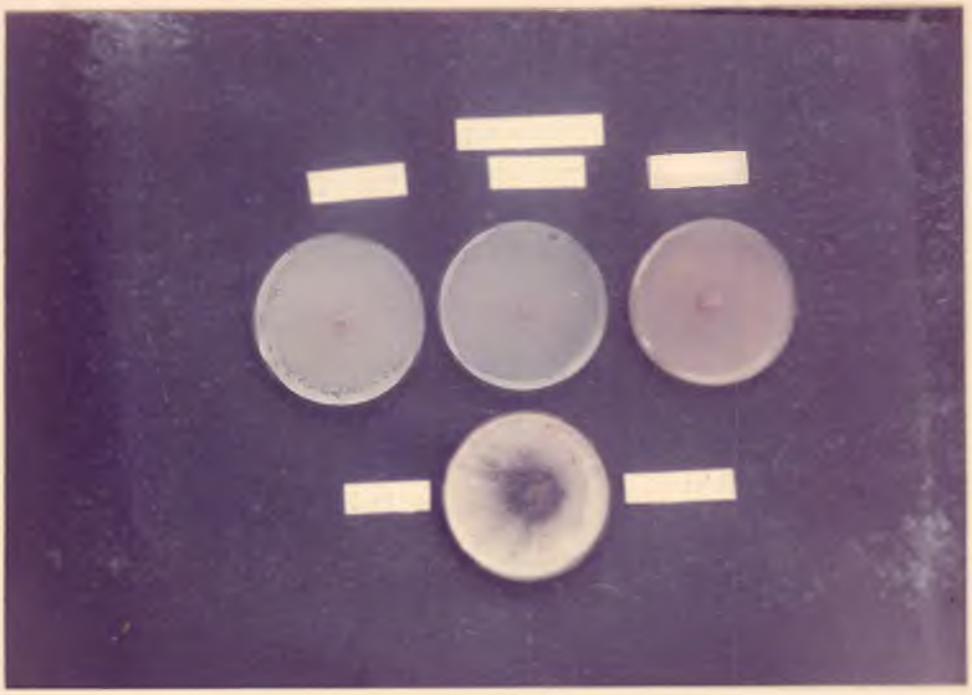


Plate-15

Effect of Carbendazim on the growth of *Botryodiplodia theobromae*.

Plate-16

Effect of Bordeaux mixture on the growth of *Botryodiplodia theobromae*.



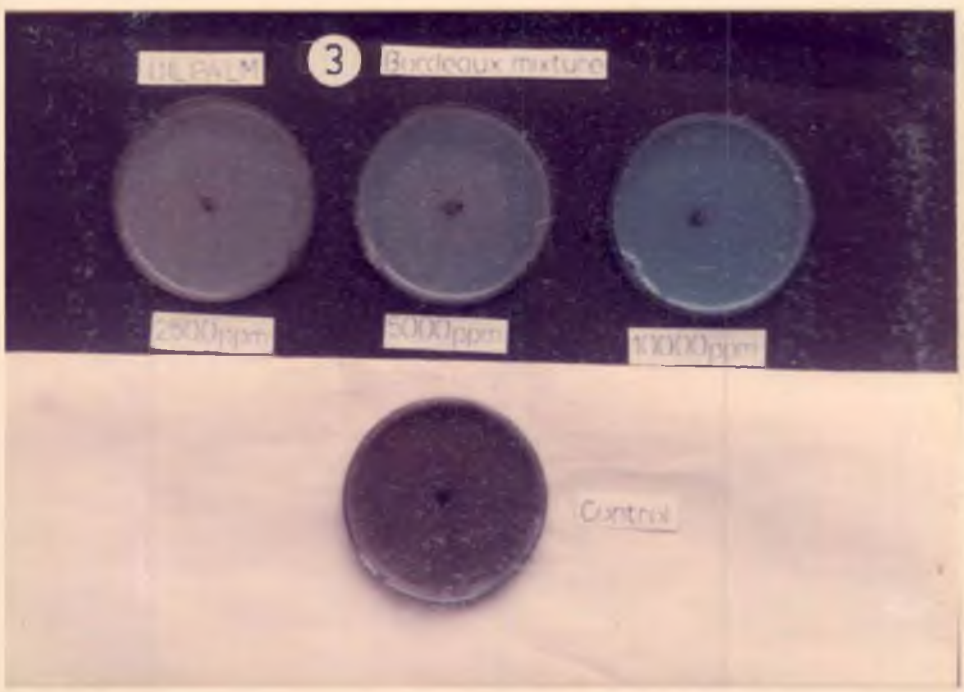

3
Bordeaux mixture
2500ppm
5000ppm
10000ppm
Control

Plate-17

Effect of Ziram on the growth of *Botryodiplodia theobromae*.

Plate-18

Effect of Mancozeb and Captafol on the growth of *Botryodiplodia theobromae*.

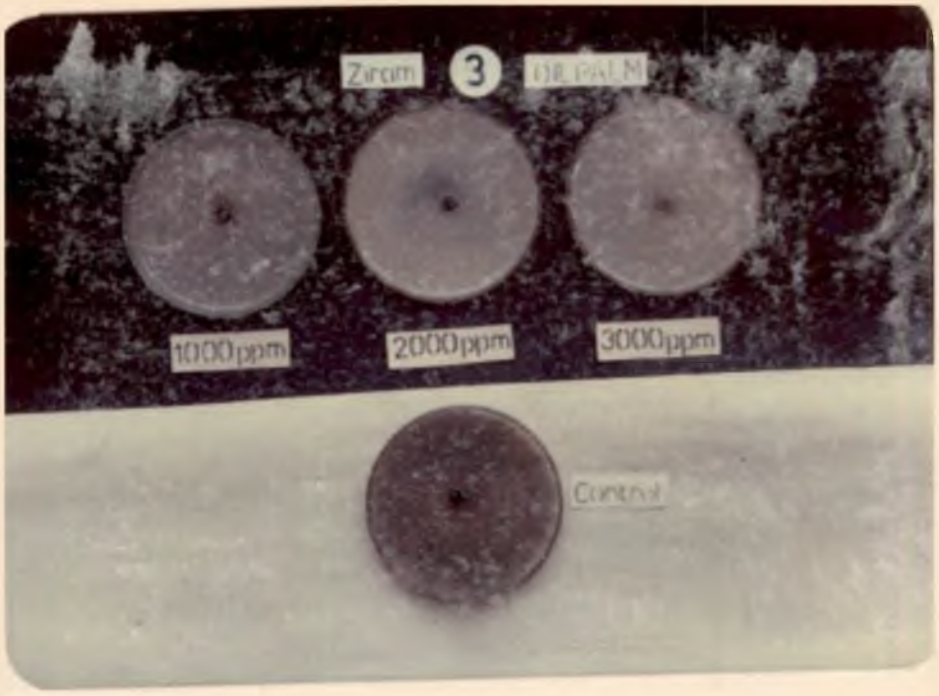

Ziram
3
1000ppm
2000ppm
3000ppm
Control

Plate-19

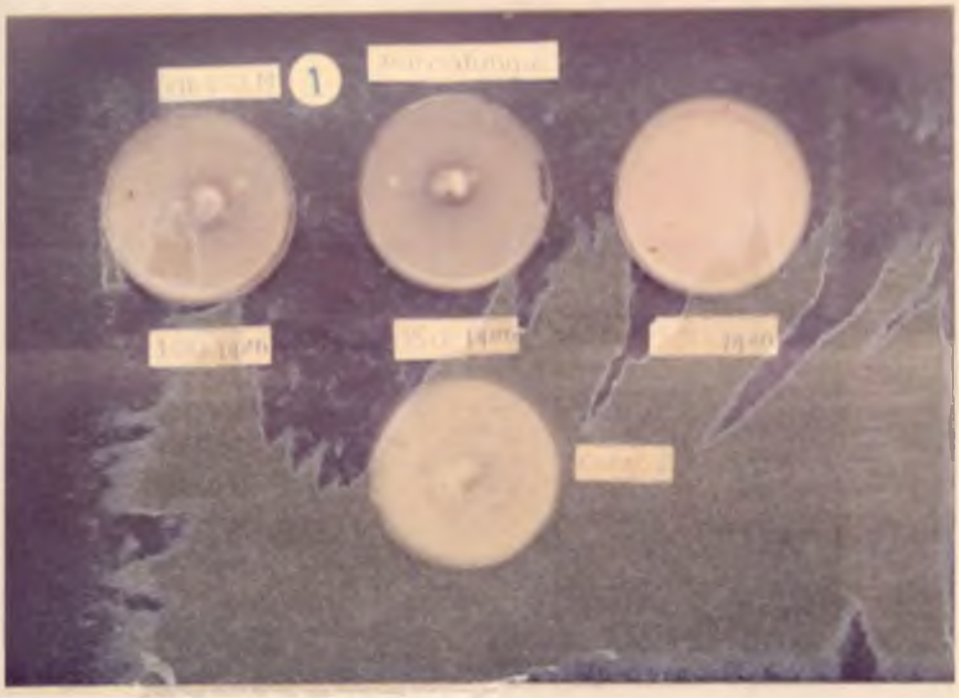
Effect of Copper oxychloride on the growth of *Botryodiplodia theobromae*.

Plate-20

Effect of Aureofungin sol on the growth of *Colletotrichum gloeosporioides*.


3
1000ppm
2000ppm
3000ppm


Control


1

ppm Foltaf (Table 10). Aureofungin sol was also effective as the per cent inhibition over control in 200, 150 and 100 ppm were 86, 79 and 75 per cent respectively. The lower concentrations 500 and 250 ppm of Bavistin and Bordeaux mixture 5000 and 2500 ppm inhibited growth over control considerably. (86, 83, 94 and 91 per cent respectively). Cuman L was found effective in all concentrations tested as the per cent inhibition was 98, 94 and 93 per cent respectively. Fytolan 1000 ppm was found to be least effective treatment as the per cent inhibition was only 39 per cent. (Fig. 6, Plate 20 to 26).

Bavistin, 1000 ppm, Bordeaux mixture 10,000 ppm, Dithane M-45 1000 ppm and Foltaf 2000 ppm were superior to all other treatments as cent per cent inhibition over control was obtained. Cuman L 3000 and 2000 ppm and Bordeaux mixture 5000 ppm were superior to the remaining treatments. The lower concentrations of Cuman L and Bordeaux mixture were superior to other treatments viz. 500 ppm Fytolan, 250 ppm Bavistin, all concentrations of Aureofungin sol and Fycolan. 500 and 250 ppm Bavistin, 200 ppm Aureofungin sol and 1000 ppm Foltaf were not significantly different, which were superior to all concentrations of Fytolan. Fytolan was not effective as the per cent inhibition was poor.

Table-10

Effect of different fungicides on the radial growth of Colletotrichum gloeosporioides on solid media (poisoned food technique)

Sl. No.	Treatment	Concentration of fungicides (in ppm)	*Mean colony diameter (mm)	Per cent inhibition over control $\frac{(C-Tx100)}{C}$
1.	Aureofungin sol (N-Methyl-p-amino aceto phenone-mycosamine heptane)	100	22.34	75.18
		150	19.00	78.89
		200	12.67	85.94
2.	Bavistin (2(Methyoxy-carbamoyl)-benzimidazole)	250	15.67	82.59
		500	12.67	85.92
		1000	0.0	100.00
3.	Bordeaux mixture	2500	7.67	91.48
		5000	5.67	93.70
		10000	0.0	100.00
4.	Cuman L (Zinc dimethyl-dithio carbamate)	1000	6.67	92.65
		2000	5.67	93.70
		3000	2.67	98.03
5.	Dithane M-45 (Zinc ion and manganese ethylene bis-dithiocarbamate)	1000	0.0	100.00
		2000	0.0	100.00
		3000	0.0	100.00
6.	Foltaf (Cis-N-(1,1,2,2-tetrachloroethyl thio)4-cyclohexane-1, 2-dicar-boximide)	1000	15.0	83.58
		2000	0.0	100.00
		3000	0.0	100.00
7.	Fytolan (Copper oxychloride-50 per cent metallic copper)	1000	54.67	39.20
		2000	40.67	54.81
		3000	26.67	70.36
8.	Control	..	90.00	..

* Average of three replications

CD for comparison = 3.58

Significant at 5% and 1% level

FIG 6 EFFECT OF DIFFERENT FUNGICIDES ON THE GROWTH OF *Colletotrichum gloeosporioides*

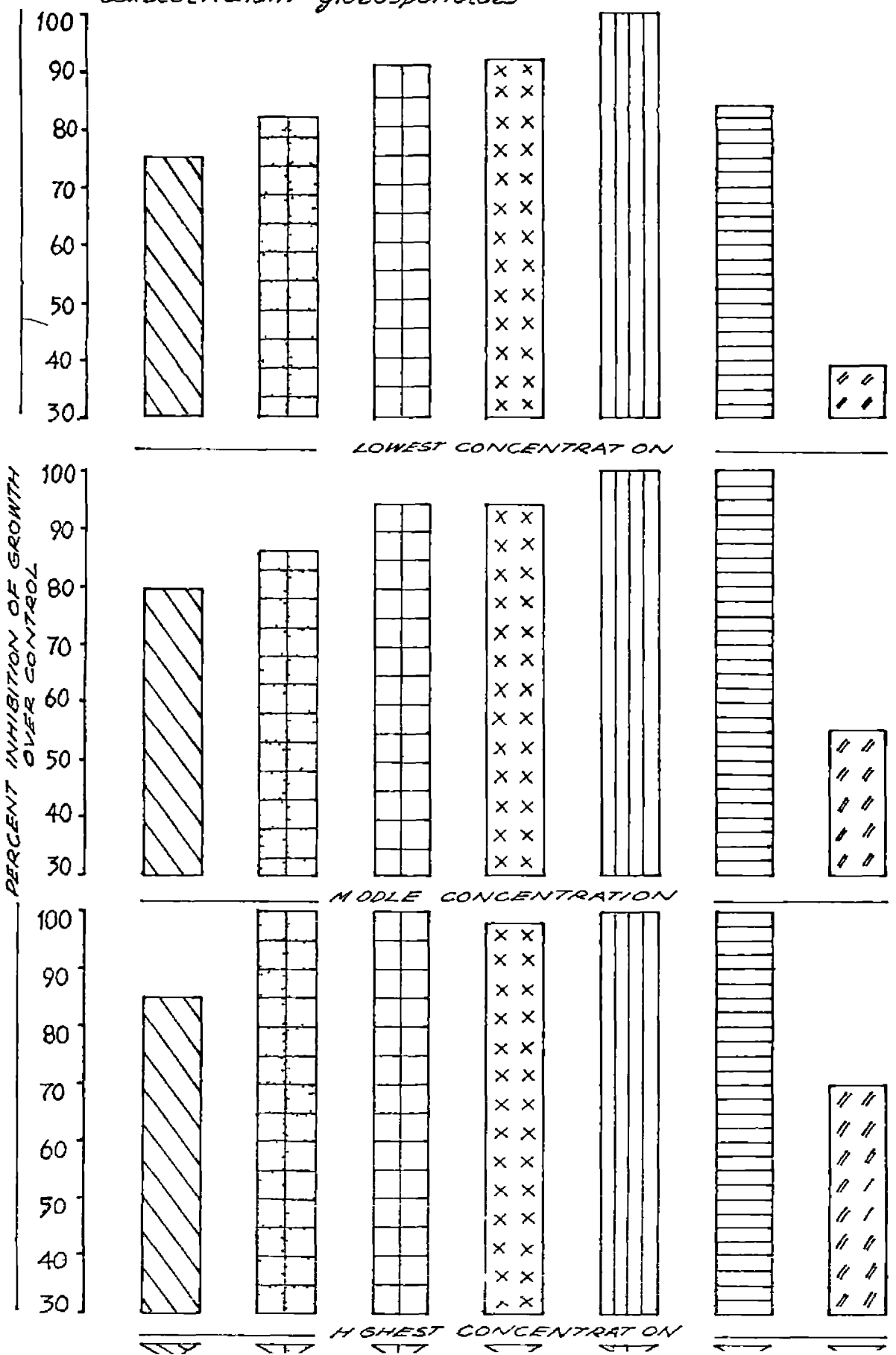
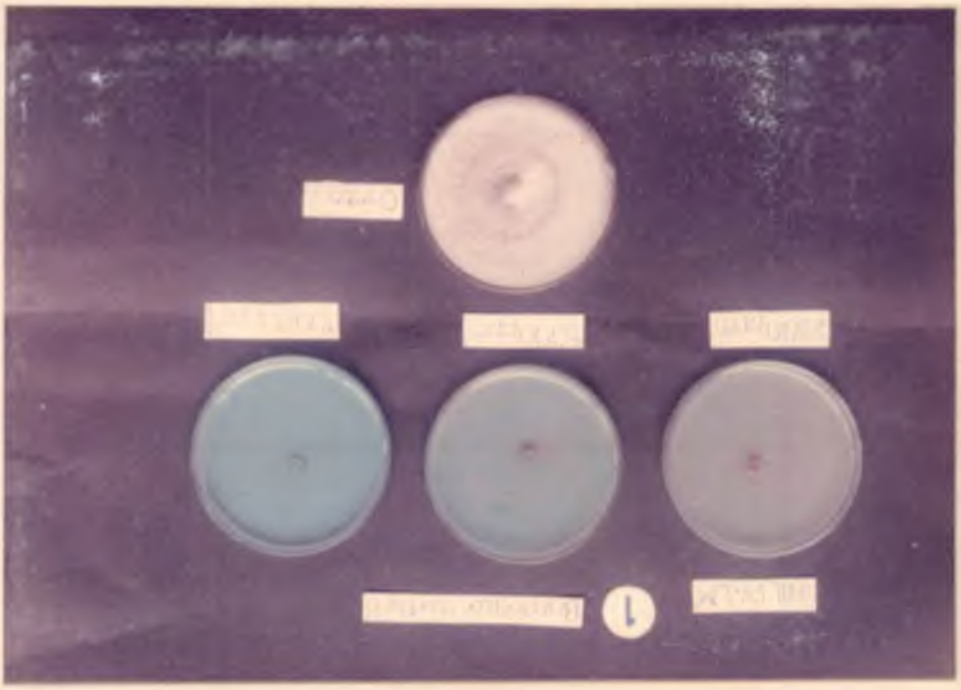


Plate-21

Effect of Carbendazim on the growth of *Colletotrichum gloeosporioides*.

Plate-22

Effect of Bordeaux mixture on the growth of *Colletotrichum gloeosporioides*.



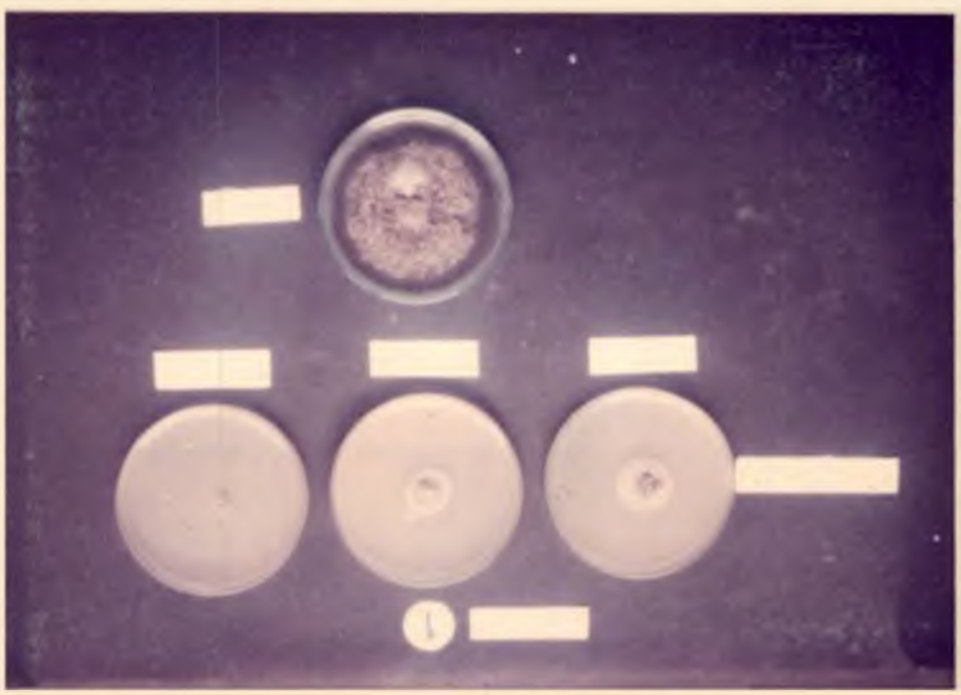
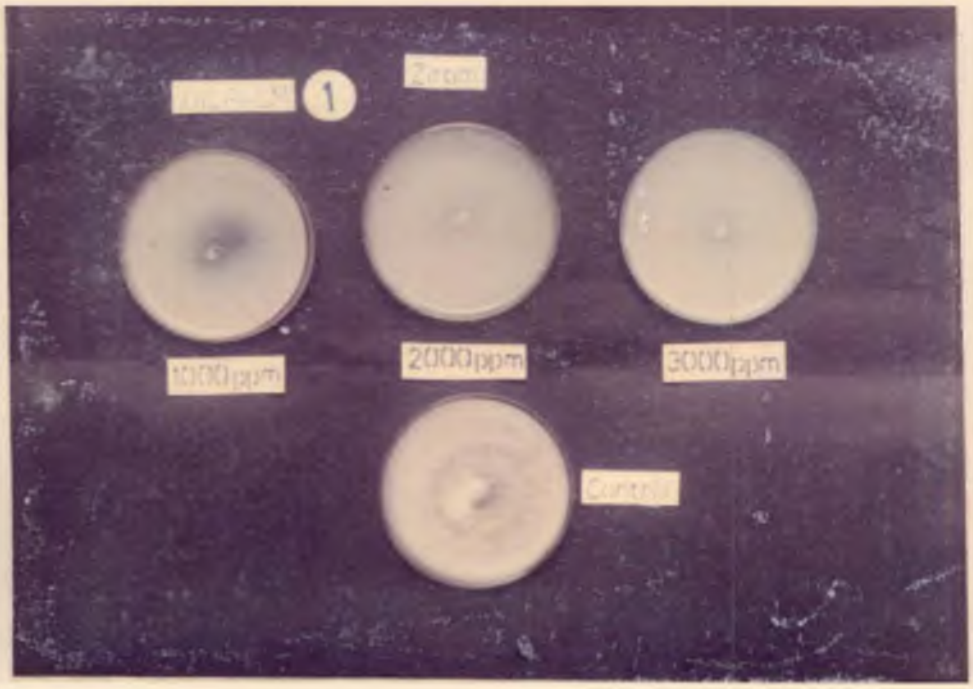


Plate-23

Effect of Ziram on the growth of *Colletotrichum gloeosporioides*.

Plate-24

Effect of Mancozeb on the growth of *Colletotrichum gloeosporioides*.


1
Zineb
1000ppm
2000ppm
3000ppm
Control

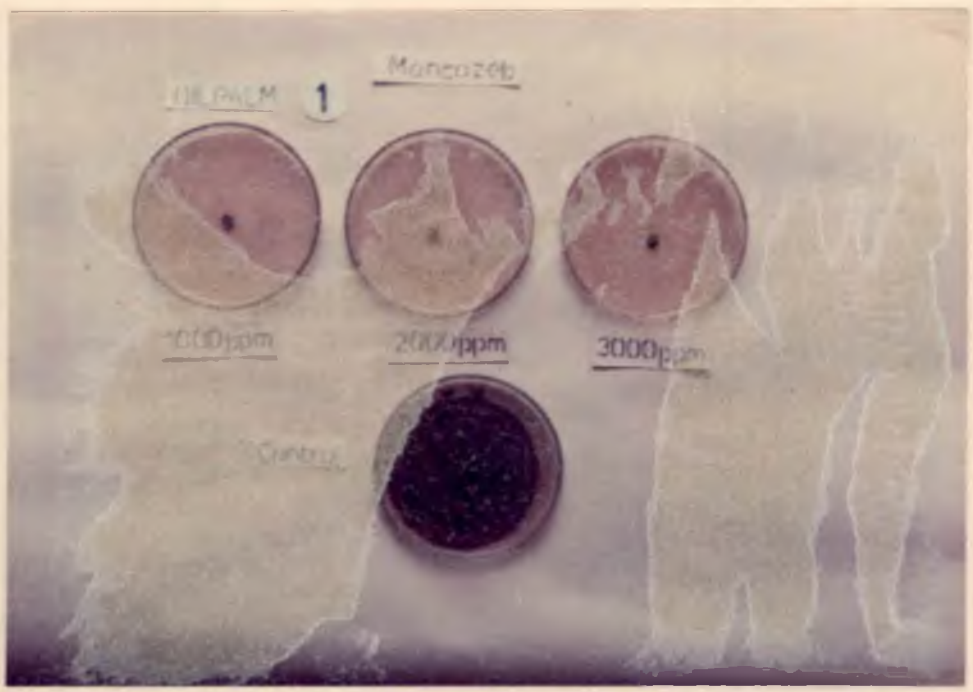
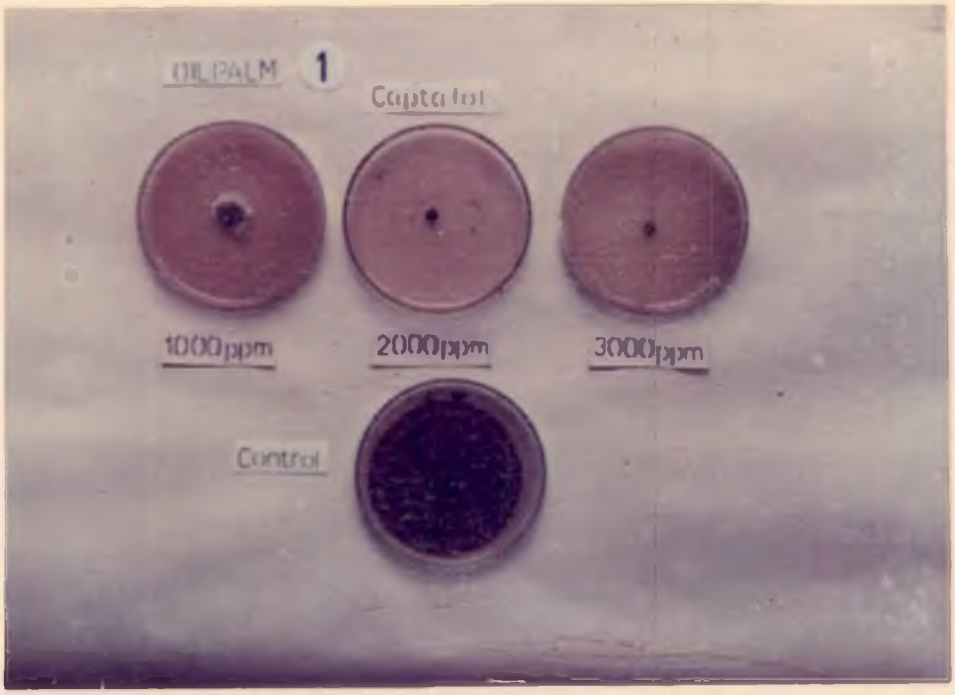

OIL PALM
1
Mancozeb
1000ppm
2000ppm
3000ppm
Control

Plate-25

Effect of Captafol on the growth of *Colletotrichum gloeosporioides*.

Plate-26

Effect of Copper oxychloride on the growth of *Colletotrichum gloeosporioides*.


OIL PALM
1
Captafol
1000ppm
2000ppm
3000ppm
Control


1

(4) Curvularia geniculata

Results revealed that Bordeaux mixture and Dithane M-45 were the most effective fungicides as the growth of the fungus was completely inhibited even in the lowest concentration tested. There was no growth in the highest concentration 3000 ppm of Cuman L also (Table 11).

Foltaf in all concentrations tested were effective as the per cent inhibition over control was 89, 84 and 81 per cent respectively. The lower concentrations (2000 and 1000 ppm) of Cuman L and all concentrations of Aureofungin sol were also effective as the per cent inhibition over control was 87, 71, 86, 83 and 75 per cent respectively. Fytolan was not found effective as the per cent inhibition was poor in all concentrations. Bavistin 250 ppm was the least effective treatment (21 per cent) (Fig. 7, Plate 27-33).

Bordeaux mixture 2000 ppm, Cuman L 3000 ppm and Dithane M-45 1000 ppm were superior to all other treatments as cent per cent inhibition over control was obtained. Foltaf 3000 ppm was superior to all other treatments. Cuman L 2000 ppm and Aureofungin sol (200 ppm) were superior to other treatments viz. all concentrations of Bavistin, Fytolan and lower concentrations of Cuman L and

Table-11

Effect of different fungicides on the radial growth of Curvularia geniculata on solid media (poisoned food technique)

Sl. No.	Treatments	Concentration of fungicides (in ppm)	*Mean colony diameter (mm)	Per cent inhibition over control (C-T x 100 / C)
1.	Aureofungin sol (N-Methyl-p-amino aceto phenone-m/cosamine heptane)	100	22.67	74.82
		150	15.67	82.61
		200	12.67	85.93
2.	Bavistin (2(Methoxy-carbamoyl)-benzimidazole)	250	71.00	21.10
		500	47.67	47.03
		1000	34.00	62.23
3.	Bordeaux mixture	2500	0.0	100.00
		5000	0.0	100.00
		10000	0.0	100.00
4.	Cuman L (Zinc dimethyl-dithio carbamate)	1000	26.00	71.11
		2000	11.33	87.41
		3000	0.0	100.00
5.	Dithane M-45 (Zinc ion and manganese ethylene bis-dithiocarbamate)	1000	0.0	100.00
		2000	0.0	100.00
		3000	0.0	100.00
6.	Foltaf (Cis-N-1,1,2,2-tetrachloroethyl thio)4-cyclohexane-1, 2-dicar-boximide)	1000	17.00	81.12
		2000	14.67	83.70
		3000	10.00	88.91
7.	Fytolan (Copper oxychloride-50 per cent metallic copper)	1000	47.33	47.41
		2000	36.67	59.26
		3000	32.00	64.45
8.	Control	..	90.00	..

* Average of three replications

CD for comparison = 1.25

Significant at 5% and 1% level

FIG 7 EFFECT OF DFFERENT FUNGICIDES ON THE GROWTH OF *Curvularia geniculata*

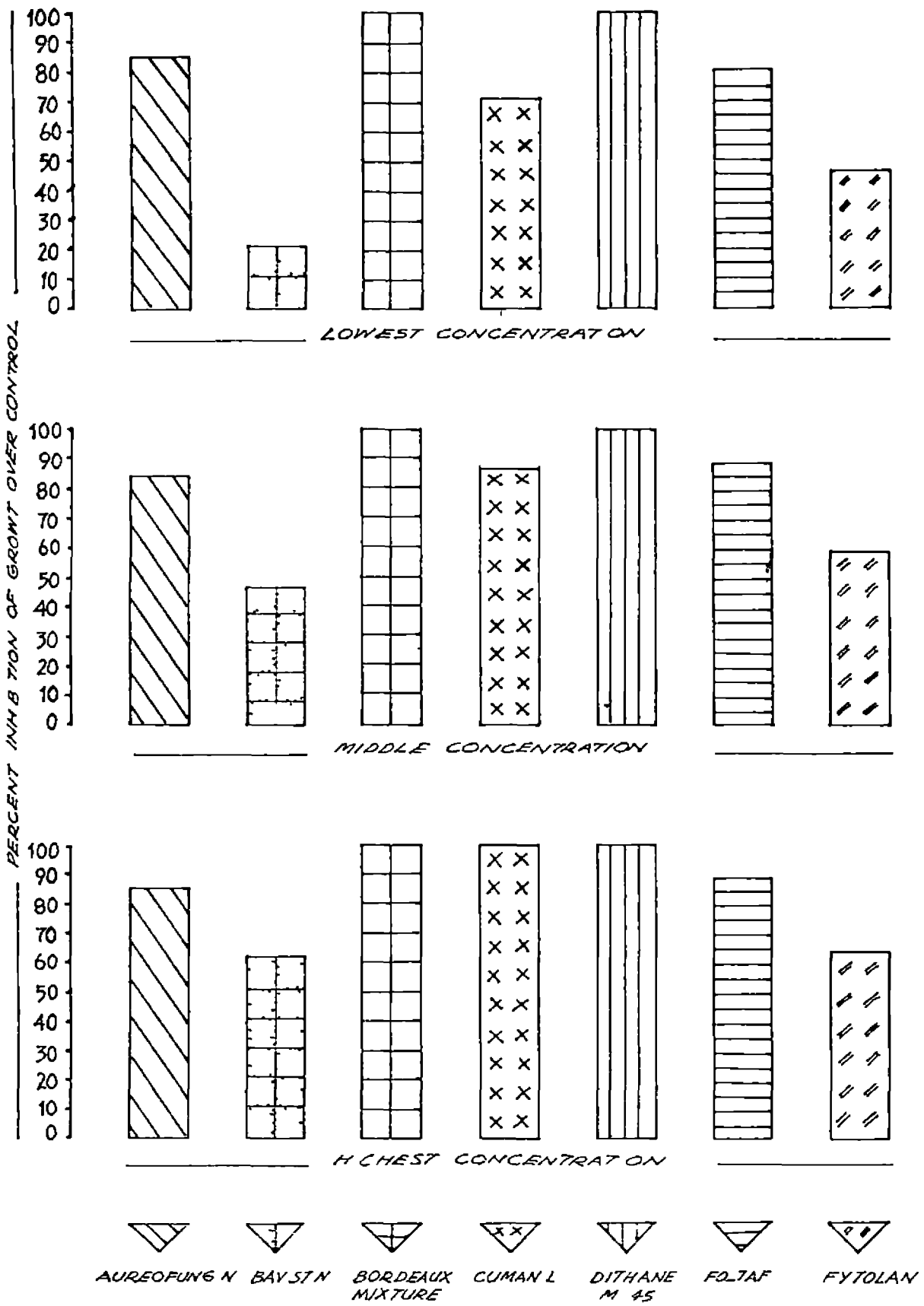
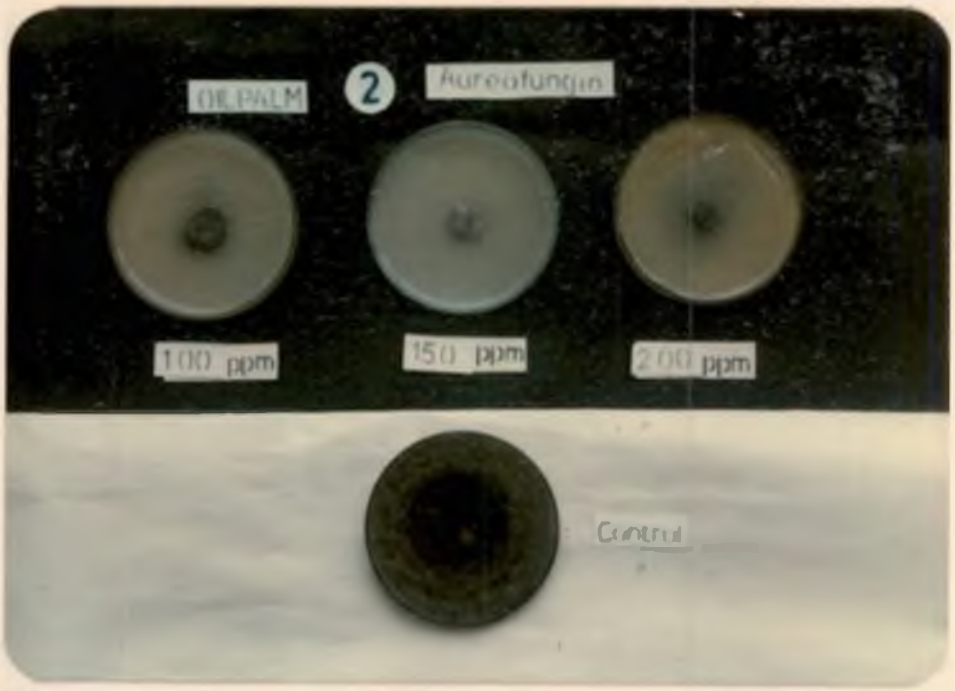


Plate-27

Effect of Aureofungin sol on the growth of Curvularia geniculata.

Plate-28

Effect of Carbendazim on the growth of Curvularia geniculata.


OE PALM
2
Aureofungin
100 ppm
150 ppm
200 ppm
Control

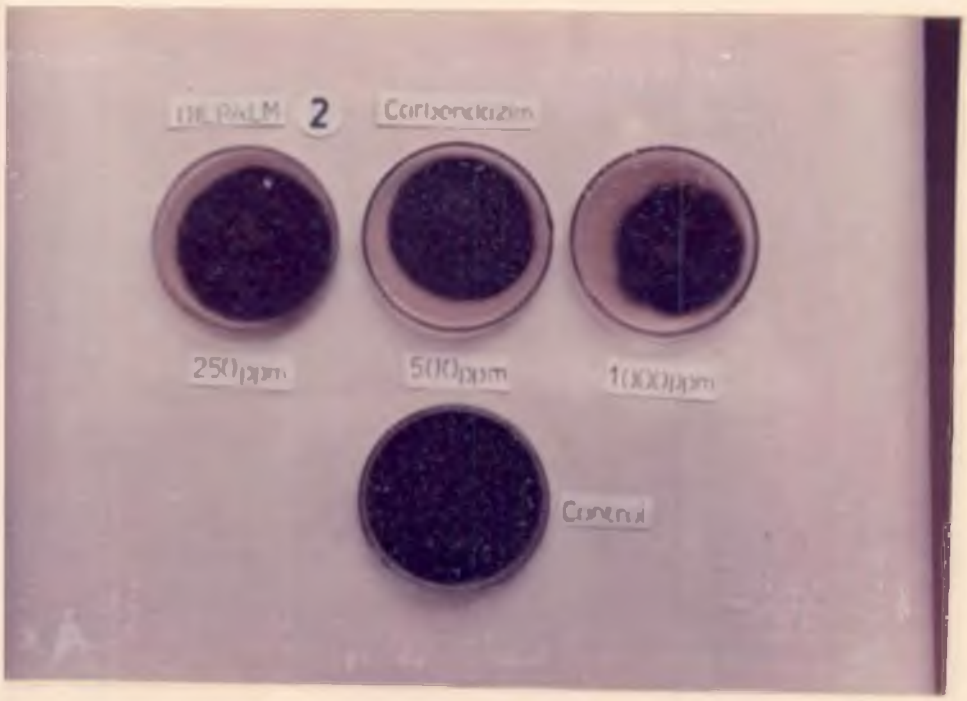
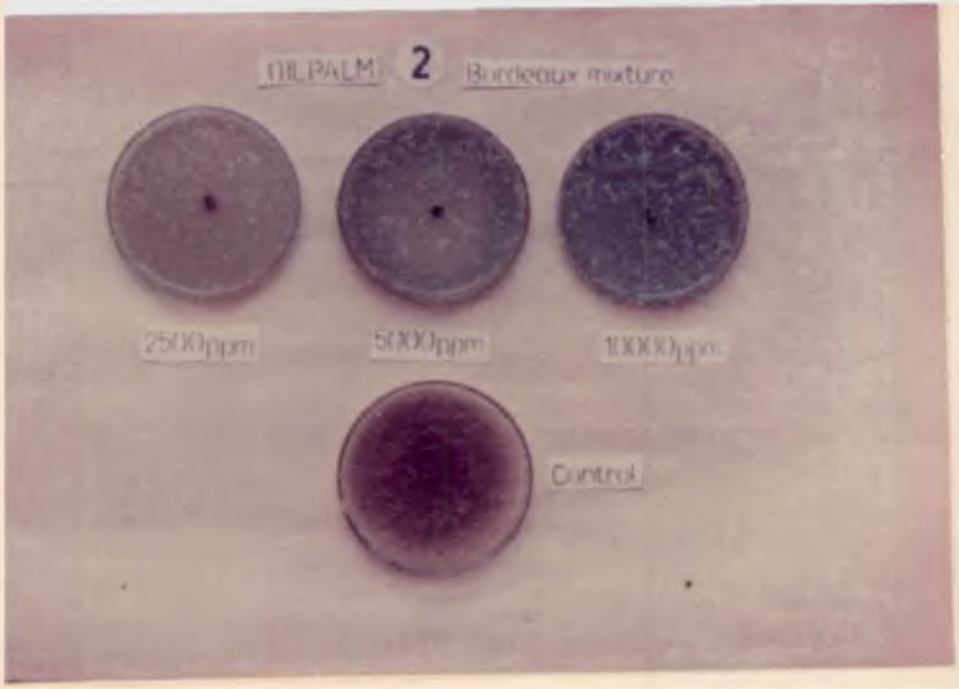

OE PALM
2
Carbendazim
250 ppm
500 ppm
1000 ppm
Control

Plate-29

Effect of Bordeaux mixture on the growth of *Curvularia geniculata*.

Plate-30

Effect of Ziram on the growth of *Curvularia geniculata*.


OIL PALM
2
Bordeaux mixture
2500ppm
5000ppm
10000ppm
Control

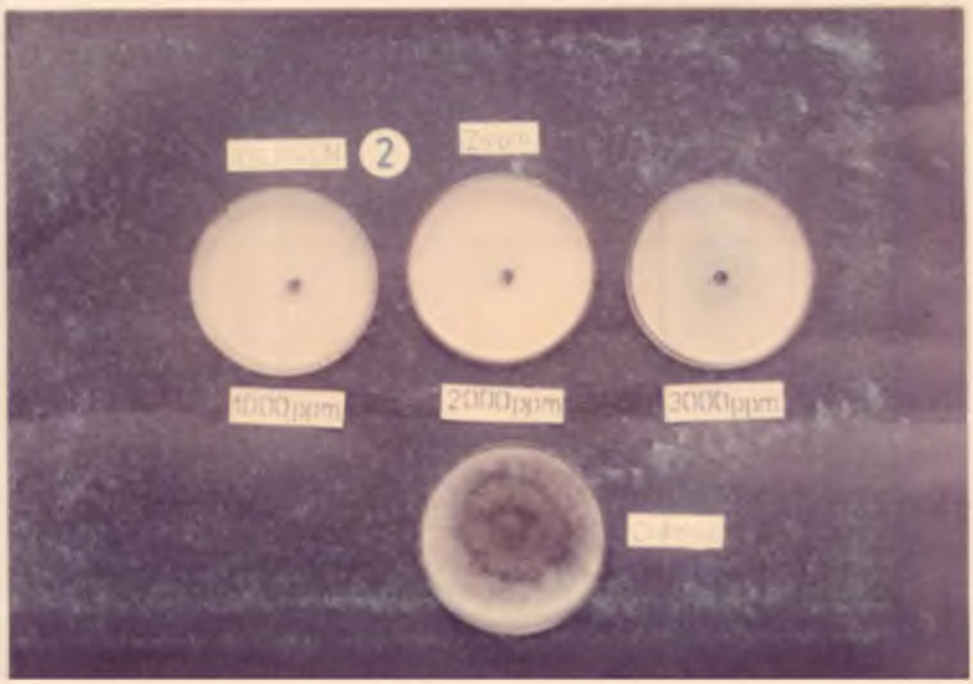
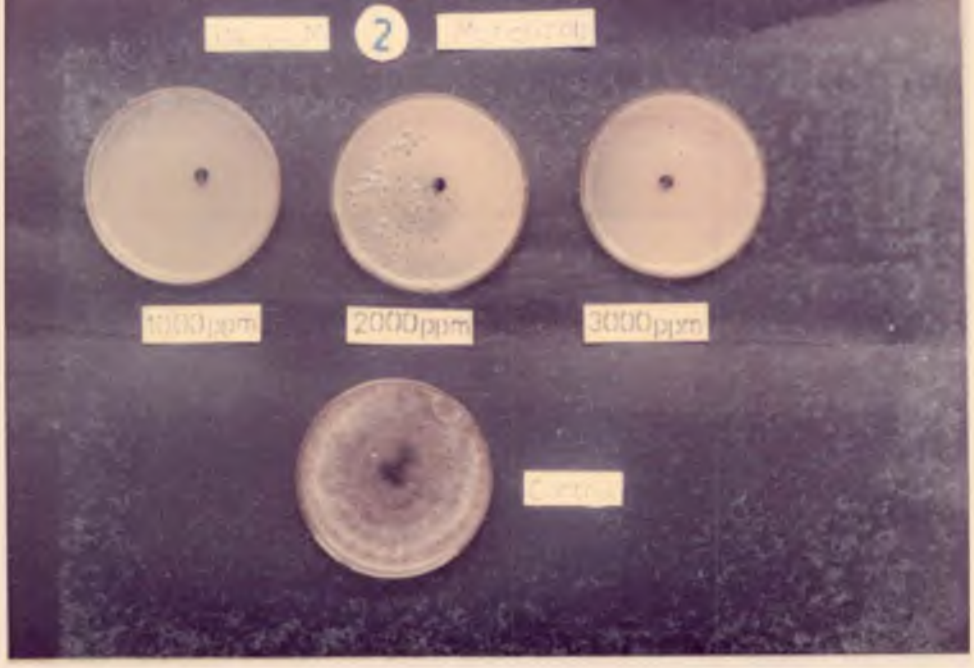

2
1000ppm
2000ppm
3000ppm

Plate-31

Effect of Mancozeb on the growth of *Curvularia geniculata*.

Plate-32

Effect of Captafol on the growth of *Curvularia geniculata*.


2
1000ppm
2000ppm
3000ppm

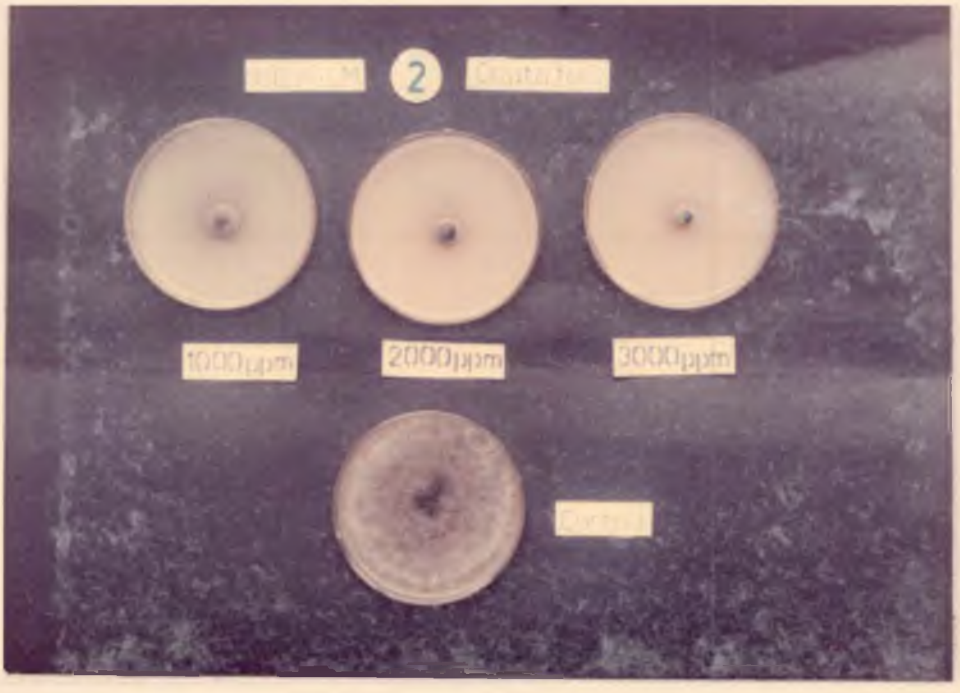
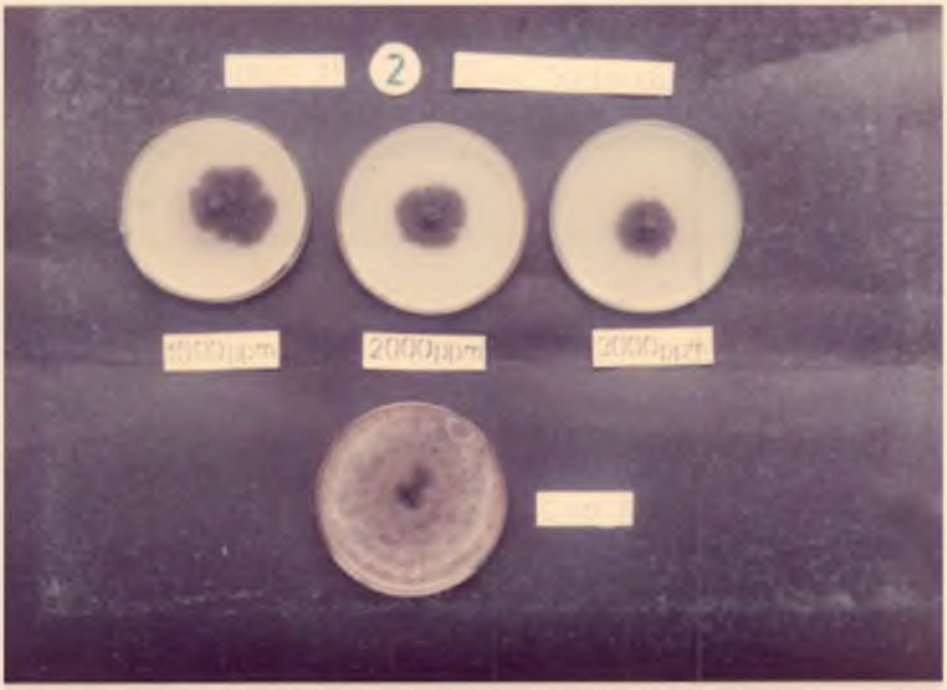

2
1000ppm
2000ppm
3000ppm

Plate-33

Effect of Captafol on the growth of *Curvularia geniculata*.

Plate-34

Effect of Aureofungin sol on the growth of *Fusarium pallidoroseum*.


2
2000ppm
3000ppm


OIL PALM
4
Aureofungin
1100 ppm
150 ppm
2100 ppm
Control

Aureofungin sol. There was no significant difference between Foltaf (2000 ppm) and Aureofungin sol (150 ppm) which were superior to Bavistin (1000 ppm) and Fytolan (3000 ppm). Bavistin (250 ppm) was found to be least effective.

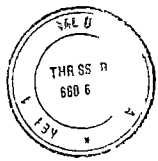
(5) Fusarium pallidoroseum

Complete inhibition of growth of the fungus was obtained in the medium containing 250 ppm Bavistin, 2500 ppm Bordeaux mixture, 1000 ppm Fytolan 2000 ppm each of Cuman L and Dithane M-45. (Table 12).

Foltaf in all concentrations were effective as the per cent inhibition over control was quite high. The lowest concentration of Cuman L (1000 ppm) also inhibited growth (89 per cent). The higher concentrations of Aureofungin sol (200 and 150 ppm) were also effective as the grown inhibition was quite high (78 and 70 per cent respectively). In Aureofungin sol (100 ppm) the per cent inhibition was 58 per cent. Dithane M-45, 1000 ppm was least effective as the per cent inhibition was only 14 per cent (Fig. 8, Plate 34-40).

All the concentrations of Fytolan, Bordeaux mixture, Bavistin and 2000 ppm each of Cuman L and Dithane M-45 were found to be very effective as cent per cent inhibition was obtained. Foltaf 3000 ppm was superior to all the remaining treatments. There was no significant difference between

Table-12



Effect of different fungicides on the radial growth of Fusarium pallidoroseum on solid media (poisoned food technique)

Sl. No.	Treatment	Concentration of fungicides (in ppm)	*Mean colony diameter (mm)	Per cent inhibition over control (C-T x 100 / C)
1.	Aureofungin sol (N-Methyl-p-amino aceto phenone-mycosamine heptane)	100	37.67	58.15
		150	27.33	69.83
		200	19.67	78.16
2.	Bavistin (2(Methoxy-carbamoyl)-benzimidazole)	250	0.0	100.00
		500	0.0	100.00
		1000	0.0	100.00
3.	Bordeaux mixture	2500	0.0	100.00
		5000	0.0	100.00
		10000	0.0	100.00
4.	Cuman L (Zinc dimethyl-dithio carbamate)	1000	10.0	88.99
		2000	0.0	100.00
		3000	0.0	100.00
5.	Dithane M-45 (Zinc ion and manganese ethylene bis-dithiocarbamate)	1000	77.00	14.35
		2000	0.0	100.00
		3000	0.0	100.00
6.	Foltaf (Ciz-N-(1,1,2,2-tetrachloroethyl thio)4-cyclohexane-1, 2-dicar-boximide)	1000	13.33	85.21
		2000	10.67	88.15
		3000	8.0	91.13
7.	Fytolan (Copper oxychloride-50 per cent metallic copper)	1000	0.0	100.00
		2000	0.0	100.00
		3000	0.0	100.00
8.	Control	..	90.00	..

* Average of three replications

CD for comparison = 1.50

Significant at 5% and 1% level

FIG 8 EFFECT OF DIFFERENT FUNGICIDES ON THE GROWTH OF *Fusarium pallidoroseu*

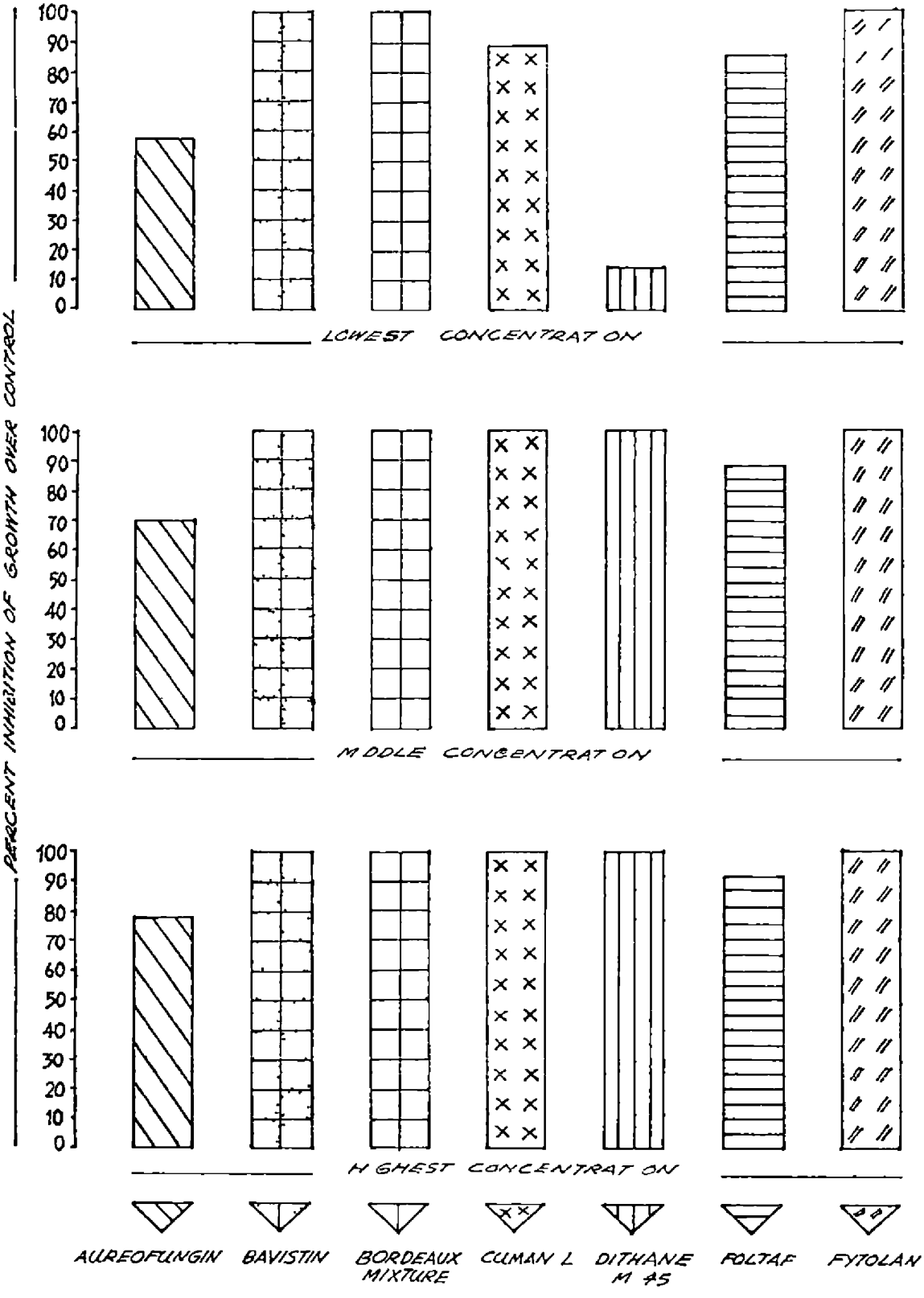


Table-13

Effect of different fungicides on the radial growth of *Phoma sorghina* on solid media (poisoned food technique)

Sl. No.	Treatment	Concentration of fungicides (in ppm)	*Mean colony diameter (mm)	Per cent inhibition over control $\frac{(C-Tx100)}{C}$
1.	Aureofungin sol (N-Methyl-p-amino aceto phenone-mycosamine heptane)	100	18.67	79.26
		150	16.33	81.86
		200	13.00	85.56
2.	Bavistin (2(Methoxy-carbamoyl)-benzimidazole)	250	0.0	100.00
		500	0.0	100.00
		1000	0.0	100.00
3.	Bordeaux mixture	2500	0.0	100.00
		5000	0.0	100.00
		10000	0.0	100.00
4.	Cuman L (Zinc ion and dimethyl-dithio carbamate)	1000	24.33	72.97
		2000	20.00	77.78
		3000	12.67	85.95
5.	Dithane M-45 (Zinc ion and manganese ethylene bis-dithiocarbamate)	1000	0.0	100.00
		2000	0.0	100.00
		3000	0.0	100.00
6.	Foltaf (Cis-N-(1,1,2,2-tetrachloroethyl thio)4-cyclohexane-1, 2-dicarboximide)	1000	22.00	75.56
		2000	17.33	80.75
		3000	0.0	100.00
7.	Fytolan (Copper oxychloride-50 per cent metallic copper)	1000	0.0	100.00
		2000	0.0	100.00
		3000	0.0	100.00
8.	Control	..	90.0	..

* Average of three replications

CD for comparison = 0.91

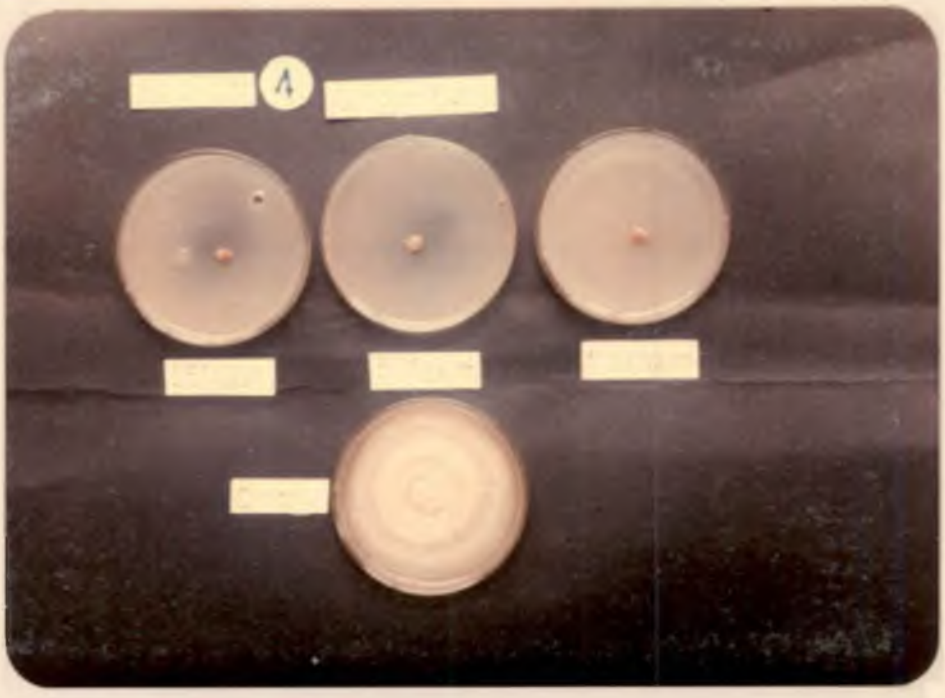
Significant at 5% and 1% level

Plate-35

Effect of Carbendazim on the growth of *Fusarium pallidoroseum*.

Plate-36

Effect of Bordeaux mixture on the growth of *Fusarium pallidoroseum*.


A

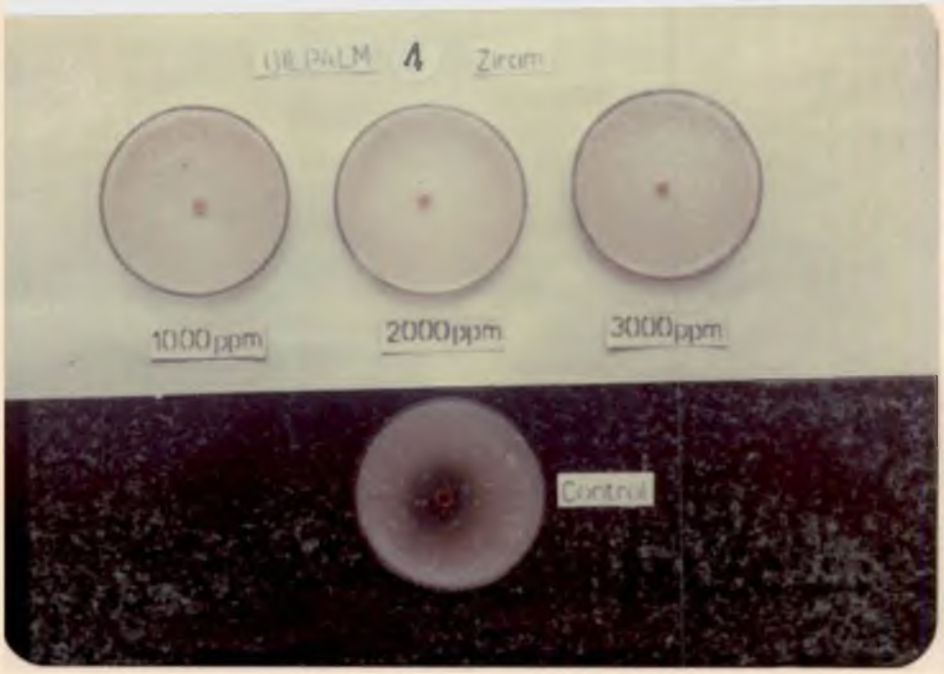

OIL PALM
A
Bordeaux mixture
250 ppm
500 ppm
1000 ppm
Control

Plate-37

Effect of Ziram on the growth of Fusarium pallidoroseum.

Plate-38

Effect of Mancozeb on the growth of Fusarium pallidoroseum.


UE PALM
A
Zircam
1000ppm
2000ppm
3000ppm
Control

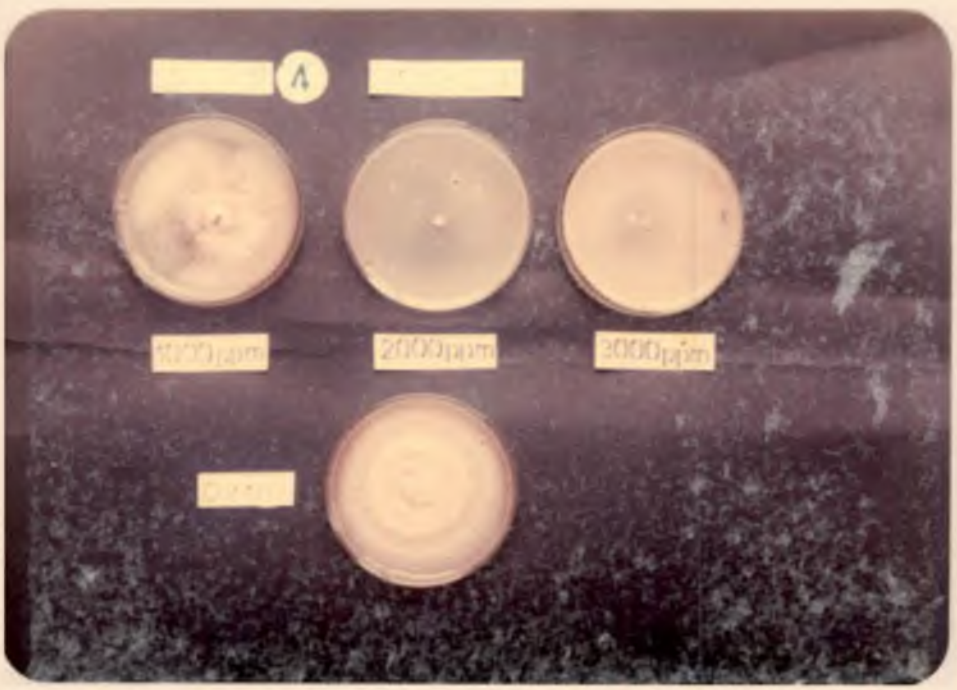
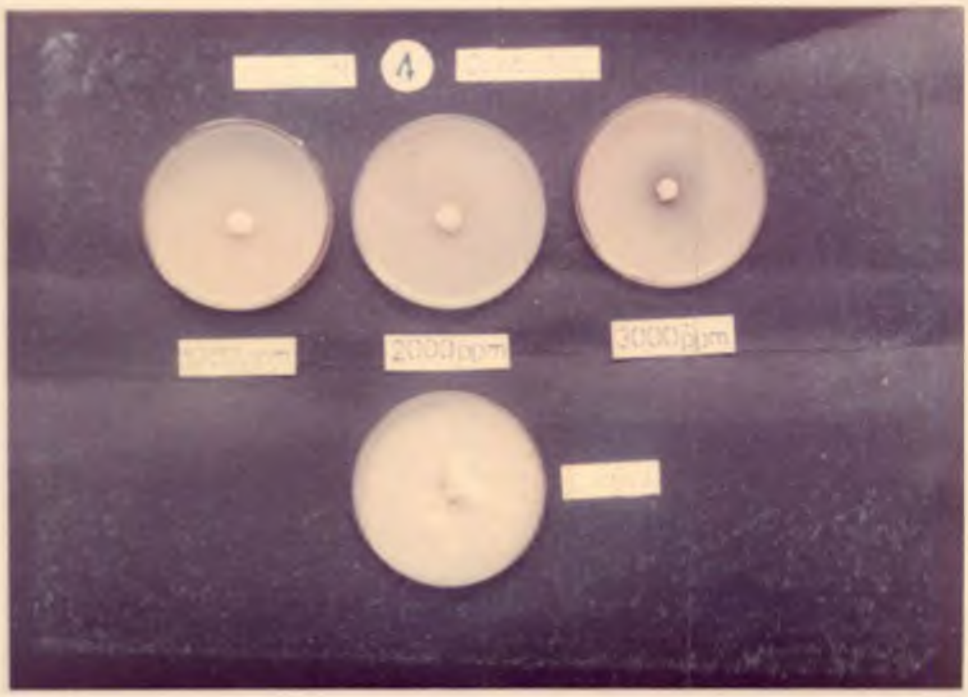

A
1000ppm
2000ppm
3000ppm

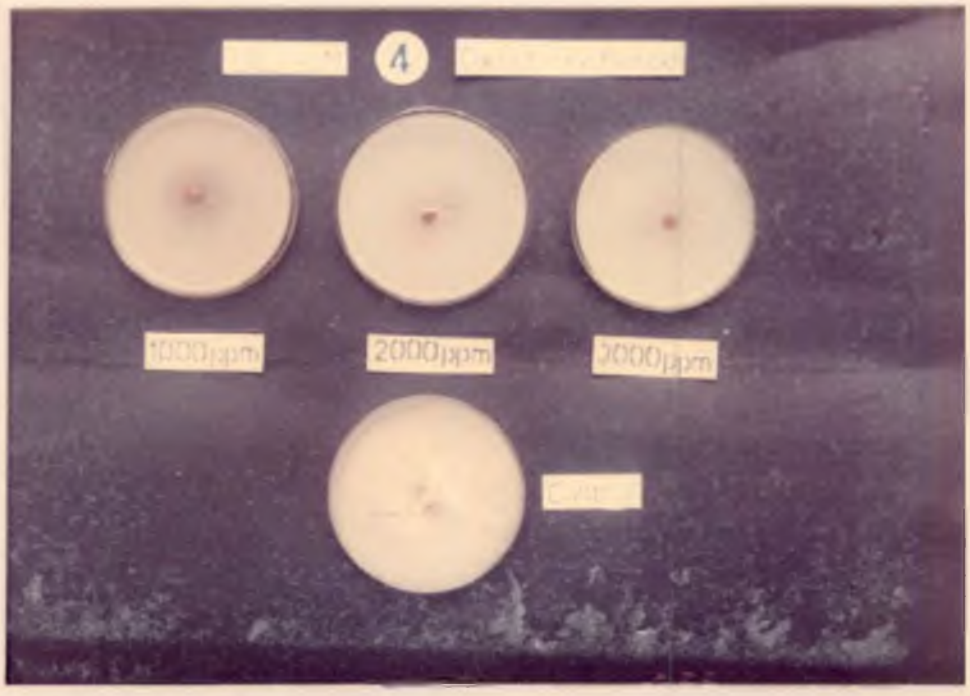
Plate-39

Effect of Captafol on the growth of *Fusarium pallidoroseum*.

Plate-40

Effect of Copper oxychloride on the growth of *Fusarium pallidoroseum*.


4
2000ppm
3000ppm


4
1000ppm
2000ppm
3000ppm

Foltaf 2000 ppm and Cuman L 1000 ppm which were superior to all concentrations of Aureofungin sol and 1000 ppm each of Foltaf and Dithane M-45. Dithane M-45 1000 ppm was the least effective treatment.

(6) Phoma sorghina

Growth of the fungus was completely inhibited by 250 ppm Bavistin, 2500 ppm Bordeaux mixture 1000 ppm each of Dithane M-45/Fytolan and 3000 ppm Foltaf (Table 13). The lower concentrations (2000 and 1000 ppm) of Foltaf inhibited growth over control considerably (81 and 76 per cent respectively) Aureofungin sol was also effective as the percentages of inhibition over control in 200, 150 and 100 ppm were 86, 82 and 79 respectively. The higher concentrations of Cuman L (3000 and 2000 ppm) inhibited the growth of the fungus considerably (86 and 78 per cent respectively). Cuman L 1000 ppm was found to be least effective among the fungicides tested (73 per cent) (Fig. 9, Plate 41-47).

All the concentrations of Bavistin, Bordeaux mixture, Dithane M-45, Fytolan and Foltaf 3000 ppm were found to be superior to all other treatments as cent per cent inhibition over control were obtained. Cuman L 3000 ppm and Aureofungin sol 200 ppm were superior to the remaining treatments. Aureofungin sol 150 ppm was found superior to other

FIG 9 EFFECT OF DIFFERENT FUNGICIDES ON THE GROWTH OF *Phoma sorghina*

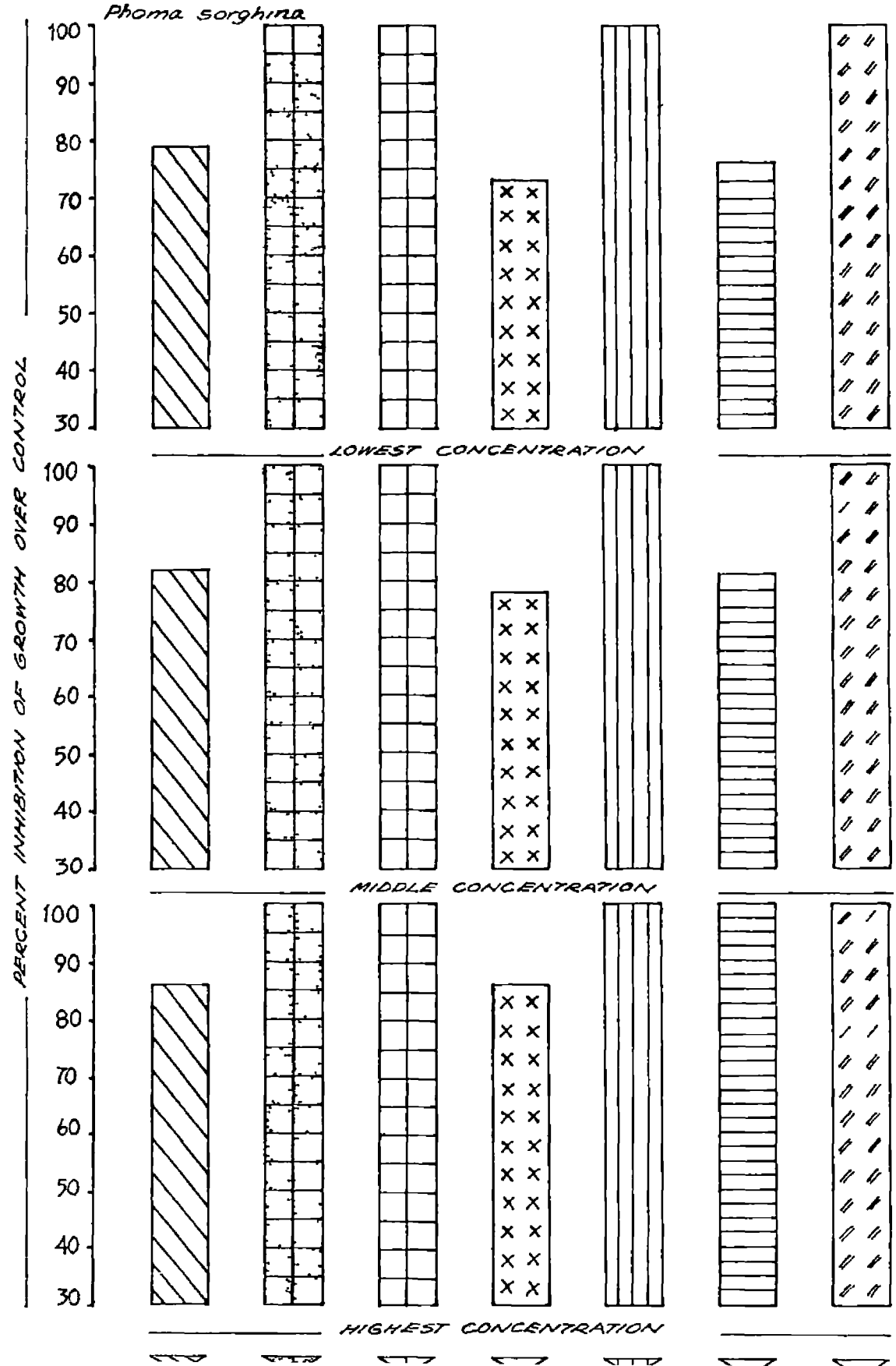
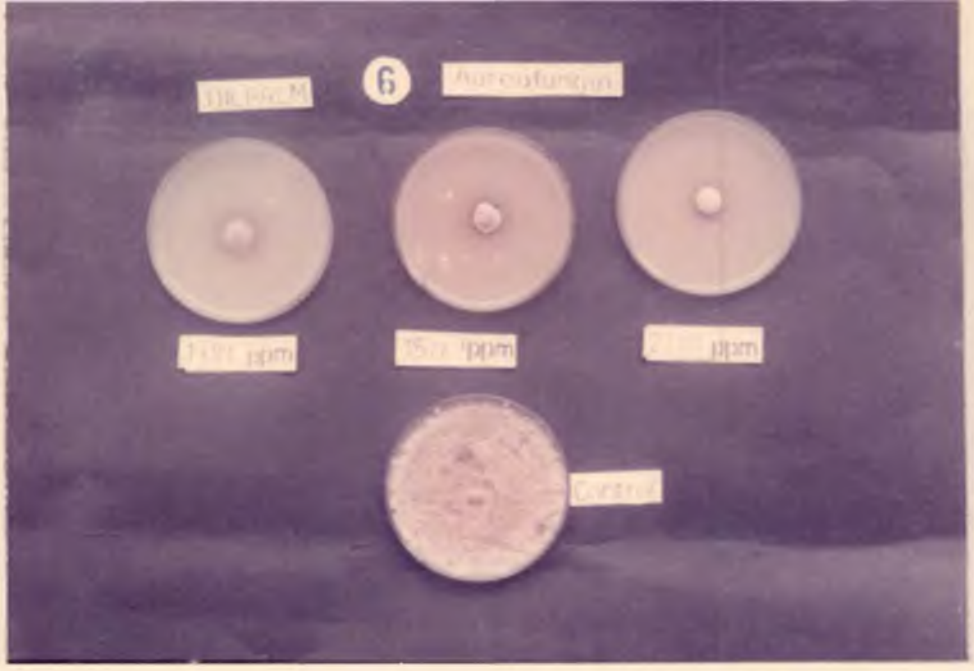


Plate-41

Effect of Aureofungin sol on the growth of *Phoma sorghina*.

Plate-42

Effect of Carbendazim on the growth of *Phoma sorghina*.


6

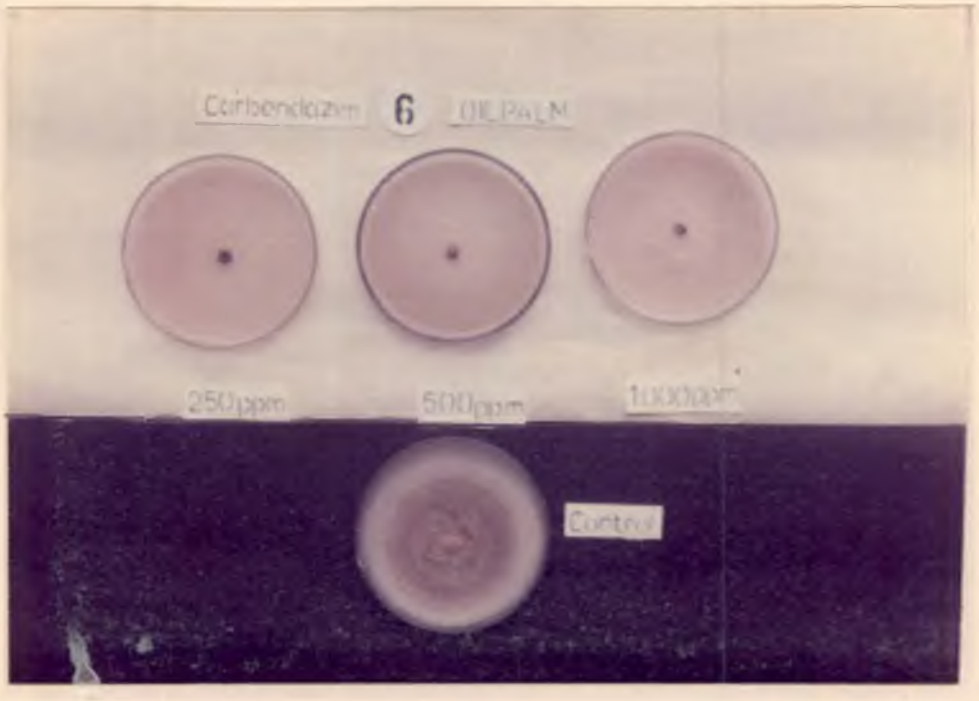
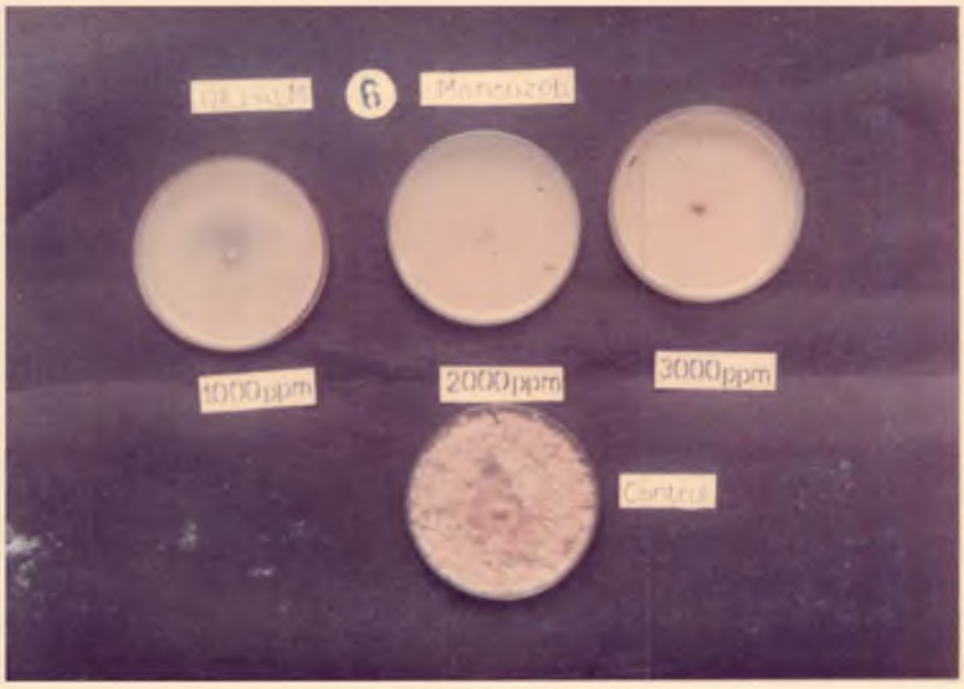

Carbendazim
6
OILPALM
250ppm
500ppm
Control

Plate-43

Effect of Bordeaux mixture on the growth of *Phoma sorghina*.

Plate-44

Effect of Ziram on the growth of *Phoma sorghina*.


6
1000)ppm
2000)ppm
3000)ppm
Control

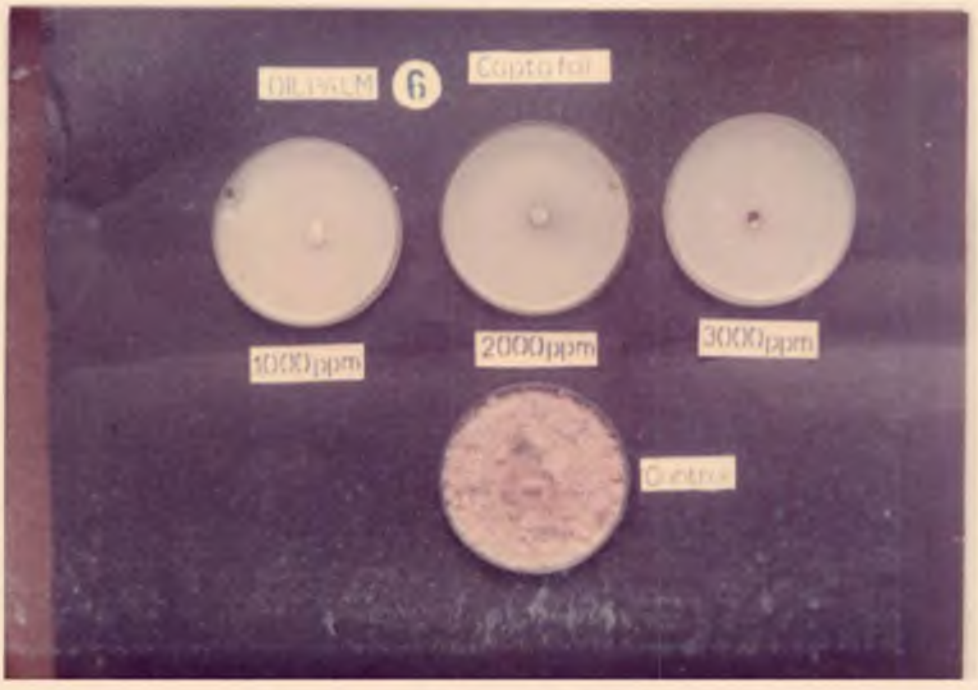
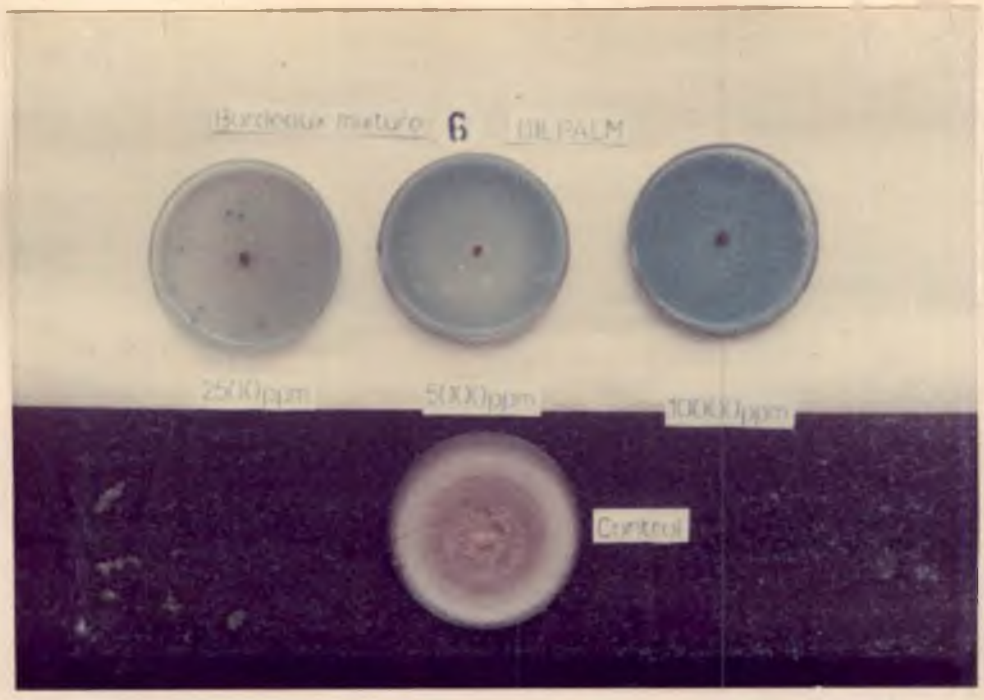

6
Captafol
1000)ppm
2000)ppm
3000)ppm
Control

Plate-45

Effect of Mancozeb on the growth of *Phoma sorghina*.

Plate-46

Effect of Captafol on the growth of *Phoma sorghina*.


Bordeaux mixture
6
OIL PALM
2500ppm
5000ppm
10000ppm
Control

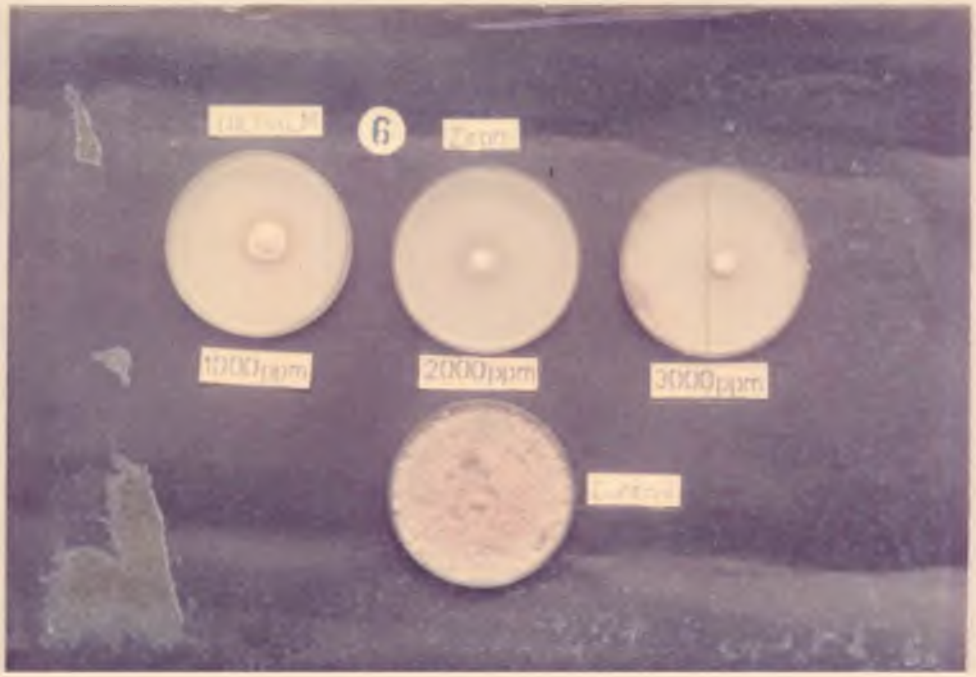
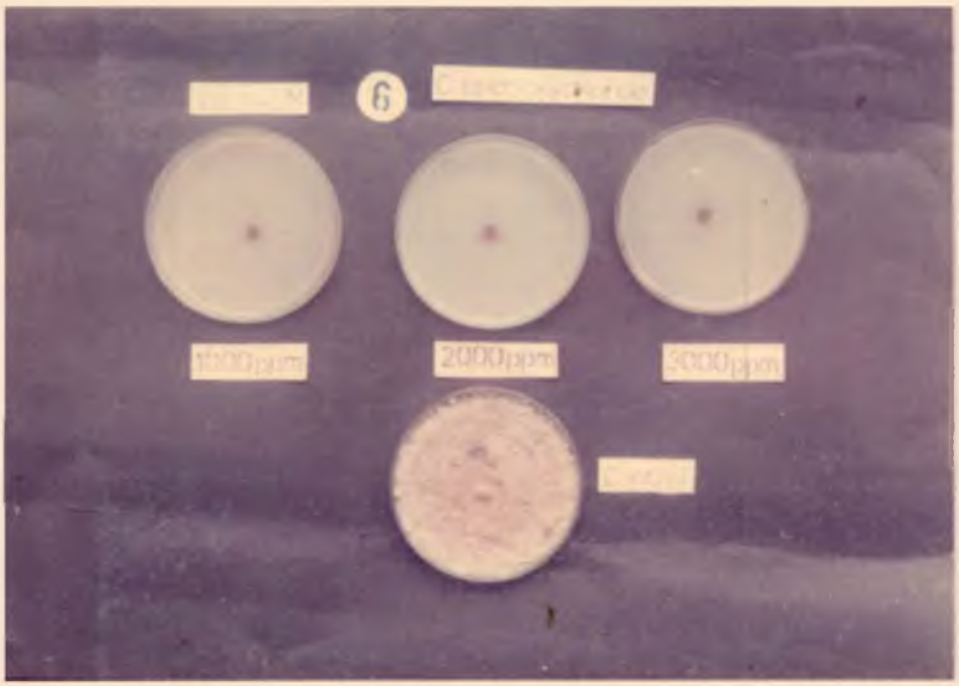

6
1000ppm
2000ppm
3000ppm

Plate-47

Effect of Copper oxychloride on the growth of *Phoma sorghina*.


6
2000ppm

treatments viz. Cuman L, 2000 and 1000 ppm, Foltab, 1000 ppm and Aureofungin sol 100 ppm. The lower concentrations of Foltaf and Cuman L were not effective as the growth inhibition was poor.

Field evaluation of fungicides against leaf spot disease caused by Colletotrichum gloeosporioides

The effect of different fungicides against the leaf spot disease caused by Colletotrichum gloeosporioides based on the disease intensity observed on the newly formed leaves, are tabulated and presented (Table 14).

The results revealed that all the fungicides reduced the percentage of the disease significantly as compared with the control. Among the fungicides tested, Bavistin (0.1 per cent) was found to be the most effective. A disease control of 84 per cent over control was achieved by the application of Bavistin. Effective control was also achieved by the application of 0.2 per cent Dithane M-45 (66 per cent over control) and 0.2 per cent Foltaf (65 per cent over control). Considering the high phytotoxic effect of copper on oil palm, Bordeaux mixture was not included in the field evaluation, eventhough it was found effective in the in vitro studies.

All the treatments are found to be effective in controlling leaf spot disease caused by Colletotrichum gloeosporioides. Bavistin (0.1 per cent) was found to be superior to all other treatments viz. Dithane M-45, Foltaf and Cuman L. There were no significant difference between treatments with Dithane M-45, Foltaf and Cuman L.

Table-14

Field evaluation of fungicides against Colletotrichum gloeosporioides

Sl. No.	Fungicide	Disease intensity Before	Disease intensity After	Per cent efficiency over control
1.	Bavistin 0.1% 2 (Methoxy carbamoyl) benzimidazole	18.75	3.00	84.00
2.	Dithane M-45 (0.2% Zinc ion and manganese ethylene bisdithiocarbamate)	14.75	5.00	66.10
3.	Foltaf 0.2% (Cis-N-(1,1,2,2-tetrachloro ethyl) thio-4-cyclo hexane-1,2, dicarboximide)	20.5	7.25	64.63
4.	Cuman L 0.2% (Zinc dimethyl dithiocarbamate)	17.0	7.75	54.41
5.	Control	25.0	20.25	..

DISCUSSION

DISCUSSION

Leaf spot diseases have been recognised as one of the major problems of oil palm in Kerala. However, no systematic effort has been made to study the various leaf spot diseases and to recommend proper control measures. A quarterly survey was conducted for a period of one year in four oil palm plantations of the State, viz., Palode, Kulathupuzha, Anchal and Thodupuzha to study the occurrence of leaf spot diseases affecting oil palm. Six leaf spot diseases were recorded in these plantations during the course of the survey. They include leaf spot diseases caused by Bipolaris hawaiiensis, Botryodiplodia theobromae, Colletotrichum gloeosporioides, Curvularia geniculata, Fusarium pallidoroseum and Phoma sorghina. All these diseases are new records. The symptomatology and etiology of these leaf spot diseases are described.

The leaf spot disease caused by Bipolaris hawaiiensis was found to be severe in nurseries and young palms during rainy season. Symptoms on the leaves appeared on the spear or youngest opened frond as small, pale green spots which later attained 10-45 mm in diameter. Thompson (1939) reported Helminthosporium sp. on oil palm seedlings from Malaya. Bull (1954), Dupriez and Bredas (1957), Johnston (1959), Turner and Bull (1968) and Trafton and Washburn (1969) also reported

Helminthosporium sp. from various countries. Kovachich (1954) reported Drechslera halodes var. elaeicola, on the adult palms from Zaire, Drechslera rostrata from Malaya. (Williams and Liu, 1976). It is likely that organisms reported by earlier workers in different names refer to the same organism, viz. Bipolaris hawaiiensis, recorded during the present investigation.

Inoculation studies on the attached and detached oil palm leaves with spore suspension and culture bits of Bipolaris hawaiiensis developed typical symptoms of the disease. Initial symptoms were noticed in 4-5 days when inoculated with the spore suspension and in 5-6 days when inoculated with culture bits in injured leaves. Uninjured leaves showed symptoms in 5-6 days of inoculation. Jimenez and Reyes (1977) reported that the leaf disease due to Helminthosporium spp. developed on those leaves which were injured by insects. Buckley and Allen (1951) reported that seedling susceptibility to infection by Helminthosporium sp. was influenced by wounds.

Leaf spot disease caused by Botryodiplodia theobromae was observed in nurseries and isolated palms in the main-field throughout the year. The attack due to this fungus

was seen on the distal end of the leaf. Lesions appeared as small clear spots initially and later developed into necrotic patches covering nearly the entire leaf let. Ravise (1965) from Ivory Coast and Turner and Bull (1968) from Peninsular Malaysia reported B. theobromae from oil palm seedlings. Williams and Liu (1976), Alibert (1944) and Hughes (1953) also reported B. theobromae in adult palms.

In the inoculation studies, symptoms appeared in injured attached/detached leaves in 2-3 days when inoculated with spore suspension and in 3-4 days when inoculated with culture bits of Botryodiplodia theobromae. In uninjured leaves infection appeared in 4-5 days. The percentage infection was higher in injured leaves than in uninjured leaves.

The leaf spot disease caused by Colletotrichum gloeosporioides was observed in nurseries and mainfield during monsoon season. Symptoms on the leaves appeared initially as small brown dots which enlarged with circular to irregular brown border and were surrounded by pale yellow halo. The adjoining spots eventually coalesced and formed irregular necrotic patches. Staner (1929) from Belgian Congo and Jagoe and Heath (1954) from Peninsular Malaysia

reported Colletotrichum sp. on oil palm. McIntosh (1951) reported Glomerella cingulata from Belgian Congo; Punnee Soothrompoot (1969) reported C. gloeosporioides from Combodia. Thompson (1940) reported C. capsici from Malaya, Kovachich (1957) reported Glomerella cingulata from Belgian Congo; Waterston (1953) from Nigeria.

Inoculation with the spore suspension and culture bits of Colletotrichum gloeosporioides on the attached/ detached oil palm leaves produced symptoms in 2-4 days in injured leaves whereas, in uninjured leaves 5-6 days were required to initiate symptoms. The percentage of infection was more in injured leaves than in uninjured leaves. Jimenez and Reyes (1977) recorded that the leaf disease due to Colletotrichum sp. developed on the wounds caused by insects.

The leafspot disease caused by Curvularia geniculata was found severe in nurseries during rainy season. Symptoms appeared as yellow spots initially. Eventually they enlarged and became irregular with light brown centre and reddish brown margin attaining 7-8 mm in length. Heath (1955) and Turner and Bull (1968) reported Curvularia sp. and Williams (1969) reported C. eragrostidis on oil palm seedlings. Turner and Gillbank (1974) and Williams and Liu (1976) from Malaysia and Ahisa and Choudhury (1986) from Bangladesh

reported C. fallax in oil palm. Williams (1969) reported C. lunata from Asia. Williams and Liu (1976) reported C. lunata var. aeria from Malaysia. It is likely that all the pathogen reported by earlier workers refer to the same organism viz., C. geniculata.

Inoculation studies with Curvularia geniculata showed infection in injured leaves either attached or detached in 2-3 days when inoculated with the spore suspension and 3-4 days when inoculated with culture bits. Symptoms appeared in uninjured leaves in 4-5 days. However, the percentage infection was higher in injured than in injured leaves.

Leaf spot disease caused by Fusarium pallidoroseum was observed in nurseries during rainy season. Symptoms on the leaves appeared as minute spots surrounded by yellow halo. The spots enlarged gradually to form irregular necrotic patches.

Fusarium sp. was reported from Sierra Leone (Deighton, 1933), F. oxysporum and F. solani from Malaya (Thompson, 1940), F. moniliformae from Nigeria (Bull, 1954), F. equiseti from peninsular Malaysia (Johnston, 1962) and F. lateritium from Sabah (Williams and Liu, 1976) causing leaf diseases of oil palm. Bull (1954) and Turner (1971) isolated Fusarium species from oil palm seedlings from Nigeria and Malaysia respectively. It is likely that all the species reported by earlier workers refer to the same organism viz., F. pallidoroseum recorded during the present investigation.

Inoculation with the spore suspension and culture bits of Fusarium pallidoroseum showed symptoms in 4-6 days of inoculation both in the attached and detached leaves which are injured. The infection ranged from 60-80 per cent in the injured leaves. No symptom was visible in uninjured leaves.

Leaf spot disease caused by Phoma sorghina was observed in nurseries during rainy season. Symptoms on the leaves appeared initially as small dots, which soon enlarged to attain a size of 9-30 mm in diameter. Sanchez potes (1970) reported Phoma sp. causing leaf spot disease of oil palm from Sierra Leone and Williams and Liu (1976) from Sabah. It is likely that all the specis reported by earlier workers refer to the same organism viz., Phoma sorghina, recorded during the present investigation. Inoculation studies in the attached/detached leaves of oil palm with P. sorghina showed symptoms in the injured and uninjured leaves in 2-3 days and 3-4 days of inoculation respectively.

The results of laboratory evaluation on the effect of seven different fungicides on the growth of Bipolaris hawaiiensis on solid media indicate that Bordeaux mixture 2500 ppm, Cuman L 3000 ppm and Dithane M-45 1000 ppm caused complete inhibition. Bavistin was found to be least effective. Cox (1956) reported that Mancozeb (0.15 per cent) was effective in inhibiting the growth of Helminthosporium

maydis. Padmanabhan et al., (1963) reported that Copper oxychloride was effective in inhibiting H. oryzae. Vir and Raychaudhuri (1968) reported that Aureofungin sol was effective in inhibiting H. gramineum. Dwivedi and Shukla (1983) reported that H. halodes was sensitive to Thiram, Cuman L, Zineb and Aureofungin sol. Pawar and Patil (1978) reported that Dithane M-45 and Aureofungin inhibited the sporulation of H. rostratum. Edington et al., (1971) reported that, with the exception of Torula herbarum, all members of Porosporae like Bipolaris sorokinanum, Curvularia geniculata etc. were insensitive to Bemomyl.

The growth of Botryodiplodia theobromae was completely inhibited by Bavistin 500 ppm, Bordeaux mixture 10,000ppm, Dithane M-45 1000 ppm and Fytolan 2000 ppm. Foltaf and Cuman L 1000 ppm were found least effective. Vijayan (1978) obtained complete inhibition of the radial growth of B. theobromae with Bavistin 250 ppm and Dithane M-45 1000ppm. Agarwal et al., (1982) reported that Aureofungin sol 100 ppm was effective in inhibiting the growth of the fungus. Om Gupta and Nema (1978) reported that Ziram 1000 ppm was not effective against B. theobromae.

Total inhibition of the growth of Colletotrichum gloeosporioides was obtained with seven different fungicides

viz., Dithane M-45 1000 ppm, Foltaf 2000 ppm, Bavistin 1000 ppm and Bordeaux mixture 10,000 ppm. Fytolan was not found effective as the per cent inhibition was low. Narain and Panigrahi (1971) revealed that Aureofungin 50 ppm was effective in restricting the conidial germination of C. capsici. Kumaga (1964) reported that Ziram (0.2 per cent) was effective against C. gloeosporioides. Okigo (1978) obtained good control on the mycelial growth of C. gloeosporioides with Captafol. Solel and Oren (1978) revealed that Bordeaux mixture, Captafol, Maneb and Mancozeb were effective against C. gloeosporioides Karunakaran (1981) obtained complete inhibition of the mycelial growth of C. gloeosporioides with Bordeaux mixture and Fytolan.

In vitro studies conducted on the effect of fungicides revealed that complete inhibition of the radial growth of Curvularia geniculata was obtained with Bordeaux mixture 2500 ppm, Cuman L 3000 ppm and Dithane M-45 1000 ppm The above fungicides were significantly superior to the other fungicides tested. Bavistin was found to be the least effective. Heath (1958) reported that copper oxychloride 0.1 per cent was very effective in controlling oil palm leaf blight caused by Curvularia sp. Turner (1967)

observed growth inhibition of Curvularia sp. with Dithane M-45. Saikia (1982) reported that Cuman L 1000 ppm, Aureofungin 200 ppm, Copper oxychloride 4000 ppm and Dithane M-45 2000 ppm inhibited the growth of C. eragrostidis. Donald and Erwin (1973) reported that dark spored members of Deutromycetes were insensitive to Benomyl.

Bavistin 250 ppm, Bordeaux mixture 2500 ppm, Cuman L 2000 ppm, Dithane M-45 2000 ppm and Fytolan 1000 ppm caused complete inhibition of the growth of Fusarium pallidoroseum. Khanna and Chandra (1977) observed that Aureofungin was effective against Fusarium sp. Zencin (1978) reported that Bordeaux mixture was effective in inhibiting Fusarium spp. Qudri et al., (1982) reported that Bavistin (0.1 per cent), Ziride, Difolatan, Dithane M-45 each at 0.2 per cent concentration inhibited the radial growth of Fusarium sp. on solid media.

The mycelial growth of Phoma sorghina was completely inhibited by Bavistin 250 ppm, Bordeaux mixture 2500 ppm, Dithane M-45 1000 ppm, Foltaf 3000 ppm and Fytolan 1000 ppm, and were significantly superior to other fungicides tested. Maduewesi (1977) observed that Dithane M-45 was effective in inhibiting P. sorghina. Brown and Hendrix (1978) reported Benomyl and Captafol were effective in inhibiting

growth of Phoma spp. Rebenko et al., (1978) reported that Bordeaux mixture was effective in inhibiting the mycelial growth of P. viticola. Mansk et al., (1981) reported Difolatan (Captafol) was effective in inhibiting Phoma spp.

The leaf spot disease caused by Colletotrichum gloeosporioides was observed in all oil palm plantations in Kerala in a serious proportion especially during monsoon periods. So an attempt was made to control the disease with fungicides under field conditions. Field evaluation conducted against leaf spot disease caused by C. gloeosporioides indicated that all the fungicides tested viz. Bavistin, Dithane M-45, Foltaf and Cuman L were effective. Eventhough Bordeaux mixture gave excellent results in the laboratory, the same was not tried for field evaluation as it showed phytotoxic symptoms. Bavistin was found to be the best treatment. Mendoza (1977) indicated that application of Dithane M-45 and Maneb gave good control against C. gloeosporioidea. Karunakaran (1981) reported that Bordeaux mixture, Dithane Z-78, Fytolan, Cuman L, Difolatan and Bavistin reduced the percentage of infection caused by C. gloeosporioides. Kotze et al., (1981) reported Captafol and Copper oxychloride reduced the incidence of disease caused by C. gloeosporioidea.

SUMMARY

SUMMARY

A quarterly survey for a period of one year was conducted in the oil palm growing areas of Palode, Anchal, Kulathupuzha and Thodupuzha to study the occurrence of the various leaf spot diseases affecting oil palm. Six leaf spot diseases were recorded in these plantations. They include the leaf spots caused by Bipolaris hawaiiensis, Botryodiplodia theobromae, Colletotrichum gloeosporioides, Curvularia geniculata, Fusarium pallidoroseum and Phoma sorghina. All these are new records from India. Of the six leaf spot diseases, the leaf spot caused by C. gloeosporioides was found to be the most severe.

Studies on symptomatology and etiology of different leaf spot diseases of oil palm caused by Bipolaris hawaiiensis, Botryodiplodia theobromae, Colletotrichum gloeosporioides, Curvularia geniculata, Fusarium pallidoroseum and Phoma sorghina were made. The pathogenicity of the above six fungi was established by following Koch's postulates. Inoculation studies on oil palm, both in injured and uninjured leaves with the spore suspension and culture bits of the above six leaf spot causing organisms showed that infection percentage was higher on injured leaves.

In vitro evaluation of fungicides on the inhibition of mycelial growth of Bipolaris hawaiiensis showed that

complete inhibition was noticed with Bordeaux mixture, Cuman L and Dithane M-45.

Complete inhibition of mycelial growth of Botryodiplodia theobromae was observed with Bavistin, Bordeaux mixture, Dithane M-45 and Fytolan in the in vitro studies.

Total inhibition of the mycelial growth of Colletotrichum gloeosporioides was recorded with Bavistin, Bordeaux mixture, Dithane M-45 and Foltaf in in vitro studies.

In vitro evaluation of fungicides on the inhibition of mycelial growth of Curvularia geniculata showed that complete inhibition was noticed with Bordeaux mixture, Cuman L and Dithane M-45. Bavistin was found to be the least effective.

Out of seven fungicides tested for the inhibition of mycelial growth of Fusarium pallidoroseum, it was noticed that Bavistin, Bordeaux mixture, Cuman L, Dithane M-45 and Fytolan completely inhibited growth.

Complete inhibition of the mycelial growth of the Phoma sorghina, was noticed with Bavistin, Bordeaux mixture, Dithane M-45, Foltaf and Fytolan in in vitro studies.

The results of a field trial carried out indicated that Bavistin (0.1 per cent) Dithane M-45, Foltaf and Cuman L were effective in controlling the disease. Bordeaux mixture was not included in the field study due to high phytotoxic effect of copper on oil palm.

REFERENCE

REFERENCES

Agarwal, V., Khara, H.S. and Thind, T.S. (1982). Chemical control of mandarin fruit rot caused by Botryodiplodia theobromae pat. Hindustan Antibiotics Bulletin., 24: 21-23.

*Alibert, H. (1944). Etude sur les maladies du Palmier a'huile au Dahomey. (Typescript) 8 pp.

Anon, (1976). Rep. Institute de Recherches pour les Huiles et Oleagineux: 41-42.

*Anonymous (1955). Oil palm diseases. Third Annual Report, West African Institute for oil palm

Brown, E.A. and Hendrix, F.F. (1978). Effect of certain fungicides sprayed durning apple bloom on fruit set and fruit rot. Plant Disease Reporter, 62: 739-741.

*Buckley, T.A. and Allen, E.F. (1951). Notes on current investigations, April to June. Malay. agric. J. 34: 133-141.

*Bull, R.A. (1954). A preliminary list of the oil palm diseases encountered in Nigeria. J.W.Afr.Inst. Oil palm Res., 1. 53-93.

Chakrabarti, N. and Nandi, J. (1976). In vitro inhibitory effect of certain fungicides on the growth of Botryodiplodia theobromae pat. Indian J. Microbiol., 16. 97-98.

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 (Colletotrichum lagenarium) of bottlegourd. Pesticides, 14: 20-21.

*Coleman, P.G. (1958). Annual Report of the Department of Agriculture, Federation of Malaya for the year 1958.

Common wealth Mycological Institute, (1970). Records of Herb. I.M.I.

*Costache, M., Sindile, N. and Sociu, S. (1979). Studies on the integrated control of tomato wilt caused by F. Oxysporum f. sp. lycopersici (Sacc). Sn and H. 244-247.

Cox, R.S. (1956). Control of Helminthosporium blight disease of sweet corn in Florida. Phytopathology, 46: 112-115.

*Deighton, F.C. (1933). Mycological work. Ann. Rept. Agric. Dept. Sierra Leone. 20-23 pp.

Donald. C. Erwin. (1973). Systemic fungicides: Disease control, translocation and mode of action. Annual Review of phytopathology., 11. 389-412.

*Dupriez, G. and Bredas, J. (1957). pepinieres del' Elaeis. Bull. Inf. I.N.E.A.C., 6: 205-255.

Dwivedi, K. and Shukla, P. (1983). Evaluation of some fungicides and antibiotics against Drechslera halodes causing leaf spot of mung. Pesticides., 17: 21-22.

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

*Eikelenboom, E. (1964). A microbioassay for fungicide residues. Chem. Weekbl., 60: 222-223.

*Ellis, M.B. (1971). Dematiaceous Hypomycetes kew: Commonwealth Mycological Institute, 668 pp.

*Espinoza, M.A.S., Garzon, F.C. and Delgado, J.C. (1977). Principales enfermedades de la palma africana en el Eeuador. (Type script)

Genty, P., Lopez, G.J. and Mariau, D. (1975). Degates de Pestalotiopsis in duits par des attaques de Graphia. Oleagineux, 30: 199-204.

Grewal, R.K. and Payak, M.M. (1978). Field evaluation of Difolatan and Captan against Curvularia leaf spot. Pesticides., 12: 17.

Gupta, C. (1974). Relative efficacy of fungicides against some fruit rot pathogen of chillies in vitro. Indian phytopath., 27: 421-422.

*Heath, R.G. (1955). Annual report of the Dept. of Agriculture, Malaya, for the year 1955.

*Heath, R.G. (1958). Rep. Dip. Agric. Malaya, 38-39 pp.

Heim, R. and Banchy, A. (1949). Observations preliminaires sur une grave maladie du palmier a' huile sevissant au Congo francais. C. r. Acad. Sci., 228: 217-220.

*Hughes, S.J. (1953). Fungi from the Gold Coast. Mycol. pap., 50. 104 pp.

*Jagoe, R.B. and Heath, R.G. (1954). Notes on current investigations, research, April to June; Malay agric. J., 37: 173-181.

*Jimenez, O.D. and Reyes. (1977). Study of a leaf necrosis affecting several oil palm (Elaeis guineensis Jacq) plantations in colombia. Fitopatologia colombiana., 6: 15-32.

*Johnston, A. (1959). Oil palm seedling blight. Malay. agric. J., 42. 14-20.

*Johnston, A. (1962). Quarterly report for Jan. - March, of the plant protection committee for the South East Asia and pacific Region. Bangkok, F.A.O., 12 pp.

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.

Khanna, K.K. and Chandra, S. (1977). Control of banana fruit rot caused by Fusarium moniliforme and Fusarium roseum. Indian Phytopath., 29. 20-21.

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

*Khazaradze, E.P. (1957). Phomopsis on Dates - Date canker (P. diospyri Boug) under the conditions of the Georgian S.S.R. Trud. Inst. Zashch. Rast. Acad. Sci. Georgia., 12: 153-175.

*Khisa, S.K. and Choudhury, J.H. (1986). Leaf blight of oil palm in forest nursery and its control. Bano Biggyan Patrika., 12. 53-56.

Kothari, K. L. and Bhatnagar, M. K. (1966). Evaluation of fungicides against crop diseases on Colletotrichum capsici causing blight of Guava. Indian phytopath., 18: 116-117.

*Kotze, J.M., Kuschke, E. and Durand, B. (1981). Pre-harvest chemical control of anthracnose and sooty blotch. Year book, South African Avacado Grower's Association., 4. 69-70.

*Kovachich, W.G. (1953). Rep. Res. Dep., Huilever S.A., Yaligamba, Belgian Congo.

*Kovachich, W.G. (1954). A leaf disease of the oil palm (Elaeis guineensis) caused by Helminthosporium halodes var. elaeicola. Var. nov. Trans. Br. Mycol. Soc., 37: 422-425.

Kovachich, W.G. (1956). Patch Yellow disease of the oil palm. Trans. Br. Mycol. Soc., 39: 427-430.

Kovachich, W.G. (1957). Some diseases of the oil palm in the Belgian Congo. J. W. Afr. Inst. Oil palm Res., 2: 221-229.

*Kumaga, E.M. (1964). Oil palm production in Ghana. Ghana Farmer., 8: 72-80.

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.

Lal, B., Arya, A. and Rai, R.N. (1981). A new soft-rot of 'ber' caused by Phomopsis natsume and its chemical control. Indian Phytopath., 34: 361-363.

Lue, M. (1953). Three fungi of the oil palm in the Ivory Coast. Rev. mycol., 18: 94-102.

Madaan, R.L. and Grover, R. K. (1979). Chemical control of Colletotrichum lagenarium causing anthracnose and scab of bottlegourd. Indian phytopath., 32: 210-215.

*Madueweni, J.N.C. (1977). Evaluation of antracol and dithane M.45 for white leaf spot disease of fluted pumpkin (Telfairia occidentalis) Nigerian Journal of plant protection, 3: 119-121.

Mansk, Z., Matiello, J.B., Almeida, S.R. and Miguel, A.E. (1981). Effect of doses of the fungicide Difolatan (Captafol) in the control of Phoma spp. on coffee. Brazilian Coffee Inst., 226-229.

*McIntosh, A.E.S. (1951). Rep. Dep. Agric. Malaya, 87 pp.

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

Meunier, J., Renard, J.L. and Quillec, G. (1979). Heredity resistance to Fusarium disease in oil palm Elaeis guineensis jacq. Oleagineux 34: 555-561.

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

*Nakov, B., Boshnakov, P. and Angelov, D. (1979). Smutty spots on garlic and their control. Rastitelna zashchita, 27. 22-25.

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

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

*Okiogo, D.M. (1978). The role of copper fungicides in the control of coffee diseases. kenya coffee, 43: 221-130.

Om Gupta and Nema, K.G. (1978). A note on efficiency of some systemic and non systemic fungicides against Colletotrichum papayae and Botryodiplodia theobromae. Pesticides, 12: 30-31.

Padmanabhan, S.Y., Ganguly, G.H., Chandwani and Veeraghavan, J. (1963). Control of blast disease of rice with spray fungicides. An economic spray schedule. Indian phytopath., 16. 55-61.

Pawar, N. B., and Patil, B.P. (1978). Fungicidal control of Helminthosporium leaf spot of hybrid jowar. Journal of Maharashtra Agricultural University, 3: 178-179.

Pillai, V.S.K. (1969). Some observations on Curvularia eragrostodes (Henn.) Meyer., the cause of seedling blight of oil palm (Elaeis guineensis jacq) Thesis, University of Malaya, 54 pp.

Punithalingam, E. (1974). New species of Phomopsis. Transactions of the British Mycological Society, 63. 229-236.

*Punnee Soonthronpoot, (1969). List of plant diseases in Combodia. Tech. Docum F.A.O. Pl. Prot Comm., 70. 23 pp.

Qudri, 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.

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.

Rao, D.P.C. and Agarwal, S.C. (1976). Efficacy of antibiotics against phomopsis destructum, causing fruit rot of gauva. Hindustan Antibiotics, Bulletin, 18: 108-110.

Rao, D.P.G. and Agarwal, S.C. (1977). Efficacy of fungicides against Phomopsis fruit rot of guava. Indian phytopath., 29. 345-346.

*Ravise, A. (1965). Etude des parasites de plantules d' Elaeis guineensis en prepepinieres. Cong. Prot. Cult. Trop., 801-806 pp.

*Rebenko, V.P., Miroshnichenko., Prutyan, M.D. and Wgrik, E.P. (1978). A dangerous disease of grape vine. Zashchita Rastenii, 3. 45.

*Robertson, J.S. (1956). Leaf diseases of oil palm seedlings. J. W. Afr. Inst. Oil palm Res., 1: 110-122.

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

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.

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

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

Srivastava, M.P. and Tandon, R.N. (1971). Efficacy of certain fungicides and an antibiotic against 4 isolates of Botryodiplodia theobromae. Indian Phytopath., 24.396-397.

*Staner, P. (1929). The enemies of Elaeis Agric. et. Elevage. av. Congo. Belge, 26: 405-407.

Sutton, B.C. (1988). Common Wealth Mycological Institute. Report No.H.209/88/YIZ.

Swamy, S.K. and Urs, S.D. (1978). In vitro evaluation of fungicides against H. sacchari. Mysore Journal of Agricultural Science, 12: 579-581.

*Thompson, A. (1939). Notes on plant diseases. Malay. agric. J. 27: 86-98.

*Thompson, A. (1940). Notes on plant diseases. Malay. agric. J., 28: 400-407.

*Trafton, M. and Washburn, R.A. (1969). Elaborase en centro-america aceite de palma arricana. Hacienda, 64. 31-38.

*Turner, P.D. (1967). Fungicides in the control of some fungus disease or oil palm in Malaya. Malay Agric J., 46: 46-48.

*Turner, P.D. (1968). Leaf diseases in Malaysian oil palm nurseries and their control. Planter ., 44: 254-261.

*Turner, P.D. (1968). Laboratory evaluation of fungicides for the control of two fungi associated with spear rot in oil palm. Malay. agric. J., 46. 451-457.

*Turner, P.D. (1969). Laboratory assessment of fungicides for the control of Helminthosporium leaf spot of oil palm. Malaysian agric. J., 47: 268-274.

*Turner, P.D. (1971). A recent survey of oil palm diseases in Indonesia. Pl. prot. Bull. F.A.O., 19. 49-56.

*Turner, P.D. and Bull, R.A. (1968). Diseases and disorders of the oil palm in Malaysia. Incorp. Soc. of planters, Kolalampur, 247 pp.

*Turner, P.D. and Gillbanks, R.A. (1974). Oil palm cultivation and management. Incorporated Society of planters, 672 pp.

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

*Williams, T.H. (1969). Plant pathology. A. Rep. Dep. Agric., 31: 89-91.

Williams, T.H. and Liu, P.S.W. (1976). A host list of plant diseases in Sabah, Malaysia. Phytopath. pap., 19, 67 pp.

Vir, D. and Raychaudhuri, S.P. (1968). Control of stripe disease of Barley (Helminthosporium gramineum) with antibiotics. Hindustan Antibiot. Bull., 10: 319.

*Waterston, J.M. (1953). Observations on the influence of some ecological factors on the incidence of oil palm diseases in Nigeria. J. W. Afr. Inst. Oil palm Res., 1: 24-59.

*Zamorski, C. and Bielska (1983). Curvularia trifolii. Pasmalee and Luttwell, a Gladiolus pathogen new to Poland. Acta Agrobotanica., 36: 135-144.

*Zengin, H. (1978). Control trial against damping off of seedlings in the Marmara region. Zirai Miicadele Arastirma yillig., 12: 122.

* Original not seen

APPENDICES

Appendix - I

Analysis of variance table

Effect of different fungicides on the radial growth of *Bipolaris hawaiiensis* on social media (poisoned food technique)

Source	SS	df	MS	F
Total	28410.25	62	-	-
Treatments	28892.08	20	1419.60	3272.63**
Error	18.22	42	0.43	-

CD for comparison = 1.08

**Significant at 5% and 1% level

Appendix - II

Analysis of variance table

Effect of different fungicides on the radial growth of *Botryodiplodia theobromae* on solid media (poisoned food technique)

Source	SS	df	MS	F
Total	15657.69	62	-	-
Treatments	15413.69	20	770.68	182.66**
Error	244.00	42	5.81	-

CD for comparison = 3.97

**Significant at 5% and 1% level

Appendix - III

Analysis of variance table

Effect of different fungicides on the radial growth of Colletotrichum gloeosporioides on solid media (poisoned food technique)

Source	SS	df	MS	F
Total	14025.31	62	-	-
Treatments	13827.19	20	691.36	146.56**
Error	198.125	42	4.72	-

CD for comparison = 3.58

**Significant at 5% and 1% level

Appendix - IV

Analysis of variance table

Effect of different fungicides on the radial growth of Curvularia geniculata on solid media (poisoned food technique)

Source	SS	df	MS	F
Total	21745.72	62	-	-
Treatments	21721.69	20	1086.08	1898.18**
Error	24.03	42	5721.73	-

CD for comparison = 1.25

**Significant at 5% and 1% level

Appendix - V

Analysis of variance table

Effect of different fungicides on the radial growth of Fusarium pallidoroseum on solid media (poisoned food technique)

Source	SS	df	MS	F
Total	20308.97	62	-	-
Treatments	20274.16	20	1013.71	1223.00**
Error	34.81	42	0.83	-

CD for comparison = 1.50

**Significant at 5% and 1% level

Appendix - VI

Analysis of variance table

Effect of different fungicides on the radial growth of Phoma sorghina on solid media (poisoned food technique)

Source	SS	df	MS	F
Total	10666.50	62	-	-
Treatments	10653.59	20	532.68	1733.47**
Error	12.91	42	0.31	-

CD for comparison = 0.91

**Significant at 5% and 1% level

Appendix - VII

Analysis of variance table

Field evaluation of fungicides against leaf spot disease caused by *Colletotrichum gloeosporioides*

Source	D.F.	S.S.	M.S.S.	F
Treatments	4	5797841	144.946	25.8997**
Error	14	78.35026	5.596	-

CD for comparison = 3.633

**Significant at 5% and 1% level

STUDIES ON THE LEAF SPOT DISEASES OF OIL PALM (*Elaeis guineensis* jacq) IN KERALA

BY

THOMAS JOHN

ABSTRACT OF A THESIS

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ABSTRACT

A survey was conducted in the oil palm growing areas of Palode, Anchal, Kulathupuzha and Thodupuzha. Six leaf spot diseases were noticed. They include the leaf spots caused by Bipolaris hawaiiensis, Botryodiplodia theobromae, Colletotrichum gloeosporioides, Curvularia geniculata, Fusarium pallidoroseum and Phoma sorghina. All these are new records from India. Out of the six leaf spot diseases, the leaf spot caused by C. gloeosporioides was found to be the most severe causing damage in all the four plantations and it was considered to be of major economic importance. Other diseases recorded during the present investigation were of minor importance.

Inoculation studies with six leaf spot causing pathogens showed that injury to leaves makes the plant more susceptible to leaf spot disease. The percentage of infection was more in injured leaves than in uninjured leaves.

In invitro evaluation of fungicides showed that Bordeaux mixture, Dithane M-45 and Foltaf were effective. Bavistin controlled all the pathogens, except B. hawaiiensis and C. geniculata.

The leaf spot disease caused by C. gloeosporioides was observed in all oil palm plantations in Kerala in a

serious proportion, especially during monsoon periods. Field evaluation of fungicides against the above disease indicated that Bavistin, Dithane M-45, Foltaf and Cuman L were effective.