SEED MYCOFLORA OF SOME VEGETABLES IN KERALA

BY

A. NASEEMA

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DECLARATION

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

Naseema

(A.NASEEMA)

College of Agriculture,
Vellayani,
28th March, 1981.

CERTIFICATE

Certified that this thesis entitled "Seed mycoflora of some vegetables in Kerala" is a record of research work done independently by Kum. A. Naseema under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

Dr. S. BALAKRISHNAN
Chairman
Advisory Committee
Associate Professor
of Plant Pathology.

College of Agriculture
Vellayani
28th March, 1981.

APPROVED BY:

CHAIRMAN

Dr. S.BALAKRISHNAN

MEMBERS

1. Dr. M.CHANDRASEKHARAN NAIR

2. Sri. P.SETHUMADHAVAN

3. Dr. (Smt.) P. PADMAJA

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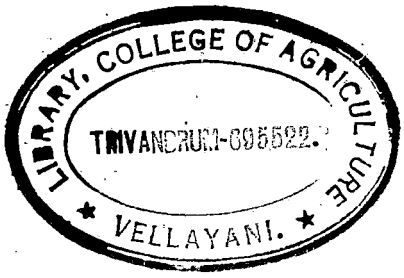
Introduction



INTRODUCTION

Vegetables are among the essential requirements in our diet. The area under vegetables in our country is estimated to be about 2 million hectares. Vegetable crops are mostly attacked by many diseases in the field, at harvest, transit and in storage. Several seed-borne fungi of vegetables are known to cause considerable damage either directly to the seeds that carry them or to the crops that are raised from contaminated seeds.

The nature of damage consists of lowering or total inhibition of germination, or poor development of crops showing various kinds of disease symptoms or production of mycotoxins such as aflatoxins which are toxic even to human beings. Seed mycoflora are also responsible for the annual recurrence of some of the diseases and their spread to new localities.

Considerable progress has been made in advanced countries with regard to the study of the seed-borne diseases of many crops including vegetables but in India, especially in Kerala, little attention appears to have been paid to the study of micro-organisms carried through the seeds. At present, efforts are being made for the improvement of vegetable varieties in the country with a view to increase the production of vegetables. One of the accepted methods for vegetable production is to use improved seeds. This is achieved by building up of stocks of

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superior quality seeds which are free from diseases and pests.

For laying down seed health standards against seed-borne diseases of vegetables considerable background information is needed regarding the mycoflora associated with seeds, their role, if any, on the disease outbreaks and the nature and extent of damage they cause. With this object in view, studies were conducted on the mycoflora of the common vegetable seeds, effect of these on the seeds and the seedlings, production of toxins by these fungi, effect of storage conditions on the germination and moisture content of seeds and the *in vitro* effect of fungicides against seed-borne fungi.

Review of Literature

REVIEW OF LITERATURE

Seed mycoflora of various crops have been studied by many investigators with a view to find out the losses caused by them and to evolve suitable measures to control them. A review of literature pertinent to the present studies is presented in this chapter.

1. Isolation of seed-borne fungi of vegetables

Witte (1944) reported the occurrence of Ascochyta pisi and Macrosporium commune on the seeds of peas (Pisum sativum) and beans (Phaseolus vulgaris) respectively. Moore (1946) found that 27 per cent of the pea seeds were infected by Ascochyta pisi and Ascochyta pinodella.

Groves and Skolko (1946) isolated Trichocladium asporum from pumpkin (Cucurbita pepo), pea (Pisum sativum) and broad beans (Vicia faba), but they suggested that this fungus did not appear to have any great pathological significance. Skolko and Groves (1948) isolated Chaetomium elatum from peas, Chaetomium funicolum from peas, cucumber (Cucumis sativus) and tomato (Lycopersicon esculentum), Chaetomium indicum from peas, tomato and beans and Chaetomium reflexum from peas, tomato and bhindi (Abelmoschus esculentus). Crosier (1949) reported that Colletotrichum lindemuthianum and Ascochyta sp. were found to be seed-borne on peas.

Navare (1971) conducted studies on the mycoflora of seeds of different varieties of peas and found that Alternaria sp.,

Aspergillus sp. Rhizopus sp., Mucor sp. and Fusarium sp. were associated with seeds of all the five varieties of peas tested. Filipourie (1976) found that Fusarium oxysporum, Fusarium culmorum and Fusarium tricinctum were frequently associated with pea seeds. Mannerucci and Cambogi (1976) while conducting studies on the pathology of pea seeds observed that Ascochyte spp. and Fusarium oxysporum f. sp. pisi were associated with the seeds. Charpentie and Nicot (1973) isolated Cladosporium sp., Aspergillus spp., and Ascochyta spp. from pea seeds.

Ogilvie (1947) reported that Didymella lycopersici on tomato, Botrytis cinerea on beans were found to be internally seed-borne. Neergaard (1949) reported that seed-borne fungi of beans included Colletotrichum lindemuthianum and Ascochyta hortensis and that the cucumber seeds were harboured by Phyllosticta cucurbitacearum.

Colletotrichum lindemuthianum causing bean anthracnose survived at least for two years in the seeds of beans and the secondary infection may be probably caused by conidia from lesions on the cotyledons produced by primary seed-borne infection (Tochinai and Sawada, 1952). Walker (1960) reported that beans was usually attacked by Rhizoctonia spp. and Sclerotinia sclerotiorum which were internally seed-borne. The degree of seed infection was found to be related to the weather conditions during seed maturation.

Polanco and Casanova (1966) showed that Fusarium solani f. sp. pisi, Macrophomina phaseolina, Rhizoctonia solani and Colletotrichum lindemuthianum were the most important seed-borne fungal pathogens of beans. Nath et al. (1970) reported the occurrence of Cercospora kikuchii, Colletotrichum truncatum, Myrothecium roridum, Botryodiplodia palmarum, Fusarium equiseti and Macrophomina phaseolina on mung bean (Phaseolus aureus) seeds.

Petrov (1972) showed that Colletotrichum lindemuthianum causing anthracnose of bean was seed-borne. Fulco et al. (1977) reported that Fusarium spp. Phytophthora sp., Rhizoctonia sp., Colletotrichum sp. and Diaporthe sp. were often found associated with bean seeds. Saxena and Sinha (1977) investigated the seed-borne fungi of black gram (Vigna mungo) and found the occurrence of Ascochyta chartarum, Colletotrichum truncatum and Fusarium semitectum. These fungi were reported to be seed-borne in several leguminous crops causing diseases in the field.

Lasca (1978) studied the seed mycoflora of bean using the blotter method, agar planting and growth tests and found that Elsinoe phaseoli was transmitted through seeds.

Seckston (1969) found that cowpea (Vigna sinensis) seeds which were outwardly healthy in appearance were internally infected by Macrophomina phaseolina which may be transmitted from one area to another through the seeds. Singh and Chohan

(1974) isolated the following fungi from cowpea seeds. Aspergillus niger, Aspergillus terreus, Cochliobolus lunatus, Curvularia vernuculosa, Drechslera hawaiiensis, Fusarium concolor, Fusarium moniliforme, Penicillium crustosum, Pleospora infectoria, Rhizoctonia bataticola and Rhizopus arrhizus. Sinha and Khare (1977 b) isolated Aspergillus spp., Aspergillus flavus, Aspergillus niger, Fusarium equiseti and Macrophomina phaseolina.

Horn et al. (1957) reported that Colletotrichum lindemuthianum causing anthracnose of cucumber (Cucumis sativus) was externally seed transmitted in six out of 50,000 seedlings grown from commercial seeds. Jenkins and Winstead (1959) found that Colletotrichum spp. caused seedling damping off and fruit rot of watermelon (Citrullus lanatus). The fungus was seed-borne and was found to overwinter as small black sclerotial structures on seeds from infected watermelon fruits. Khandelwal and Prasada (1978) carried out investigations on the seed mycoflora of cucumber seeds and obtained Aspergillus sp., Rhizopus sp., Cladosporium sp., Cylindrocladium sp., Helminthosporium sp., Alternaria sp., Fusarium sp., Curvularia sp., Penicillium sp., Botrytis sp. and Verticillium spp.

Robbs et al. (1972) and Gangopadhyay and Kapoor (1978) isolated Fusarium oxysporum f. sp. vasinfectum causing wilt of bhindi (Abelmoschus esculentus) from the seeds of bhindi and reported that the fungus was externally as well as internally seed-borne.

Kapoor and Hingorani (1958) reported the occurrence of Alternaria sp., on brinjal (Solanum melongena) causing fruit rot and leaf spot. The pathogen was also found to be susceptible to the isolate from brinjal. Sarode and Kadam (1974, 1977) have isolated Helminthosporium spiciferum from the seeds of brinjal and found that this fungus was consistently associated with the seeds of brinjal.

Hodosy (1966) isolated Alternaria solani and Corticium solani from tomato seeds and reported that these fungi caused dark sunken spots on the fruits, and collor rot of seedlings.

Suryanarayana and Bhombe (1961) studied the fungal flora of some vegetable seeds, namely, cabbage (Brassica oleraceae var. capitata), radish (Raphanus sativus), peas (Pisum sativum), onion (Allium cepa), brinjal (Solanum melongena), chilli (Capsicum frutescens) and Bhindi (Abelmoschus esculentus). They reported that among the externally seed-borne fungi Alternaria sp. was found to be the common genus, while Aspergillus sp. and Fusarium sp. were next in order of sequence. Important genera of fungi such as Colletotrichum sp. in chilli, Helminthosporium sp. in radish, and Phomopsis sp. in brinjal were internally seed-borne in the seeds tested.

The mycoflora of sesamum (Sesamum indicum), sunflower (Helianthus annuus), brinjal and tomato seeds were estimated quantitatively and qualitatively by Manoharachary et al. (1975).

The commonest fungi isolated by them were Aspergillus sp., Alternaria alternata, Rhizopus arrhizus, Curvularia lunata, Penicillium sp., and Sclerotium oryzae (Helminthosporium salvinii).

2. Effect of seed-borne fungi on the germination of seeds

Skolko and Groves (1948) reported that seed samples heavily infected by Chaetomium sp. showed a corresponding low germination and emitted a characteristic odour. Fields and King (1962) studied the influence of storage fungi on the deterioration of stored pea seeds and reported that germinability of pea seeds was reduced by inoculation with spores of Aspergillus flavus, Aspergillus ruber, Aspergillus candidus, Aspergillus restrictus and Aspergillus amstelodami.

Lopez and Christensen (1962) found that population of Aspergillus glaucus and Aspergillus restrictus increased with increase in moisture content of bean seeds and germination percentage of bean seeds decreased with the increase in moisture content.

Hawere (1971) reported that Fusarium spp. and Rhizoctonia spp. were always predominent in pea seeds and reduced germination. Sekhon and Shivapuri (1971) found that a number of fungi were associated with stored cauliflower, bean and pea seeds, but only Helminthosporium sp., Fusarium sp. and Alternaria sp. proved pathogenic causing some pre-emergence injuries and considerable post-emergence damage to the three vegetables.

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Reti and Ramalingam (1974) studied the effect of Aspergillus flavus on the germinating seeds of some tropical crop plants and found that Aspergillus flavus was one of the important pathogens of the germinating seeds of leguminous plants in the tropics.

Lambhate and Bhide (1976) while studying the defective seed germination in peas found that Fusarium oxysporum f. sp. pisi race 1 was pathogenic to the seeds of the variety Bonneville.

Kher'kova et al. (1974) reported that the seed-borne pathogens which reduced germination of chilli and brinjal seeds included Alternaria cepaici - annui, Colletotrichum piperis and Fusarium semitectum. Suryanarayana (1978) reported that Alternaria tenuis on chilli was externally as well as internally seed-borne and the infected seeds failed to germinate as the embryos were damaged.

Brodnik (1976) conducted studies on seed-borne fungi and reported that the germination percentages of maize seed infected by four isolates of Aspergillus flavus were 68, 76, 82 and 88 respectively and that in the uninfected seeds the germination percentage was 95.

3. Effect of seed-borne fungi on seeds and seedlings

Cruickshank (1951) reported that on peas, Fusarium sp., developed characteristic symptoms of seed decay and seedling rot.

Jacks (1951) reported that Pythium spp., Fusarium sp. and Rhizoctonia spp. were the main causes of seed rotting and damping-off of lettuce seedlings.

Kanjenasoon and Nathur (1961) studied the fungus flora of stored vegetable seeds and pulse seeds and found that Alternaria polandii, and Alternaria tenuis predominated among the fungi associated with seven vegetables and three pulse samples. When these seeds were sown in autoclaved soil, emergence and seedling height were reduced. Lopez and Christensen (1962) found that in bean the symptoms known as 'Bald head' and 'Snake head' can result from seed infection by Aspergillus sp.

El Nur and Priegoun (1970) isolated Helminthosporium spicifernm from seeds of broad bean and in glass house tests they found that the fungus caused severe root rotting and stunting of the seedlings. Nath et al. (1970) studied the seed-borne fungi of mung bean (Phaseolus aureus) and found that Fusarium semitecti, Macrophomina phaseolina and Botryodiplodia theobromae caused seed rot and seedling blight. Agarwal et al. (1973) reported that mung bean seeds infected with Fusarium spp. showed grey to brown discolouration and were deformed and wrinkled. The infected seeds on sowing either developed rotting or produced seedlings which become blighted.

Gangopadhyay and Kapoor (1978) found that Fusarium oxysporum f. sp. vasinfectum on bhindi was seed-borne and

caused loss of weight to infected seeds.

Suryanerayana (1978) reported that in cowpea seeds, infection by Macrophomina phaseolina, and Colletotrichum lindemuthianum caused failure of germination and seedling blight. He also found that pea seeds infected by Alternaria sp. produced dark patches on the seed coat and cotyledons of the seedlings. The radicle of these seedlings were blighted and the seeds showed reduction in germination upto 32 per cent.

4. Production of aflatoxin by seed-borne fungi

Blount (1961), during his investigation on the cause of "Turkey 'X' disease", led to the discovery that strains of the fungus, Aspergillus flavus present in the feed material of groundnut meal, were responsible for producing the toxic factor which was named as 'Aflatoxin'.

Joffe (1969) reported that shoots of groundnut, peas, beans and tomato when dipped in liquid media inoculated with toxic isolates of Aspergillus flavus were wilted and dried with in a few days. It was found that aflatoxin was present in the media in which all the plants were dipped.

Schroeder (1969) reported that Aspergillus flavus group are the principal producers of aflatoxin and that temperature of 25 - 35°C and humidity of 80 - 100 per cent were most favourable for toxin production in storage.

Lalithakumari et al. (1970) studied the role of aflatoxin in groundnut seed spoilage and reported that all the species

of Aspergillus isolated from stored pods and kernel caused failure of seed germination and reduction in seedling vigour but only Aspergillus flavus and Aspergillus tamarii produced aflatoxin.

Kang et al. (1971) suggested that toxins elaborated by Aspergillus flavus called aflatoxins, caused albinism in plants. Of the four aflatoxins, B1 was found to be the most potent.

Harman (1972) found that infection by Aspergillus ruber in stored pea seeds inhibited their germination and the extract from infected seed induced necrosis and inhibited growth of healthy embryonic axis. Viability of pea seeds was found to be rapidly lost following infection by Aspergillus ruber. It was evident that a toxin kills the embryonic axis in advance of fungal infection (Harman and Glenda, 1972).

Lillehoj et al. (1975) suggested that Aspergillus flavus was the most important contaminant of stored maize kernels and the quantity of aflatoxin B1 produced was 0.40 ppm. Brodnik and Klemenc (1976) found that maize seeds inoculated with four isolates of Aspergillus flavus produced 420, 280, 210 and 500 ppb of aflatoxin.

Thomson and Mehdy (1976) reported that 70 per cent of the isolates of Aspergillus flavus from pistachio nuts produced aflatoxin B1.

3. Effect of seed dressing fungicides on seed-borne fungi.

Jacks (1951) reported that Thiram (0.2%) treatment of

lettuce seed inoculated with one of the following fungi such as Alternaria solani, Rhizoctonia solani and Botrytis cinerea gave 100 per cent germination.

Veenenbos (1955) showed that Thiram containing fungicides could be used for effectively controlling seed-borne fungi of peas and beans. Sanchez (1956) found that Captan (2 g/kg seed) proved to be the best for the control of damping off and seed decay in peas and beans. Harper (1964) reported that seed treatment with Captan (0.2%) controlled Pythium sp. and Fusarium sp. in peas. Maude (1966) showed that Mycosphaerella pinodes and Ascochyta pisi associated with pea seeds can be eradicated by soaking for 24 hours in 0.2% suspension of Thiram or Captan at 30°C.

Kaul (1973) reported that Captan and Thiram at 0.2% gave effective control of the mycoflora of beans while leaving germination unimpaired during storage for four years. Bedi and Kapoor (1974) found that treatment of pea seeds with fungicides such as Captan and Thiram (0.25%) was mainly effective in controlling pre and post emergence mortality caused by seed-borne fungi.

Gangopadhyay and Kapoor (1976) suggested that the control of Fusarium oxysporum f. sp. pisi on pea can be achieved by soaking the seeds in a 1:1 suspension of Captafol (0.1%) and Captan (0.2%) for 30 minutes at 30°C. Zoto et al. (1976) reported that Mithane Z-78 (0.2%) was most effective in

eliminating externally seed-borne infection of Colletotrichum lindemuthianum on field bean (Dolichos lab lab). Utikar et al. (1978) found that the wilt of pea caused by Fusarium oxysporum f. sp. pisi could be effectively controlled by seed treatment with Bavistin and Benlate at 0.017 per cent.

Ashworth et al. (1964) showed that for the control of Aspergillus niger associated with groundnuts, Thiram and Captan (0.3%) were more effective than mercury seed dressings. Wales and somers (1968) reported that Difolatan (0.25%) was best for the control of Aspergillus flavus in groundnuts, in the field and in storage. Frank (1969) conducted laboratory and field trials and it was proved that 3 parts of 75 per cent Captan + 1 part of 75 per cent PCNB at 3 g/kg seed gave effective control of Aspergillus and Rhizopus rot of groundnut seedlings.

Lewin and Natarajan (1971) found that maximum germination and emergence with a significant reduction in post emergence infection by Rhizoctonia bataticola on groundnut and yield increase of 13.2 - 23.2 per cent were obtained by seed treatment with Captan and Thiram (0.3%). Whitehead and Thirumalachar (1971) reported that Aureofungin (< 2 ug/ml) inhibited the growth of Cercospora personata, Sclerotium rolfsii, Aspergillus niger and Aspergillus flavus in vitro. Further, they found that when harvested groundnut pods were washed with Aureofungin (20 ppm) Aspergillus flavus infestation was reduced. Mercer and Kisyombe (1978) isolated Aspergillus flavus, Aspergillus niger, Macrophomina phaseolina and Pencillium sp. from kernels of

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groundnut and they found that these fungi could be controlled by seed treatment with Thiram (0.3%).

Singh et al. (1970) reported that Macrophomina phaseolina on bhindi was satisfactorily controlled by Dithane M-45 (0.3%) and Brassicol (0.3%) in in vitro studies. Gangopadhyay and Kapoor (1979) reported that wilt of bhindi caused by Fusarium oxysporum f. sp. vasinfectum can be controlled by seed treatment with Ziram (0.3%).

Of the 10 seed-dressing fungicides screened in pot tests by Grover and Bansal (1970) against Colletotrichum capsici in chilli seeds, it was found that Thiram (0.2%) and Brassicol (0.25%) were very effective. Siddiqui et al. (1977) reported that best control of Colletotrichum dematium on chilli was obtained by seed treatment with Thiram (0.2%) followed by three sprays of Difolatan (0.25%) and Thiram (0.25%) at 15 days intervals starting 60 days after transplanting.

Frolova (1976) found that dipping cucumber seeds in 0.2 per cent Thiram gave best control of Didymella bryoniae. Tandon et al. (1976) found that seed treatment with 2000 ppm of Dithane M-45 gave 83 per cent control of Fusarium semitectum causing fruit decay in smooth gourd (Luffa cylindrica). Nadeem and Grover (1978) studied the chemical control of Colletotrichum lagenarium causing anthracnose and scab of bottle gourd (Lagenaria siceraria) and found that where the disease was seed-borne or soil-borne, seed treatment with Benomyl (0.125%) was likely to give an excellent control of primary infection.

Vidhyasekharan and Arjunan (1976) treated seeds of black gram with Thiram and Captan at 2 g/kg seed and found that with this treatment, yields could be maintained even after 5 months or more in storage.

Sinha and Khare (1977 a) reported that Thiram, Captan and Difolatan (3000 ppm) were excellent in controlling seed-borne infection of Macrophomina phaseolina and Fusarium equiseti on cowpea in pots and field. Jamaluddin (1978) conducted studies on the effect of Bavistin, Benlate and Captan at 100, 250, 500, 1000 and 1500 ppm on the growth of Myrothecium roridum by poisoned food technique and found that the growth of the fungus was less at 100 ppm of Bavistin and Captan while Benlate completely checked the growth at this concentration. The organism failed to grow at other concentrations of the fungicides.

Kolev et al. (1977) reported that in field and laboratory tests semi-wet disinfection of vegetable seeds was superior to dry and wet treatments. When a saturated suspension of Thiram (200 g in 700 ml of water per 100 kg of seed) was used, treated seeds in storage resisted infection by pathogenic fungi.

6. Effect of culture filtrate on the inhibition of germination of seeds

Zoosalis and Hamilton (1957) found that the culture filtrates of Rhizoctonia solani reduced germination of soybean seeds and growth of roots of seedlings. Ludwig (1957) used

inhibition of seed germination as a method of bioassay for testing the toxicity of culture filtrates of Helminthosporium sativum. He also reported that Helminthosporium oryzae reduced germination of rice seed and caused seedling to grow abnormally. Krishnaswamy et al. (1969) also used inhibition of seed germination as a method of bioassay for testing toxin productivity of Pyricularia oryzae.

Orachanskaya (1960) reported that the culture filtrate of Diplodia zeae inhibited the germination of maize seeds to a considerable extent. Brian et al. (1961) found that Fusarium equiseti produced toxic metabolites that inhibited elongation of stem of beans at concentrations as low as 1 ppm.

Govindan (1963) found that culture filtrates of Pyricularia oryzae inhibited the germination and plumule elongation of blast susceptible varieties of paddy. Inhibition of germination of paddy seeds was observed by Nair (1969) with the culture filtrates of Trichoconis padwickii. Vidhyasekharan et al. (1970) noted that the metabolites of certain seed-borne fungi namely Aspergillus flavus, Curvularia pallescens, Curvularia lunata and Fusarium moniliforme caused inhibition of seed germination and root and shoot elongation in paddy.

White and Starrett (1967) found that zinniol produced by Alternaria zinniae inhibited the germination of zinnia, tomato, lettuce and watermelon at concentrations of 500 ppm and above. Narain and Omprakash (1968) found that culture filtrates of

Aspergillus niger reduced seed germination and disorganised the succulent scales and leaves of onion.

Narain and Das (1970) reported the toxin production during pathogenesis of Colletotrichum capsici causing anthracnose of chilli. They filtered two types of preparations. Assay of both types of filtrates were done on seed germinability and found that both types of culture filtrates showed marked inhibition in the rate of seed germination. Rajagopalan (1971) observed that the culture filtrates of Diplodia natalensis caused considerable reduction in germination percentage of cucumber and snake gourd seeds.

Materials and Methods

MATERIALS AND METHODS

Collection of seeds.

The seeds used for the present investigations were collected from different districts of Kerala, namely, Trivandrum, Quilon, Palghat and Kozhikode during two seasons i.e. March-April and September-October.

Seeds of the following vegetables were used for the investigations.

1. Amaranthus	-	*Amaranthus gangeticus* L.
2. Bhindi	-	*Abelmoschus esculentus* L.
3. Brinjal	-	*Solanum melongena* L.
4. Bitter gourd	-	*Momordica charantia* L.
5. Cowpea	-	*Vigna sinensis* Endl.
6. Cucumber	-	*Cucumis sativus* L.
7. Pumpkin	-	*Cucurbita pepo* L.
8. Snake gourd	-	*Trichosanthus anguina* L.
9. Tomato	-	*Lycopersicon esculentum* Mill.

1. Isolation of seed-borne fungi

Isolation of seed-borne fungi was done according to the method described by Suryanarayana and Bhombe (1961). About 100 seeds were taken at random for isolating the fungi. Isolation of externally seed-borne fungi was done by placing the seeds, without surface sterilizing on a thin layer of

Potato Dextrose Agar medium in sterilized petri dishes. The seeds were arranged at equal distances on the medium, at the rate of 5 or 10 seeds per petri dish depending upon the size of seeds. The petri dishes were incubated at room temperature.

Isolation of internally seed-borne fungi was done by using the seeds surface sterilized with 0.1 per cent mercuric chloride for one minute and washed in three changes of sterile distilled water. The seeds were then placed on a thin layer of Potato Dextrose Agar in petri dishes as described above and incubated at room temperature.

In both the above cases, the plates were examined periodically for twelve days. As soon as the fungal growth appeared, they were transferred to Potato Dextrose Agar slants. Single spore isolations were done from these cultures and the pure cultures obtained were maintained on Potato Dextrose Agar slants. The pure cultures of some of the fungi were sent to Common Wealth Mycological Institute, U.K., for identification.

2. Effect of seed-borne fungi on germination of seeds

The seeds of the above nine vegetables were taken, to determine the effect of seed-borne fungi on germination of seeds. Ten seeds were taken for each treatment. The spores were harvested and a suspension was made in sterile distilled water. The concentration was adjusted to contain

50 or 60 spores under the low power of the microscope. The seeds were first soaked for 12 hrs in 5 ml of the respective fungal spore suspension. They were then spread on sterile filter paper, moistened with sterile distilled water, inside sterile petri dishes and incubated at room temperature. In the control plates the seeds were surface sterilised with mercuric chloride followed by washing in three changes of sterile distilled water. Observations on the number of seeds germinated were recorded for every third day for a period of three weeks and the per cent inhibition in germination over control was calculated in each case.

3. Pathogenicity test in pot culture experiment

The following fungal isolates were used for testing their pathogenicity in pot culture experiment.

i. Achaetomium macrosporum Rai, Wadhwani and Tewari
ii. Aspergillus flavus Link ex Fr.
iii. Aspergillus niger van Tiegh.
iv. Aspergillus ochraceus Wilhelm
v. Botryodiplodia theobromae Pat.
vi. Cephalosporium irregularis Thaxter
vii. Colletotrichum lagenarium (Pass.) Ellis & Halst.
viii. Curvularia lunata (Wakker) Boedijn
ix. Drechslera rostrata (Drechsler) Richardson & Fraser
x. Fusarium equiseti (Corda) Sacc.
xi. Fusarium oxysporum Schlecht

xii. Fusarium solani (Mart.) Sacc.

xiii. Myrothecium roridum Tode ex Fr.

xiv. Nectria haematococca Berk. & Br.

xv. Penicillium sp.

xvi. Rhizopus stolonifer (Fr.) Lind

Separate lots of 15 seeds of the above vegetables were taken. The spores of each of the fungi listed above were harvested and a suspension was made in sterile distilled water. The concentration was adjusted to contain 50 or 60 spores under the low power of the microscope. The seeds were soaked for 12 hours in 10 ml of the respective fungal spore suspension. They were then sown in sterilized soil taken in pots at the rate of 5 seeds per pot. Three replications were maintained for each treatment. Uninoculated seeds soaked in distilled water for the same durations were also sown at the same time in separate pots to serve as control. Observations on the number of seeds germinated and seedling infection, if any, in germinated seeds were recorded after two weeks. The per cent inhibition in germination of seeds over control was calculated in each case.

4. Production of Aflatoxin by seed-borne fungi

The method described by Thomson and Mehdy (1978) was followed in the present investigations. Seven isolates of Aspergillus flavus Link ex Fr. obtained from the seeds of amaranthus, bhindi, bitter gourd, brinjal, cowpea, cucumber

and snake gourd were used for this experiment. These isolates were grown on Czapek's (Dox) Agar medium for two weeks at 27°C. Ten grams of the culture and medium were triturated in 30 ml of chloroform and centrifuged. The chloroform phase was evaporated and the residue was assayed for the presence of aflatoxin by thin layer chromatography on silica gel G plates.

i. Preparation of chromatoplates

Glass plates of 20 x 20 cm size were taken, cleaned and oven dried. Silica gel G was used as the absorption powder. For this silica gel was made into a slurry with water (60gsilica gel + 100 ml distilled water) and spread uniformly, by using the applicator, to a thickness of 0.5 mm. The plates were air dried for 30 minutes and were then activated at 100°C for 30 minutes.

ii. Sample spotting

The residue was dissolved in 2 ml of chloroform. Different quantities of the samples, viz., 1, 2, 3, 4, 5, 6, 8 and 10 ul were spotted besides 3 ul of standard aflatoxin by means of a micropipette. The standard aflatoxin used, was obtained from Sigma Chemical Company, U.S.A. The plates were dipped in the solvent system of chloroform: acetone: n-hexane (65: 15: 20 v/v) till it ascended almost upto the top. Then the spots were observed

under UV light at the range of 320-360 mm wave length.

iii. Quantitative estimation

The quantity of aflatoxin produced was estimated, using the following formula suggested by Sons et al. (1971).

Quantity of aflatoxin in the sample =

$$\frac{\text{(Quantity of standard aflatoxin to get minimum fluorescence} \times \text{Volume of the sample} \times 1000.}{\text{Visible spot number} \times \text{weight of the sample)}.} \text{ ppm.}$$

5. Effect of seed dressing fungicides on seed-borne fungi

The effect of the following seven fungicides on the growth of the various seed-borne fungi was tested by poisoned food technique described by Zentmeyer (1955).

		Concentrations in ppm.
i.	Aureofungin Sol. (N-methyl - P - aminoaceto phenone mycosamine heptane)	12.5, 25, 50, 100 and 200
ii.	Brassicol (Penta chloro nitro benzene)	500, 1000, 2000, 3000 and 4000
iii.	Captan N-(trichloromethyl thio) 4tetra hydrophthalimide.	500, 1000, 2000, 3000 and 4000
iv.	Difolatan Cis N-(1, 1, 2, 2 - tetra chloroethyl thio) - 4 - cyclohexane - 1, 2 - dicarboximide.	500, 1000, 2000, 3000 and 4000
v.	Dithane M-45 (Zinc ion and Manganese ethylene bisdithio carbamate)	500, 1000, 2000, 3000 and 4000
vi.	Dithane Z-78 (Zinc ethylene bisdithio-carbamate)	500, 1000, 2000, 3000 and 4000

vii. Thiride (Tetra methyl thiuram disulphide) 500, 1000, 2000, 3000 and 4000

The following were the fungi against which the fungicides were tested.

i. Aspergillus flavus Link ex Fr.

ii. Botryodiplodia theobromae Pat.

iii. Cephalosphora irregularis Thaxter

iv. Colletotrichum lagenarium (Pass.) Ellis & Halst.

v. Curvularia lunata (Wakker) Boedijn

vi. Drechslera rostrata (Drechsler) Richardson & Fraser

vii. Fusarium equiseti (Corda) Sacc.

viii. Myrothecium roridum Tode ex Fr.

ix. Nectria haematococca Berk. & Br.

x. Penicillium sp.

xi. Rhizopus stolonifer (Fr.) Lind.

Stock solutions of the fungicides were prepared and the requisite quantity of each was added separately to fifty ml of sterilized Potato Dextrose Agar so as to get the desired concentrations of the fungicides. Fifteen ml each of the poisoned medium was poured in sterile petri dish and after solidification 5 mm disc from a seven day old culture of the fungus was cut out by a sterile cork borer and placed at the centre of the plate. The plates were then incubated at room temperature (28 ± 2°C). Potato Dextrose Agar without any fungicide served as control. The colony diameter was

measured when maximum growth was observed in control plates. The radial growth was calculated by deducting the diameter of the culture disc placed in the centre of the medium from the final colony diameter. The per cent inhibition over control was calculated by the formula.

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

C = radial growth in control
T = radial growth in treatment

6. Effect of storage conditions on the germination of seeds

i. Storage in different containers

The following containers were used to find out the effect of storing the seeds in them on the germination.

1. Cloth bags
2. Earthen pots
3. Gunny bags
4. Paper bags
5. Polythene bags
6. Tin containers

Before storing, the germination percentages of the seeds were determined. For this, 25 numbers of seeds of each of the vegetables, namely, amaranthus, bhindi, bitter gourd, brinjal, cowpea, cucumber, snake gourd and tomato were spread on moist filter paper kept in petri dishes and

incubated at room temperature. Observations on the number of seeds germinated were taken daily up to three weeks and percentages of germination were calculated.

One hundred seeds each of the above vegetables were stored in each container for six months. One in three months the percentage of germination was calculated.

ii. Indigenous methods of storage of seeds

The materials used for indigenous methods of seed storage were Ash, Coconut pith, Sand and Saw dust. The materials were dried thoroughly before use.

The seeds of the above vegetables after determination of percentage of germination were taken (100 seeds for each treatment) mixed with the material, and stored in earthen pots for six months. The percentage of germination of seeds for each treatment was taken once in three months.

7. Effect of storage conditions on the moisture content of seeds

The moisture content of the seeds were found out in the above two experiments before and after storing by the method described by Zeleny (1961).

Five grams each of seeds of the vegetables, namely, bhindi, bitter gourd, brinjal, cowpea, cucumber, snake gourd and tomato from each treatment were weighed out and placed in an oven maintained at 130°C for 60 minutes. After this,

the seeds were placed in a desiccator, cooled for 30-40 minutes and weighed again. The percentage of moisture was calculated using the formula.

$$\text{Percentage of moisture} = \frac{M_1 - M_2}{M_1} \times 100$$

M_1 = Weight of seeds before drying

M_2 = Weight of seeds after drying

8. Determination of the effect of culture filtrates of seed-borne fungi on the germination of certain vegetable seeds.

The method described by Vidhyasekharan et al. (1970) was followed for this experiment. The effect of the culture filtrates of the following seed-borne fungi on the germination of the seeds of amaranthus, bhindi, brinjal, chillies, cowpea and cucumber were done.

1. Achaetomium macrosporum Rai, Wadhwani and Tewari
2. Aspergillus flavus Link ex Fr.
3. Aspergillus niger Van Tiegh.
4. Aspergillus ochraceus Wilhelm
5. Botryodiplodia theobromae Pet.
6. Cephaliophora irregularis Thaxter
7. Colletotrichum lagenarium (Pass.) Ellis & Halst.
8. Curvularia lunata (Wakker) Boedijn
9. Drechslera rostrata (Drechsler) Richardson & Fraser
10. Fusarium oxysporum (Corda) Sacc.

11. Fusarium oxysporum Schlecht

12. Fusarium solani (Mart.) Sacc.

13. Myrothecium roridum Tode ex Fr.

14. Nectria haematococca Berk. & Br.

15. Penicillium sp.

16. Rhizopus stolonifer (Fr.) Lind

Czapek's (Dox) liquid media at the rate of 50 ml were taken in 250 ml conical flask and autoclaved. These flasks were inoculated with 5 mm discs of actively growing cultures of the above fungi, cut out with a cork borer and aseptically transferred to each flask. After an incubation period of 10 days, the cultures were filtered through filter paper and the filtrates thus obtained were taken.

The seeds were first surface sterilized with 0.1 per cent mercuric chloride solution and then washed in three changes of sterile distilled water. They were then spread on whatman No.1 filter paper placed in sterile petri dishes at the rate of 5 seeds per plate. An aliquot of 5 ml of the culture filtrate was poured into the plates over the filter paper and the dishes were incubated at room temperature. Three replications were maintained for each treatment. In the control plates sterile distilled water was used instead of the culture filtrate. Observations on the number of seeds germinated were recorded on every third day for a period of three weeks in each of the treatments and the percentages of germination over control were calculated.

Statistical analysis.

Data relating to different experiments were analysed statistically following the methods of Snedecor and Cochran (1967). 'F' test was carried out by analysis of variance method and significant results were compared by working out the critical difference.

Results

RESULTS

1. Isolation of seed-borne fungi.

A number of fungi were isolated from the seeds of the nine vegetable crops in the present investigation(Table 1, Fig. x). Externally seed-borne fungi were *Aspergillus flavus*, *Aspergillus niger*, *Curvularia lunata*, *Fusarium equiseti* and *Myrothecium roridum* from amaranthus, *Aspergillus flavus*, *Aspergillus niger*, and *Fusarium oxysporum* from bhindi, *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus ochraceus* and *Rhizopus stolonifer* from bitter gourd, *Aspergillus niger*, *Aspergillus ochraceus* and *Rhizopus stolonifer* from brinjal. *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus ochraceus* and *Botryodiplodia theobromae* from cowpea, *Aspergillus flavus* from cucumber, *Aspergillus niger* and *Rhizopus stolonifer* from pumpkin, *Aspergillus flavus*, *Aspergillus niger* and *Rhizopus stolonifer* from snake gourd and *Aspergillus niger* and *Rhizopus stolonifer* from tomato.

The internally seed-borne fungi were *Aspergillus ochraceus*, *Fusarium equiseti* and *Penicillium* sp. from amaranthus, *Botryodiplodia theobromae*, *Fusarium oxysporum* and *Nectria haematococca* from bhindi, *Achaetomium macrosporum*, *Aspergillus flavus*, *Botryodiplodia theobromae* and *Colletotrichum legenarium* from bitter gourd, *Aspergillus flavus* from brinjal, *Drechslera rostrata*, *Penicillium* sp. and *Rhizopus stolonifer* from cowpea,

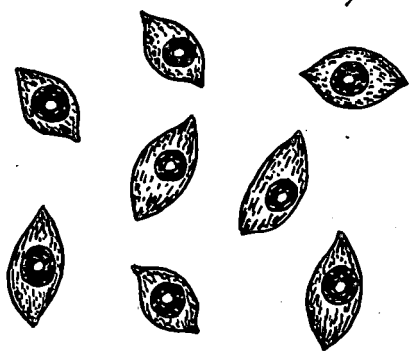
Table 1. Fungi isolated from the vegetable seeds.

Sl. No.	Name of crop	Externally seed-borne fungi	Internally seed-borne fungi
1.	Amaranthus	Aspergillus flavus Link ex Fr. Aspergillus niger van Tiegh. Curvularia lunata (Walker) Boedijn Fusarium equiseti (Corda) Sacc. Myrothecium roridum Tode ex Fr.	Aspergillus ochraceus Wilhelm Fusarium equiseti (Corda) Sacc. Penicillium sp.
2.	Bhindi	Aspergillus flavus Link ex Fr. Aspergillus niger van Tiegh. Fusarium oxysporum Schlecht.	Botryodiplodia theobromae Pat. Fusarium oxysporum Schlecht. Nectria haematococca Berk & Br.
3.	Bitter gourd	Aspergillus flavus Link ex Fr. Aspergillus niger van Tiegh. Aspergillus ochraceus Wilhelm Rhizopus stolonifer (Fr.) Lind	Achaetomium macrosporum Rai, Wadhwani & Tewari Aspergillus flavus Link ex Fr. Botryodiplodia theobromae Pat. Colletotrichum lagenarium (Pass.) Ellis & Halst.
4.	Brinjal	Aspergillus niger van Tiegh. Aspergillus ochraceus Wilhelm Rhizopus stolonifer (Fr.) Lind	Aspergillus flavus Link ex Fr.
5.	Cowpea	Aspergillus flavus Link ex Fr. Aspergillus niger van Tiegh. Aspergillus ochraceus Wilhelm Botryodiplodia theobromae Pat.	Drechslera rostrata (Drechsler) Richardson & Fraser Penicillium sp. Rhizopus stolonifer (Fr.) Lind
6.	Cucumber	Aspergillus flavus Link ex Fr.	

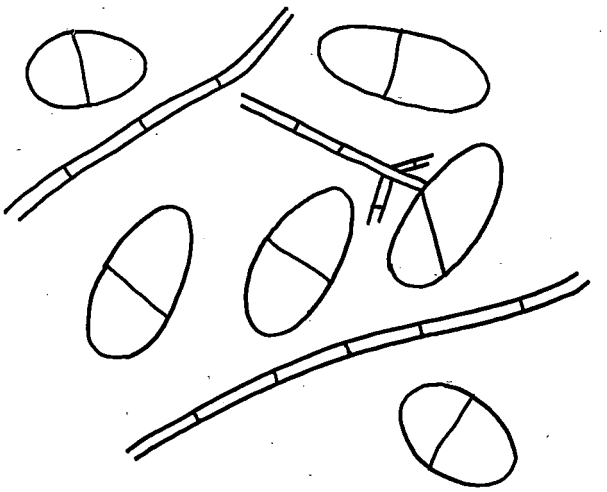
Table 1. Contd.

Sl. No.	Name of crop	Externally seed-borne fungi	Internally seed-borne fungi
7.	Pumpkin	*Aspergillus niger* van Tiegh. *Rhizopus stolonifer* (Fr.) Lind	*Cephalosporium irregulare* Thaxter *Fusarium solani* (Mart.) Sacc.
8.	Snake gourd	*Aspergillus flavus* Link ex Fr. *Aspergillus niger* van Tiegh. *Rhizopus stolonifer* (Fr.) Lind	*Aspergillus flavus* Link ex Fr. An unidentified non sporulating fungus
9.	Tomato	*Aspergillus niger* van Tiegh. *Rhizopus stolonifer* (Fr.) Lind	*Aspergillus niger* van Tiegh.

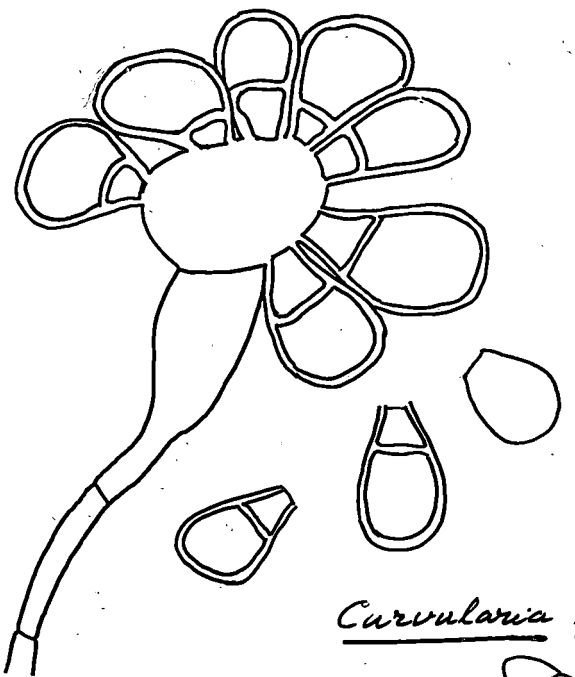
Achaetomium macrosporum – ascospores



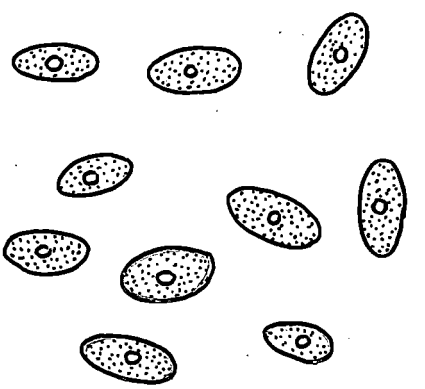
Botryodiplodia theobromae – conidia



Cephaliophora irregularis – conidiophore with conidia



Colletotrichum lagenarium – conidia



Curvularia lunata – conidia

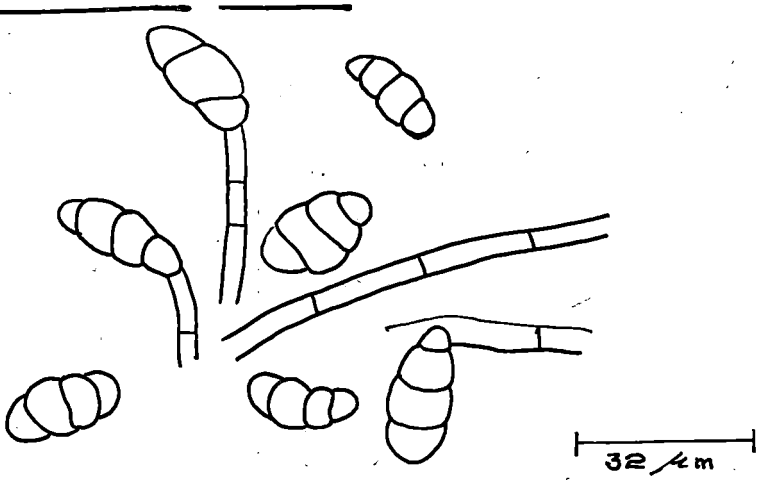
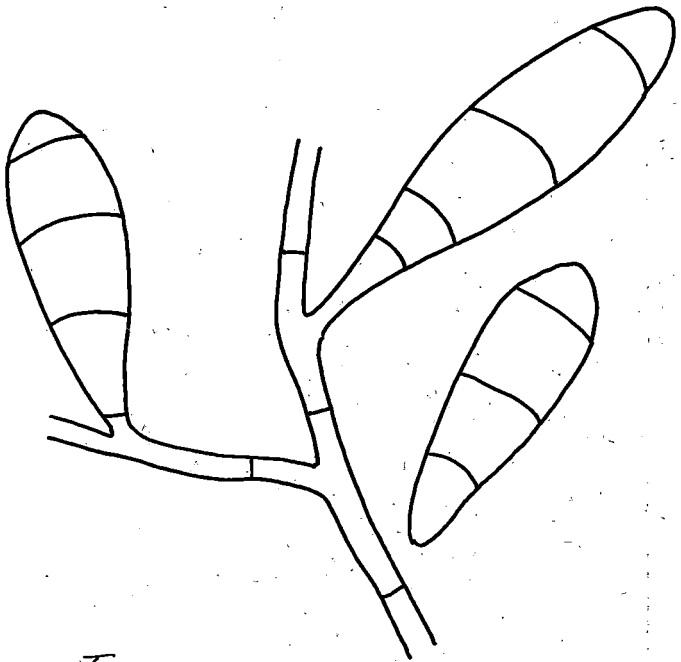


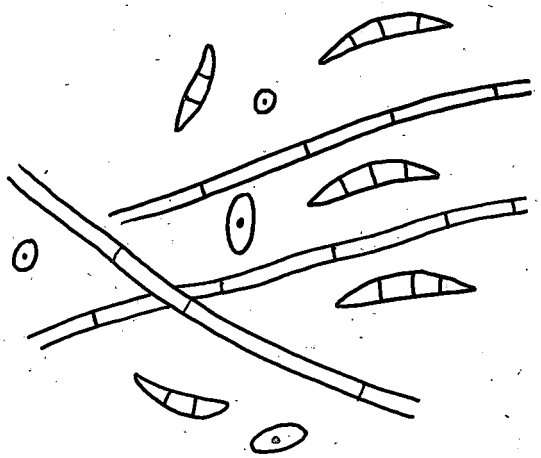
FIG. X. SOME FUNGI ISOLATED FROM VEGETABLE SEEDS

(CONTINUED)

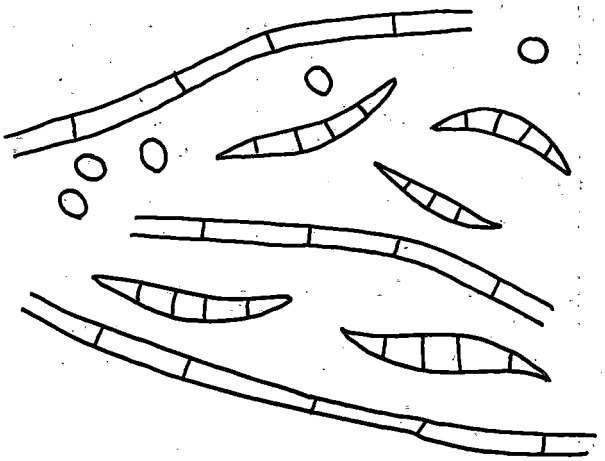
Drechslera rostrata –
conidiophore with conidia



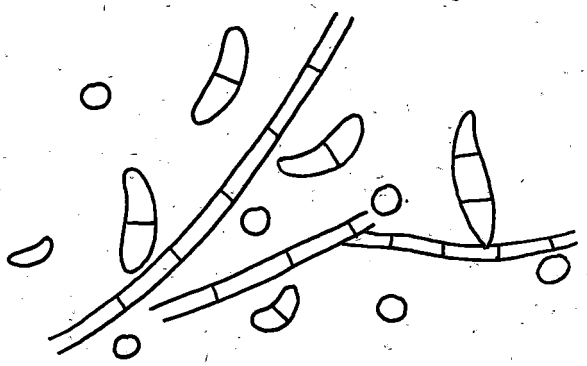
Fusarium equiseti –
macro and micro conidia



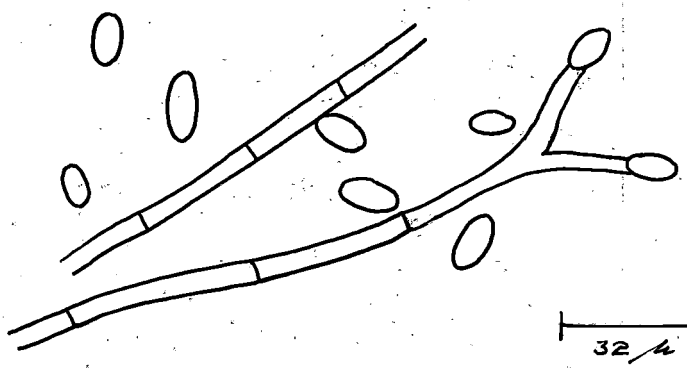
Fusarium oxysporum –
macro and micro conidia



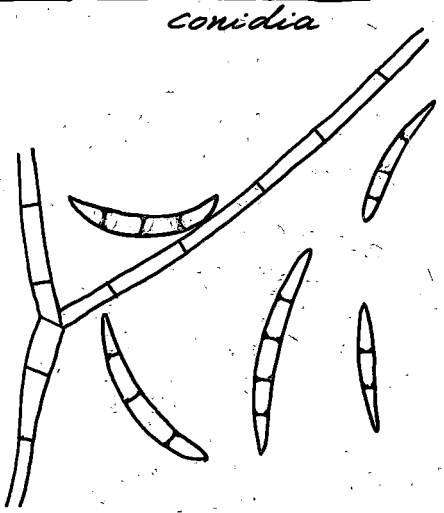
Fusarium solani
macro and micro conidia



Myrothecium roridum –
conidia



Nectria haematococca –
conidia



Cephaliophora irregularis and Fusarium solani from pumpkin, Aspergillus flavus and an unidentified non sporulating fungus from snake gourd and Aspergillus niger from tomato.

2. Effect of seed-borne fungi on the germination of seeds.

Most of the seed-borne fungi were found to cause inhibition in the germination of the respective vegetable seeds from which they were isolated (Table 2).

i. Amaranthus

The per cent inhibition of germination of amaranthus seeds dipped in spore suspension of Aspergillus flavus was found to be 77.78. Aspergillus niger, Aspergillus ochraceus and Fusarium semiseti caused 66.67 per cent and Curvularia lunata, Myrothecium roridum, and Penicillium sp. caused 44.44 per cent inhibition.

ii. Bhindi

When bhindi seeds were dipped in spore suspension of Nectria haematococca there was 75 per cent inhibition in germination. Aspergillus flavus caused 37.5 per cent, Aspergillus niger and Fusarium oxysporum caused 25 per cent and Botryodiplodia theobromae caused 18.75 per cent inhibition of germination of bhindi seeds.

iii. Bitter gourd

Achaetomium macrosporum, Aspergillus flavus, Aspergillus niger and Colletotrichum lagenarium caused 100 per cent

inhibition of germination of bitter gourd seeds. Rhizopus stolonifer, Aspergillus ochraceus and Botryodiplodia theobromae caused 78.26, 56.52 and 34.78 per cent inhibition of germination respectively.

iv. Brinjal

The germination of brinjal seeds was inhibited by 75 per cent by Aspergillus flavus, Aspergillus niger and Rhizopus stolonifer. But Aspergillus ochraceus caused only 37.5 per cent inhibition.

v. Cowpea

There was 100 per cent inhibition of germination of cowpea seeds when the seeds were dipped in spore suspension of Aspergillus flavus, Botryodiplodia theobromae and Penicillium sp. Drechslera rostrata, Rhizopus stolonifer, Aspergillus niger and Aspergillus ochraceus were found to cause 84.24, 76.47, 64.71 and 29.41 per cent inhibition of germination respectively.

vi. Cucumber

The germination of cucumber seeds was inhibition by 60.00 per cent by Aspergillus flavus.

vii. Pumpkin

Cephaliophora irregularis, Rhizopus stolonifer, Fusarium solani and Aspergillus niger caused 50, 44.44, 37.5 and 25 per cent inhibition in germination respectively in pumpkin seeds.

Table 2. Effect of seed-borne fungi on germination of seeds. (Figures indicate the per cent inhibition of germination over control).

Sl. No.	Fungi	Amaranthus	Bhindi	Brinjal	Bitter gourd	Cowpea	Cucumber	Pumpkin	Snake gourd	Tomato
1.	Achaetomium macrosporum	--	--	--	100	--	--	--	--	--
2.	Aspergillus flavus	77.78	37.50	75.00	100	100	60.00	--	80.00	--
3.	Aspergillus niger	66.67	25.00	75.00	100	64.71	--	25.00	40.00	83.33
4.	Aspergillus ochraceus	66.67	--	37.50	56.52	29.41	--	--	--	--
5.	Botryodiplodia theobromae	--	18.75	--	34.78	100	--	--	--	--
6.	Cephaliophora irregularis	--	--	--	--	--	--	50.00	--	--
7.	Colletotrichum lagenarium	--	--	--	100	--	--	--	--	--
8.	Curvularia lunata	44.44	--	--	--	--	--	--	--	--
9.	Drechslera rotrata	--	--	--	--	84.24	--	--	--	--

Table 2. Contd.

Sl. No.	Fungi	Amaranthus	Bhindi	Brinjal	Bitter gourd	Cowpea	Cucumber	Pumpkin	Snake gourd	Tomato
10.	Fusarium equiseti	66.67	—	—	—	—	—	—	—	—
11.	Fusarium oxysporum	—	25	—	—	—	—	—	—	—
12.	Fusarium solani	—	—	—	—	—	—	37.50	—	—
13.	Myrothecium roridum	44.44	—	—	—	—	—	—	—	—
14.	Nectria haematococca	—	75.00	—	—	—	—	—	—	—
15.	Penicillium sp.	44.44	—	—	—	100	—	—	—	—
16.	Rhizopus stolonifer	—	—	75.00	73.26	76.47	—	44.44	60.00	72.22

viii. Snake gourd

Aspergillus flavus, Rhizopus stolonifer and Aspergillus niger were found to inhibit the germination of snake gourd seeds by 80, 60 and 40 per cent respectively.

ix. Tomato

The germination of tomato seeds was inhibited by Aspergillus niger and Rhizopus stolonifer by 83.33 and 72.22 per cent respectively.

3. Pathogenicity test in pot culture experiment.

Seed inoculation tests in pots with seed-borne fungi were carried out (Table 3).

i. Amaranthus

In pot culture experiment Aspergillus flavus caused 100 per cent inhibition in germination over control in amaranthus seeds. Fusarium equiseti and Aspergillus niger caused 47 per cent and 37 per cent rotting respectively, in amaranthus seedlings that emerged. Aspergillus ochraceus Curvularia lunata, Myrothecium roridum and Penicillium sp. showed no effect on the seeds and the seedlings.

ii. Bhindi

Botryodiplodia theobromae, Aspergillus flavus and Fusarium oxysporum caused 41.67, 33.33 and 26.67 per cent inhibition in germination, respectively, in bhindi seeds.

Aspergillus niger caused 33.33 per cent rotting of the bhindi seedlings. Nectria haematococca was not found to be pathogenic in pot culture experiment.

iii. Bitter gourd

Colletotrichum lagenarium and Achaetomium macrosporum caused 100 and 78.57 per cent inhibition in germination of bitter gourd seeds. Aspergillus flavus and Botryodiplodia theobromae caused 28.57 per cent inhibition in germination respectively. There was no seedling rot caused by these fungi in bitter gourd. Aspergillus niger, Aspergillus ochraceus and Rhizopus stolonifer were found to have no effect on bitter gourd seeds and seedlings that emerged.

iv. Brinjal

Aspergillus flavus caused 58.33 per cent inhibition in the germination of brinjal seeds over control. There was no seedling rot caused by Aspergillus flavus in brinjal. Aspergillus niger, Aspergillus ochraceus, Rhizopus stolonifer were found to have no effect on the seeds and seedlings of brinjal.

v. Cowpea

Botryodiplodia theobromae, Drechslera rostrata and Aspergillus flavus caused 46.67, 38.46 and 15.38 per cent inhibition of germination of cowpea seeds. Seedling rotting was caused only by Drechslera rostrata and that too was only

20 per cent. Aspergillus niger, Aspergillus ochraceus, Penicillium sp. and Rhizopus stolonifer showed no effect on the seeds and the seedlings.

vi. Cucumber

The germination of cucumber seeds was inhibited by 26.67 per cent by Aspergillus flavus and there was no seedling rot.

vii. Pumpkin

The germination of pumpkin seeds was inhibited by 100 per cent and 37.5 per cent by Cephaliophora irregularis and Fusarium solani. Aspergillus niger and Rhizopus stolonifer showed no effect on pumpkin seeds and seedlings.

viii. Snake gourd

Aspergillus flavus caused 40 per cent inhibition in the germination of snake gourd seeds. Aspergillus niger and Rhizopus stolonifer were not found to be pathogenic in pot culture experiment.

ix. Tomato

The germination of tomato seeds was inhibited by Aspergillus niger by 64.29 per cent and by Rhizopus stolonifer by 35.71 per cent. Rhizopus stolonifer caused seedling rot also in 40 per cent of the seedlings. Aspergillus niger was not found to cause seedling infection.

Table 3. Effect of seed inoculation on seeds and seedlings.

Sl. No.	Fungi		Amaranthus	Bhindi	Brinjal	Bitter gourd	Cowpea	Cucumber	Pumpkin	Snake gourd	Tomato
1.	Achaetomium macrosporum	I.G	—	—	—	78.57	—	—	—	—	—
		S.I	—	—	—	—	—	—	—	—	—
2.	Aspergillus flavus	I.G	100	33.33	58.33	28.57	15.38	26.67	—	40.00	—
		S.I	—	—	—	—	—	—	—	—	—
3.	Aspergillus niger	I.G	—	—	—	—	—	—	—	—	64.29
		S.I	37	33.33	—	—	—	—	—	—	—
4.	Botryodiplodia theobromae	I.G	—	41.67	—	28.57	46.67	—	—	—	—
		S.I	—	—	—	—	—	—	—	—	—
5.	Cephaliophora irregularis	I.G	—	—	—	—	—	—	100	—	—
		S.I	—	—	—	—	—	—	—	—	—
6.	Colletotrichum lagenarium	I.G	—	—	—	100	—	—	—	—	—
		S.I	—	—	—	—	—	—	—	—	—
7.	Drechslera rostrata	I.G	—	—	—	—	38.46	—	—	—	—
		S.I	—	—	—	—	20.00	—	—	—	—
8.	Fusarium equiseti	I.G	—	—	—	—	—	—	—	—	—
		S.I.	47	—	—	—	—	—	—	—	—
9.	Fusarium oxysporum	I.G	—	26.67	—	—	—	—	—	—	—
		S.I	—	—	—	—	—	—	—	—	—
10.	Fusarium solani	I.G	—	—	—	—	—	—	37.5	—	—
		S.I	—	—	—	—	—	—	—	—	—
11.	Rhizopus stolonifer	I.G	—	—	—	—	—	—	—	—	35.71
		S.I	—	—	—	—	—	—	—	—	40.00

I.G - Per cent inhibition in germination
S.I - Per cent of seedling infection

4. Production of Aflatoxin by seed-borne fungi.

The quantity of aflatoxin produced by various isolates of Aspergillus flavus was found out. It was estimated that 0.133 ppm of aflatoxin was produced by the isolates obtained from bitter gourd, cucumber and snake gourd. The quantity of aflatoxin produced by Aspergillus flavus from amaranthus was 0.100 ppm and that produced by isolates from brinjal and bhindi was 0.067 ppm. The isolate from cowpea produced only 0.057 ppm of aflatoxin (Table 4, Fig.1).

5. Effect of seed-dressing fungicides on seed-borne fungi.

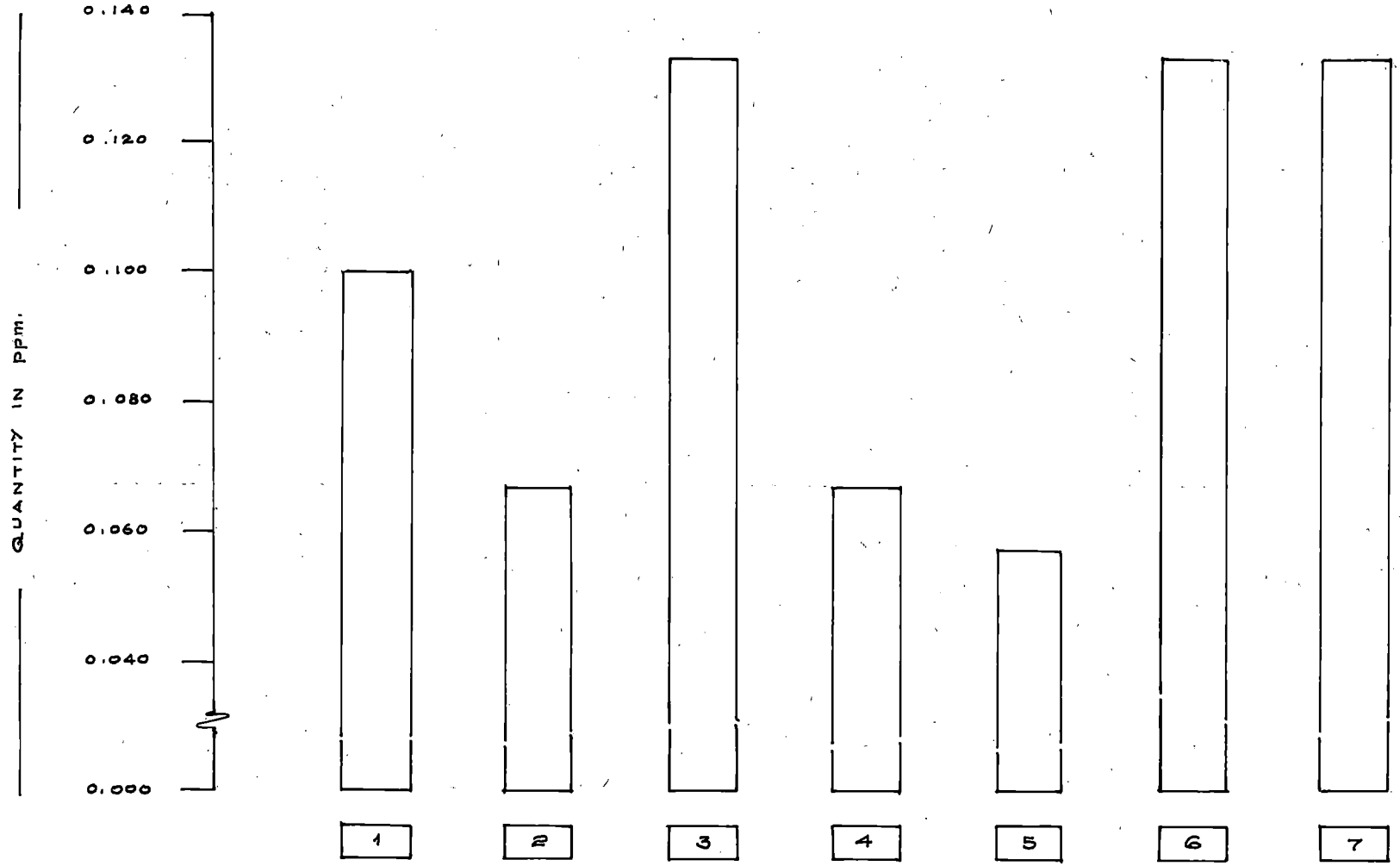
In vitro evaluation of fungicides against seed-borne fungi was done in the case of fungi which were found to be pathogenic.

1. Aspergillus flavus

Complete inhibition of the growth of Aspergillus flavus was obtained with 3000 ppm and 4000 ppm of Thiride, 4000 ppm of Captan as well as Difolatan. The per cent inhibition by Aureofungin Sol at 12.5 ppm concentration, over control was 60.00 and there was an increase in the per cent inhibition as the concentration of fungicide increased and it was 84.51 at 200 ppm. Brassicol at 500 ppm gave 56.67 per cent inhibition and 79.41 per cent inhibition was obtained at 4000 ppm. The effect of captan at 500 ppm was 94.12 per cent inhibition and it reached 100 per cent at 4000 ppm.

Table 4. Aflatoxin production by different isolates of *Aspergillus flavus*

Sl.No.	Isolates	Quantity in ppm.
1.	Amaranthus	0.100
2.	Bhindi	0.067
3.	Bitter gourd	0.133
4.	Brinjal	0.067
5.	Cowpea	0.057
6.	Cucumber	0.133
7.	Snake gourd	0.133



1. AMARANTHUS 2. BHINDI 3. BITTER GOURD 4. BRINJAL 5. COWPEA 6. CUCUMBER 7. SNAKE GOURD

FIG: 1. PRODUCTION OF AFLATOXIN BY *Aspergillus flavus* ISOLATES

The growth of the fungus was inhibited by 90 per cent at 500 ppm concentration of Difolatan and the per cent inhibition has increased with the increase in concentration of the fungicide and it gave 100 per cent inhibition at 4000 ppm.

Dithane M-45 was found to inhibit the growth of Aspergillus flavus by 69.21 per cent at 500 ppm and the per cent inhibition increased when higher concentrations of the fungicide were used. At 4000 ppm the inhibition was 81.76 per cent. In the case of Dithane Z-78, 500 ppm of the fungicide gave 60.20 per cent and it gave a maximum inhibition of 75.68 per cent at 4000 ppm. Thiride gave 93.33 per cent inhibition of growth of Aspergillus flavus at 500 ppm and the per cent inhibition reached 100 at 3000 ppm itself (Table 5 a, Fig.2).

11. Botryodiplodia theobromae

The growth of Botryodiplodia theobromae was checked by 56.27 per cent at 12.5 ppm of Aureofungin Sol and the inhibition was 77.85 per cent at 4000 ppm of the fungicide. The effect of Brassicol was 73.73 per cent inhibition at 500 ppm and this inhibitory effect was found to increase with the higher concentrations and reached 91.18 per cent inhibition at 4000 ppm. Captan at 500 ppm gave 69.41 per cent inhibition and at 4000 ppm there was 89.24 per cent inhibition. Difolatan at 500 ppm, gave 78.44 per cent inhibition and it has become 94.91 per cent at 4000 ppm.

Table 5(a). Effect of fungicides on the growth of *Aspergillus flavus*.

Sl. No.	Treatment	Concentration of fungicides (ppm)	Mean* radial growth (mm)	Per cent inhibition over control
1.	Aureofungin Sol	12.50	34.00	60.00
		25.00	31.67	62.74
		50.00	21.33	74.91
		100.00	16.50	80.59
		200.00	13.17	84.51
2.	Brassicol	500	36.83	56.67
		1000	33.00	61.18
		2000	22.50	73.53
		3000	21.83	74.32
		4000	17.50	79.41
3.	Captan	500	5.00	94.12
		1000	3.83	95.49
		2000	3.83	95.49
		3000	2.00	97.65
		4000	—	100.00
4.	Difolatan	500	8.50	90.00
		1000	5.33	93.73
		2000	4.67	94.50
		3000	2.83	96.67
		4000	—	100.00
5.	Dithane M-45	500	26.17	69.21
		1000	23.17	72.74
		2000	23.17	72.74
		3000	18.33	78.44
		4000	15.50	81.76
6.	Dithane Z-78	500	33.83	60.20
		1000	33.66	60.40
		2000	27.50	67.65
		3000	24.67	70.98
		4000	20.50	75.88
7.	Thiride	500	5.67	93.33
		1000	2.00	97.65
		2000	1.00	98.82
		3000	—	100.00
		4000	—	100.00
8.	Control	—	85.00	—

* Average of 3 replications

C.D (0.05) for comparison between fungicides = 1.516

C.D (0.05) for comparison between levels of fungicides = 3.396

C.D (0.05) for comparison between fungicides and control = 2.622

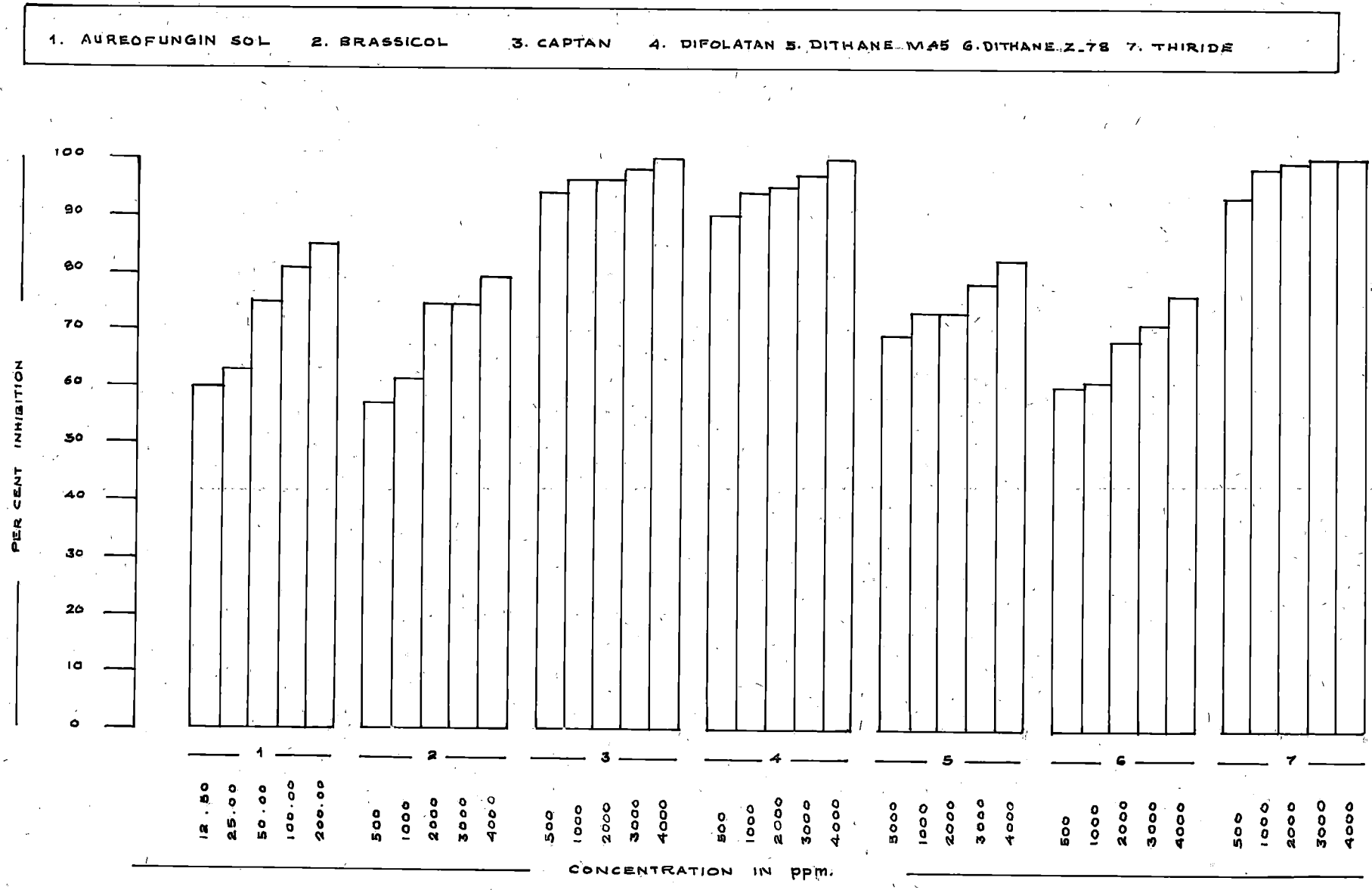


FIG: 2. EFFECT OF FUNGICIDES ON THE GROWTH OF *Aspergillus flavus*

The inhibitory effect of Dithane M-45 was 51.19 per cent at 500 ppm and it has reached 75.08 per cent at 4000 ppm. Dithane Z-78 at 500 ppm gave 73.92 per cent inhibition and this has increased to 100 per cent at 4000 ppm. Thiride was found to inhibit the growth of Botryodiplodia theobromae by 87.26 per cent at 500 ppm and at 3000 ppm itself it gave 100 per cent inhibition (Table 5 b, Fig.3).

iii. Cephaliophora irregularis

Complete inhibition of the growth of Cephaliophora irregularis was obtained with Difolatan and Thiride at all concentrations tested. Brassicol was found to be least effective against the fungus. Aurcofungin Sol at 12.5 ppm gave 79.61 per cent inhibition and it became 95.29 per cent inhibition at 200 ppm. Brassicol gave 20.59 per cent inhibition at 500 ppm and at 4000 ppm, the inhibition was 73.53 per cent. The per cent inhibition over control at 500 ppm of Captan was 79.21 and at 4000 ppm the inhibition reached 95.09 per cent. In the case of Dithane M-45 at 500 ppm, the inhibition was 36.47 per cent and at 4000 ppm, it was 87.85 per cent. Dithane Z-78 gave only 26.27 per cent inhibition at 500 ppm, while at 4000 ppm it was 90.79 per cent (Table 5 c, Fig.4).

iv. Colletotrichum lagenarium

Complete inhibition of the growth of Colletotrichum lagenarium was obtained with 4000 ppm of Dithane Z-78 and

Table 5(b). Effect of fungicides on the growth of Botryodiplodia theobromae.

Sl. No.	Treatment	Concentration of fungicides (ppm)	*Mean radial growth (mm)	Per cent inhibition over control
1.	Aureofungin Sol	12.50	37.17	56.27
		25.00	32.83	61.38
		50.00	30.50	64.12
		100.00	23.50	72.35
		200.00	18.83	77.85
2.	Brassicol	500	22.33	73.73
		1000	19.50	77.05
		2000	15.83	81.38
		3000	8.67	89.80
		4000	7.50	91.18
3.	Captan	500	26.00	69.41
		1000	21.33	74.91
		2000	16.33	80.79
		3000	13.00	84.71
		4000	10.00	88.24
4.	Difolatan	500	18.33	78.44
		1000	14.50	82.94
		2000	11.83	86.08
		3000	8.17	90.39
		4000	4.33	94.91
5.	Dithane M-45	500	41.50	51.18
		1000	33.67	60.39
		2000	32.00	62.35
		3000	31.00	63.53
		4000	20.50	75.88
6.	Dithane Z-78	500	22.17	73.92
		1000	20.00	76.47
		2000	12.17	85.68
		3000	3.83	95.49
		4000	—	100.00
7.	Thiride	500	10.83	87.26
		1000	5.00	94.12
		2000	3.33	96.08
		3000	—	100.00
		4000	—	100.00
8.	Control	—	85.00	—

* Average of 3 replications

C.D (0.05) for comparison between fungicides = 0.780

C.D (0.05) for comparison between levels of fungicides = 1.748

C.D.(0.05) for comparison between fungicides and control = 1.350

1. AUREOFUNGIN SOL 2. BRASSICOL 3. CAPTAN 4. DIFOLATAN 5. DITHANE M-45 6. DITHANE Z-78 7. THIRIDE

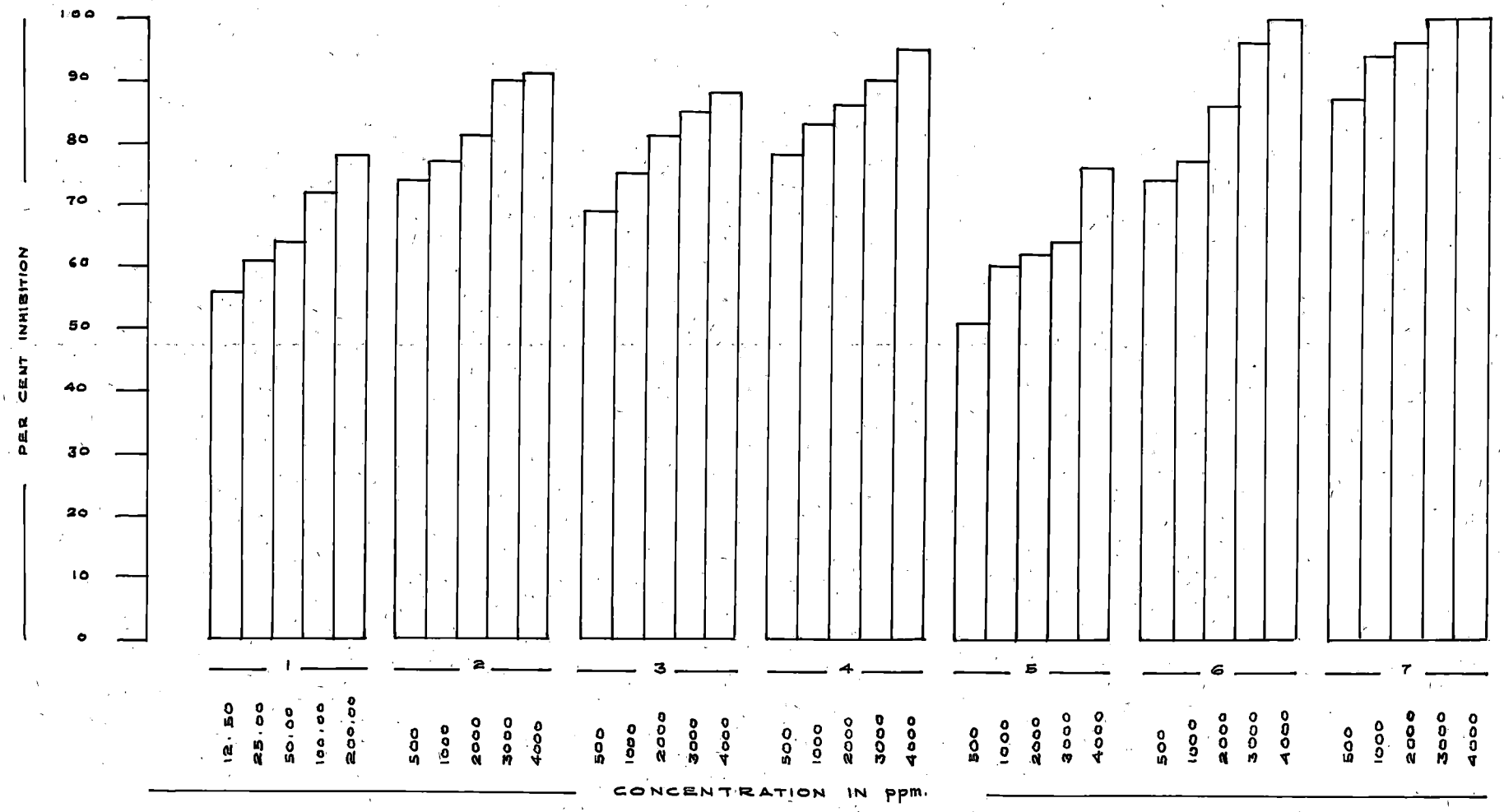


FIG: 3 EFFECT OF FUNGICIDES ON THE GROWTH OF *Botryodiplodia theobromae*

Table 5(c). Effect of fungicides on the growth of Cephaliophora irregularis.

Sl. No.	Treatment	Concentration of fungicides (ppm)	*Mean radial growth (mm)	Per cent inhibition over control
1.	Aureofungin Sol	12.50	17.33	79.61
		25.00	13.17	84.50
		50.00	9.00	89.41
		100.00	6.00	92.94
		200.00	4.00	95.29
2.	Brassicol	500	67.50	20.59
		1000	49.33	41.96
		2000	33.33	60.79
		3000	27.17	68.04
		4000	22.50	73.53
3.	Captan	500	17.67	79.21
		1000	13.83	84.91
		2000	8.67	89.80
		3000	5.00	94.12
		4000	4.17	95.09
4.	Difolatan	500	—	100.00
		1000	—	100.00
		2000	—	100.00
		3000	—	100.00
		4000	—	100.00
5.	Dithane M-45	500	54.00	36.47
		1000	29.33	65.49
		2000	16.83	80.20
		3000	14.67	82.74
		4000	10.33	87.85
6.	Dithane Z-78	500	62.67	26.27
		1000	56.33	33.73
		2000	37.33	56.08
		3000	19.00	77.65
		4000	7.83	90.79
7.	Thirido	500	—	100.00
		1000	—	100.00
		2000	—	100.00
		3000	—	100.00
		4000	—	100.00
8.	Control	—	85.00	—

* Average of 3 replications

C.D (0.05) for comparison between fungicides = 1.596
C.D (0.05) for comparison between levels of fungicides = 3.575
C.D (0.05) for comparison between fungicides and control = 2.701

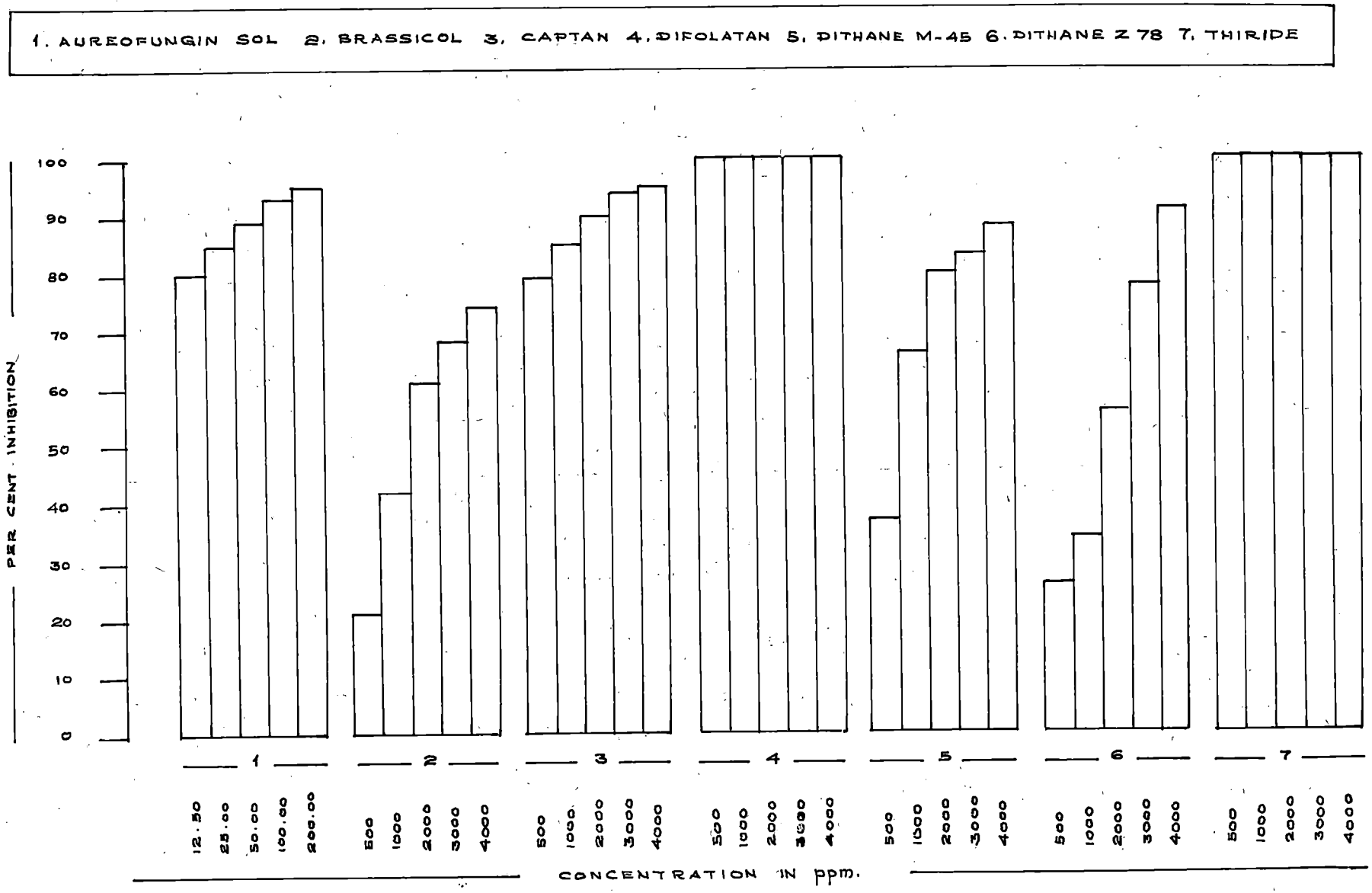


FIG: 4. EFFECT OF FUNGICIDES ON THE GROWTH OF *Cephaliophora irregularis*

Thiride at all concentrations tested. Aureofungin Sol at 12.5 ppm gave only 26.47 per cent inhibition over control on the growth of the fungus while at 200 ppm it gave 89.91 per cent inhibition. Effect of Brassicol at 500 ppm on the inhibition of the growth of Colletotrichum lagenarium was 76.47 per cent and at 4000 ppm it was 94.90 per cent. Captan at 500 ppm gave 57.45 per cent inhibition of the growth of the fungus and it was 72.35 per cent at 4000 ppm. Difolatan gave 50.00 per cent inhibition at 500 ppm and at 4000 ppm the per cent inhibition has increased to 96.86. Dithane M-45 was found to inhibit the growth of Colletotrichum lagenarium only by 47.06 per cent at 500 ppm and this effect has increased only to 60.39 per cent at 4000 ppm. Dithane Z-78 gave 76.27 per cent inhibition at 500 ppm and the per cent inhibition has increased to 100 at 4000 ppm. Thiride gave 100 per cent inhibition at 500 ppm itself (Table 5 d, Fig.5).

v. Curvularia lunata

Growth of Curvularia lunata was completely checked at 100 ppm and 200 ppm of Aureofungin Sol and 4000 ppm of Thiride. The effect of Aureofungin Sol in inhibiting the growth of the fungus was 79.21 per cent at 12.5 ppm and reached 100 per cent at 100 ppm itself. The per cent inhibition at 500 ppm of Brassicol was 49.80 and it increased only slightly as the concentration of the fungicide was increased and it was only 59.41 per cent at 4000 ppm.

Table 5(d). Effect of fungicides on the growth of *Colletotrichum legenarium*

Sl. No.	Treatment	Concentration of fungicides (ppm)	*Mean radial growth (mm)	Per cent inhibition over control
1.	Aureofungin Sol	12.50	62.50	26.47
		25.00	59.17	30.39
		50.00	42.83	49.61
		100.00	10.17	88.04
		200.00	8.58	89.91
2.	Brassicol	500	20.00	76.47
		1000	18.67	78.04
		2000	12.50	85.29
		3000	9.33	89.02
		4000	4.33	94.90
3.	Captan	500	36.17	57.45
		1000	30.83	63.73
		2000	25.67	69.80
		3000	23.50	72.35
		4000	23.50	72.35
4.	Difolatan	500	42.50	50.00
		1000	18.33	78.44
		2000	6.17	92.74
		3000	5.00	94.12
		4000	2.67	96.86
5.	Dithane M-45	500	45.00	47.06
		1000	42.33	50.20
		2000	40.00	52.94
		3000	34.00	60.00
		4000	33.67	60.39
6.	Dithane Z-78	500	20.17	76.27
		1000	19.00	77.65
		2000	12.67	85.09
		3000	4.67	94.51
		4000	--	100.00
7.	Thiride	500	--	100.00
		1000	--	100.00
		2000	--	100.00
		3000	--	100.00
		4000	--	100.00
8.	Control	--	85.00	--

*Average of 3 replications.

C.D (0.05) for comparison between fungicides = 0.498
C.D (0.05) for comparison between levels of fungicides = 1.116
C.D (0.05) for comparison between fungicides and control = 0.862

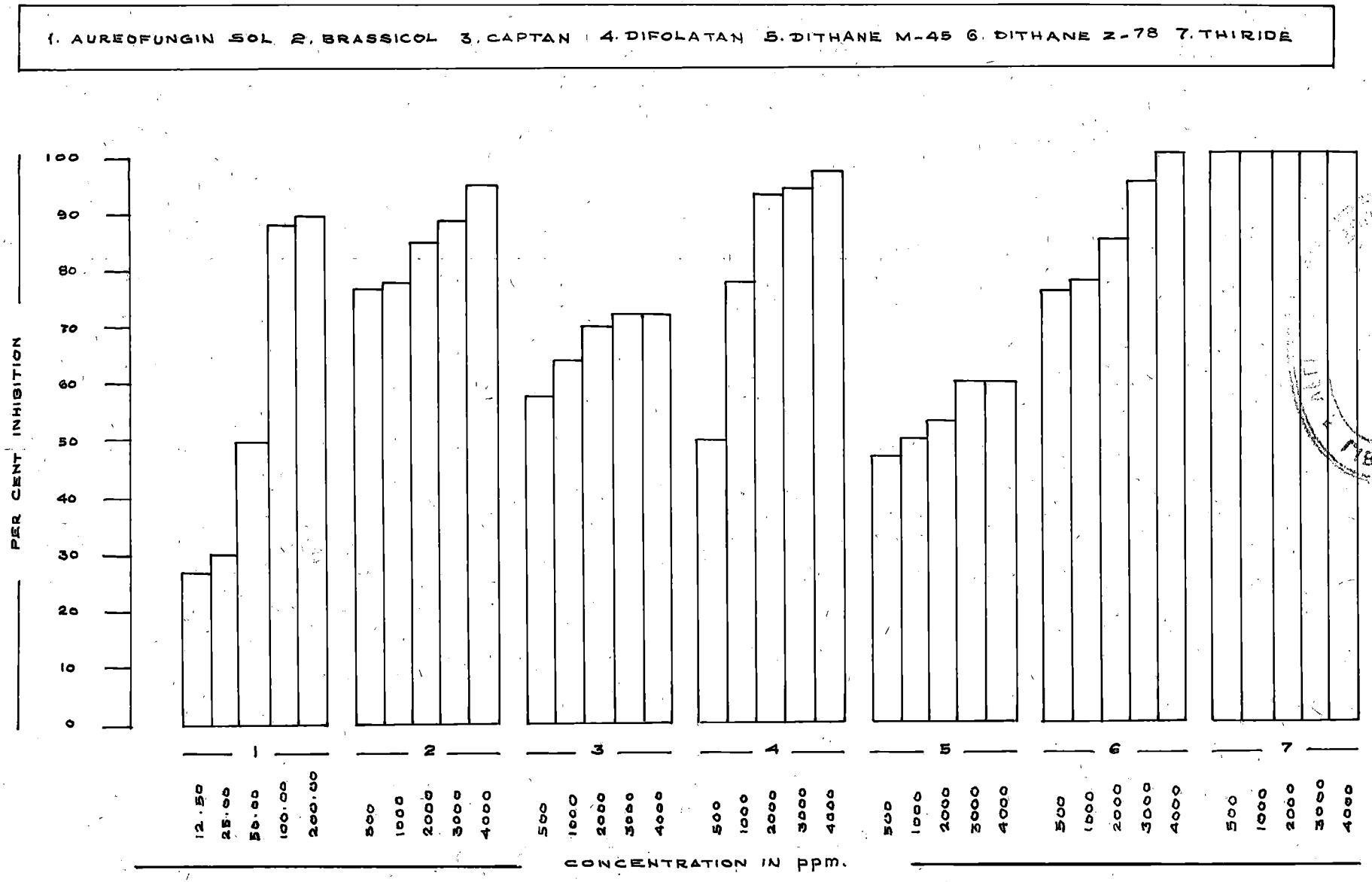


FIG: 5. EFFECT OF FUNGICIDES ON THE GROWTH OF *Colletotrichum lagenarium*

Captan at 500 ppm gave 74.51 per cent inhibition, while at 4000 ppm it gave 84.51 per cent inhibition. The effect of Difolatan in inhibiting the growth of the fungus was 52.15 per cent at 500 ppm and it increased to 70.79 per cent at 4000 ppm. The per cent inhibition by Dithane M-45 at 500 ppm was 76.08 and it reached 86.47 at 4000 ppm. Similarly Dithane Z-78 gave 75.09 per cent inhibition at 500 ppm and 93.73 per cent inhibition at 4000 ppm. The growth of Curvularia lunata was found to be inhibited by 89.21 per cent with 500 ppm of Thiride and the per cent inhibition has reached 100 at 4000 ppm (Table 5 e, Fig.6).

vi. Drechslera rostrata

In the case of Drechslera rostrata, complete inhibition of growth was obtained with 4000 ppm of Dithane Z-78 and Thiride. Aureofungin sol was found to be least effective against the fungus. It gave only 56.27 per cent inhibition at 12.5 ppm and the inhibition became 84.12 per cent at 4000 ppm. Brassicol at 500 ppm gave 75.68 per cent inhibition and at 4000 ppm, the inhibition was found to be 91.18 per cent. The per cent inhibition caused by Captan at 500 ppm was 70.79 and it reached 84.91 per cent at 4000 ppm of the fungicide. Difolatan at 500 ppm showed 78.82 per cent inhibition and at 4000 ppm the inhibition was 91.76 per cent. Similarly Dithane M-45 caused 76.27 per cent inhibition at 500 ppm and this inhibitory effect has increased to 90 per cent

Table 5(a). Effect of fungicides on the growth of Curvularia lunata

Sl. No.	Treatment	Concentrations of fungicides (ppm)	Mean radial growth (mm)	Per cent inhibition over control
1.	Aureofungin Sol	12.50	17.67	79.21
		25.00	15.33	81.96
		50.00	4.33	94.91
		100.00	—	100.00
		200.00	—	100.00
2.	Brassicol	500	42.67	79.80
		1000	40.83	51.96
		2000	38.83	54.32
		3000	37.17	56.27
		4000	34.50	59.41
3.	Captan	500	21.67	74.51
		1000	19.67	76.86
		2000	18.00	78.82
		3000	15.33	81.96
		4000	13.17	84.51
4.	Difolatan	500	40.67	52.15
		1000	32.83	61.38
		2000	31.00	63.52
		3000	28.33	66.67
		4000	24.83	70.79
5.	Dithane M-45	500	20.33	76.08
		1000	18.50	78.24
		2000	16.17	80.98
		3000	14.67	82.74
		4000	11.50	86.47
6.	Dithane Z-78	500	21.17	75.09
		1000	19.00	77.65
		2000	12.50	85.29
		3000	10.67	87.45
		4000	5.33	93.73
7.	Thiride	500	9.17	89.21
		1000	7.67	90.98
		2000	6.17	92.85
		3000	1.83	97.85
		4000	—	100.00
8.	Control	—	85.00	—

*Average of 3 replications.

C.D (0.05) for comparison between fungicides = 1.106
C.D (0.05) for comparison between levels of fungicides = 2.478
C.D (0.05) for comparison between fungicides and control = 1.915

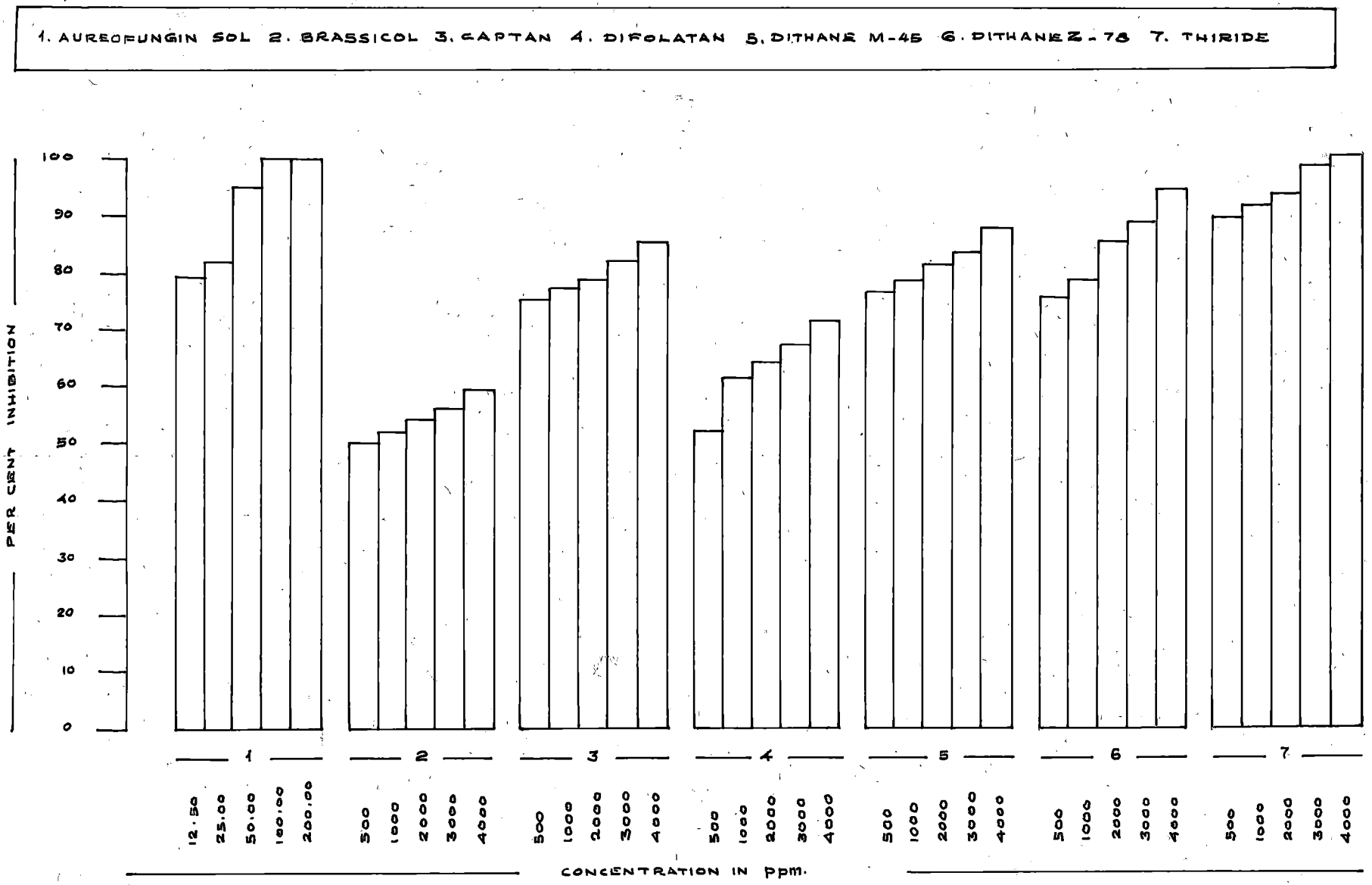


FIG: 6. EFFECT OF FUNGICIDES ON THE GROWTH OF *Curvularia lunata*

at 4000 ppm. Dithane Z-78 caused 73.92 per cent inhibition of growth of Drechslera rostrata and this effect was found to increase with the increase in concentration of the fungicide. At 3000 ppm the per cent inhibition was 95.49 and at 4000 ppm it reached 100 per cent. Thiride at 500 ppm inhibited the growth of the fungus by 87.85 per cent. This inhibitory effect has increased to 94.91 per cent at 3000 ppm and at 4000 ppm 100 per cent inhibition was obtained (Table 5 f, Fig. 7).

vii. Fusarium equiseti

The growth of Fusarium equiseti was completely checked at 3000 and 4000 ppm of Difolatan. Similarly Thiride also completely inhibited the growth of the fungus at 2000, 3000 and 4000 ppm. Aureofungin Sol at 12.5 ppm was found to inhibit the growth of Fusarium equiseti by 84.51 per cent and at 200 ppm it was 96.47. Brassicol at 500 ppm gave only 20.59 per cent inhibition and it increased to 83.53 per cent at 4000 ppm. Captan gave 83.14 per cent inhibition at 500 ppm and at 4000 ppm it reached 93.73 per cent. Difolatan was found to cause 97.65 per cent inhibition at 500 ppm and 100 per cent inhibition was obtained at 3000 ppm itself. Dithane M-45 caused only 29.21 per cent and 72.55 per cent inhibition at 500 ppm and 4000 ppm respectively. Dithane Z-78 gave only 22.55 per cent inhibition at 500 ppm and reached 91.53 per cent at 4000 ppm. Thiride was found to

Table 5(f). Effect of fungicides on the growth of Drechslera rostrata

Sl. No.	Treatment	Concentration of fungicides (ppm)	*Mean radial growth (mm)	Per cent inhibition over control
1.	Aureofungin Sol	12.50	37.17	56.27
		25.00	32.83	61.38
		50.00	30.50	64.12
		100.00	24.50	71.18
		200.00	13.50	84.12
2.	Brassicol	500	20.67	75.68
		1000	19.60	76.94
		2000	15.83	81.38
		3000	8.67	89.80
		4000	7.50	91.18
3.	Captan	500	24.83	70.79
		1000	18.00	78.82
		2000	17.50	79.41
		3000	15.50	81.76
		4000	12.83	84.91
4.	Difolatan	500	18.00	78.82
		1000	13.67	83.92
		2000	9.67	88.62
		3000	9.17	89.21
		4000	7.00	91.76
5.	Dithane M-45	500	20.17	76.27
		1000	17.50	79.41
		2000	14.33	83.14
		3000	9.67	88.62
		4000	8.50	90.00
6.	Dithane Z-78	500	22.17	73.92
		1000	20.00	76.47
		2000	12.17	85.68
		3000	3.83	95.49
		4000	—	100.00
7.	Thiride	500	10.33	87.85
		1000	8.67	89.80
		2000	4.83	94.32
		3000	4.33	94.91
		4000	—	100.00
8.	Control	—	85.00	—

* Average of 3 replications
C.D (0.05) for comparison between fungicides = 1.482
C.D (0.05) for comparison between levels of fungicides = 3.315
C.D (0.05) for comparison between fungicides and control = 2.564

1. AUREOFUNGIN SOL 2. BRASSICOL 3. CAPTAN 4. DIFOLATAN 5. DITHANE M-45 6. DITHANE Z-78. 7. THIRIDE

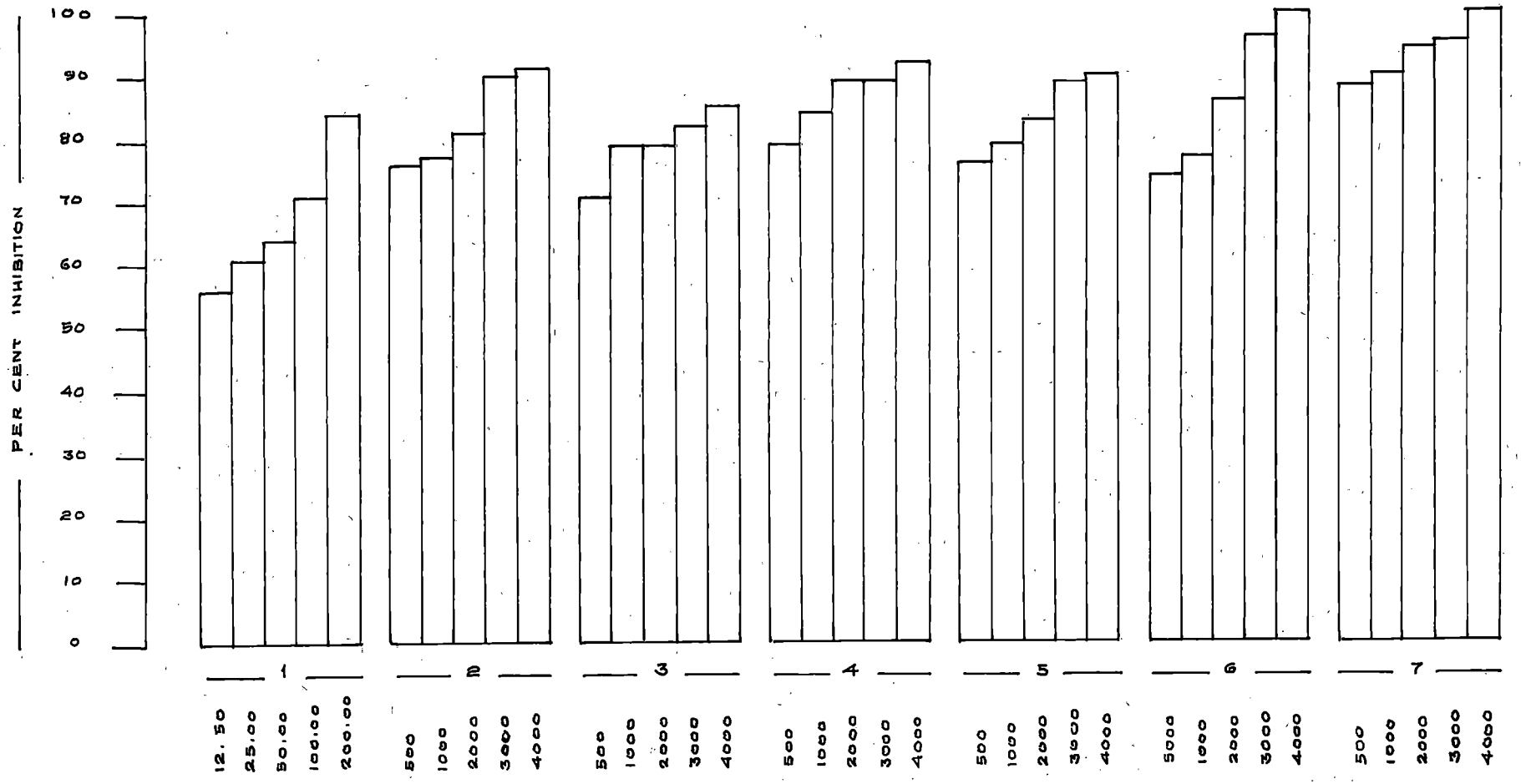


FIG: 7. EFFECT OF FUNGICIDES ON THE GROWTH OF *Drechslera rostrata*

Table 5(g). Effect of fungicides on the growth of *Fusarium equiseti*

Sl. No.	Treatment	Concentration of fungicides (ppm)	*Mean radial growth (mm)	Per cent inhibition over control
1.	Aureofungin Sol	12.50	13.17	84.51
		25.00	9.00	89.41
		50.00	6.00	92.94
		100.00	5.00	94.12
		200.00	3.00	96.47
2.	Brassicol	500	67.50	20.59
		1000	48.50	42.94
		2000	32.83	61.38
		3000	23.50	72.35
		4000	14.00	83.53
3.	Captan	500	14.33	83.14
		1000	12.33	85.49
		2000	7.50	91.18
		3000	5.67	93.32
		4000	5.33	93.73
4.	Difolatan	500	2.00	97.65
		1000	0.67	99.21
		2000	0.67	99.21
		3000	—	100.00
		4000	—	100.00
5.	Dithane M-45	500	60.17	29.21
		1000	48.53	42.91
		2000	46.33	45.49
		3000	37.83	55.49
		4000	23.33	72.55
6.	Dithane Z-78	500	65.83	22.55
		1000	65.17	23.33
		2000	36.50	57.06
		3000	17.50	79.41
		4000	7.20	91.53
7.	Thiride	500	8.17	90.39
		1000	6.50	92.35
		2000	—	100.00
		3000	—	100.00
		4000	—	100.00
8.	Control	—	85.00	—

* Average of 3 replications

C.D (0.05) for comparison between fungicides = 3.843
C.D (0.05) for comparison between levels of fungicides = 8.610
C.D (0.05) for comparison between fungicides and control = 6.656

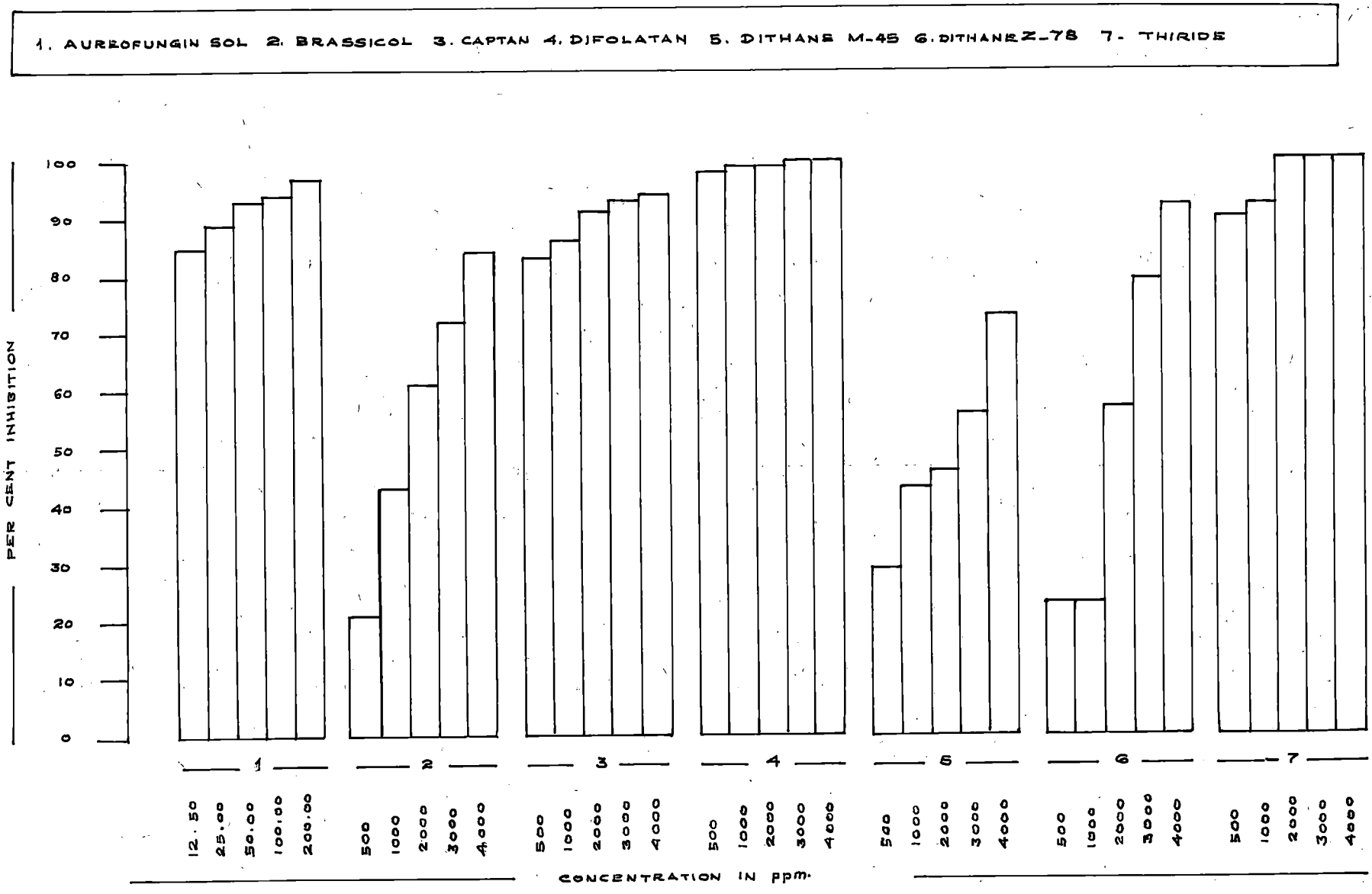


FIG: 8. EFFECT OF FUNGICIDES ON THE GROWTH OF *Fusarium equiseti*

inhibit the growth of Fusarium equiseti by 90.39 per cent at 500 ppm and it gave 100 per cent inhibition at 2000 ppm itself (Table 5 g, Fig. 8).

viii. Myrothecium roridum

The growth of Myrothecium roridum was found to be completely inhibited by Aureofungin Sol at 100 and 200 ppm and Thiride at 3000 and 4000 ppm. Aureofungin Sol at 12.5 ppm was found to cause 79.61 per cent inhibition in the growth of Myrothecium roridum. There was 100 per cent inhibition when 100 ppm of Aureofungin Sol was used. Brassicol gave only 30.39 per cent and 61.76 per cent inhibition at 500 and 4000 ppm, respectively. Captan at 500 ppm caused 74.51 per cent inhibition of the growth of the fungus. The per cent inhibition has increased to 82.74 at 4000 ppm. Difolatan caused 52.15 per cent inhibition at 500 ppm, which has reached 83.14 per cent at 4000 ppm. Dithane M-45 was found to inhibit the growth of Myrothecium roridum by 76.47 per cent at 500 ppm and their effect has increased to 86.47 per cent at 4000 ppm. Dithane Z-78 at 500 ppm caused 71.56 per cent inhibition and at 4000 ppm the inhibitory effect was 87.45 per cent. Thiride was found to be effective in checking the growth of Myrothecium roridum by 94.51 at 500 ppm and 100 per cent inhibition was obtained at 3000 ppm itself (Table 5 h, Fig. 9).

Table 5(h). Effect of fungicides on the growth of *Myrothecium roridum*

Sl. No.	Treatment	Concentration of fungicides (ppm)	*Mean radial growth (mm)	Per cent inhibition over control
1.	Aureofungin Sol	12.50	17.33	79.61
		25.00	15.00	82.35
		50.00	6.50	92.35
		100.00	—	100.00
		200.00	—	100.00
2.	Brassicol	500	59.17	30.39
		1000	57.50	32.35
		2000	53.17	37.44
		3000	35.00	58.82
		4000	32.50	61.76
3.	Captan	500	21.67	74.51
		1000	19.67	76.86
		2000	18.00	78.82
		3000	15.33	81.96
		4000	14.67	82.74
4.	Difolatan	500	40.67	52.15
		1000	34.00	60.00
		2000	25.00	70.59
		3000	22.33	73.73
		4000	14.33	83.14
5.	Dithane M-45	500	20.00	76.47
		1000	18.50	78.24
		2000	16.17	80.98
		3000	14.67	82.74
		4000	11.50	86.47
6.	Dithane Z-78	500	24.17	71.56
		1000	23.17	72.74
		2000	17.00	80.00
		3000	12.50	85.29
		4000	10.67	87.45
7.	Thiride	500	4.67	94.51
		1000	3.50	95.88
		2000	1.00	98.82
		3000	—	100.00
		4000	—	100.00
8.	Control	—	85.00	—

* Average of 3 replications

C.D (0.05) for comparison between fungicides = 0.395
C.D (0.05) for comparison between levels of fungicides = 0.885
C.D (0.05) for comparison between fungicides and control = 0.694

1. AUREOFUNGIN SOL 2. BRASSICOL 3. CAPTAN 4. DIFOLATAN 5. DITHANE M-45 6. DITHANE Z-78 7. THIRIDE

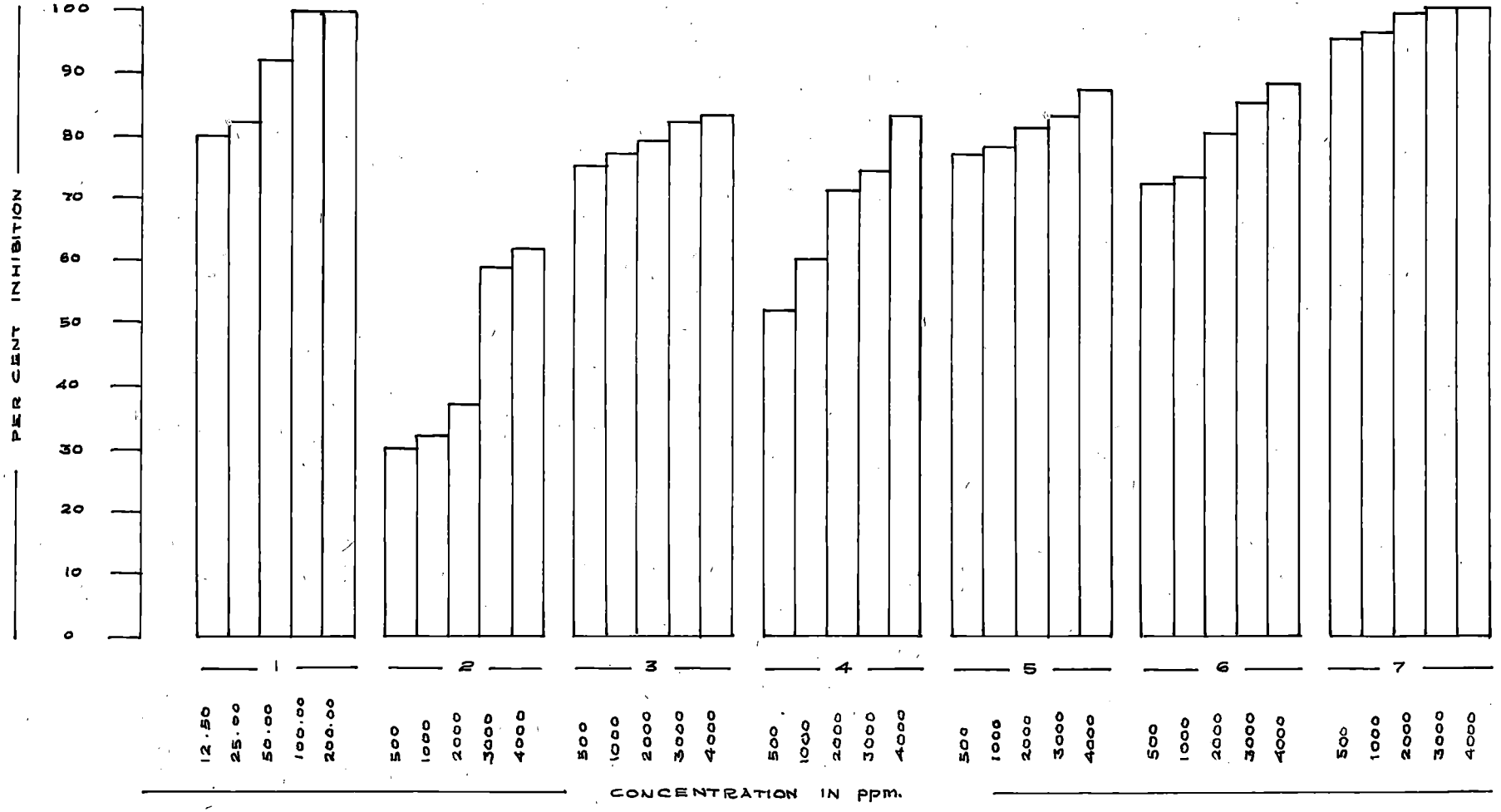


FIG: 9. EFFECT OF FUNGICIDES ON THE GROWTH OF *Myrothecium roridum*

ix. Nectria haematococca

The growth of Nectria haematococca was checked by 65.49 per cent at 12.5 ppm of Aureofungin Sol and the inhibitory effect reached 81.56 per cent at 200 ppm of the fungicide. The per cent inhibition at 500 ppm of Brassicol was 75.68 and it was 91.18 at 4000 ppm. Captan at 500 ppm gave 55.68 per cent inhibition, while at 4000 ppm it gave 91.39 per cent inhibition. The growth of Nectria haematococca was found to be inhibited by 78.44 per cent with 500 ppm of Difolatan and the per cent inhibition has reached 89.41 per cent at 4000 ppm. The per cent inhibition by Dithane M-45 at 500 ppm was only 37.46 and it reached only 50.00 at 4000 ppm. Dithane Z-78 gave only 31.76 per cent inhibition at 500 ppm and the per cent inhibition has increased to 61.18 per cent at 4000 ppm. Thiride at 500 ppm inhibited the growth of the fungus by 72.15 per cent. This inhibitory effect has increased to 91.76 per cent at 4000 ppm (Table 5 i, Fig. 10).

x. Penicillium sp.

In the case of Penicillium sp. complete inhibition of its growth was obtained with 200 ppm of Aureofungin Sol and 4000 ppm of Thiride. Aureofungin Sol at 12.5 ppm gave 78.04 per cent inhibition and with 200 ppm of the fungicide the per cent inhibition was 100. Brassicol was found to be least effective against the fungus and it gave only 50.00 per cent and 59.61 per cent inhibition at 500 ppm and 4000 ppm

Table 5(1). Effect of fungicides on the growth of Nectria haematococca

Sl. No.	Treatment	Concentration of fungicides (ppm)	*Mean radial growth (mm)	Per cent inhibition over control
1.	Aureofungin Sol	12.50	29.33	65.49
		25.00	25.67	68.62
		50.00	21.83	74.32
		100.00	19.83	76.67
		200.00	15.67	81.56
2.	Brassicol	500	20.67	75.68
		1000	19.50	77.06
		2000	15.83	81.38
		3000	8.67	89.80
		4000	7.50	91.18
3.	Captan	500	37.50	55.88
		1000	22.83	73.14
		2000	17.00	80.00
		3000	13.17	84.51
		4000	7.33	91.38
4.	Difolatan	500	18.33	78.44
		1000	15.50	81.76
		2000	15.17	82.15
		3000	11.33	86.67
		4000	9.00	89.41
5.	Dithane M-45	500	53.16	37.46
		1000	52.61	38.10
		2000	51.00	40.00
		3000	47.00	44.71
		4000	42.50	50.00
6.	Dithane Z-78	500	58.00	31.76
		1000	55.80	34.35
		2000	53.80	36.71
		3000	49.50	41.76
		4000	33.00	61.18
7.	Thiride	500	23.67	72.15
		1000	14.17	83.33
		2000	11.33	86.67
		3000	10.00	88.24
		4000	7.00	91.76
8.	Control	—	85.00	—

* Average of 3 replications

C.D (0.05) for comparison between fungicides = 0.800

C.D (0.05) for comparison between levels of fungicides = 1.793

C.D (0.05) for comparison between fungicides and control = 1.386

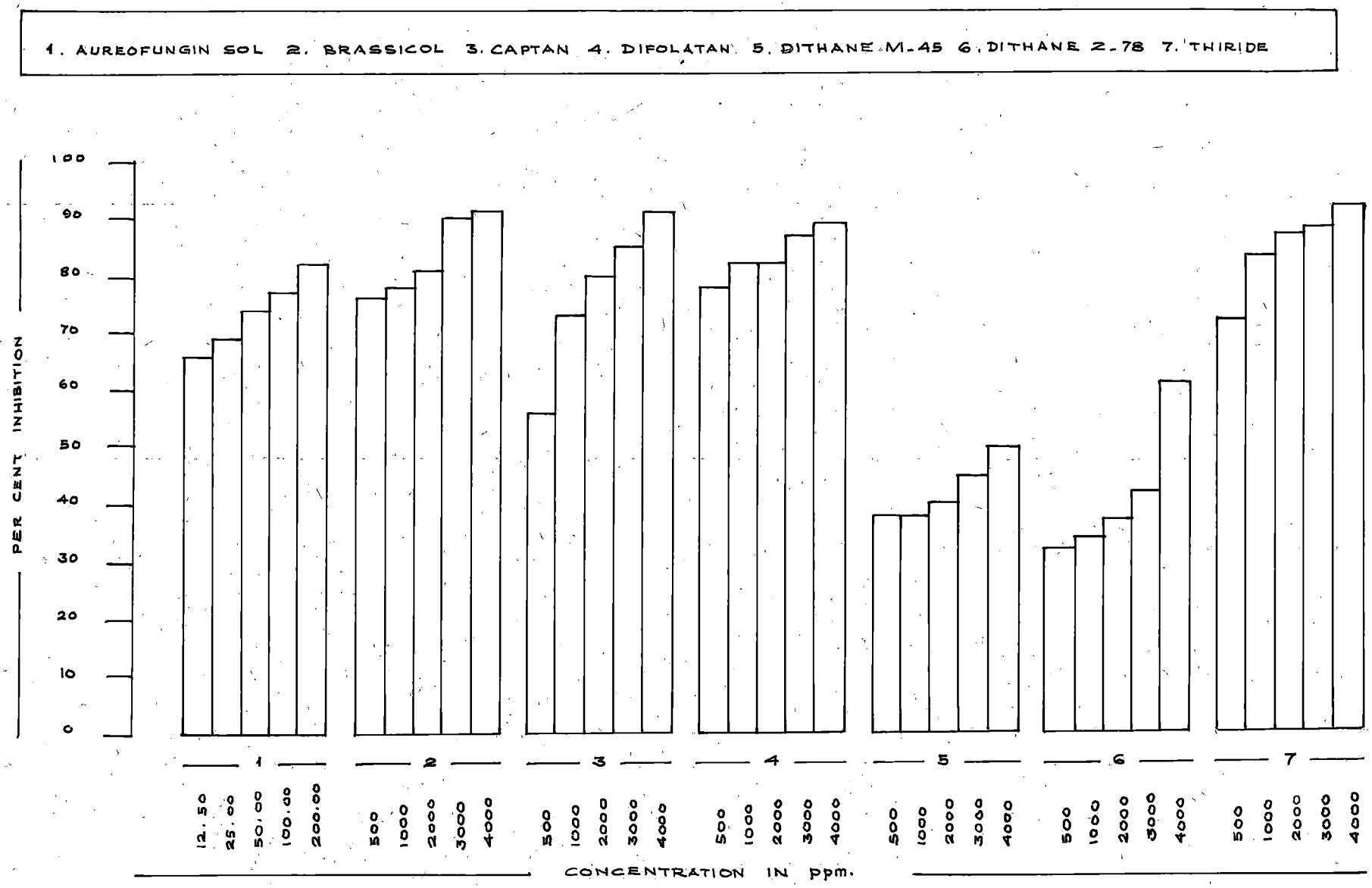


FIG: 10 EFFECT OF FUNGICIDES ON THE GROWTH OF *Nectria haematococca*

respectively. Captan at 500 ppm caused 74.91 per cent inhibition and it has increased to 85.68 at 4000 ppm. Difolatan at 500 ppm caused 50.20 per cent inhibition, which has become 71.38 per cent at 4000 ppm. Dithane M-45 caused 68.82 per cent inhibition of the growth of Penicillium sp. at 500 ppm and this effect was found to increase with the increase in concentration of the fungicide, and reached 85.88 per cent at 4000 ppm. Dithane Z-78 at 500 ppm showed 74.51 per cent inhibition and at 4000 ppm the inhibition was 92.94 per cent. Thiride gave 88.24 per cent inhibition of the growth of the fungus at 500 ppm and the per cent inhibition reached 100 at 4000 ppm (Table 5 j, Fig. 11).

xi. Rhizopus stolonifer

Aureofungin Sol at 12.5 ppm gave 65.88 per cent inhibition over control and 86.67 per cent inhibition at 200 ppm. Brassicol was found to inhibit the growth of Rhizopus stolonifer by 91.76 per cent at 500 ppm and at 3000 ppm itself it gave 100 per cent inhibition. The percentage inhibition over control at 500 ppm of Captan was 88.62 and at 4000 ppm the inhibition reached 100 per cent. Difolatan at 500 ppm, gave 61.96 per cent inhibition and was 82.94 per cent at 4000 ppm. The inhibitory effect of Dithane M-45 was 69.21 per cent at 500 ppm and it has reached 83.14 per cent at 4000 ppm. Dithane Z-78 gave 62.35 per cent inhibition at 500 ppm and at 4000 ppm, the per cent inhibition has increased to 77.65

Table 5(j). Effect of fungicides on the growth of *Penicillium* sp.

Sl. No.	Treatment	Concentration of fungicides (ppm)	*Mean radial growth (mm)	Per cent inhibition over control
1.	Aureofungin Sol	12.50	18.67	78.04
		25.00	18.00	78.82
		50.00	4.33	94.91
		100.00	4.33	94.91
		200.00	—	100.00
2.	Brassicol	500	42.50	50.00
		1000	40.00	52.94
		2000	39.00	54.12
		3000	37.50	55.88
		4000	34.33	59.61
3.	Captan	500	21.33	74.91
		1000	18.83	77.85
		2000	17.66	79.22
		3000	15.33	81.96
		4000	12.17	85.68
4.	Difolatan	500	42.33	50.20
		1000	34.00	60.00
		2000	31.00	63.53
		3000	29.00	65.88
		4000	24.33	71.38
5.	Dithane M-45	500	26.50	68.82
		1000	18.50	78.24
		2000	16.17	80.98
		3000	15.00	82.35
		4000	12.00	85.89
6.	Dithane Z-78	500	21.67	74.51
		1000	19.00	77.65
		2000	12.50	85.29
		3000	10.67	87.45
		4000	6.00	92.94
7.	Thiride	500	10.00	88.24
		1000	7.33	91.38
		2000	6.33	92.55
		3000	3.67	95.68
		4000	—	100.00
8.	Control	—	85.00	—

* Average of 3 replications

C.D (0.05) for comparison between fungicides = 0.471

C.D (0.05) for comparison between levels of fungicides = 1.054

C.D (0.05) for comparison between fungicides and control = 0.814

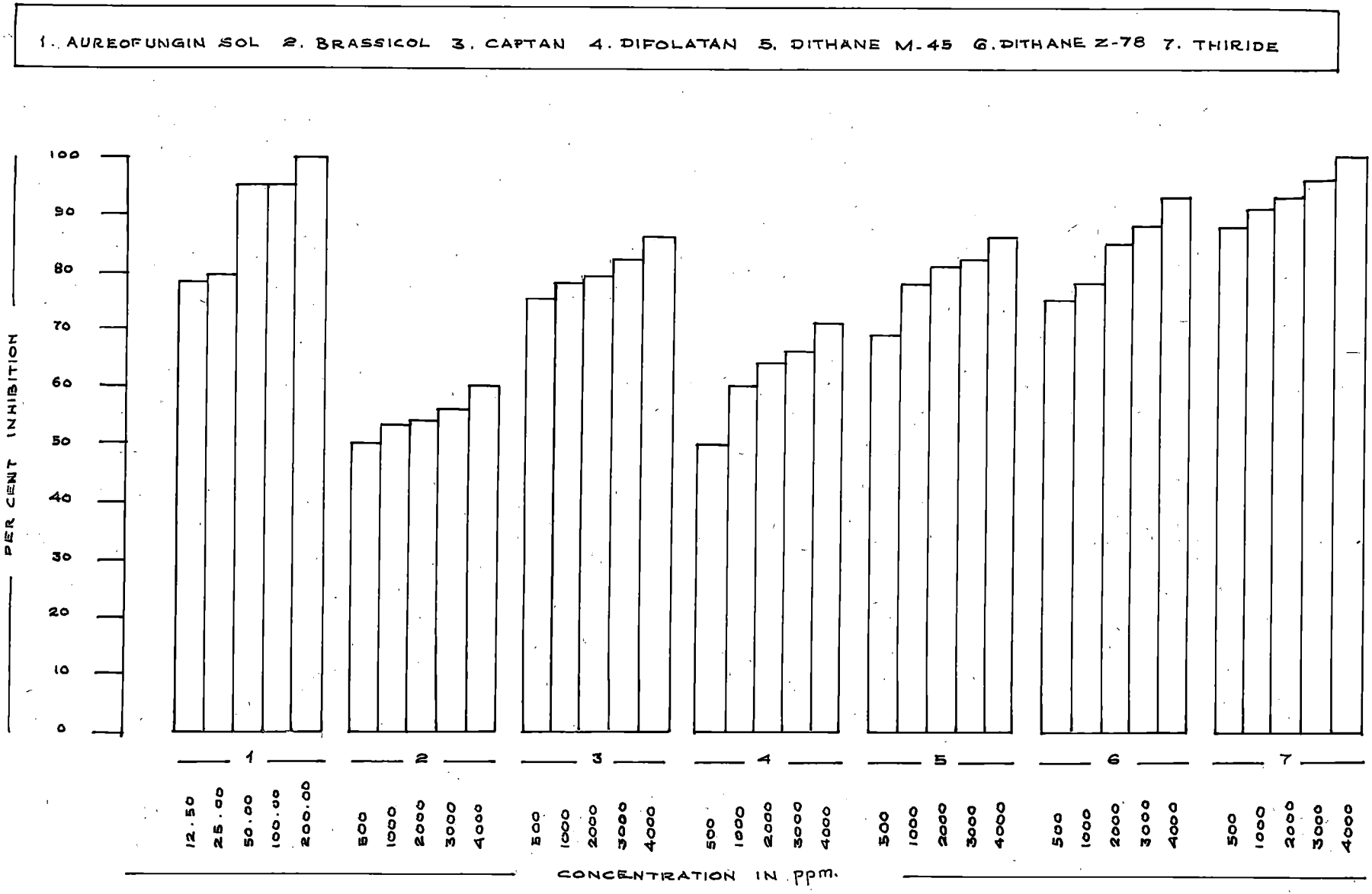


FIG: 11. EFFECT OF FUNGICIDES ON THE GROWTH OF *Penicillium sp:*

Table 5(k). Effect of fungicides on the growth of *Rhizopus stolonifer*

Sl. No.	Treatment	Concentration of fungicides (ppm)	*Mean radial growth (mm)	Per cent inhibition over control
1.	Aureofungin Sol	12.50	29.00	65.88
		25.00	27.83	67.26
		50.00	21.50	74.71
		100.00	18.00	78.82
		200.00	11.33	86.67
2.	Brassicol	500	7.00	91.76
		1000	3.50	95.88
		2000	2.00	97.65
		3000	—	100.00
		4000	—	100.00
3.	Captan	500	9.67	88.62
		1000	7.67	90.98
		2000	4.50	94.71
		3000	2.00	97.65
		4000	—	100.00
4.	Difolatan	500	32.33	61.96
		1000	30.67	63.92
		2000	22.00	74.12
		3000	16.67	80.39
		4000	14.50	82.94
5.	Dithane M-45	500	26.17	69.21
		1000	23.17	72.74
		2000	23.17	72.74
		3000	18.17	78.62
		4000	14.33	83.14
6.	Dithane Z-78	500	32.00	62.35
		1000	28.50	66.47
		2000	25.83	69.61
		3000	22.67	73.33
		4000	19.00	77.65
7.	Thiride	500	6.67	92.15
		1000	4.00	95.29
		2000	—	100.00
		3000	—	100.00
		4000	—	100.00
8.	Control	—	85.00	—

* Average of 3 replications
C.D (0.05) for comparison between fungicides = 0.550
C.D (0.05) for comparison between levels of fungicides = 1.230
C.D. (0.05) for comparison between fungicides and control = 0.953

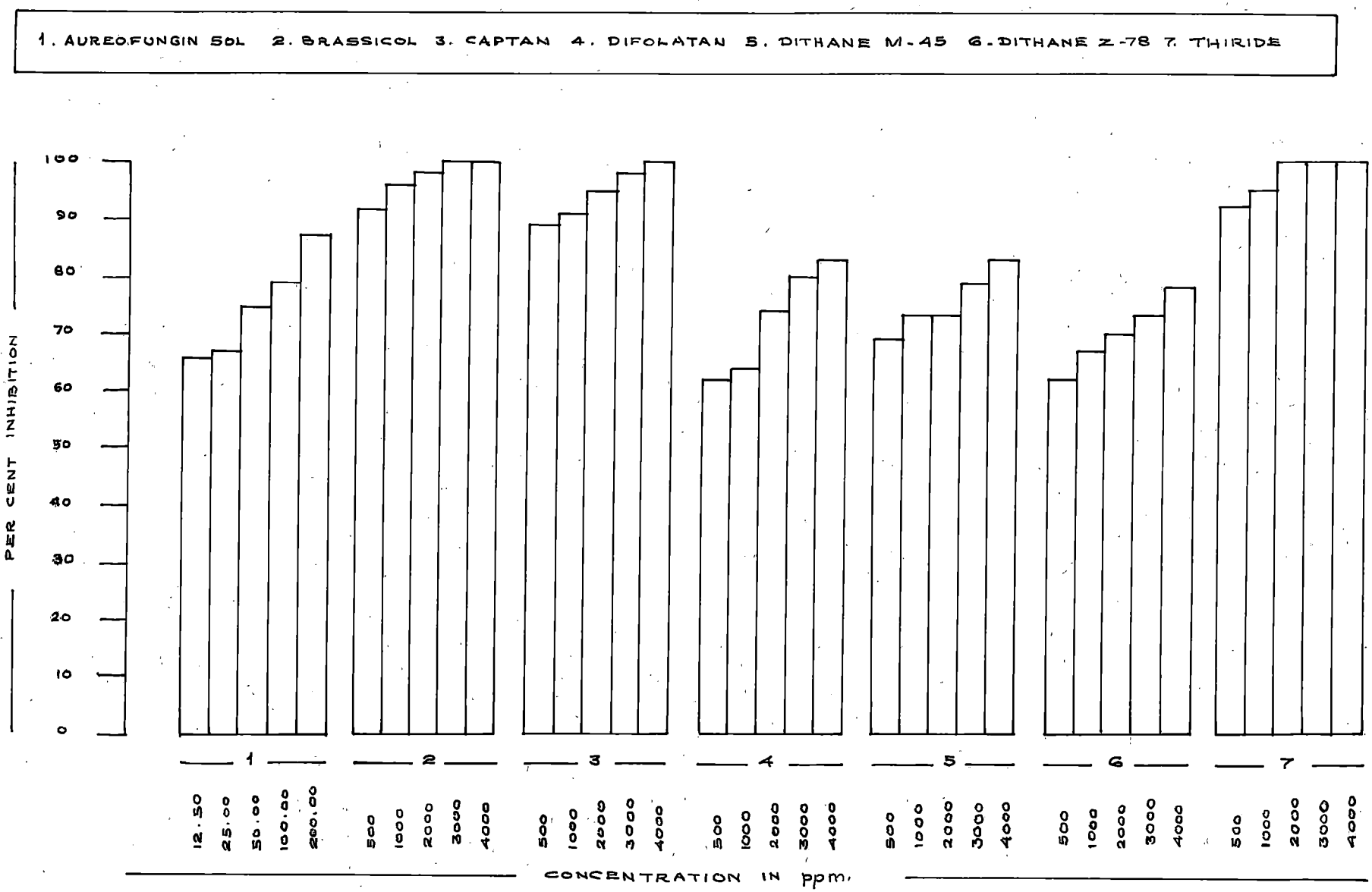


FIG: 12. EFFECT OF FUNGICIDES ON THE GROWTH OF *Rhizopus stolonifer*

Thiride was found to inhibit the growth of Rhizopus stolonifer by 92.15 per cent at 500 ppm and at 2000 ppm itself it gave 100 per cent inhibition (Table 5 k, Fig. 12).

In pooled analysis, it was found that the effect of Aureofungin sol in inhibiting the growth of seed-borne fungi, over control was 67 per cent at 12.5 ppm and it reached 91 per cent at 200 ppm. The effect of Brassicol at 500 ppm, was 56 per cent inhibition over control, and at 4000 ppm, it was 78 per cent . The inhibitory effect of Captan on the growth of seed-borne fungi was 75 per cent at 500 ppm and it reached 89 per cent at 4000 ppm. The inhibition caused by 500 ppm of Difolatan was 72 per cent and it became 89 per cent at 4000 ppm of the fungicide. In the case of Dithane M-45, 500 ppm of the fungicide gave 58 per cent inhibition and a maximum of 78 per cent inhibition was obtained at 4000 ppm. Dithane Z-78 was found to inhibit the growth of seed-borne fungi by 59 per cent at 500 ppm and at 4000 ppm there was 89 per cent inhibition. The inhibitory effect of Thiride was 90 per cent at 500 ppm and this has increased to 99 per cent at 4000 ppm (Table 5 l).

6. Effect of storage conditions on the germination of seeds.

1. Storage in different containers

The effect of storage of the seeds in different containers on the germination of seeds was determined as

Table 5(1). Effect of fungicides on the growth of seed-borne fungi.

Sl. No.	Treatment	Concentration of fungicides (ppm)	*Mean radial growth (mm)	Per cent inhibition over control
1.	Aureofungin Sol	12.5	28.47	67.00
		25	25.89	70.00
		50	18.06	79.00
		100	11.62	86.00
		200	8.01	91.00
2.	Brassicol	500	37.50	56.00
		1000	32.44	62.00
		2000	27.11	68.00
		3000	21.20	75.00
		4000	18.70	78.00
3.	Captan	500	31.44	75.00
		1000	17.09	80.00
		2000	13.88	84.00
		3000	11.62	86.00
		4000	9.47	89.00
4.	Difolatan	500	23.85	72.00
		1000	18.20	79.00
		2000	14.27	83.00
		3000	12.08	86.00
		4000	9.14	89.00
5.	Dithane M-45	500	36.00	58.00
		1000	29.68	65.00
		2000	26.85	68.00
		3000	23.11	73.00
		4000	18.52	78.00
6.	Dithane Z-78	500	34.83	59.00
		1000	32.76	61.00
		2000	22.88	73.00
		3000	16.82	81.00
		4000	9.65	89.00
7.	Thiride	500	8.11	90.00
		1000	5.35	94.00
		2000	2.91	97.00
		3000	1.80	98.00
		4000	0.64	99.00
8.	Control	—	85	—

* Average of 3 replications

C.D (0.05) for comparison between fungicides = 5.33

C.D (0.05) for comparison between fungicides =11.92

C.D (0.05) for comparison between fungicides and control = 9.23

described under materials and methods (Table 6).

(a) Amaranthus

In the case of amaranthus the per cent germination before storage was 93.50. After three months of storage, a maximum of 92.5 per cent germination was observed in the case of tin containers and a minimum of 15 per cent germination was observed in seeds stored in paper bags (Fig.13a). After six months of storage, the germination percentages were 90 and 15 respectively.

(b) Bhindi

The per cent germination of bhindi seeds before storage was 90. After three months, seeds stored in earthen pots and cloth bags gave the maximum germination of 60 per cent and a minimum of 35 per cent was observed with seeds in gunny bags (Fig.13a). After six months, the percentage of germination in the above cases were 55, 50 and 15 respectively.

(c) Bitter gourd

In bitter gourd seeds the per cent germination was 92 before storage. After three months of storage the maximum germination percentage was 85, observed in seeds stored in paper bags and a minimum of 10 per cent in the case of gunny bags (Fig. 13a). After six months, the germination percentage of seeds stored in paper bags was 65 and in gunny bag it was 10.

(d) Brinjal

The germination percentage of the seeds of brinjal before storage was 80. After three months of storage, a maximum of 60 per cent germination was obtained in the case of seeds stored in earthen pots and a minimum of 25 per cent germination was observed with seeds in paper bags (Fig.13 a). After six months of storage, the maximum germination of 35 per cent was found in seeds stored in earthen pots and minimum per cent germination of 10 was observed both in seeds stored in gunny bags and paper bags.

(e) Cowpea

The percentage of germination of cowpea seeds before storage was 85. After three months of storage, a maximum of 65 per cent germination was observed in seeds stored in cloth bags and the minimum per cent germination of 40 was observed in seeds stored both in paper bags and gunny bags (Fig. 13 b). After six months of storage, the maximum and minimum percentages of germination were 40 and 10 respectively.

(f) Cucumber

The germination percentage of cucumber seeds before storage was 95. After three months of storage, a maximum percentage of germination of 80 was observed in seeds stored in earthen pots and paper bags, while a minimum percentage of germination of 50 was observed in seeds stored in gunny bags (Fig. 13b). After six months, the maximum percentage of germination was found to be only 65 observed in seeds stored in earthen pots and the percentage was 60 in the case of

seeds stored in paper bags. The minimum percentage of germination was 25, which was observed in seeds stored in tin containers and polythene bags.

(g) Snake gourd

There was 100 per cent germination in snake gourd seeds before storage. After three months of storage, a maximum percentage of germination of 80 was observed in seeds stored in tin containers. The minimum percentage of germination was 15 observed in seeds stored in gunny bags (Fig. 13 b). After six months, the maximum percentage of germination was only 45 and it was observed in seeds stored in tin containers. The minimum percentage of germination in this case was found to be 5 and this was observed in seeds stored in polythene bags as well as in gunny bags.

(h) Tomato

The germination percentage of tomato seeds before storage was 90. After three months of storage, the maximum percentage of germination obtained was 70 found in seeds stored in cloth bags. The minimum percentage of germination was found to be 40 and it was observed in seeds stored in polythene bags (Fig. 13b). After six months storage, the maximum germination percentage was found to be only 55 per cent which was observed in seeds stored in cloth bags. The minimum percentage of germination after six months of storage was found to be 20, observed in the case of seeds stored both in paper bags and in gunny bags.

Table 6. Effect of storage of vegetable seeds in different types of containers (The figures indicate the per cent germination of seeds).

Vegetable	Before storage	After 3 months						After 6 months					
		Tin containers	Polythene bags	Earthen pots	Paper bags	Cloth bags	Gunny bags	Tin Containers	Polythene bags	Earthen pots	Paper bags	Cloth bags	Gunny bags
Amaranthus	93.5	92.5	40	35	15	82.5	40	90	20	20	15	80	35
Bhindi	80	40	45	60	50	60	35	30	40	55	30	50	15
Bitter gourd	92	40	50	30	85	60	10	30	25	10	65	40	10
Brinjal	80	57.5	55	60	25	55	27.5	30	25	35	10	30	10
Cowpea	85	55	60	55	40	65	40	30	35	30	10	40	10
Cucumber	95	70	70	80	80	75	50	25	25	65	60	40	35
Snake gourd	100	80	20	70	65	60	15	45	5	40	10	20	5
Tomato	90	67.5	40	60	45	70	45	35	25	35	20	55	20

ii. Indigenous methods of storage of seeds

The effect of various indigenous methods of seed storage on the germination of the seeds was found out (Table 7).

(a) Amaranthus

The seeds of amaranthus were found to have a germination percentage of 93 before storage in this method. Storage of seeds of amaranthus for three months in ash gave a maximum of 70 per cent germination followed by that in coconut pith, saw dust and sand, viz., 67.50, 57.50 and 50 per cent, respectively (Fig. 13 a). After six months of storage, the germination percentages were 45, 60, 30 and 35 in the case of seeds stored in ash, coconut pith, saw dust and sand respectively.

(b) Bhindi

The germination percentage of bhindi seeds before storage was 80. Storage of the seeds for three months in sand gave 65 per cent germination, followed by that in coconut pith which gave 55 per cent germination. When stored in ash and in saw dust there was only 40 per cent germination (Fig. 13a). After six months of storage, the germination percentages were 45 in the case of seeds stored in sand and in coconut pith, 25 per cent in ash and 20 per cent in saw dust.

(c) Bitter gourd

The germination percentages of bitter gourd seeds before storage was 92. The percentages of germination of bitter gourd

seeds stored in the different materials for three months were 66.67 for seeds stored in sand, 33.33 per cent in coconut pith and in ash and 25 per cent for seeds stored in saw dust (Fig. 13a). The corresponding percentages after six months of storage were 30.77, 30.50, 10 and 15.77 respectively.

(d) Brinjal

Brinjal seeds also had a germination percentage of 80 before storage. The seeds stored in coconut pith gave a maximum of 65 per cent germination followed by that stored in sand which was only 55 per cent after three months of storage. When stored in ash and in saw dust the germination percentages were 47.50 and 37.50 respectively (Fig. 13 a). After six months, the germination percentages of seeds stored in cocnut pith, sand, ash and saw dust were 50, 35, 27.50 and 30 respectively.

(e) Cowpea

Cowpea seeds had a germination percentage of 85 before storage. Storing cowpea seeds in ash gave a maximum of 80 per cent germination followed by 50 per cent for seeds in saw dust, in coconut pith and in sand, after three months (Fig. 13 b). The effect of these treatments after six months were 45 per cent germination for seeds stored in ash, 25 per cent for seeds stored in saw dust and in coconut pith and the germination percentage was only 20 in the case of seeds stored in sand.

(f) Cucumber

The germination percentage of cucumber seeds before storage was 95. Cucumber seeds after three months storage in sand gave maximum germination of 80 per cent, followed by 55 per cent in the case of seeds stored in saw dust, in coconut pith and in ash (Fig. 13 b). The above treatments, after six months gave 50, 30, 30 and 25 per cent germination, respectively.

(g) Snake gourd

The seeds of snake gourd were having a germination percentage of 100 before storage. Three months of storage of snake gourd seeds in ash, coconut pith, sand and saw dust gave 100 per cent, 80 per cent, 45 per cent and 40 per cent germination, respectively Fig. 13 b). After six months of storage, the corresponding percentages of germination were 60, 55, 40 and 40 respectively.

(h) Tomato

The germination percentage of tomato seeds before storage was 90. The percentages of germination of the seeds after three months storage in sand, ash, saw dust and coconut pith were 60, 50, 45 and 40 respectively (Fig. 13 b). and after six months the percentages were 30, 35, 30 and 25 respectively (Table 7).

Table 7. Effect of indigenous methods of storage of vegetable seeds. (The figures indicate the per cent germination of seeds).

Vegetable	Before storing	After 3 months				After 6 months			
		Ash	Saw dust	Coco-nut pith	Sand	Ash	Saw dust	Coco-nut pith	Sand
Amaranthus	93	70	57.5	67.5	50	45	30	60	35
Bhindi	80	40	40	55	65	25	20	45	45
Bitter gourd	92	33.33	25	33.33	66.67	10	15.77	30.5	30.77
Brinjal	80	47.5	37.5	65	55	27.5	30	50	35
Cowpea	85	80	50	50	50	45	25	25	20
Cucumber	95	55	55	55	80	25	30	30	50
Snake gourd	100	100	40	80	45	60	40	55	40
Tomato	90	50	45	40	60	35	30	25	30

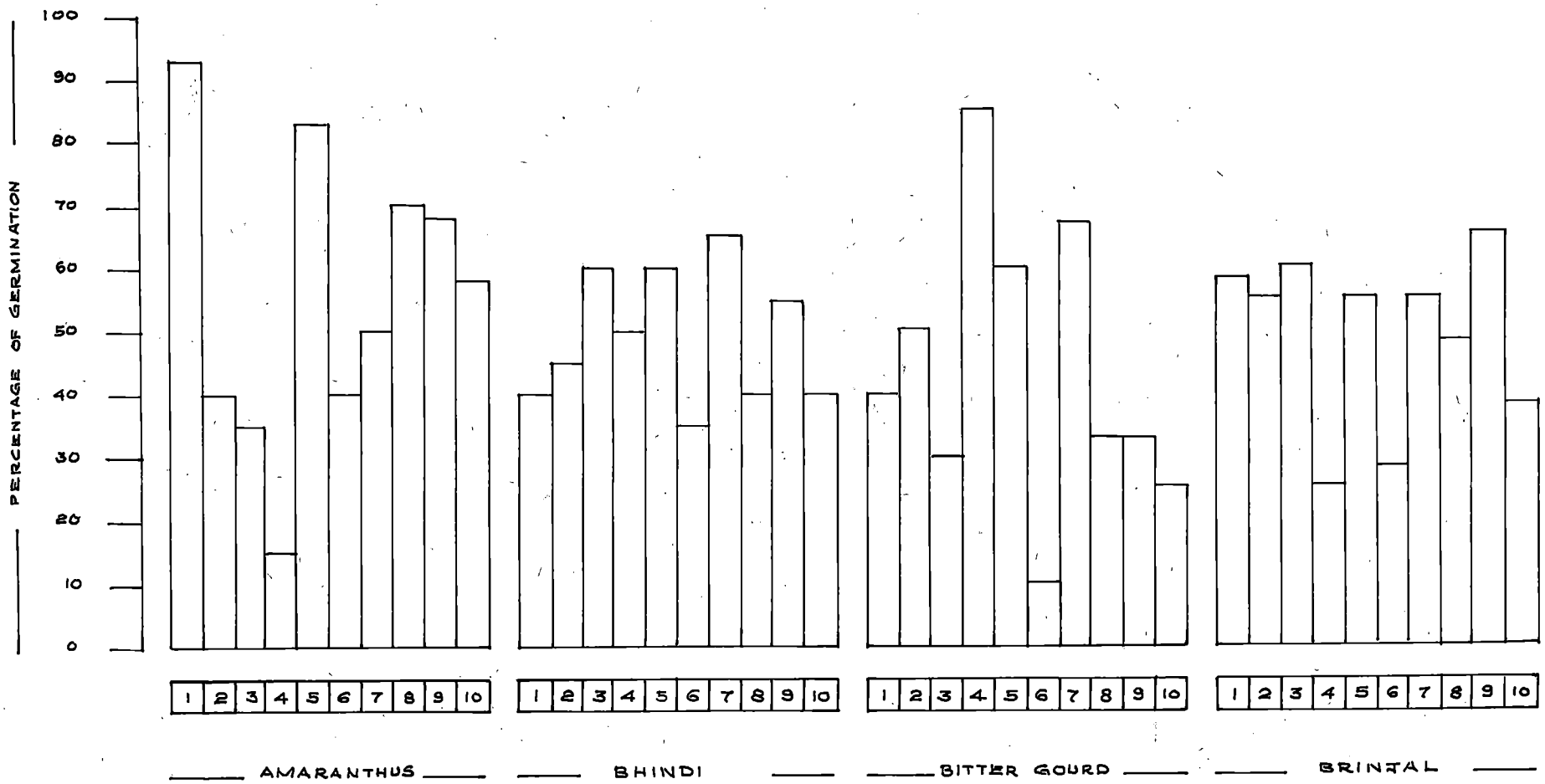


FIG: 13 (a) GERMINATION PERCENTAGE OF VEGETABLE SEEDS STORED UNDER DIFFERENT CONDITIONS

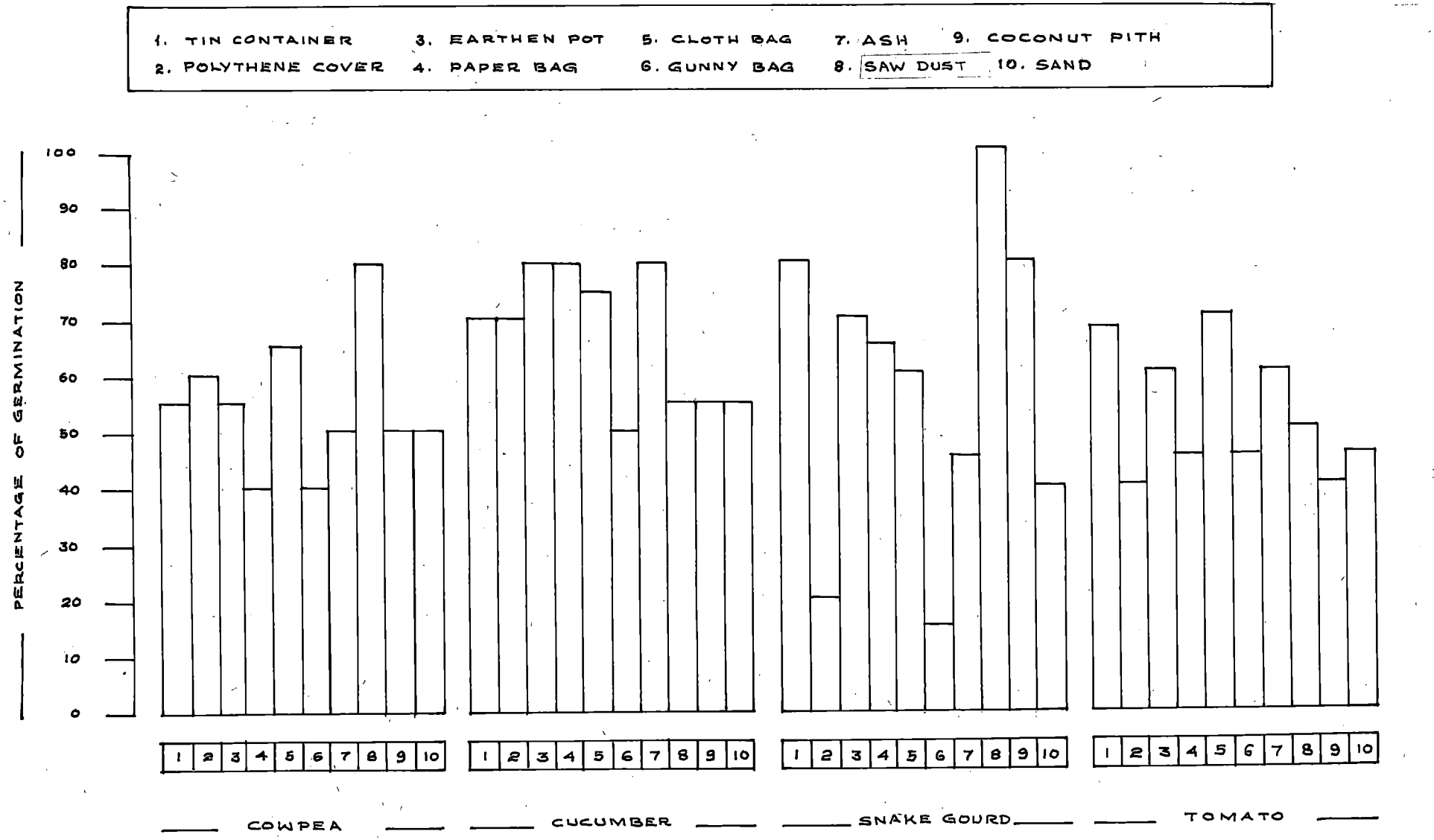


FIG: 13 (b) GERMINATION PERCENTAGE OF VEGETABLE SEEDS STORED UNDER DIFFERENT CONDITIONS

7. Effect of storage conditions on the moisture content of seeds.

The percentages of moisture present in the seeds stored in the above two cases were found out.

i. Bhindi

The moisture content in bhindi seeds before storage was 17.42 per cent. When stored for three months in earthen pots, these seeds had the highest moisture content of 15.43 per cent followed by 14.79 per cent in seeds stored in tin containers and the lowest moisture content was 7.33 per cent in seeds stored in gunny bags. After six months of storage the moisture content decreased in all the cases and it was only 12.43 per cent in seeds stored in earthen pots, 10.73 per cent in seeds stored in tin containers and 5.33 per cent in seeds stored in gunny bags (Table 8 a). The moisture percentages of bhindi seeds stored in sand, ash, coconut pith and saw dust were 16.33, 14.33, 14.25, 14.00 respectively, after three months of storage. After six months, the moisture percentages were 15.24, 11.33, 13.08, and 7.85 respectively (Table 8 b).

ii. Bitter gourd

The percentage of moisture in bitter gourd seeds before storage was 10.71 per cent. The highest moisture content of bitter gourd seeds after three months of storage was 9.95 per cent in those stored in tin containers and the lowest moisture content was found to be 8.82 per cent in seeds

stored in polythene bags. The highest and lowest moisture content after six months were 9.19 and 6.99 per cent for seeds stored in tin containers and gunny bags respectively (Table 8 a). After three months of storage in sand, coconut pith, ash and saw dust, the moisture percentages were found to be 9.05, 8.85, 8.79 and 8.25, respectively. The percentages of moisture after six months of storage were 7.87, 7.37, 7.03 and 7.33, respectively (Table 8 b).

iii. Brinjal

Brinjal seeds had 8.00 per cent moisture before storage. After three months of storage, the seeds in earthen pots had the maximum moisture content of 7.80 per cent and the minimum was 3.20 per cent found in seeds in gunny bags. After six months the moisture content were 7.60 and 3.00 per cent, respectively (Table 8 a). The seeds of brinjal stored for three months in coconut pith, sand, saw dust and ash had 7.80, 6.90, 6.77 and 6.33 per cent moisture, respectively. After six months, the moisture percentages were 6.80, 6.50, 6.00 and 5.80 respectively (Table 8 b).

iv. Cowpea

Cowpea seeds had a moisture content of 17.45 per cent before storage. The seeds stored in cloth bags had the highest moisture content of 13.79 per cent and the lowest moisture content was 7.00 per cent in seeds stored in paper bags, after three months of storage. The moisture

content of seeds after six months of storage in cloth bags was 7.22 per cent and that of seeds in paper bags was only 2.25 per cent (Table 8 a). The seeds after three months of storage in ash, sand, coconut pith and saw dust had 16.33, 8.21, 8.05 and 7.99 per cent respectively. After six months, the moisture content were 7.35, 5.22, 6.33 and 6.15 per cent, respectively (Table 8 b).

v. Cucumber

There was 10.20 per cent moisture in cucumber seeds before storage. When these seeds were stored for three months, the highest moisture content of 9.40 per cent was found in the seeds stored in earthen pots and it was only 3.22 per cent in the case of seeds stored in tin containers. After six months, the corresponding moisture content were 8.50 and 3.00 per cent, respectively (Table 8 a). The seeds stored for three months in sand, coconut pith, saw dust and ash had 9.25, 7.44, 7.35 and 7.22 per cent, respectively. After six months the corresponding values were 7.22, 4.68, 4.50 and 4.24 per cent, respectively (Table 8 b).

vi. Snake gourd

In the case of Snake gourd seeds the moisture content before storage was 12.05. After three months of storage a moisture content of 10.61 per cent was found in seeds stored in tin containers and a moisture content of 9.33 per cent was found in seeds stored in gunny bags. After six months

of storage, the highest and the lowest moisture percentages were 8.55 and 6.25 for seeds in tin containers and polythene bags, respectively (Table 8 a). The moisture percentages of snake gourd seeds stored in ash coconut pith, sand, and saw dust were 12.00, 10.62, 8.85 and 7.80, respectively. After six months of storage, the corresponding moisture percentages were 9.38, 9.30, 7.73 and 7.78, respectively (Table 8 b).

vii. Tomato

The moisture content of tomato seeds before storage was 7.80 per cent. After three months of storage, the highest moisture content of 7.67 per cent was found in seeds stored in cloth bags and 4.77 per cent moisture found in seeds stored in paper bags. The highest and lowest moisture content after six months were 7.22 and 6.11 per cent for seeds in cloth bags and gunny bags, respectively (Table 8 a). When these seeds were stored for three months in sand, ash, saw dust and coconut pith had 7.33, 6.25, 4.98 and 4.22 per cent moisture respectively. After six months the corresponding moisture percentages were 4.31, 4.70, 4.33 and 4.11 respectively (Table 8 b).

8. Effect of culture filtrates of seed mycoflora on the germination of certain vegetable seeds.

The culture filtrates of the fungi were found to exert inhibitory effects on the germination of seeds of amaranthus, bhindi, brinjal, chillies, cowpea and cucumber.

Table 8(a). Percentage of moisture of seeds stored under different conditions.

Vegetable	Before storing	After 3 months						After 6 months					
		Tin container	Polythene bags	Earthen pots	Paper bags	Cloth bags	Gunny bags	Tin-container	Polythene bags	Earthen pots	Paper bags	Cloth bags	Gunny bags
Bhindi	17.42	14.79	10.56	15.43	14.37	11.33	7.33	10.73	10.38	12.43	11.33	10.88	5.33
Bitter gourd	10.71	9.95	8.82	9.05	9.79	9.00	8.85	9.19	8.33	7.39	8.87	8.69	6.99
Brinjal	8.00	7.00	6.80	7.80	6.50	6.90	3.20	6.00	6.33	7.60	5.00	6.88	3.00
Cowpea	17.45	7.60	12.14	9.20	7.00	13.79	7.22	5.25	7.14	5.29	2.25	7.22	3.00
Cucumber	10.20	3.22	7.33	9.40	9.33	7.50	6.80	3.00	4.33	8.50	8.00	7.22	6.25
Snake gourd	12.05	10.61	9.40	9.89	9.47	9.38	9.33	8.55	6.25	7.73	7.33	6.71	6.61
Tomato	7.80	7.50	5.00	7.30	4.77	7.67	4.89	7.11	4.99	6.80	4.22	7.22	4.11

Table 8(b). Percentage of moisture of seeds stored under different conditions.

Vegetable	Before storing	After 3 months				After 6 months			
		Ash	Saw dust	Coco-nut pith	Sand	Ash	Saw dust	Coco-nut pith	Sand
Bhindi	17.42	14.33	14.00	14.25	16.33	11.33	7.85	13.00	15.24
Bitter gourd	10.71	8.79	8.25	8.85	9.05	7.03	7.33	7.37	7.87
Brinjal	8.00	6.33	6.77	7.80	6.90	5.80	6.00	6.80	6.50
Cowpea	17.45	16.33	7.99	8.05	8.21	7.35	6.15	6.33	5.22
Cucumber	10.20	7.22	7.35	7.44	9.25	4.24	4.50	4.68	7.22
Snake gourd	12.05	12.00	7.80	10.62	8.85	9.38	7.78	9.30	7.73
Tomato	7.80	6.25	4.98	4.22	7.33	4.70	4.33	4.11	4.31

The culture filtrate of Achaetomium macrosporum was found to exert highest inhibition of 100 per cent in brinjal and chilli seeds and the lowest being 25 per cent in cucumber seeds. The culture filtrate of Aspergillus flavus caused 100 per cent inhibition in brinjal and chilli seeds and a minimum of 25 per cent in bhindi seeds. It was found that the culture filtrate of Aspergillus niger exerted 100 per cent inhibition in amaranthus, bhindi, brinjal and cucumber seeds followed by 83.33 per cent in chilli seeds and 80 per cent in cowpea seeds. The culture filtrate of Aspergillus ochraceus showed 100 per cent inhibition in germination of amaranthus and brinjal seeds followed by 93.75 per cent in bhindi seeds, 90 per cent in cucumber seeds and a minimum of 50 per cent in cowpea seeds.

With the culture filtrate of Botryodiplodia theobromae the inhibition was highest in brinjal seeds, being 81.25 per cent and lowest in cucumber seeds being 5 per cent. The culture filtrate of Cephalosphora irregularis caused maximum inhibition in germination of 100 per cent in amaranthus seeds and cucumber seeds, and lowest in bhindi seeds, being 62.5 per cent. The culture filtrate from Colletotrichum lagenarium showed a maximum of 65 per cent inhibition in germination of amaranthus seeds and the minimum was 10 per cent in cucumber seeds. The inhibition was highest in brinjal and cucumber seeds with the culture filtrate of Curvularia lunata being 100 per cent and lowest in bhindi seeds being 37.5 per cent.

The culture filtrate of Drechslera rostrata was found to exCert highest inhibition of 85 per cent in cucumber seeds and the lowest being 25 per cent in bhindi seeds. With the culture filtrate of Fusarium equiseti the inhibition in germination was highest in amaranthus seeds and cucumber seeds being 70 per cent and lowest inhibition of 45 per cent was found in cowpea seeds. The inhibition of germination with the culture filtrate of Fusarium oxysporum was highest in brinjal seeds, being 100 per cent andlowest in cowpea seeds being 10 per cent. The culture filtrate of Fusarium solani showed 100 per cent inhibition of germination in chilli seeds followed by 93.5 per cent in brinjal seeds and a minimum of 25 per cent in bhindi seeds.

The culture filtrate of Myrothecium roridum caused an inhibition of 100 per cent in brinjal seeds and lowest in cucumber seeds being 5 per cent. The culture filtrate of Nectria haematococca caused maximum inhibition of 60 per cent in cucumber seeds and lowest being 20 per cent in bhindi seeds. The culture filtrate of Penicillium sp. showed 100 per cent inhibition in germination of all vegetable seeds tested namely, amaranthus, bhindi, brinjal, chillies, cowpea and cucumber. The culture filtrate of Rhizopus stolonifer caused 80 per cent inhibition in cucumber seeds and a minimum of 20 per cent in amaranthus seeds (Table 9).

Table 9. Per cent inhibition of germination of vegetable seeds treated with culture filtrate of different seed-borne fungi.

Treatments	Amaranthus	Bhindi	Brinjal	Chillies	Cowpea	Cucumber
Achaetomium macrosporum	85	93.50	100	100	60	25
Aspergillus flavus	80	25	100	100	60	35
Aspergillus niger	100	100	100	83.33	80	100
Aspergillus ochraceus	100	93.75	100	88.89	50	90
Botryodiplodia theobromae	45	25	81.25	50	25	5
Cephaliophora irregularis	100	62.50	68.75	72.22	75	100
Colletotrichum lagenarium	65	37.50	43.75	55.56	45	10
Curvularia lunata	90	37.50	100	88.89	80	100
Drechslera rostrata	65	25	31.25	55.56	40	85
Fusarium equiseti	70	56.25	68.75	66.67	45	70
Fusarium oxysporum	55	75	100	44.44	10	85
Fusarium solani	45	25	93.50	100	65	80
Myrothecium roridum	55	62.50	100	72.22	30	5
Nectria haematococca	45	20	50	44.44	25	60
Penicillium sp.	100	100	100	100	100	100
Rhizopus stolonifer	20	25	31.25	50	25	80
Control (Distilled water)	100	80	80	90	100	100

Discussion

DISCUSSION

1. Seed mycoflora and their effect on seeds and seedlings

The survey of the seed mycoflora of common vegetables of Kerala during two seasons revealed the presence of a number of seed-borne fungi. Storage fungi like *Aspergillus flavus*, *Aspergillus niger*, *Fusarium* spp. *Penicillium* sp. and *Rhizopus stolonifer* were found to be externally as well as internally seed-borne on almost all vegetable seeds taken for the study (Table 1).

In the present study seven fungi were obtained from amaranthus seeds (Table 1). A perusal of literature revealed that so far only *Alternaria amaranthi* has been reported from the seeds of amaranthus (Venkatakrishnaiah, 1952). All the fungi obtained in the present study were new records on amaranthus seeds. A total number of five species of fungi were isolated from bhindi seeds (Table 1). Of these, the seed-borne nature of *Fusarium oxysporum* f. sp. *vasinfectum* (Nobbs *et al*., 1972 and Gangopadhyay and Kapoor, 1976) and *Aspergillus* spp. and *Rhizopus* spp. on bhindi (Suryanarayana and Bhamba, 1961) were reported earlier. Apart from these *Chaetomium roflexum* (Skolko and Groves, 1948), *Ascochyta abelmoschi* (Silveira, 1950), *Colletotrichum hibisci* (Hu and Hou, 1956), *Botrytis* sp. (Peres and Summers, 1963) and *Corticium solani* (Suryanarayana *et al*., 1963) were also reported from bhindi seeds. It was found that *Botryodiplodia*

theobromae and Nectria haematococca isolated during the present studies were new reports on bhindi seeds. Fusarium oxysporum has been recorded already from the rhizosphere of bhindi plants in India (Rao and Mukerji, 1972). The study by Robbs et al. (1972) revealed the potential damage of this fungus as a threat to bhindi cultivation by its seed-borne nature. Detection of this as a seed-borne fungus of bhindi in the present study also adds evidence to this potential danger.

In the present investigation seven fungi were isolated from bitter gourd seeds (Table 1). All these fungi are found to be new reports on bitter gourd seeds. From brinjal seeds, Aspergillus flavus, Aspergillus niger, Aspergillus ochraceus and Rhizopus stolonifer were isolated (Table 1). Manoharachary et al. (1975), isolated Aspergillus spp. and Rhizopus arrhizus from brinjal seeds. Apart from these many other fungi were already reported from brinjal viz., Rhizoctonia solani (Baker, 1947), Phomopsis vexans (Silveira, 1950 and Suryanarayana and Shombe, 1961), Verticillium albo-atrum (Cox, 1956), Fusarium spp. (Garofalo, 1956), Alternaria tenuis (Kapoor and Mingorani, 1958), Colletotrichum melongena (Markov, 1958) and Helminthosporium spicifernm (Sarode and Kadam, 1974, 1977). Seven species of fungi were isolated from cowpea seeds (Table 1). Sinha and Khare (1977 b) isolated a number of fungi from cowpea seeds including Aspergillus flavus, Aspergillus niger, Penicillium sp.,

Rhizopus stolonifer etc., which were recorded in the present study also. Botryodiplodia theobromae and Drechslera rostrata were found to be new reports on cowpea seeds.

In the present study only Aspergillus flavus was isolated from cucumber seeds (Table 1). The seed mycoflora of cucumber seeds were subjected to detailed study by many other workers and Aspergillus spp. Penicillium spp. and Rhizopus spp. (Khandelwal and Prasada, 1970), Chaetomium funicolum (Skolko and Groves, 1948), Ascochyta hortensis, Colletotrichum lindemuthianum and Phyllosticta cucurbitacearum (Neergaard, 1949) and Colletotrichum lagenarium (Horn et al., 1957) were already recorded. From pumpkin seeds, four species of fungi were isolated (Table 1). Of these Fusarium solani was already reported from pumpkin seeds by Conroy (1953). Apart from this, Trichocladium asperum was isolated from pumpkin seeds by Groves and Skolko (1946). Four species of fungi were isolated from snake gourd seeds (Table 1). There is no earlier report of any seed-borne fungus on snake gourd. All the four fungi detected in the present study are new records on this seed. Aspergillus niger and Rhizopus stolonifer were isolated from tomato seeds (Table 1). Manoharachary et al. (1975) isolated Aspergillus sp. and Rhizopus sp. from tomato seeds. Apart from these Didymella lycopersici (Ogilvie, 1947), Chaetomium spp. (Skolko and Groves, 1948), Alternaria solani and Corticium solani (Hodosy, 1966) were isolated earlier from tomato seeds.

The inhibitory effect of seed mycoflora on the germination of seeds, was in general, more when tested under laboratory conditions. It was found that storage fungi such as Aspergillus flavus, Aspergillus niger, Penicillium sp. and Rhizopus stolonifer resulted in maximum inhibition of germination (Table 2). Similar results were obtained by Suryanarayana and Bhombe (1961) and Fields and King (1962) who found that germinability of pea seeds was reduced by inoculation with species of Aspergillus and Rhizopus. In general the effect of storage fungi on germination of seeds was less pronounced in the pot culture experiments. Hence these fungi were found to cause more damage in the storage conditions than in the field conditions. In the case of other fungi such definite trend was not obtained in the present studies.

In the pot culture experiments it was found that among the different species of Aspergillus, only Aspergillus niger caused rotting in tomato seedlings (Table 3). Suryanarayana (1970) also found that Aspergillus niger caused rotting in groundnut seedlings. Botryodiplodia theobromae caused 41.67, 28.57 and 46.67 per cent inhibition in the germination of bhindi, bitter gourd and cowpea seeds respectively (Table 3). Nath et al. (1970) found that Botryodiplodia theobromae caused seed rot and seedling blight of mung beans, while in the present study Botryodiplodia theobromae was not found to

cause any discernible effect on the seedlings. Cephalophora irregularis inhibited the germination of pumpkin seeds by 100 per cent (Table 3).

Colletotrichum lagenarium isolated from bitter gourd seeds was found to cause 100 per cent inhibition in germination of bitter gourd seeds (Table 3). Gram and Weber (1952) reported that seedlings arising from the seeds of French beans infected by Colletotrichum lagenarium were having linear brown lesions or spots and that the diseased seedlings died ultimately. But in the present studies all the inoculated seeds failed to germinate and this showed that the isolate used in the present study was more deleterious to seeds of bitter gourd. It was found that Drechslera rostrata caused 38.46 per cent inhibition in germination of cowpea seeds and also rotting in 20 per cent of the seedlings (Table 3). In a similar study El Nur and Friegoun (1970) showed that an isolate of Helminthosporium spicifernm was capable of causing root rot and stunting of the seedlings of broad beans.

Fusarium equiseti from amaranthus caused inhibition of germination of seeds and rotting of seedlings. Fusarium oxysporum from bhindi seeds and Fusarium solani from pumpkin seeds were found to cause considerable inhibition in germination of seeds but they did not affect the seedling growth (Table 3). Seed transmission of Fusarium oxysporum f. sp. vasinfectum, causing the wilt disease of bhindi, was reported by Robbs et al. (1972). Seed transmission of

Fusarium spp. was reported in other vegetable crops like pea (Snyder, 1932) and watermelon (Walker, 1952), and it was reported that these caused rotting of seeds and seedlings. Agarwal et al. (1972) also reported that a species of Fusarium was found to be carried on the surface of the seeds of peas and beans and reduced the germination of seeds as well as caused seedling rotting. It was found that Rhizopus stolonifer inhibited the germination of bitter gourd brinjal, cowpea, pumpkin, snake gourd and tomato seeds. It also caused rotting in the case of tomato seedlings. Suryanarayana and Bhambe (1961) found that Rhizopus sp. caused soft rot of vegetables like bitter gourd, brinjal, cucumber, snake gourd and tomato and that the fungus penetrated into the seeds from the attached fruit tissue, remained below the seed coat and resulted in failure of germination of seeds and also in rotting of seedlings produced by germination of affected seeds.

2. Production of aflatoxin by seed mycoflora

Since it is a well known fact that Aspergillus flavus is the principal group of fungus producing aflatoxin (Blount, 1961), a comparative study was undertaken in the present investigation also to test seven different isolates of Aspergillus flavus for the ability to produce aflatoxin. All the seven isolates tested were found to produce aflatoxin (Table 4). Joffe (1969), Schroeder (1969), Lalithakumari et al. (1970), Kang et al. (1971) and Thomson and Mehdy (1978) have proved

that Aspergillus flavus group are the principal producers of aflatoxin. In the present investigations it was found that a maximum quantity of 0.133 ppm of aflatoxin was produced by the isolate of Aspergillus flavus obtained from cucurbitaceous seeds, viz., bitter gourd, cucumber and snake gourd, while the least quantity was produced by isolates from bhindi, brinjal and cowpea and the amaranthus isolate was in between these extremes. Brodnik and Klemenc (1976) found that maize seeds inoculated with four isolates of Aspergillus flavus produced 420, 280, 210 and 500 ppb of aflatoxin.

3. Effect of seed-dressing fungicides on seed mycoflora

In vitro evaluation of fungicides against seed-borne fungi were done in the case of fungi which were found to be pathogenic. Against Aspergillus flavus Aureofungin Sol was found to be not as effective as Thiride, Captan, Difolatan and Dithane M-45, however, it was found to be superior to Brassicol and Dithane Z-78 (Table 5 a). The inhibitory effect of Aureofungin Sol on Aspergillus flavus was reported by Whitehead and Thirumalachar (1971). But in the present studies it was found that even though Aureofungin Sol is inhibitory to Aspergillus flavus it was not as effective as most of the other fungicides tested. Raghavan et al. (1979) during their investigation found that Aureofungin Sol was the most effective antifungal antibiotic against

Botryodiplodia theobromae. But in the present studies it it was found that in the control of Botryodiplodia theobromae. Aureofungin Sol was less effective when compared with other fungicides tested except Dithane M-45 (Table 5 b). Its effect against Cephalosphora irregularis was on par with Captan but superior to Thiride and Difolatan (Table 5 c). The growth of Curvularia lunata was completely checked at 100 ppm and 200 ppm of Aureofungin Sol. On statistical analysis it was found that Aureofungin Sol was less effective when compared with Thirids, but superior to other fungicides namely Dithane Z-78, Dithane M-45, Captan, Difolatan and Brassicol in its inhibitory effect against Colletotrichum lagenarium (Table 5 d), Curvularia lunata (Table 5 e), Myrothecium roridum (Table 5 h) and Penicillium sp. (Table 5 j). Aureofungin Sol was found to be less effective in the control of Drechslera rostrata when compared with other fungicides tested (Table 5, f). It was next to Difolatan and Thiride, however, superior to other fungicides namely Captan, Dithane Z-78, Brassicol and Dithane M-45 in the control of Fusarium equiseti (Table 5 g). In the control of Nectria haematococca it was found to be superior to Dithane M-45 and Dithane Z-78, but its effect was less when compared with other fungicides tested (Table 5 i). Against Rhizopus stolonifer it was found to be superior to Difolatan and Dithane Z-78, but it was less effective when compared with other fungicides tested (Table 5 k).

Brassicol was found to be superior to Dithane Z-78, but less effective when compared with Thiride, Captan, Difolatan, Dithane M-45 and Aureofungin Sol against Aspergillus flavus (Table 5 a). Brassicol was least effective against Cephalosphora irregularis (Table 5 c), Colletotrichum lagenarium (Table 5 d), Curvularia lunata (Table 5 e), Myrothecium roridum (Table 5 h), and Penicillium sp. (Table 5 j) when compared with other fungicides tested. Against Botryodiplodia theobromae (Table 5 b), and Drechslera rostrata (Table 5 f), Brassicol was found to be less effective when compared with Thiride, Difolatan and Dithane - Z-78, however it was superior to Captan, Aureofungin Sol and Dithane M-45. Raghavan and Saksena (1978) found that Brassicol at 0.2 per cent was best for the control of Botryodiplodia theobromae. The inhibitory effect of Brassicol on Fusarium equiseti (Table 5 g) was on par with that of Dithane Z-78, however, superior to Dithane M-45. But all the other fungicides tested were superior to Brassicol in their effect on Fusarium equiseti. Brassicol was next to Thiride and Difolatan in its effect against Nectria haematococca, however superior to other fungicides tested (Table 5 i). Barbu and Veronican (1970) found that Brassicol (0.3 per cent) was best for the control of Nectria radicicola. Grover and Bansal (1970) reported that Colletotrichum capsici in chilli seeds can be very effectively controlled by Brassicol (0.25 per cent). But in the present studies it was not found

to give promising results against Colletotrichum lagenarium, when compared with other fungicides. Against Rhizopus stolonifer, Brassicol ranked next to Thiride, however, it was found to be superior to other fungicides tested (Table 5, k). Frank (1969) showed that seed treatment with Brassicol was best for the control of Rhizopus rot of groundnut seedlings.

Captan was proved to be next to Thiride and superior to Difolatan, Dithane M-45, Aureofungin Sol, Brassicol and Dithane Z-78 in its inhibitory effect against Aspergillus flavus (Table 5 a). Captan at 500 ppm caused 94.12 per cent inhibition on the growth of Aspergillus flavus and it reached 100 per cent at 4000 ppm (Table 5 a). Ashworth et al. (1964) showed that Captan (0.3 per cent) was effective in controlling Aspergillus niger associated with groundnut. In controlling Botryodiplodia theobromae Captan ranked next to Thiride, Difolatan, Dithane Z-78, and Brassicol while it was superior to Aureofungin Sol and Dithane M-45 (Table 5 b). While Raghavan and Saksena (1978) showed that in in vitro tests Captan completely inhibited the growth of Botryodiplodia theobromae. Against Cephaliophora irregularis, Captan was on par with Aureofungin Sol and superior to Dithane M-45, Dithane Z-78 and Brassicol (Table 5 c). In controlling Colletotrichum lagenarium (Table 5 d) and Fusarium equiseti (Table 5 g) in vegetable seeds, Captan was found to be

superior to Dithane M-45, Difolatan and Brassicol, but not so effective as Thiride, Aureofungin Sol and Dithane Z-78. Captan gave 93 per cent inhibition in the growth of Fusarium equiseti at 500 ppm itself and caused 94 per cent inhibition at 4000 ppm (Table 5 g). Sanches (1956) and Harper (1964) found that Captan (0.2 per cent) was best for seed treatment in peas and beans against damping-off and seed decay caused by Fusarium sp. Gangopadhyay and Kapoor (1976) suggested that Captan was effective against Fusarium oxysporum f. sp. pisi in peas. Against Curvularia lunata (Table 5 e) and Myrothecium roridum (Table 5 h) Captan was found to be superior to Difolatan and Brassicol, but less effective when compared with other fungicides tested. It was found to be superior to Aureofungin Sol, Dithane M-45 and Dithane Z-78, against Nectria haematococca (Table 5 i). In the case of Penicillium sp. (Table 5 j) it was superior to Dithane M-45, Difolatan and Brassicol, but less effective when compared with Thiride, Aureofungin Sol and Dithane Z-78. Andreeva (1979) showed that Captan was best for seed treatment against Penicillium spp. Against Rhizopus stolonifer Captan ranked next to Thiride and Brassicol, however, superior to other fungicides tested (Table 5, k). Frank (1969) reported that Captan was effective in seed treatment for the control of Rhizopus rot and Aspergillus rot of groundnut seedlings.

Bedi and Kapoor (1974) suggested that Captan was best for seed treatment in peas against seed-borne fungi. In the present studies also Captan was found to be effective against most of the fungi, but it was least effective against Drechslera rostrata (Table 5 f).

Difolatan was superior to Dithane M-45, Aureofungin Sol and Dithane Z-78, but not so effective as Thiride and Captan, against Aspergillus flavus. Difolatan caused 90.00 per cent inhibition to the growth of Aspergillus flavus at 500 ppm and it reached 100 per cent at 4000 ppm (Table 5 e). Wales and Somers (1968) who suggested that Difolatan was best for the control of Aspergillus flavus in groundnuts. Difolatan ranks next to Thiride, however, superior to other fungicides tested in its effect against Botryodiplodia theobromae (Table 5 b), Drechslera rostrata (Table 5 f) and Nectria haematococca (Table 5 i) Anon. (1971) found that Difolatan (0.2 per cent) was efficient in controlling Botryodiplodia theobromae. In the case of Cephaliophora irregularis (Table 5 c) Difolatan was on par with Thiride and found to be superior to other fungicides tested. Complete inhibition on the growth of Cephaliophora irregularis was obtained with Difolatan and Thiride at all concentrations tested (Table 5 c). Sivaprakasam et al. (1978) found that Difolatan was effective against Colletotrichum capsici while in the present studies Difolatan was found to be not much effective, but superior to Brassicol, when compared with

other fungicides tested against Colletotrichum legenarium (Table 5 d), Curvularia lunata (Table 5 c), Myrothecium roridum (Table 5 h) and Penicillium sp. (Table 5 j). Difolatan was found to be superior to all other fungicides tested against Fusarium equiseti (Table 5 g). At 500 ppm it caused 97.65 per cent inhibition and at 3000 ppm, the per cent inhibition was 100, in the growth of Fusarium equiseti (Table 5 g). Sinha and Khare (1977 a) reported that Difolatan (3000 ppm) was excellent in controlling seed-borne infection of Fusarium equiseti on cowpea. Difolatan was superior to Dithane Z-78, but less effective when compared with other fungicides tested against Rhizopus stolonifer (Table 5 k).

Dithane M-45 was found to be next to Thiride, Captan and Difolatan in its effect against Aspergillus flavus, however, it was superior to Aureofungin Sol, Brassicol and Dithane Z-78 (Table 5 a). Tandon et al. (1976) found that seed treatment with 2000 ppm of Dithane M-45 gave 83 per cent control of Fusarium semitectum in smooth gourd but in the present studies it was least effective in inhibiting the growth of Botryodiplodia theobromae (Table 5 b), Fusarium equiseti (Table 5 g) and Nectria haematococca (Table 5 i), when compared with other fungicides tested. It was found to be superior to Dithane Z-78 and Brassicol but less effective when compared with Thiride, Difolatan, Captan and Aureofungin Sol in inhibiting the growth of

Cephaliophora irregularis (Table 5 c). In inhibiting the growth of Colletotrichum lagenarium (Table 5 d) Myrothecium roridum (Table 5 h) and Penicillium sp.(Table 5 j), Dithane M-45 was next to Thiride and Aureofungin Sol, however superior to Dithane Z-78, Captan, Difolatan and Brassicol. Guzman et al. (1979) showed that Dithane M-45 was effective in controlling Colletotrichum lindemuthianum in beans. It ranked next to Thiride, Aureofungin Sol and Dithane Z-78, while superior to Captan, Difolatan and Brassicol in inhibiting the growth of Curvularia lunata (Table 5 e). Against Drechslera rostrata (Table 5 f) Dithane M-45 was more effective than Captan and Aureofungin Sol, but less effective when compared with Thiride, Difolatan, Dithane Z-78 and Brassicol, while Vir et al. (1970) showed that Dithane M-45 (0.3 per cent) controlled Drechslera spp. in barley and oats. Against Rhizopus stolonifer Dithane M-45 was superior to Aureofungin Sol, Difolatan, Dithane Z-78 but less effective when compared with Thiride, Brassicol and Captan (Table 5 k).

Dithane Z-78 was found to be least effective in inhibiting the growth of Aspergillus flavus, (Table 5 a) Nectria haematococca (Table 5 i) and Rhizopus sp. (Table 5 k). It ranks next to Thiride and Difolatan, among the fungicides tested against Botryodiplodia theobromae (Table 5 b) and Drechslera rostrata (Table 5 f) Pawar and Patel (1978) reported that Dithane Z-78 was effective in inhibiting the growth and

sporulation of Drechslera rostrata. Against Cephalosphora irregularis (Table 5 c) Dithane Z-78 was found to be superior only to Brassicol and less effective when compared with all the other fungicides tested. It was found to be next to Thiride and Aureofungin Sol in inhibiting the growth of Colletotrichum lagenarium (Table 5 d), Curvularia lunata (Table 5 e) and Penicillium sp. (Table 5 j) but superior to Captan, Dithane M-45, Difolatan and Brassicol. Sote et al. (1976) had reported that Dithane Z-78 was effective in eliminating seed-borne infection of Colletotrichum lindemuthianum in field beans. The effect of Dithane Z-78 in inhibiting the growth of Fusarium equiseti (Table 5 g), was on par with Brassicol and superior to Dithane M-45, but not so effective as Difolatan, Thiride, Aureofungin Sol. and Captan. In inhibiting the growth of Myrothecium roridum (Table 5 h) it was superior to Captan, Difolatan and Brassicol but less effective when compared with Thiride, Aureofungin Sol and Dithane M-45.

Thiride was found to be superior to all other fungicides tested in inhibiting the growth of Aspergillus flavus (Table 5 a) Botryodiplodia theobromae (Table 5 b), Cephalosphora irregularis (Table 5 c), Colletotrichum lagenarium (Table 5 d), Curvularia lunata (Table 5 e), Drechslera rostrata (Table 5 f) Myrothecium roridum (Table 5 h), Neotria haematococca (Table 5 i) Penicillium sp. (Table 5 j)

and Rhizopus stolonifer (Table 5 k). Complete inhibition on the growth of Cephaliophora irregularis (Table 5 c) and Colletotrichum lagenarium (Table 5 d) was caused with Thiride at all concentrations tested. Veenenbos (1955), Kaul (1973) and Bedi and Kapoor (1974) suggested that Thiram containing fungicides could be effective in controlling seed-borne fungi of vegetables. Ashworth et al. (1964) reported that Thiram was effective against Aspergillus niger and Mercer and Kisyombe (1978) found it effective against Aspergillus flavus and Penicillium sp. Grover and Bansal, (1970) and Siddique et al. (1977) reported the effectiveness of Thiram in inhibiting the growth of Colletotrichum spp. Sinha and Khare (1977 a) suggested that Fusarium equiseti on cowpea seeds can be effectively controlled by Thiram (3000 ppm). In the present study against Fusarium equiseti, Thiride ranked next to Difolatan but superior to all other fungicides tested. Thiride was found to inhibit the growth of Fusarium equiseti by 90.39 per cent at 500 ppm and it gave 100 per cent inhibition at 2000 ppm itself (Table 5 g).

In pooled analysis, it was found that Thiride was found to be superior to all the other six fungicides tested against seed-borne fungi. Thiride gave more than 90 per cent inhibition over control on the growth of seed-borne fungi, at all concentrations tested. The superiority of Thiride as a seed dressing fungicide especially against vegetable

seeds is already known. Veenenbos (1955), Kaul (1973), and Bedi and Kapoor (1974), suggested that Thiram containing fungicides could be effective in controlling seed-borne fungi of vegetables. Sohi and Rawal (1974) found that seed treatment with 0.3 per cent Thiride was best for the control of Fusarium oxysporum in cowpea. In the present study the effect of Captan was on par with Difolatan and ranked next to Thiride, however superior to other fungicides tested. Bedi and Kapoor (1974) suggested that Captan was best for seed treatment in peas against seed-borne fungi, Sohi and Rawal (1974) found that seed treatment with Difolatan 0.3 per cent was best against Colletotrichum legenerium in cowpea. The effects of Dithane M-45 and Brassicol were on par and they were least effective when compared with other fungicides tested. The present study clearly demonstrates the superiority of tetra methyl thiuram disulphide and heterocyclic nitrogen compounds for the treatment of vegetable seeds (Table 5 1).

Effect of storage conditions on germination and moisture content of seeds.

The seeds of the vegetables, namely, amaranthus, bhindi, brinjal, bitter gourd, cowpea, cucumber, snake gourd and tomato were stored under different conditions, viz., tin containers, polythene bags, cloth bags, earthen pots, gunny bags, paper bags, and also indigenous methods such as

storage in ash, coconut pith saw dust and sand were tried. The effect of these treatments on the germination and moisture content of the seeds were studied.

It was found that the germination percentages of amaranthus seeds in tin containers and cloth bags were on par and were superior to other containers tested. In the case of bhindi, seeds stored in earthen pots and cloth bags gave a higher per cent germination and they were superior to other containers tested. The seeds of bitter gourd, stored in paper bags had a higher germination per cent when compared with other containers tested. The germination percentages of the seeds of brinjal stored in earthen pots, tin containers, polythene bags, and cloth bags were on par and superior to other containers tested. There was no significant difference in the germination per cent of cowpea seeds stored in various containers. The germination percentage of cucumber seeds stored in earthen pots, and paper bags were statistically on par and these were found to be superior to other containers tested. In the case of snake gourd, seeds stored in tin containers followed by earthen pots, paper bags and cloth bags gave high germination percentages. The germination percentages of tomato seeds stored in cloth bags, tin containers and earthen pots were statistically on par and these were superior to other containers tested (Table 6).

In pooled analysis, it was found that there was no

significant difference in the germination percentage of vegetable seeds stored under different storage conditions. The seeds stored in gunny bags gave least germination percentage, when compared with other treatments (Table 6). Lalithakumari et al. (1972) during their investigation on storage of groundnut, also found that seeds stored in gunny bags were found to loose the viability quickly indicating the unsuitability of this container in the storage of groundnut seeds.

In the case of seeds of amaranthus, bitter gourd, brinjal and tomato there was no significant difference in the germination percentage of seeds stored under different indigenous storage conditions, while in the case of snake gourd and cowpea seeds stored in ash gave higher germination percentage and this was found to be superior to other treatments. In pooled analysis, it was found that there was no significant difference in the germination percentage of vegetable seeds stored under different indigenous methods (Table 7).

There was positive correlation between the moisture content of the seeds and the germination percentage. When the moisture content of the seeds decreased, the germination percentage also decreased (Table 8a, b). It was found that the seeds stored in gunny bags were found to loose the viability quickly when compared with other containers tested (Table 8a). This result was found to be similar to that obtained by

Lalithakumari et al. (1972) during their investigation on the effect of different containers on the viability of stored groundnut.

Effect of culture filtrate of seed mycoflora on the germination of vegetable seeds.

The culture filtrates of the fungi were found to exert a definite inhibitory effect on the germination of seeds of amaranthus, bhindi, brinjal, chillies, cowpea and cucumber. But the degree of inhibition varied with different fungi and different seeds. The germination of amaranthus seeds was completely inhibited by the culture filtrate of Aspergillus niger, Aspergillus ochraceus, Cephaliophora irregularis and Penicillium sp. In the case of bhindi seeds 100 per cent inhibition in the germination was caused by the culture filtrate of Aspergillus niger and Penicillium sp. The culture filtrates of Achaetomium macrosporum, Aspergillus flavus, Aspergillus niger, Aspergillus ochraceus, Curvularia lunata, Fusarium oxysporum, Myrothecium roridum and Penicillium sp. caused 100 per cent inhibition in the germination of brinjal seeds. The germination of chilli seeds was completely inhibited by the culture filtrate of Achaetomium macrosporum, Aspergillus flavus, Fusarium solani and Penicillium sp. Penicillium sp. alone caused complete inhibition in the germination of cowpea seeds. In the case of cucumber seeds, there was cent per cent inhibition in the germination by the culture

filtrates of Aspergillus niger, Cephalosphora irregularis, Curvularia lunata and Penicillium sp. (Table 9). It is the toxic principle in the culture filtrate of these fungi, which was responsible for inhibiting the germination of the seeds of the vegetables. Narain and Omprakash (1960) found that the culture filtrate of Aspergillus niger reduced seed germination in onion. Narain and Das (1970) showed that the culture filtrates of Colletotrichum capsici inhibited the germination of chilli seeds. Vidhyasekharan et al. (1970) noted that the metabolites of certain seed-borne fungi, such as Aspergillus flavus, Curvularia spp. and Fusarium moniliforme caused inhibition in the germination of paddy seeds.

Summary

SUMMARY

Survey of the seed mycoflora of vegetables, namely, amaranthus, bhindi, bitter gourd, brinjal, cowpea, cucumber, pumpkin, snake gourd and tomato, revealed the presence of a number of seed-borne fungi. Storage fungi such as Aspergillus flavus, Aspergillus niger, Fusarium spp., Penicillium sp. and Rhizopus sp. were found to be externally as well as internally seed-borne. Apart from these other fungi like Curvularia lunata and Myrothecium roridum from amaranthus, Botryodiplodia theobromae from bhindi, bitter gourd and cowpea, Fusarium oxysporum and Nectria haematococca from bhindi, Acheetomium macrosporum and Colletotrichum lagenarium from bitter gourd, Drechslera rostrata from cowpea, Cephalosphora irregularis and Fusarium solani from pumpkin, were also obtained.

The seed-borne fungi were found to cause inhibitory effect on the germination of the respective seeds from which they were isolated. The storage fungi like Aspergillus flavus, Aspergillus niger, Penicillium sp. and Rhizopus stolonifer were found to cause maximum inhibition in germination. Seedling rotting was caused by Aspergillus niger, and Rhizopus stolonifer on tomato, Drechslera rostrata on cowpea and Fusarium equiseti on amaranthus.

Isolates of Aspergillus flavus obtained from the seeds of amaranthus, bhindi, bitter gourd, brinjal, cowpea, cucumber

and snake gourd were found to produce aflatoxin. A maximum quantity of 0.133 ppm was produced by the isolate obtained from bitter gourd, cucumber and snake gourd.

Investigations on the *in vitro* effect of fungicides against seed-borne fungi have shown that complete inhibition on the growth of *Aspergillus flavus* can be obtained with 3000 ppm and 4000 ppm of Thiride and 4000 ppm of Difolatan. The growth of *Botryodiplodia theobromae* was completely checked by 4000 ppm of Thiride. Difolatan and Thiride at all concentrations tested, caused complete inhibition on the growth of *Cephalosphora irregularis*. Complete inhibition on the growth of *Colletotrichum legenarium* was obtained with 4000 ppm of Dithane Z-78, and Thiride at all concentrations tested. The growth of *Curvularia lunata* was completely checked at 100 ppm and 200 ppm of Aureofungin Sol and 4000 ppm of Thiride. In the case of *Drechslera rostrata* complete inhibition on the growth was obtained with 4000 ppm of Dithane Z-78 and Thiride. The growth of *Fusarium equiseti* was completely checked at 3000 ppm and 4000 ppm of Thiride. Aureofungin Sol, 100 ppm and 200 ppm and Thiride 3000 ppm and 4000 ppm caused complete inhibition on the growth of *Myrothecium roridum*. In the case of *Penicillium* sp. Aureofungin Sol 200 ppm and Thiride 4000 ppm caused complete inhibition on growth. The growth of *Rhizopus stolonifer* was completely checked by Brassicol 3000 ppm, and 4000 ppm, Captan 4000 ppm, and Thiride 2000 ppm, 3000 ppm and 4000 ppm. Thiride was

found to be superior to other fungicides tested, namely, Aureofungin Sol, Brassicol, Captan, Difolatan, Dithane M-45, and Dithane Z-78 in inhibiting the growth of Aspergillus flavus, Botryodiplodia theobromae, Cephalosphora irregularis, Colletotrichum lagenarium, Curvularia lunata, Drechslera rostrata, Myrothecium roridum, Nectria haematococca, Penicillium sp. and Rhizopus stolonifer. In general Thiride was found to be superior to other fungicides tested against all the seed-borne fungi taken for the study.

The effect of storing the seeds of the vegetables in different containers, namely tin containers, polythene bags, cloth bags, earthen pots, gunny bags, paper bags and under indigenous methods such as in ash, coconut pith, saw dust and sand, on the germination and moisture content of the seeds were found out. In all cases it was found that seeds stored in gunny bags gave very low germination and moisture percentage. In the case of seeds of amaranthus, bitter gourd, brinjal and tomato there was no significant difference in the germination percentage of seeds stored under different indigenous storage conditions, while in the case of cowpea and snake gourd, seeds stored in ash gave higher germination percentage and moisture percentage.

It was found that the culture filtrates of the above seed-borne fungi caused inhibition in the germination of the seeds of amaranthus, bhindi, brinjal, chillies, cowpea and cucumber. The germination of amaranthus seeds was completely inhibited by the culture filtrates of Aspergillus niger,

Aspergillus ochraceus, Cephaliophora irregularis, and Penicillium sp. There was 100 per cent inhibition in the germination of bhindi seeds by Aspergillus niger. The culture filtrate of Achaetomium macrosporum, Aspergillus flavus, Aspergillus niger, Aspergillus ochraceus, Curvularia lunata, Fusarium oxysporum, Myrothecium roridum and Penicillium sp. caused 100 per cent inhibition in the germination of brinjal seeds. The germination of chilli seeds was completely inhibited by the culture filtrates of Achaetomium macroporum, Aspergillus flavus, Fusarium solani and Penicillium sp. Penicillium sp. alone caused complete inhibition of germination of cowpea seeds. In the case of cucumber seeds, there was complete inhibition in the germination, by the culture filtrates of Aspergillus niger, Cephaliophora irregularis, Curvularia lunata and Penicillium sp.

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Appendices

APPENDIX I

Analysis of variance table

(Effect of fungicides on the growth of *Aspergillus flavus*)

Source	SS	df	M.S	F. value	Whether significant or not
Total	29637.21	107			
Treatment	29325.88	35	837.88	193.77	Significant
Between fungicides	12358.96	6	2059.83	476.36	Significant
Treatment vs Control	14155.87	1	14155.87	3273.72	Significant
Error	311.33	72	4.32		

Ranking T_7 T_3 T_4 T_5 T_1 T_2 T_6

APPENDIX II

Analysis of variance table

(Effect of fungicides on the growth of *Botryodiplodia theobromae*)

Source	SS	df	M.S.	F. value	Whether significant or not
Total	26545.23	107			
Treatment	26462.73	35	756.08	659.85	Significant
Between fungicides	88916.20	6	1486.03	1296.94	Significant
Treatment vs Control	13481.00	1	13481.00	11765.58	Significant
Error	82.50	72	1.15		

Ranking T_7 T_4 T_6 T_2 T_3 T_1 T_5

APPENDIX III

Analysis of variance table

(Effect of fungicides on the growth of *Cephaliophora irregularis*)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	53735.02	107			
Treatment	53389.85	35	1525.42	318.20	Significant
Between fungicides	24869.26	6	4144.88	864.60	Significant
Treatment vs Control	13358.53	1	13358.53	2786.51	Significant
Error	345.17	72	4.79		

Ranking $\overline{T_7\ T_4\ T_3\ T_1}\ T_5\ T_6\ T_2$

APPENDIX IV

Analysis of variance table

(Effect of fungicides on the growth of *Colletotrichum lagenarium*)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	44460.27	107			
Treatment	44426.64	35	1269.33	2717.98	Significant
Between fungicides	18744.65	6	3124.11	6689.74	Significant
Treatment vs Control	12175.00	1	12175.00	26070.66	Significant
Error	33.63	72	0.47		

Ranking $T_7\ T_1\ T_6\ T_3\ T_5\ T_4\ T_2$

APPENDIX V

Analysis of variance table

(Effect of fungicides on the growth of Curvularia lunata)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	28950.11	107			
Treatment	28784.30	35	822.41	357.12	Significant
Between fungicides	13670.82	6	2278.47	989.39	Significant
Treatment vs Control	12841.77	1	12841.77	5576.35	Significant
Error	165.81	72	2.30		

Ranking T_7 T_1 T_6 T_5 T_3 T_4 T_2

APPENDIX VI

Analysis of variance table

(Effect of fungicides on the growth of Drechslera rostrata)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	22551.58	107			
Treatment	22253.74	35	635.82	153.69	Significant
Between fungicides	3591.98	6	598.66	144.71	Significant
Treatment vs Control	14439.83	1	14439.83	3490.41	Significant
Error	297.83	72	4.14		

Ranking T_7 $\overline{T_4\ T_6}$ T_2 T_5 T_3 T_1

APPENDIX VII

Analysis of variance table

(Effect of fungicides on the growth of *Fusarium equiseti*)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	62725.84	107			
Treatment	60724.44	35	1734.98	62.41	Significant
Between fungicides	32377.39	6	5396.23	194.12	Significant
Treatment vs Control	12294.05	1	12294.05	442.25	Significant
Error	2001.5	72	27.80		

Ranking T_4 T_7 T_1 T_3 $\overline{T_6\ T_2}$ T_5

APPENDIX VIII

Analysis of variance table

(Effect of fungicides on the growth of *Myrothecium roridum*)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	36965.71	107			
Treatment	36944.55	35	1055.56	3590.56	Significant
Between fungicides	19649.39	6	3274.90	11139.87	Significant
Treatment vs Control	12547.82	1	12547.82	42682.57	Significant
Error	21.17	72	0.29		

Ranking T_7 T_1 T_5 T_6 T_3 T_4 T_2

APPENDIX IX

Analysis of variance table

(Effect of fungicides on the growth of Nectria haematococca)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	39606.02	107			
Treatment	39519.19	35	1129.12	936.24	Significant
Between fungicides	24869.31	6	4144.89	3436.89	Significant
Treatment vs Control	10097.27	1	10097.27	8372.53	Significant
Error	86.83	72	1.21		

Ranking T_7 T_4 T_2 T_3 T_1 $\overline{T_5\ T_6}$

APPENDIX X

Analysis of variance table

(Effect of fungicides on the growth of Penicillium sp.)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	28398.06	107			
Treatment	28368.06	35	810.52	1945.24	Significant
Between fungicides	3990.66	6	655.11	1596.14	Significant
Treatment vs Control	12655.55	1	12655.55	30370.89	Significant
Error	30.00	72	0.42		

Ranking T_7 T_1 T_6 T_3 T_5 T_4 T_2

APPENDIX XI

Analysis of variance table

(Effect of fungicides on the growth of *Rhizopus stolonifer*)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	27209.53	107			
Treatment	27168.53	35	776.24	1363.27	Significant
Between fungicides	10241.92	6	1706.99	2997.87	Significant
Treatment vs Control	14539.68	1	14539.68	25535.09	Significant
Error	41.00	72	0.57		

Ranking T_7 T_2 T_3 T_5 T_1 T_4 T_6

APPENDIX XII

Analysis of variance table

(Effect of fungicides on the growth of seed-borne fungi

Pooled analysis)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	2832848.70	107			
Treatment	2828997.50	35	80828.50	1511.10	Significant
Between fungicides	747437.68	6	124572.94	2328.90	Significant
Treatment vs Control	1558112.50	1	1558112.50	29129.04	Significant
Error	3851.20	72	53.49		

Ranking T_7 $\overline{T_3\ T_4}$ T_1 T_6 $\overline{T_5\ T_2}$

APPENDIX XIII

Analysis of variance table

(Effect of storage conditions on the germination of amaranthus seeds)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	229.96	23	36		
Treatment	183.71	5	36.74	14.30	Significant
Error	46.25	18	2.57		

Ranking $\overline{T_1\ T_5}\ \overline{T_2\ T_3\ T_6\ T_4}$

APPENDIX XIV

Analysis of variance table

(Effect of storage conditions on the germination of bhindi seeds)

Source	SS.	df	M.S.	F.value	Whether significant or not
Total	25.33	23			
Treatment	21.33	5	4.27	19.39	Significant
Error	4.00	18	0.22		

Ranking $\overline{T_3\ T_5}\ \overline{T_4\ T_2\ T_1}\ T_6$

APPENDIX XV

Analysis of variance table

(Effect of storage conditions on the germination of bitter gourd seeds)

Source	S.S	df	M.S	F.value	Whether significant or not
Total	194.00	23			
Treatment	128.00	5	25.60	6.98	Significant
Error	66.00	18	3.67		

Ranking T_4 $\overline{T_5\ T_2\ T_1\ T_3}$ T_6

APPENDIX XVI

Analysis of variance table

(Effect of storage conditions on the germination of brinjal seeds)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	87.33	23			
Treatment	50.83	5	10.17	5.02	Significant
Error	36.50	18	2.03		

Ranking $\overline{T_3\ T_1\ T_2\ T_6}$ $\overline{T_5\ T_4}$

APPENDIX XVII

Analysis of variance table

(Effect of storage conditions on the germination of cowpea seeds)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	78.50	23			
Treatment	21.50	5	4.30	1.36	Not significant
Error	57.00	18	3.16		

APPENDIX XVIII

Analysis of variance table

(Effect of storage conditions on the germination of cucumber seeds)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	31.83	23			
Treatment	6.83	5	1.37	0.99	Not significant
Error	25.00	18	1.39		

APPENDIX XIX

Analysis of variance table

(Effect of storage conditions on the germination of snake gourd seeds)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	199.33	23			
Treatment	142.33	5	28.46	8.98	Significant
Error	57.00	18	3.17		

Ranking $\overline{T_1\ T_3\ T_4\ T_5}\ \overline{T_2\ T_6}$

APPENDIX XX

Analysis of variance table

(Effect of storage conditions on the germination of tomato seeds)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	69.96	23			
Treatment	33.21	5	6.64	3.26	Significant
Error	36.75	18	2.04		

Ranking $\overline{T_5\ T_1\ T_3}\ \overline{T_4\ T_6\ T_2}$

APPENDIX XXI

Analysis of variance table

(Effect of storage conditions on the germination of vegetable seeds - Pooled analysis)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	1838.96	23			
Treatment	1275.71	5	255.14	8.15	Significant
Error	563.25	18	31.29		

Ranking $\overline{T_1\ T_5\ T_3\ T_2\ T_4\ T_6}$

APPENDIX XXII

Analysis of variance table

(Effect of indigenous methods of storage on the germination of amaranthus seeds)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	31.75	15			
Treatment	10.25	3	3.42	1.91	Not significant
Error	21.50	12	1.79		

APPENDIX XXIII

Analysis of variance table

(Effect of indigenous methods of storage on the germination of bhindi seeds)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	36.00	15			
Treatment	18.00	3	6.00	4.00	Significant
Error	18.00	12	1.50		

Ranking $\overline{T_4\ T_3}\ T_1\ T_2$

APPENDIX XXIV

Analysis of variance table

(Effect of indigenous methods of storage on the germination of bitter gourd seeds)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	210.94	15			
Treatment	92.19	3	30.73	3.11	Not significant
Error	118.75	12	9.89		

APPENDIX XXV

Analysis of variance table

Effect of indigenous methods of storage on the germination of brinjal seeds)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	38.94	15			
Treatment	15.69	3	5.23	2.70	Not significant
Error	23.25	12	1.94		

APPENDIX XXVI

Analysis of variance table

(Effect of indigenous methods of storage on the germination of cowpea seeds)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	33.00	15			
Treatment	27.00	3	9.00	18.00	Significant
Error	6.00	12	0.50		

Ranking T_1 $\overline{T_3\ T_4\ T_2}$

APPENDIX XXVII

Analysis of variance table

(Effect of indigenous methods of storage on the germination of cucumber seeds)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	99.75	15			
Treatment	3.75	3	1.25	0.16	Not significant
Error	96.00	12	8.00		

APPENDIX XXVIII

Analysis of variance table

(Effect of indigenous methods of storage on the germination of snake gourd seeds)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	124.00	15			
Treatment	108.00	3	36.00	27.06	Significant
Error	16.00	12	1.33		

Ranking T_1 T_3 $\overline{T_4\ T_2}$

APPENDIX XXIX

Analysis of variance table

(Effect of indigenous methods of storage on the germination of tomato seeds)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	53.75	15			
Treatment	16.25	3	5.42	1.73	Not significant
Error	37.50	12	3.13		

APPENDIX XXX

Analysis of variance table

(Effect of indigenous methods of storage on the germination of vegetable seeds - Pooled analysis)

Source	SS.	df	M.S	F.value	Whether significant or not
Total	13680.00	15			
Treatment	13363.50	3	4454.50	168.86	Significant
Error	316.50	12	26.38		

Ranking $\overline{T_4\ T_1\ T_3\ T_2}$

ABSTRACT

The survey of the seed mycoflora of vegetable seeds revealed the presence of a number of seed-borne fungi. Storage fungi like Aspergillus flavus, Aspergillus niger, Penicillium sp. and Rhizopus stolonifer were found to be externally as well as internally seed-borne, in almost all the vegetable seeds taken for the study. Apart from these, other fungi like Curvularia lunata, Fusarium equiseti and Myrothecium roridum from amaranthus, Botryodiplodia theobromae from bhindi, bitter gourd and cowpea, Fusarium oxysporum and Nectria haematococca from bhindi, Achaetomium macrosporum and Colletotrichum lagenarium from bitter gourd, Drechslera rostrata from cowpea, Cephalosporn irregularis and Fusarium solani from pumpkin were obtained.

The seed-borne fungi were found to cause inhibitory effect on the germination of the seeds, from which they were isolated. Maximum inhibition in the germination was found to be caused by storage fungi like Aspergillus flavus, Aspergillus niger, Penicillium sp. and Rhizopus stolonifer. Rotting of the seedlings was caused by Fusarium equiseti on amaranthus, Drechslera rostrata on cowpea, Aspergillus niger and Rhizopus stolonifer on tomato.

Isolates of Aspergillus flavus obtained from bitter gourd, cucumber and snake gourd produced the maximum quantity of 0.133 ppm of aflatoxin.

In vitro evaluation of fungicides against the seed-borne fungi showed that the growth of Aspergillus flavus was completely inhibited at 3000 ppm and 4000 ppm of Thiride and 4000 ppm of Difolatan. The growth of Botryodiplodia theobromae was completely checked by 4000 ppm of Dithane Z-78, 3000 ppm and 4000 ppm of Thiride. Complete inhibition of the growth of Cephaliophora irregularis was obtained with Difolatan and Thiride at all concentrations tested. Complete inhibition of the growth of Colletotrichum lagenarium was obtained with 4000 ppm of Dithane Z-78 and Thiride at all concentrations tested. Growth of Curvularia lunata was completely checked at 100 ppm and 200 ppm of Aureofungin Sol and 4000 ppm of Thiride. In the case of Drechslera rostrata complete inhibition was obtained with 4000 ppm of Dithane Z-78 and Thiride. The growth of Fusarium oxisseti was completely checked at 3000 ppm and 4000 ppm of Difolatan, 2000 ppm, 3000 ppm and 4000 ppm of Thiride. The growth of Myrothecium roridum was found to be completely inhibited by 100 ppm and 200 ppm of Aureofungin Sol and Thiride 3000 ppm and 4000 ppm. In the case of Penicillium sp. cent per cent inhibition on the growth of the fungus was obtained with 200 ppm of Aureofungin Sol and 4000 ppm of Thiride. The growth of Rhizopus stolonifer was completely inhibited by 3000 ppm and 4000 ppm of Brassicol, 4000 ppm of Captan and 2000 ppm, 3000 ppm and 4000 ppm of Thiride. In General

Thiride was found to be superior to other fungicides tested against all the seed-borne fungi taken for the study.

The effect of storing the seeds in different conditions showed that seeds of vegetables stored in gunny bags gave very low percentages of germination and moisture.

In the case of indigenous methods of seeds storage, it was found that there was no significant difference in the germination percentage of seeds of amaranthus, bitter gourd, brinjal and tomato, stored under different conditions. While in the case of sneke gourd and cowpea, seeds stored in ash were found to have higher germination percentage.

It was found that the culture filtrates of the above seed-borne fungi caused inhibition in the germination of the seeds of amaranthus, bhindi, brinjal, chillies, cowpea and cucumber.