# ETIOLOGY AND CONTROL OF BLIGHT AND FRUIT ROT OF BRINJAL

BY

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DECLARATION

I hereby declare this thesis entitled "Etiology and control of blight and fruit rot of Brinjal" 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.

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Certified that this thesis entitled "Etiology and control of blight and fruit rot of Brinjal" is a record of research work done independently by Miss. Jenny John 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.

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JENNY JOHN

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# INTRODUCTION

# INTRODUCTION

Brinjal (Solanum melongena L.) is a common vegetable crop very much favoured in homesteads as well as for commercial cultivation. Among the various fungal diseases affecting this crop, blight and fruit rot caused by Phomopsis vexans (Sacc. and Sydow.) Harter is the most important one and it causes heavy damage to the stem, leaf as well as fruit of the crop. The incidence of blight and fruit rot caused by P. vexans has been reported from most of the countries around the world, including tropical as well as sub-tropical areas and it is considered second only to bacterial wilt caused by Pseudomonas solanacearum among the diseases of brinjal as regards to the extent of damage (Singh, 1985).

The main mode of transmission of P. vexans in brinjal is through seeds and it is internally seed borne also. Hence, seed treatment is a major step to be adopted for the successful management of this disease. Eventhough the incidence of the disease has been noted from different parts of the state, no authentic report has so far been made on this disease from Kerala. Since the main mode of transmission of this pathogen is through seed both externally and internally there is every possibility for the occurrence of the disease in epiphytotic proportions in the coming

seasons. Hence a detailed study was undertaken to work out the basic details necessary for formulating satisfactory management practices of this disease to prevent its occurrence in a serious manner.

In the present investigation, the following aspects were worked out.

1. Study of symptomatology of the disease
2. Isolation, purification and maintenance of the pathogen
3. Morphology, pathology and identification of the causal organism
4. Effect of fruit infection on seed and seedlings
5. Laboratory evaluation of fungicides against the pathogen
6. Field evaluation of promising fungicides
7. Seed treatment with different fungicides

# REVIEW OF LITERATURE

## REVIEW OF LITERATURE

Fruit rot of brinjal caused by Phomopsis vexans was first reported in India in Gujarat by Harter during 1914. Herald (1933) reported that fruit rot caused by Phomopsis vexans (Sacc. & Sydow.) Harter produced three types of symptoms (a) damping off of seedlings and stem blight of seedlings due to the attack of the fungus at about 2-3 cm above the soil level (b) brown leaf spot of 2-3 cm in diameter. It may be round, oval or oblongate and (c) fruit lesions. Decker (1951) reported blight symptom caused by Phomopsis vexans on brinjal to be present on stems and leaves of susceptible plants soon after transplanting and later spread rapidly. Walker (1952) reported that the first phase of disease symptom in brinjal is girdling of stem slightly above the soil with dark brown lesions later becoming grey in the centre. Pawar and Patel (1957) described Phomopsis blight and fruit rot of brinjal. They reported that the disease symptoms ranged from seedling blight to fruit rot. During the early stages, the disease was prominent on leaves where it manifested in the form of more or less circular spots with buffy olive colour and later becoming cinnamon black. Lesions on the petiole or on the lower part of the midrib caused death of the entire leaf. Blight symptom was prominent under humid conditions.

Affected leaves dropped prematurely and the infection spot became covered by numerous pycnidia. On the stem, the symptom appeared as elongated lesions. Diseased plants produced smaller leaves and axillary buds are often killed. On the fruit the disease appeared as minute, sunken dull and dusky purple spots which merged to form large rotten areas. On such fruits numerous pycnidia of the fungus could be observed. Kapoor and Hingorani (1958) reported that Alternaria tenuis caused fruit rot in brinjal and the lesions were small (± 1/2 cm) concentric dark brown sunken and olivaceous due to spore formation. Markov and Ahtpakhosa (1958) reported eggplant anthracnose caused by Colletotrichum melongena which induced extensive lesions and lead to complete rotting.

Ramakrishnan and Wilson (1968) reported Rhizopus rot of brinjal with profuse fungal growth and Diplodia rot in which dark coloured spots appeared on fruit surface followed by rotting of tissue. Westcolt (1971) reported Phomopsis blight and fruit rot of brinjal plant. In addition to complete destruction of affected plant parts, rotting of seedlings were also reported. Leaf spots appear which are circular, grey to brown and have light centres. Stem cankers were also noticed with constriction. Fruit lesions were pale brown with pycnidia arranged concentrically.

Maholay (1977) reported dry rot of brinjal caused by Botryodiplodia theobromae. Alice and Pailey (1978) reported that in brinjal fruit, Diplodia sp caused water soaked sunken lesions with white mycelial growth and Rhizopus arrhizus produced soft rot with brown coloured ooze coming out from the affected portions. Vyas et al. (1978) reported soft rot of brinjal particularly on borer infested fruits. Small brownish water soaked area appeared around some injury. This quickly spread with mycelial mass bearing brown to black sporangia. The whole fruit decayed within two to three days except in dry weather. Suryanaryana (1978) reported Phomopsis vexans producing small spots on leaves with buff coloured centre and blackish margins. On the fruits, sunken dusky spots appeared. These often coalesced and the flesh below the infected portions rotted. Datar (1980) reported brinjal fruit rot on variety Manjiri Gota. Visually the fruits were sunken and turned brown with pinkish growth on calyx. Mandal and Dasgupta (1980) reported fruit scab of brinjal caused by Cladosporium tenuissimum characterised by scab like growth with light cracks and hard and disfigured fruits. Under humid conditions partial rotting developed. Dhingra and Mehrotra (1980) reported yellow rot of brinjal which produced light yellow depressed area with sunken and pulpy underlying tissue. Singh (1985) reported that Phomopsis blight and fruit rot of brinjal

appeared from seedling stage of the plant to its marutity. In seedbeds it appeared as damping off. After transplanting the leaves coming in contact with soil got infected and showed clearly defined, circular, grey to brown spots with light coloured centre. The spots showed numerous black pycnidia. Affected leaves turned yellow and died. Sometimes petioles and stem got attacked and showed cankers. The lesions on the stem appeared dark brown becoming grey in centre, as pycnidia developed. Mostly the stem got affected and characterised by constriction of the base or a grey dry rot. The skin peeled off and the inner tissue got exposed. In strong winds the plants toppled down due to breaking of the main stem. On fruits, pale sunken spots developed which progressed to cover the entire fruit surface. These spots were marked by the presence of many black pycnidia. The internal portion of the fruit rotted. If the fungus entered through the calyx the whole fruit became mummified due to dry rot. Singh (1985) also reported Sclerotina blight of eggplant caused by Sclerotinia sclerotiorum. Kumar et al. (1986a) classified the different rots affecting brinjal in Punjab into two groups, dry rot and soft rot.

Aspergillus niger, Chaetomium erraticum, Colletotrichum capsici, Curvularia lunata, Fusarium moniliforme, Fusarium oxysporum, Fusarium semitectum, Phomopsis vexans, Rhizoctonia solani, cause dry rot, and Aspergillus nidulans, Cephalosporium acremonium, Fusarium moniliforme, F. oxysporum,

elliptical, and biguttulate. This was the common type of spore developing in nature and also on artificial media. On diseased fruit, stem and leaves, spores measured 4.0-6.8 x 2.3-2.7 µm. Almost the same measurement were encountered on various agar media. Westcolt (1971) reported that pycnidia were dark with ostiole. Spores were one celled and hyaline. The characteristics were same as phoma except that leaves rather than stem are infected. Singh (1985) reported the perfect or teliophase as Diaporthe vexans. It belonged to family Diaporatheceae, order Sphaeriales, class Pyrenomycetes of Ascomycotina. However, the sexual stage was not found in nature but was obtained in culture. They noted that the pycnidia may or may not contain beak and is first buried in host tissue later becoming erumpent as brown to black speck extending slightly above the host surface. On the leaves the pycnidia are 60-200 µm in diameter and on the fruits they are 60-200 µm in diameter and on fruits they are 120-250 µm. They are globose to irregular with 20-50 µm wide ostiole. The conidiophores (phialides) in the pycnidium are hyaline simple or branched, sometimes septate 10-16 µm long and arise from the inner most layer of the cell lining the pycnidial cavity. Pycnospores are hyaline, one celled, subepidermal 5.9 x 2-2.8 µm in size. Another form of conidia are the stylospores which are filiform curved

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hyaline and septate. These spores do not germinate. The perithecia in culture are usually in clusters 130-350 /um in diameter and have beaked carbonaceous, sinuate irregular ostiole. The beak is 80-500 /um long. Ascospores are hyaline narrowly ellipsoid to blunty fusoid and one septate. They measure 9-12 x 8-4.4 /um.

Gratz (1942) studied the teliophase of P. vexans at Florida agricultural experimental station where he observed that 2 per cent potato dextrose agar helped the development of perithecia of the fungus occurring in clusters. Pawar and Patel (1957) reported that the best growth of P. vexans was obtained on lima bean, potato dextrose, host decoction dextrose and oat meal agars as expressed by colony diameter and density of mycelial mat. The pycnidial formation was abundant in host decoction agar with or without dextrose, moderate in Richards's agar, poor in lima bean, Browne's and oat meal and nil in potato dextrose agar. Lapis and Deangkinay (1967) reported good growth and sporulation of P. vexans from eggplant with P.D.A., cornmeal, leonian and pure agars at 20-32°C and pH 6-9.

Divingracia (1969) reported P. vexans produced numerous pycnidia on oat meal, rice and wheat agars. They found that the pycnidia were small and solitary at low oat meal concentration large and aggregated at higher

concentration. Optimum temperature for growth and pycnidial temperature was 30°C and growth was inhibited at 35°C. For large quantities of inoculum P. vexans should be grown in 4-7% oat meal agar at 30°C in light. Pawar and Chand (1969) studied cultural characters and pathogenicity of three isolates of P. vexans. Growth occurred best at pH 2.6-7.5. Hasiza and Chowdhury (1980) reported that growth of P. vexans was best on fructose and proline among nineteen carbon and twentyseven nitrogen sources tested. Ammonium Nitrate and Ammonium Nitrite compounds generally yielded poor or moderate growth. They have also suggested that the rate of assimilation of different amino acid also varied.

Pawar and Patel (1957) reported that out of 24 varieties of brinjal tested none was found to be resistant. The fungus infects only Solanum melongena and not Capsicum annum L, Datura fastuosa L, Lycopersicum esculentum Mil Nicotiana tabacum L, Solanum nigrum L, Solanum tuberosum L and Petunia sp. Felix et al. (1965) reported that infection of P. vexans occurred after inoculation from cultures in fruits, leaves, woody stem, but not when spore suspension from field specimen was used. Singh et al. (1973) reported that maximum disease development was observed in medium sized fruits inoculated by 1/2 cm cross wise cut and minimum on fruits inoculated by pinprick method. No infection was

obtained in uninjured fruits. Chowdhury and Hasiza (1979) conducted a pathogenicity test in which axenic cultures of P. vexans causing leaf spot and fruit rot were obtained and Koch's postulates were established. Inoculated fruits showed infection and rotting where leaves developed spots on spraying the spore suspension. The pathogen is a wound parasite. The checks remained perfectly healthy. Cross inoculation tests were carried out on plant parts and fruits of Capsicum annum and Lycopersicon esculentum and were found susceptible to the disease. Narendra et al. (1979) reported that P. vexans caused blight of apricot. Datar (1980) established the pathogenicity of two pathogens Fusarium moniliforme, and Phomopsis vexans causing fruit rot of brinjal. Datar (1983) reported that severe symptoms were induced in brinjal fruits when Fusarium moniliforme and P. vexans, were inoculated together than when either of the pathogen was used. Kumar et al. (1983) reported that application of mycelial disc or conidial suspension on injured fruit caused fruit rot after six days of application. Quaiser (1987) reported that when healthy fruits of ten cultivars and two wild species of brinjal of the same age viz., Pusa purple long, Pusa purple cluster, Pusa oval green, Pusa Dwarf, Pusa Kranti, Pusa purple round, Muktakeshi, Banaras giant, Annamalai & local, Solanum gilo & S. integrifoli were inoculated with P. vexans by pinprick

method and was incubated for 15 days at 25°C and RH 55 per cent maximum percentage of rotting was observed in pusa purple long followed by Pusa purple green.

Singh and Chand (1986) reported that maximum infection was obtained when medium sized fruits were inoculated in 5 cm cut. No infection occurred in uninjured fruits.

Toole et al. (1941) studied the effect of fruit rot of eggplant on seed germination in Maryland by dividing the seeds into four groups as (1) no infection (2) slight infection (3) medium infection (4) severe infection. He got all the seeds germinated in blotting paper. The results showed that seeds from healthy fruits germinated much more rapidly and had a much higher percentage of germination than seeds from infected fruits. Martin (1930) reported that P. vexans was borne under the seed coat of seed from badly decayed brinjal fruits.

Porter (1943) studied the seed borne inoculum of P. vexans. He found that spores of P. vexans were found in six of the 27 seed samples of 12 varieties of eggplant examined at Virginia Truck Experimental Station, all six belonging to the variety Black Beauty. Seed artificially contaminated with P. vexans planted in sterile soil reduced the stand by 10.7 per cent, healthy seed in contaminated soil showed a reduction of 19.8 per cent and contaminated

seed in contaminated soil a reduction of 22.5 per cent of that obtained with healthy seed in sterile soil indicating the use of healthy seed. Gorofalo (1956) reported reduction in germination of brinjal plants, when he made an attempt in Turin in Italy to germinate 400 seeds from infected plants under aseptic conditions. 40 per cent of the seeds were covered with Fusarium oxysporum in 10 days or less and failed to germinate. While 35 per cent germinated seeds formed root lets only 25 per cent gave healthy plants.

Pawar and Chand (1969) reported in vitro effect of different fungicides on growth and sporulation of Phomopsis vexans causing fruit rot of brinjal. Of the five different fungicides tested, bordeaux mixture and copper oxychloride at 0.25 per cent concentration proved to be effective against P. vexans, the pathogen of eggplant.

Spencer et al. (1924) reported comparative results of spraying and dusting for the control of Phomopsis vexans and flea beetle. He reported that when bordeaux mixture mixed with 2 lb of calcium arsenate in the same quantity slightly inferior results were obtained. Zinc arsenate with bordeaux mixture gave in some cases better results than bordeaux calcium arsenate sprays. Bordeaux soap sprays and bordeaux alone were not satisfactory but large inqrease in yield was recorded, with Calcium arsenate sprays without

the admixture of copper fungicide. Distinctly superior yields were obtained when bordeaux dust composed of monohydrated $CuSo_4$ 16%, calcium arsenate 20% and hydrated lime 64% were used. The field trials with these materials are stated to have been so successful that their use is unreservedly recommended, which is more effective than benomyl or mancozeb. Palo (1936) reported good control for Phomopsis disease of eggplant in Pampanga province of Philippine Island by spraying bordeaux mixture 4:4:50 and a mixture of copper oxychloride and benlate or copper oxychloride alone, when applied at fortnightly intervals. Howard and Dessosiers (1941) reported the use of resistant varieties for the control of Phomopsis blight of eggplant. Kalda et al. (1976) reported that Solanum xanthocarpum, S. indicum, S. kasianum and S. niger were highly resistant against Phomopsis blight of eggplant. Teo (1984) reported that incidence of stem blight by P. vexans on brinjal was reduced by trimazone, copper oxychloride, captan, and polyram combination but not benlate (benomyl). Singh and Shukla (1985) reported the control of Alternaria leaf spot and fruit rot of brinjal caused by Alternaria alternata by using the following fungicides brestan-60 0.1 per cent, dithane M 45, difolatan, cuman L, zineb, bavistin 0.2 per cent, blue copper-50 0.3 per cent, captan 0.2 per cent and kitazin 0.1 per cent. Out of these brestan-60 proved most

effective followed by dithane M.45, difolatan, cuman L. and zineb. Singh (1985) reported the use of chemical spray in seedbed to raise disease free seedlings. He observed that maneb, mancozeb, and zineb can be used for spraying in the nursery as well as in the field at intervals of 7-10 days. Singh (1985) also reported the control of blight of brinjal caused by Sclerotina sclerotiorum by spraying ziram and ferbam or systemic fungicide like bavistin (carbendazim). Along with this measure of chemical spraying he also reported field sanitation and crop rotation with crops as onion, spinach, or maize. Grewal and Jhooty (1987) reported the control of Phomopsis fruit rot of eggplant with different fungicides as dithane M.45-0.2 per cent dithane Z.18-0.2 per cent, cuman L-0.2 per cent, bordeaux mixture-0.8 per cent, and blitox-0.3 per cent. Of the different fungicide sprayed dithane Z.78 was the best fungicide as the infected fruits were minimum 14.55 per cent, bordeaux mixture, blitox, dithane M.45 and cuman L. were next in the order as the percentage of infected fruits were 15.25, 18.58, 21.25, and 23.21 respectively. Arun Arya (1988) reported that Phomopsis fruit rot of grapes and guava could be controlled by spraying, bavistin, difolatan, calixin, dithane M-45, but spraying with fixed oils and mustard oils were most effective. Datar and Ashtaputre (1988) reported that all wild varieties of brinjal were

resistant to Phomopsis fruit rot and only less than 5 per cent were infected. They also reported that varieties like Arka Kusumakar, Aurangabad local, Bengali long were moderately resistant. Ravestijn (1988) reported the control of fruit rot of eggplant grown in glass house, by spraying with plant growth regulators 20 mg/l of 4 chlorophenoxyacetic acid along with 500 mg/l of iprodione on flower buds and fruits at weekly intervals.

Markov and Ahtpakhosa (1958) reported the control of eggplant anthracnose by disinfecting the seed with 1 per cent formation 10 g/l for 10 min or 1 per cent mercuric sublimate for destroying all plant debris from infected soil. Felix et al. (1965) reported the control of eggplant wilt caused by Diaporthe vexans by hot water treatment at 122° for 3 min. Maholoy (1977) reported the control of eggplant wilt caused by Diaporthe vexans by hot water treatment at 122°F for 3 min. Maholay (1977) reported the control of Botryodiplodia fruit rot and seed rot of eggplant by seed treatment with difolatan, benomyl and bavistin. Suryanaryana (1978) reported the control of fruit rot and blight of brinjal by hot water treatment at 30°C for 30 min. Dharam Singh and Chakrabarti (1982) reported that the treatment of brinjal seeds before sowing with chemicals like captan, difolatan, benlate, thiram,

calixin and hot water did not have any significant effect on emergence and stand of brinjal seedlings in nursery bed. Singh (1985) reported hot water treatment of seeds obtained from market at 50°C for 30 min for control of Phomopsis blight and fruit rot of brinjal.

# MATERIALS AND METHODS

# MATERIALS AND METHODS

## Symptomatology

A comparative study of symptoms produced under natural conditions and those under artificial conditions was made.

## Isolation, purification and maintenance of the pathogen

Plant parts showing initial stages of infection were collected from the Instructional Farm, College of Agriculture, Vellayani. The infected portions were cut into small bits by means of sterile scalpel. These were sterilized for one to two minutes in 1 per cent mercuric chloride solution and then washed in three changes of sterile water. The sterilized plant parts were placed under aseptic conditions in sterile petri dishes previously poured with potato dextrose agar (P.D.A.) medium and incubated at room temperature. After four to five days, when the growth of the fungus was visible, bits of mycelium were transferred to P.D.A. slants by means of sterile inoculation needle. Single spore isolation was made by dilution plate method and stock cultures were maintained on P.D.A. slants at room temperature.

## Morphology and cultural characters

The morphological characters of the fungus were studied by growing the organism on potato dextrose agar medium.

Growth of the fungus in culture media

A. Solid media

Circular discs were cut from the outer edge of 7 day old culture of the fungus by means of sterile 5 mm diameter cork borer. These were transferred into sterile solidified media viz., P.D.A., Czapek's, Richards's, oat meal, and host extract in petri dishes and incubated at room temperature. Three replications were maintained. Observations were taken after 7 days when the growth of the fungus on the media reached the edge of the petri dishes.

B. Liquid media

Hundred ml flask containing 35 ml of the respective medium viz., potato dextrose, Czapek's, Richards's, oat meal and host extract were prepared under sterile conditions and inoculated with 5 mm mycelial disc of the fungus and incubated at room temperature. Three replications were maintained. Fifteen days after inoculation when growth of the culture reached the edge of the flask, mycelial mats from the flask was filtered through previously dried and weighed filter paper disc and washed with distilled water. These were dried in a hot air oven at 60°C till constant weights were recorded. The filter paper with the mycelial disc was re-weighed in an analytical balance. The weight of mycelial mat was calculated by deducting the weight of filter paper.

Composition of the media used

1. Potato dextrose medium

| | | |
|---|---|---|
| Peeled potato (sliced) | - | 200.00 g |
| Dextrose | - | 20.00 g |
| Distilled water | - | 1000.00 ml |

2. Czapek's medium

| | | |
|---|---|---|
| Magnesium sulphate | - | 0.50 g |
| Dipotassium hydrogen phosphate | - | 1.00 g |
| Potassium chloride | - | 0.50 g |
| Sodium nitrate | - | 2.00 g |
| Ferrous sulphate | - | 0.01 g |
| Sucrose | - | 30.00 g |
| Distilled water | - | 1000.00 ml |

3. Richards's medium

| | | |
|---|---|---|
| Potassium nitrate | - | 10.00 g |
| Potassium dihydrogen phosphate | - | 5.00 g |
| Magnesium sulphate | - | 2.50 g |
| Ferric chloride | - | 0.20 g |
| Sucrose | - | 50.00 g |
| Distilled water | - | 1000.00 ml |

4. Oat meal medium

| | | |
|---|---|---|
| Rolled oats | - | 60 g |
| Agar Agar | - | 20.00 g |
| Distilled water | - | 1000.00 ml |

5. Host extract medium

| | | |
|---|---|---|
| Host extract | - | 200.00 g |
| Dextrose | - | 20.00 g |
| Agar Agar | - | 20.00 g |
| Distilled water | - | 1000.00 ml |

2 per cent agar agar was added in case of solid media

Pathogenicity tests

A. On fruits

Pathogenicity of the organism was tested by inoculating brinjal fruits of different stages of maturity with actively growing culture by pin prick and after making slight injury and covering with polythene bags. The polythene bags were removed after 3 days and the plants kept under shade for observation. Suitable controls were also maintained.

B. On twigs

Twigs of different stages of growth were inoculated with the 7 day old culture of the fungus. The twigs were given slight injury before placing small bits of actively

growing culture of the fungus and kept moistened with cotton wool wetted with sterile water. The twigs were covered with polythene covers moistened inside with wetted cotton for a period of 3 days and then removed.

Host range

The following vegetables were inoculated to study the host range of the organisms.

| | | |
|---|---|---|
| 1. | Bhindi | Abelmoschus esculentus Moench |
| 2. | Bittergourd | Momordica charantia L. |
| 3. | Carrot | Daucus carota L. |
| 4. | Onion | Allium cepa L. |
| 5. | Ginger | Zingiber officinale Rosc |
| 6. | Chilli | Capsicum annum L. |
| 7. | Cowpea | Vigna sinensis (L.) Savi |
| 8. | Cluster bean | Cyamopsis tetragonoloba (L.) Taub |
| 9. | Cucumber | Cucumis sativus L. |
| 10. | French bean | Phaseolus vulgaris L. |
| 11. | Tomato | Lycopersicon esculentum Mill |
| 12. | Potato | Solanum tuberosum Linn. |

Inoculations were conducted by the method reported by Grainger and Horne (1924). Holes of 5 mm diameter were made on all the above mentioned vegetables after washing in 1 per cent mercuric chloride solution followed by sterile

water. Inoculum consisting of the mycelium and spores of the fungus was introduced into the pit and immediately plugged with the piece of flesh scooped out by the cork borer. The inoculated vegetables were placed at room temperature under bell jars lined with moist cotton. Observations were recorded after 8 days on the type of infection developed if any.

Effect of culture filtrate of the pathogen

A. On brinjal plants

The fungus was grown in potato dextrose broth for a period of fifteen days at room temperature. This was filtered through Whatman No. I filter paper, and the filtrate was poured into 100 ml conical flasks. Two week old brinjal seedlings were dipped in the filtrate for 24 hours and same aged seedlings dipped in sterile water served as control. In another set, culture filtrate was sprayed on the leaves of mature plants after giving pin pricks and the control was sprayed with sterile water. Observations were recorded on the effect of the filtrate on symptom development.

B. On vegetable seeds

Ten seeds each from brinjal, chilli, tomato and greengram were soaked in the culture filtrate of the pathogen for a period of 24 hours. These were then transferred to

filter paper disc placed in 9 cm petri dishes and 5 ml of the culture filtrate was poured into each petri dish. The dishes were then incubated at room temperature. In one set the culture filtrate was used as such (fresh) and in another, culture filtrate previously boiled for 10 minutes was used.

Effect of fruit infection on seeds and seedlings

A. Blotter method

Ten dried seeds of brinjal extracted from infected fruit were spread over sterilized filter paper disc placed in sterile petri dishes and moistened with 2 ml sterile water. The plates were incubated at room temperature. Similarly another set of seeds from healthy fruits were washed with sterile water and kept in sterile petri dishes as mentioned above. Observations on per cent germination after 5 days and symptoms if any on seedlings were recorded. Fifteen replications were maintained.

B. Sand method

Fine grained sand was collected, washed, sundried and autoclaved for 1 hour at 15 lbs pressure. It was then filled in plastic container of 7 cm diameter. Ten seeds extracted from infected fruit were sown in each container and watered with sterile water. Similarly another set of seeds from healthy fruits were maintained as mentioned above. Fifteen replications were maintained.

Laboratory evaluation of the fungicides

The following fungicides were used.

| Fungicide | Active ingredient |
|---|---|
| 1. Bordeaux mixture | Copper sulphate-Lime mixture |
| 2. Bavistin | 2 (methoxy-carbomyl) benzimidazole |
| 3. Cuman L | Zinc dimethyl dithiocarbamate |
| 4. Calixin | 2, 6-dimethyl 4-tridecyl morpholine |
| 5. Kavach | Chlorothalonil |
| 6. COC-50 | Copper oxychloride 88% |
| 7. Dithane M-45 | Manganese-ethylene bisdithiocarbamate |

The effect of different fungicides on growth of the fungus was studied by poison food technique described by Zentmyer (1955). Stock solution of the fungicide was prepared and the required quantity of each was added separately to 45 ml of sterilized potato dextrose agar so as to get the desired concentration of fungicide. Fifteen ml each of the poisoned medium was poured in sterile petri dish and after solidification 5 mm disc from a seven day old actively growing culture of the fungus was cut with sterile cork borer and placed in the centre of the plate. The plate was then incubated at room temperature (28 $\pm$ 2°C). Suitable controls were also maintained. Three replications were kept in each case. The colony diameter was measured after 7 days. The radial growth was calculated by deducting the

# 1. Layout of field experiment

diameter of the culture disc placed in the centre of the medium from the final colony diameter. The comparative inhibitory effect of different fungicides was calculated by appropriate statistical analysis.

Field evaluation of fungicides

In the Instructional Farm, College of Agriculture, Vellayani an experiment was laid out in R.B.D. with seven treatments and three replications in order to study the comparative efficacy of fungicides for the control of the disease (Plate No. 1). Fruits were inoculated with the fungus and covered with polythene bags. After three days the cover was removed. The disease intensity was graded using an arbitrary scale from 0-10.

| % of infection | Grade |
|---|---|
| No incidence | 0 |
| 1-10 | 1 |
| 11-20 | 2 |
| 21-30 | 3 |
| 31-40 | 4 |
| 41-50 | 5 |
| 51-60 | 6 |
| 61-70 | 7 |
| 71-80 | 8 |
| 81-90 | 9 |
| 91 and above | 10 |

The fruits were then sprayed with the following fungicides COC-50, dithane M-45, bordeaux mixture, kavach, cuman-L, bavistin and calixin by means of a knap-sack sprayer. Random numbers were allotted to each plot in a block and a row for control was maintained, where water was sprayed. Spraying was started at the end of November and continued upto January, since maximum intensity was recorded during the above period. After each spraying the per cent disease incidence was recorded. The per cent efficiency of each fungicide was calculated on the basis of the following formulae evolved by Chester (1950).

$$\text{Per cent efficiency of fungicide} = \frac{\text{Per cent infection in control} - \text{per cent infection in treatment}}{\text{Per cent infection in control}} \times 100$$

Comparative efficacy of different fungicides on seed germination

Twenty seeds of brinjal were kept soaked for twenty fou hours in the spore suspension of the test fungus and another set was soaked in sterile water for the same period. Stock solution of the fungicide was prepared and requisite quantity of each fungicide viz., bavistin, COC-50 and dithane M-45 was added separately to 45 ml of sterilized potato dextrose agar so as to get the desired concentration of the fungicide.

Fifteen ml each of the poisoned media was poured into sterile petri dish and after solidification twenty seeds soaked in the spore suspension were placed in each of the above media. Seed soaked in sterile water and those soaked in spore suspension and planted in P.D.A. served as control. Three replication were maintained in each case.

Statistical methods of analysis

The data on various observations were analysed by the method described by Snedecor and Cochran (1967), Walter (1963) and their significance was tested by 'F' test (Cochran and Cox, 1965).

# RESULTS

# RESULTS

## Symptomatology

Dark brown elongated lesions were noticed on the bark of affected twigs and branches. These lesions enlarged and became grey in the centre, with dark brown margins. The size of lesions ranged from 3 mm - 12 mm in length and 2 mm - 5 mm in breadth. Under favourable conditions of disease development some lesions coalesced and formed larger patches. Sometimes the bark at the infected region gets peeled off exposing the inner tissues. Often black pin-head like pycnidial bodies could be noticed on the lesions. The leaves of the infected twigs gets dried off, and the infected twigs exhibited die back symptoms.

On fruits small dark brown spots were first noticed. These rapidly enlarged and appeared as greyish brown sunken lesions with dark brown margin. The colour of the outer margin varied depending on the colour of the fruit. The tissues beneath the lesions were also infected and in course of time the complete fruit became rotten. Under dry weather conditions the infected fruits became mummified and dried. Large number of pycnidia of the causal organism were noticed on infected portion of the fruit, often in the form of concentric rings.

Isolation, purification and maintenance of the pathogen

The fungus was isolated and brought into pure culture following single spore isolation techniques and maintained on potato dextrose agar slants with frequent subculturing.

Morphology and cultural characters

The fungus produced profuse mycelial growth on PDA, host extract and Czapek's agar. The mycelium consisted of fine hyaline septate hyphae which measured 2.7-3.9 µm in diameter. Pycnidia produced in culture are globose, immersed and partly erumpent at the tip. Conidiophores are hyaline and bearing one celled conidia. Of the two types of spores observed, ovoid to fusoid is alpha conidia and filiform curved is beta conidia. The pycniospores were 4-7 x 2.1 - 3 µm in size (Fig. 1).

Growth of the fungus in culture media

Solid media

The fungus grew well on a number of culture media. Potato dextrose agar, host extract agar and oat meal agar media were equally good for the growth of the fungus, followed by Czapek's agar. Richards's agar was found to be a poor medium for the growth and sporulation of the fungus (Table 1).

Table 1. Growth and sporulation of Phomopsis vexans on different solid media

| No. | Medium | *Mean colony diameter in mm | Colony characters |
|---|---|---|---|
| 1. | Potato dextrose agar | 90 | Mycelium aerial, white at first, later turning grey<br>Sometimes with wavy margin<br>Good sporulation |
| 2. | Host extract agar | 90 | Mycelium aerial. White to greyish<br>Entire margin, Good sporulation |
| 3. | Oat meal agar | 90 | Mycelium aerial white.<br>Entire margin. Fair sporulation |
| 4. | Czapek's agar | 65 | Mycelium aerial white to off white<br>Entire margin. Fair sporulation |
| 5. | Richards's agar | 23.6 | Mycelium aerial white to off white. No sporulation |

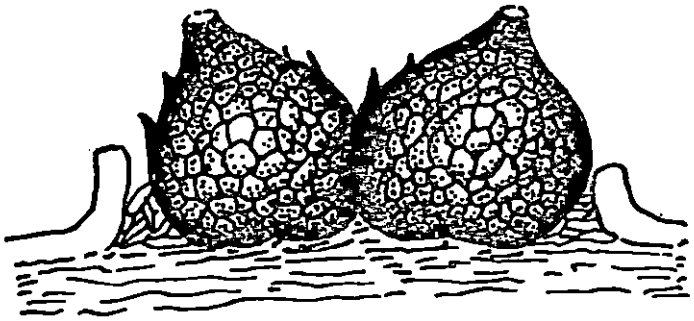
CD (0.05) = 0.47

*Average of 3 replications

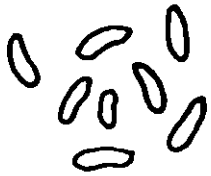
Liquid media

Maximum mycelial growth was produced in potato dextrose followed by host extract and Czapek's medium. Only scanty growth was produced in oat meal and Richards's media (Table 2).

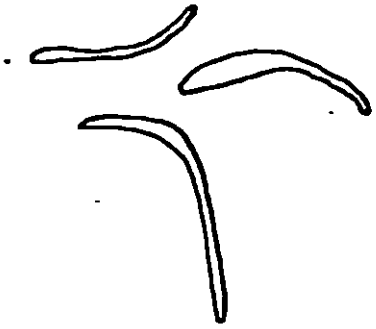
FIG. 1. SPORES AND PYCNIDIA OF *Phomopsis vexans*



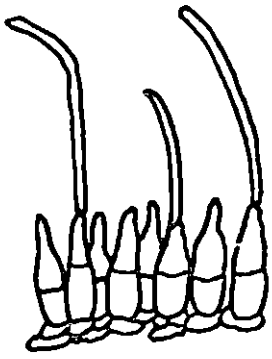
PYCNIDIA



ALPHA CONIDIA



BETA CONIDIA



CONIDIOPHORES

Table 2. Growth of Phomopsis vexans on different liquid media

| No. | Medium | *Mean dry weight of mycelium in mg | Colony characters |
|---|---|---|---|
| 1. | Potato dextrose | 1000 | Mycelium thick and white in colour |
| 2. | Czapek's | 541 | " |
| 3. | Oat meal | 276 | Mycelium scanty and white in colour |
| 4. | Richards's | 262 | Mycelium scanty and off white in colour |
| 5. | Host extract | 926 | Mycelium thick white in colour |

CD (0.05) = 0.20

*Average of 3 replications

Identification of the causal organism

The pathogen was identified as Phomopsis vexans (Sacc. & Sydow.) Harter, by Dr. E. Punithalingan of C.A.B., International Mycological Institute, U.K.

Pathogenicity tests

A. On fruits

The pathogen could attack fruits at all stages of maturity, but maximum disease development was observed in medium sized fruits (Plate No. 2). Symptoms produced on artificially inoculated fruits were identical to those

observed in nature. No symptom was observed on uninjured fruits.

In larger sized fruits, it took more time to take infection and in some cases no symptom was produced even after injury.

B. On twigs

On the twigs the symptom developed as elongated grey lesions. Later, these lesions were covered with many black pycnidia (Plate No. 3).

Host range

Of the twelve different vegetables inoculated with the fungus, it was found that it could infect only tomato, and carrot. Symptoms characterised by rotting of tissues appeared within six days after inoculation (Plate No. 4).

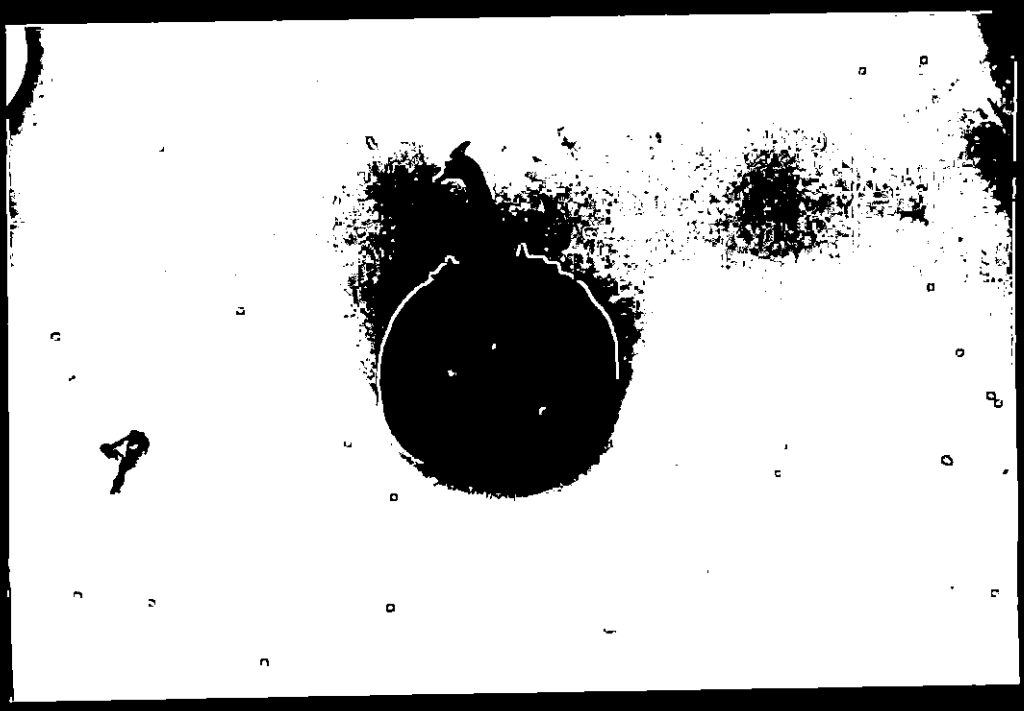
Effect of culture filtrate of the pathogen

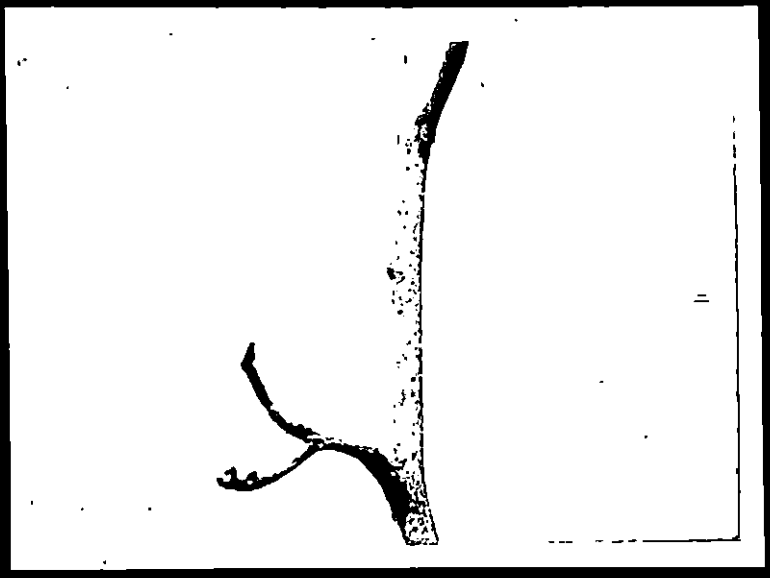
A. On brinjal plants

Brinjal seedlings when dipped in culture filtrate began to droop within two days. At first, the leaves lost turgidity, turned light brown and later dried up. Seedlings dipped in sterile water remained healthy. Leaves of matured plants when sprayed with culture filtrate developed light brown spots which later turned dark brown. These leaves dried up subsequently (Plate No. 5).

2. Symptom on fruit by artificial inoculation

3. Naturally infected twig showing pycnidial development





4. Growth of the pathogen on carrot and tomato

5. Plant showing effect of culture filtrate

B. On vegetable seed

The culture filtrate of the fungus was found to exert inhibitory effect on the germination of brinjal, chilli, tomato and greengram seeds. The mean values on extent of inhibition of germination are presented in Table 3. It was observed that the per cent germination of different seeds was above 90 in sterile water and that in fresh and boiled culture filtrate were 29.33 and 21.60 respectively. There was no significant difference in the per cent germination of seeds in fresh and boiled culture filtrates.

Effect of fruit infection on seeds and seedlings

It was observed that the seeds extracted from infected fruit had inhibitory effect on seed germination and health of the seedlings. The seedlings raised from infected fruit showed damping off symptom within 7 days. While seedlings raised from healthy fruits remained healthy. The data revealed that there was significant reduction in the per cent germination of seeds extracted from infected fruits. More or less identical results were obtained in both blotter and sand methods of testing (Table 4).

Table 3. Effect of culture filtrate on germination of seeds

| No. | Seed | Per cent germination* | | | Mean |
|---|---|---|---|---|---|
| | | Sterile water | Culture filtrate (fresh) | Culture filtrate (boiled) | |
| 1. | Brinjal | 100(90)** | 24.90(29.91) | 18.26(25.30) | 55.90(48.40) |
| 2. | Chilli | 94.34(76.24) | 29.65(32.99) | 19.84(26.44) | 50.40(45.22) |
| 3. | Tomato | 96.7(79.53) | 31.27(34) | 24.5(29.67) | 54.8(47.74) |
| 4. | Greengram | 91.8(73.37) | 31.5(34.13) | 23.8(29.21) | 51.0(45.57) |
| | | 95.71(79.78) | 29.33(32.75) | 21.60(27.65) | |

CD (0.05) for different vegetable seeds = 6.50

CD (0.05) for different treatments = 5.63

*Average of 3 replications

**Transformed mean values (angular transformation)

Table 4. Effect of fruit infection on seed germination

| No. | Medium | Per cent germination of | |
|---|---|---|---|
| | | Seeds from infected fruits | Seeds from healthy fruits |
| 1. | Sand | 38.00* (38.07)** | 99.97(89.09) |
| 2. | Blotter paper | 35.00(36.26) | 99.55(86.11) |

*Average of 15 replications

**Transformed mean values (angular transformation)

Laboratory evaluation of fungicides

The laboratory evaluation of different fungicides viz., bordeaux mixture, bavistin, dithane M.45, cuman L, calixin, kavach, and COC-50 showed that these fungicides could inhibit the growth of the fungus to a considerable extent. Bordeaux mixture and bavistin were significantly superior to the other fungicide tested in inhibiting the growth of the pathogen. Calixin was found to be significantly different from other fungicides and found to be the next best to bavistin.

Bordeaux mixture gave complete inhibition of growth of the fungus at 750 ppm concentration while bavistin had the same effect at 500 ppm. None of the other fungicides could cause cent per cent inhibition of growth even at maximum concentration tested (Table 5, Plate No. 6a, b, 7, 8a, b, 9, 10, 11a, b & 12, Fig. 2).

Table 5. Laboratory evaluation of different fungicides on growth of Phomopsis vexans (poisoned food technique)

| Sl. No. | Fungicides | 100* | 250 | 500 | 750 | 1000 | 2000 | 3000 | 10,000 | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Bordeaux mixture | 1.12** (1.46) | 0.87 (1.37) | 0.67 (1.29) | 0.0 (1.0) | 0.0 (1.0) | 0.0 (1.0) | 0.0 (1.0) | 0.0 (1.0) | 0.30 (1.14) |
| 2. | Bavistin | 1.42 (1.56) | 0.77 (1.33) | 0.0 (1.0) | 0.0 (1.0) | 0.0 (1.0) | - | - | - | 0.38 (1.18) |
| 3. | Dithane-M.45 | 4.69 (2.38) | 3.16 (2.04) | 2.97 (2.00) | 2.83 (1.96) | 2.80 (1.95) | 1.60 (1.61) | 0.30 (1.14) | - | 2.49 (1.87) |
| 4. | Cuman L. | 3.97 (2.23) | 3.77 (2.18) | 3.00 (2.00) | 2.60 (1.90) | 1.97 (1.72) | - | - | - | 2.44 (1.86) |
| 5. | Calixin | 1.54 (1.60) | 1.07 (1.44) | 0.88 (1.37) | 0.50 (1.22) | 0.26 (1.12) | - | - | - | 0.82 (1.35) |
| 6. | Kovach | 3.67 (2.16) | 3.00 (2.00) | 2.90 (1.97) | 2.83 (1.96) | 0.90 (1.38) | 0.58 (1.26) | 0.35 (1.16) | - | 1.89 (1.70) |
| 7. | COC-50 | 3.66 (2.16) | 3.03 (2.01) | 2.97 (1.99) | 2.35 (1.83) | 0.56 (1.25) | - | - | - | 2.42 (1.85) |
| 8. | Control | | | | | | | | | 9.00 (8.16) |

CD (0.05) for fungicides 0.0484 0.0439 0.0497 0.0537 0.0453

CD (0.05) between levels of fungicides = 0.1201

*Concentration of fungicide in ppm

**Mean colony diameter in cm (Figures in parentheses are values after square transformation)

6a,b Laboratory evaluation of Bordeaux mixture against *Phomopsis vexans*

a. 0 - Control

1 - 100 ppm

2 - 250 ppm

3 - 500 ppm

4 - 750 ppm

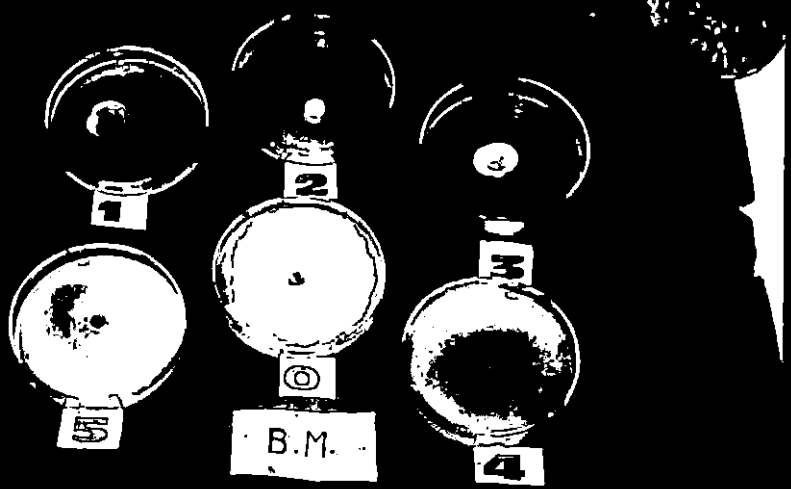
5 - 1000 ppm

b. 0 - Control

1 - 2000 ppm

2 - 3000 ppm

3 - 10000 ppm


1
2
3
0
5
B.M.
4

7. Laboratory evaluation of Bavistin against *Phomopsis vexans*

0 - Control

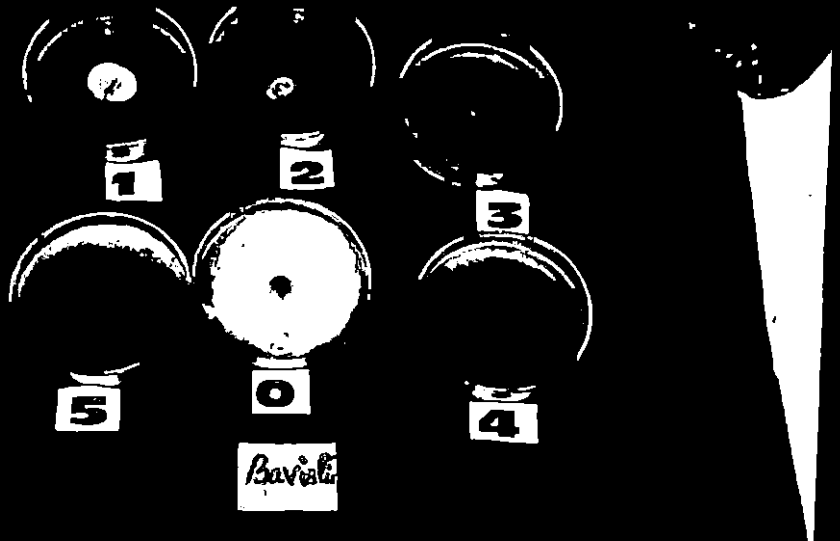
1 - 100 ppm

2 - 250 ppm

3 - 500 ppm

4 - 750 ppm

5 - 1000 ppm


1
2
3
5
0
4
Bavieli

8a,b Laboratory evaluation of Dithane M.45 against *Phomopsis vexans*

a. 0 - Control

1 - 100 ppm

2 - 250 ppm

3 - 500 ppm

4 - 750 ppm

5 - 1000 ppm

b. 0 - Control

1 - 2000 ppm

2 - 3000 ppm

1
2
3
4
5
0

9. Laboratory evaluation of Cuman L. against *Phomopsis vexans*

0 - Control

1 - 100 ppm

2 - 250 ppm

3 - 500 ppm

4 - 750 ppm

5 - 1000 ppm

1
2
3
5
0
4
Amand

10. Laboratory evaluation of Calixin against Phomopsis vexans

a. 0 - Control

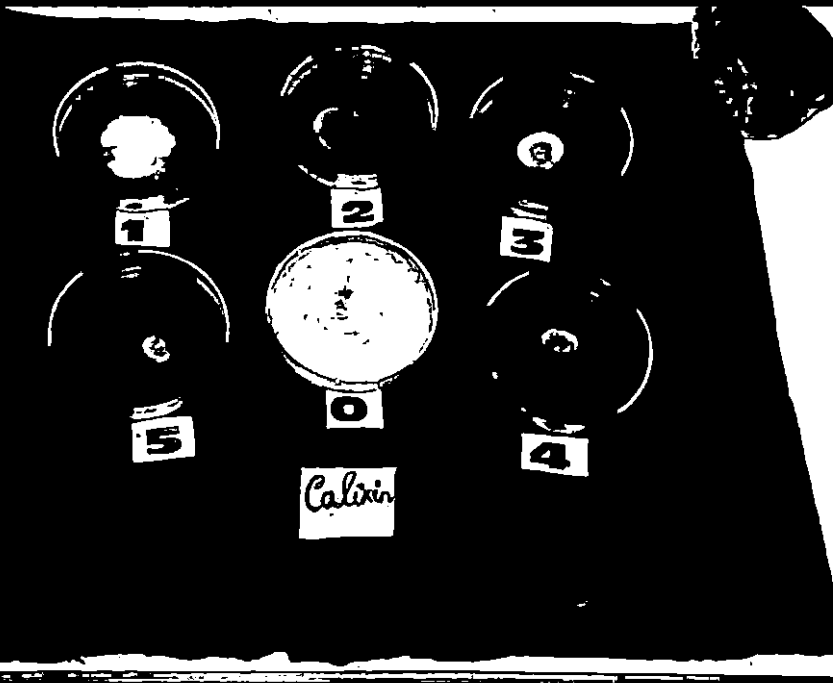
1 - 100 ppm

2 - 250 ppm

3 - 500 ppm

4 - 750 ppm

5 - 1000 ppm


1
2
3
5
0
4
Calixin

11a,b Laboratory evaluation of Kavach against *Phomopsis vexans*

a. 0 - Control

1 - 100 ppm

2 - 250 ppm

3 - 500 ppm

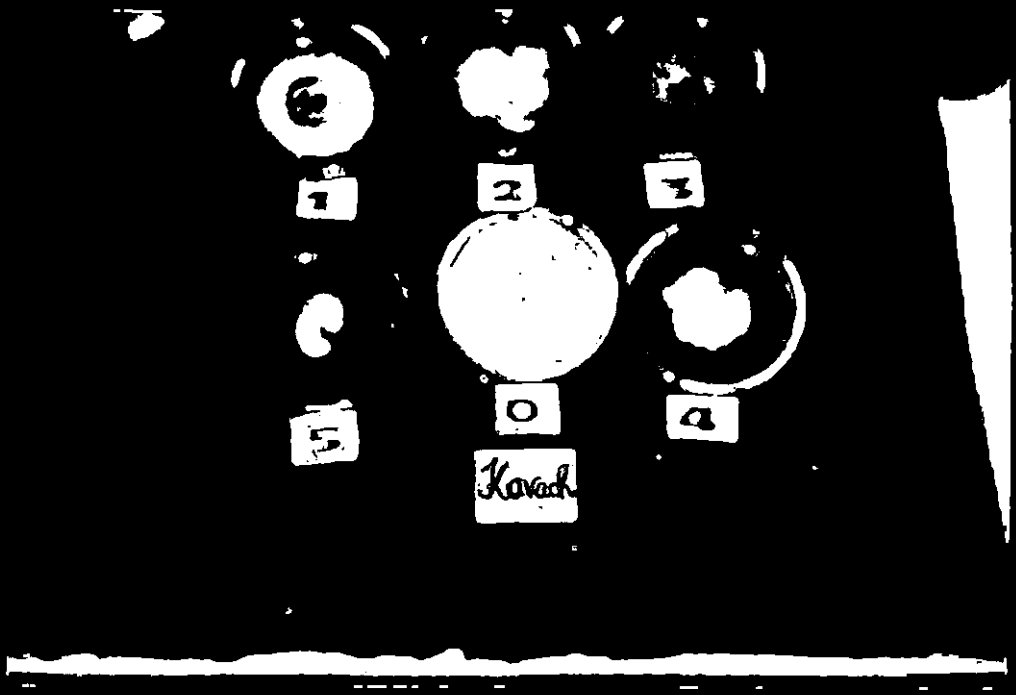
4 - 750 ppm

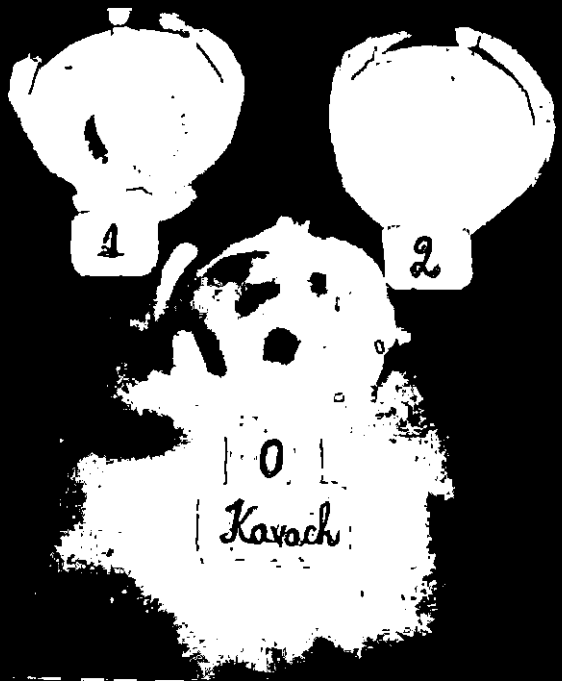
5 - 1000 ppm

b. 0 - Control

1 - 2000 ppm

2 - 3000 ppm


1
2
3
5
0
4
Kavach


1
2
0
Kavach

12. Laboratory evaluation of COC-50 against *Phomopsis vexans*

0 - Control

1 - 100 ppm

2 - 250 ppm

3 - 500 ppm

4 - 750 ppm

5 - 1000 ppm

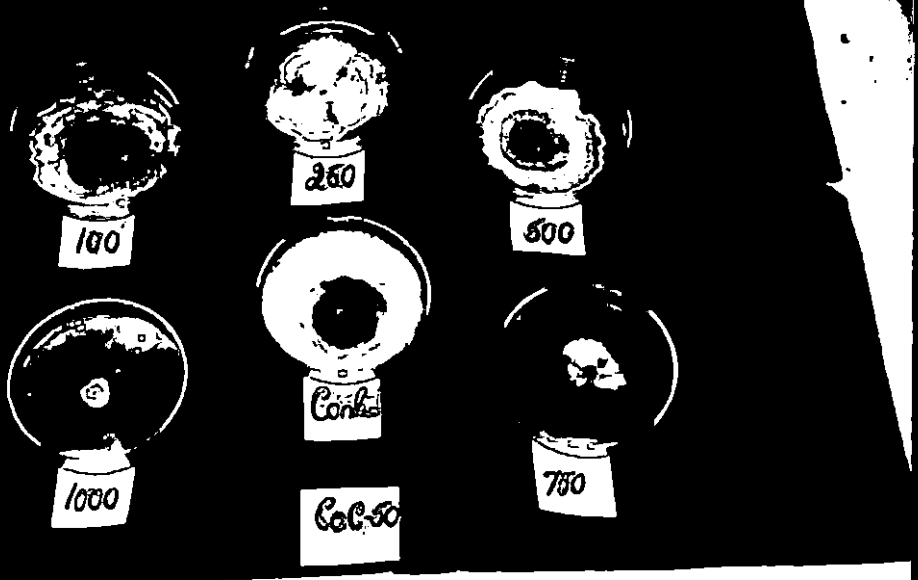
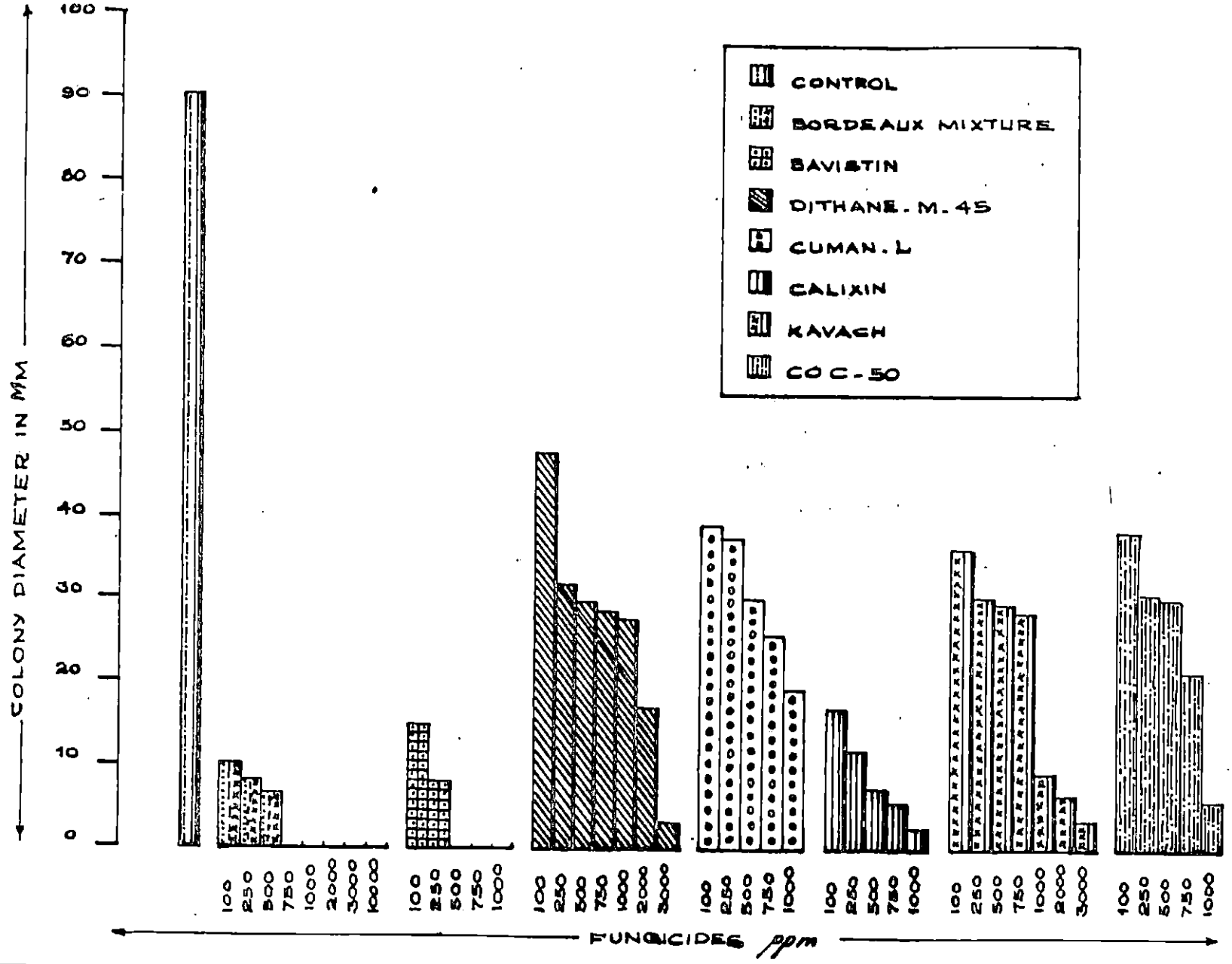

100
250
500
1000
Co-Mo
750
CoC-50

FIG. 2. LABORATORY EVALUATION OF FUNGICIDES



Field evaluation of fungicides

In the observation recorded 15 days after the first spraying it was noted that all the fungicides tested were able to reduce the percentage of infected fruits to a considerable extent. Dithane-M.45, COC-50, bordeaux mixture and kavach were significantly superior to the other fungicides tested. Though the plants sprayed with dithane-M.45 had minimum percentage (24.96) of infected fruits, the fungicide was found to be on par with COC-50, bordeaux mixture and kavach (Table 6).

When observations were recorded 15 days after the second spraying COC-50 was found to be the best fungicide closely followed by kavach in reducing the percentage of infected fruits. COC-50 was found to be significantly superior to all other fungicides tested while kavach was on par with bordeaux mixture and dithane M.45. Calixin was found to be the least effective fungicide in the first and second spraying (Table 7).

In the next observation taken 15 days after the third spraying COC-50 emerged as the best fungicide and was significantly superior to others. Cuman L had the least effect in controlling the disease (Table 8).

Final observations recorded 15 days after fourth spraying, revealed that COC-50 had the maximum effect in

Table 6. Effect of spraying with fungicides on the incidence of Phomopsis fruit rot of brinjal

(First spraying (21-11-1990)

| No. | Fungicides | Percentage of infected fruits* | | Per cent efficiency of treatment (Based on column III) over control |
|---|---|---|---|---|
| | | Pre treatment (on the date of 1st spraying) | 15 days after 1st spraying | |
| | I | II | III | |
| 1. | Bordeaux mixture (0.1%) | 42.01(40.41) | 26.10(30.72) | 34.75 |
| 2. | Bavistin (0.1%) | 41.36(40.03) | 34.95(36.24) | 12.63 |
| 3. | Dithane M.45 (0.3%) | 41.60(40.15) | 24.96(29.97) | 37.60 |
| 4. | Cuman L. (0.3%) | 32.10(34.57) | 29.05(32.61) | 27.37 |
| 5. | Calixin (0.1%) | 40.33(39.43) | 35.8(36.74) | 10.50 |
| 6. | Kavach (0.1%) | 25.96(30.63) | 27.01(31.32) | 32.47 |
| 7. | COC-50 (0.3%) | 42.01(40.41) | 26.08(30.71) | 34.80 |
| 8. | Control | 22.04(28.0) | 40.00(39.23) | - |

CD (0.05) = 2.11

*Average of 3 replications

Table 7. Effect of spraying fungicides on the incidence of Phomopsis fruit rot of brinjal

Second spraying (7-12-1990)

| No. | Fungicides | Percentage of infected fruits* | | Percent efficiency of treatment (based on column III) over control |
|---|---|---|---|---|
| | | Pretreatment (on the date of 1st spraying) | 15 days after 1st spraying | |
| | I | II | III | IV |
| 1. | Bordeaux mixture (1%) | 42.01(40.41) | 20.20(26.71) | 42.28 |
| 2. | Bavistin (0.1%) | 41.36(40.03) | 24.64(29.76) | 29.60 |
| 3. | Dithane M.45 (0.3%) | 41.60(40.15) | 19.00(25.84) | 45.71 |
| 4. | Cuman L. (0.3%) | 32.10((34.57) | 24.86(29.90) | 28.97 |
| 5. | Calixin (0.1%) | 40.33(39.43) | 25.97(30.64) | 25.80 |
| 6. | Kavach (0.1%) | 25.96(30.63) | 18.10(25.18) | 48.29 |
| 7. | COC-50 (0.3%) | 42.01(40.41) | 15.28(23.01) | 56.34 |
| 8. | Control | 22.04(28.0) | 35.00(36.27) | - |

CD (0.05) - 2.28

*Average of 3 replications

Table 8. Effect of spraying fungicides on the incidence of Phomopsis fruit rot of brinjal

Third spraying (22-12-1990)

| No. | Fungicide | Percentage of infected fruits* | | Per cent efficiency of treatment (based on column III over control) |
|---|---|---|---|---|
| | | Pretreatment (on the date of 1st spraying | 15 days after 1st spraying | |
| | I | II | III | IV |
| 1. | Bordeaux mixture (1%) | 42.01(40.41) | 12.92(21.06) | 66.06 |
| 2. | Bavistin (0.1%) | 41.36(40.03) | 19.32(26.07) | 49.25 |
| 3. | Dithane M.45 (0.3%) | 41.60(40.15) | 15.90(23.50) | 58.23 |
| 4. | Cuman L. (0.3%) | 32.10(34.57) | 23.69(29.12) | 37.77 |
| 5. | Calixin (0.1%) | 40.33(39.43) | 18.14(25.21) | 52.35 |
| 6. | Kavach (0.1%) | 25.96(30.63) | 15.66(23.31) | 58.86 |
| 7. | COC-50 (0.3%) | 42.01(40.41) | 8.94(17.40) | 76.52 |
| 8. | Control | 22.04(28.0) | 38.07(38.10) | - |

CD (0.05) - 2.32

*Average of 3 replications

Table 9. Effect of spraying with fungicides on the incidence of Phomopsis fruit rot of brinjal

Fourth spraying (7-1-1991)

| No. | Fungicides | Percentage of infected fruits* | | Per cent efficiency of treatment (based on column III) over control |
|---|---|---|---|---|
| | | Pretreatment (on the date of 1st spraying) | 15 days after 1st spraying | |
| | I | II | III | IV |
| 1. | Bordeaux mixture (1%) | 42.01(40.41) | 8.95(17.41) | 78.76 |
| 2. | Bavistin (0.1%) | 41.36(40.03) | 17.04(24.38) | 59.56 |
| 3. | Dithane M.45 (0.3%) | 41.60(40.15) | 10.70(19.09) | 74.60 |
| 4. | Cuman L. (0.3%) | 32.10(34.57) | 20.56(26.96) | 51.21 |
| 5. | Calixin (0.1%) | 40.33(39.43) | 15.35(23.07) | 63.57 |
| 6. | Kavach (0.1%) | 25.96(30.63) | 14.64(22.50) | 65.26 |
| 7. | COC-50 (0.3%) | 42.01(40.41) | 3.90(11.39) | 90.75 |
| 8. | Control | 22.04(28.0) | 42.14(40.48) | - |

CD (0.05) - 1.75

*Average of 3 replications

reducing the percentage of infected fruits and was significantly superior to the other fungicides tested. Only 3.9 per cent of the fruits were infected in plants sprayed with COC-50 while the control had 42.14 per cent infected fruits (Table 9).

All the fungicides tested were superior to control. COC-50 exhibited maximum efficiency in controlling the disease and was significantly superior to all the other fungicides. This was followed by bordeaux mixture, dithane M.45, kavach, calixin, bavistin and cuman L (Fig. 3).

Comparative efficacy of different fungicides on seed germination

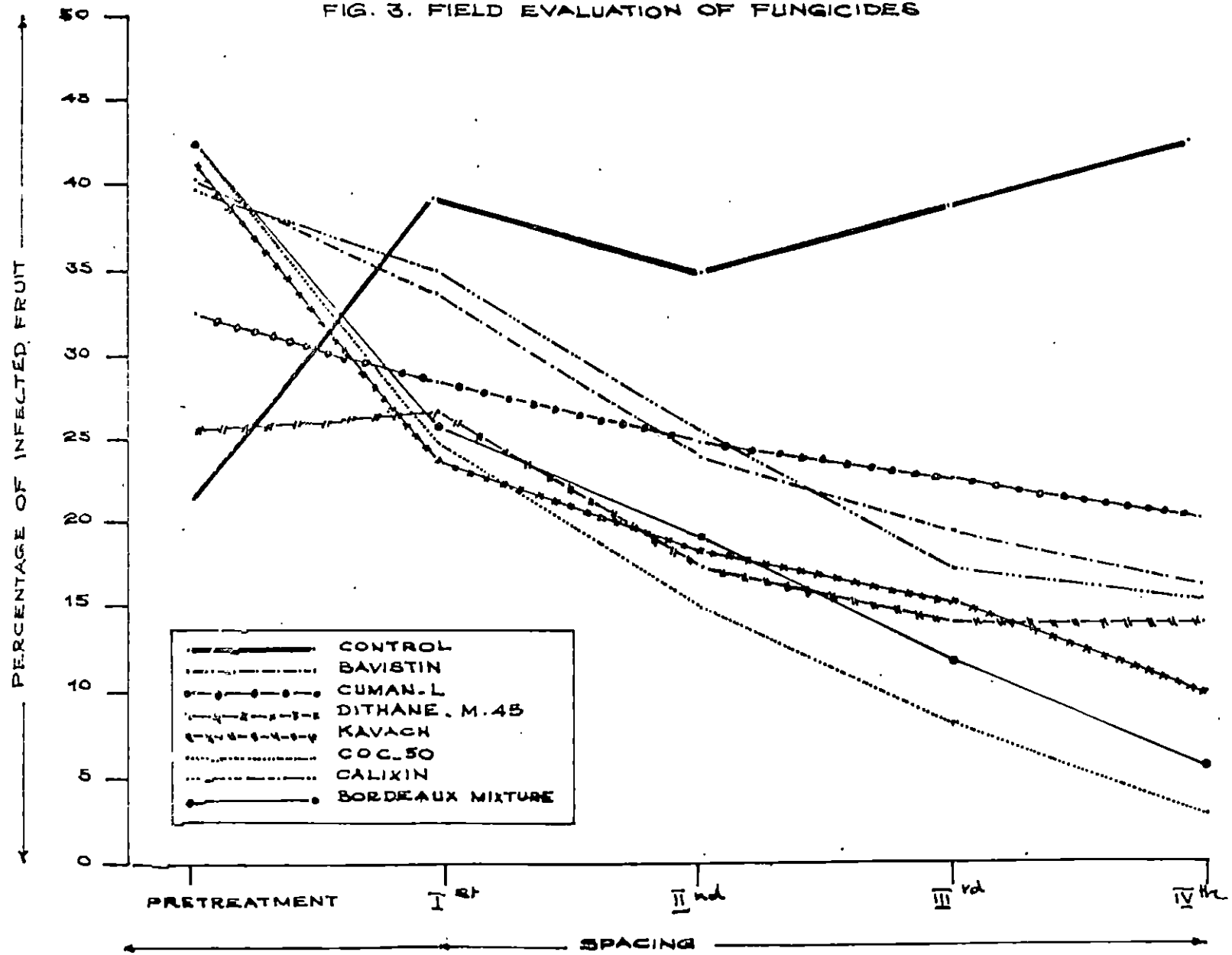
A. Effect of treatment of spore suspension in germination of seeds

In order to see the effect of spore suspension in germination of seeds of brinjal, the seeds were soaked in spore suspension of the test fungus and sterile water for 24 hours. It was found that the germination percentage was 9.67 in those seeds soaked in spore suspension and it was 17.08 in seeds soaked in sterile water showing the ability of the fungus to reduce germination of seeds.

Table 10a. Effect of spore suspension on germination of brinjal seeds

| No. | Mean per cent germination of seeds | | t value |
|---|---|---|---|
| | Soaked in spore suspension | Soaked in sterile water | |
| 1. | 9.67 | 17.08 | 6.80 |

FIG. 3. FIELD EVALUATION OF FUNGICIDES



B. Effect of fungicide

Among the 3 different fungicides used for testing the germination of seeds soaked in spore suspension of the pathogen it was found that bavistin was the best giving a germination percentage of 14.6 followed by dithane M.45 and COC-50. But it was noted that there was no significant difference among the treatments. Bavistin, COC-50 and dithane M.45 were almost on par (Table 10b).

Table 10b. Effect of different fungicides on seed germination

| No. | Treatments | *Per cent germination of seeds |
|---|---|---|
| 1. | Bavistin | 14.6(22.47)** |
| 2. | COC-50 | 13.54(21.59) |
| 3. | Dithane M.45 | 14.1(22.04) |
| 4. | Control | 17.08(8.62) |

CD (0.05) for fungicides - 21.76

*Average of 3 replications

**Transformed mean values (angular transformation)

# DISCUSSION

# DISCUSSION

Blight and fruit rot of brinjal prevalent in the Instructional Farm, College of Agriculture, Vellayani was studied during the present investigation. The symptoms of the disease particularly on the fruits were studied in detail and were found to be more or less identical to those reported by other investigators (Pawar and Patel, 1957; Suryanaryana, 1978; Singh, 1985 and Kumar et al., 1986a). The blight phase of the disease was observed in brinjal plants under field conditions at Vellayani.

Eventhough the fruit rot was prevalent in fruits of all stages of maturity the intensity of the disease was considerably high in half matured and mature fruits. On the variety Pusa purple round commonly cultivated in the farm over 25-40 per cent fruits were found affected. An interesting observation recorded during the present investigation was that the fruits produced on lower branches and touching the soil were invariably infected by the fungus under study. Similar results were reported by Dharam Singh and Chakrabarti (1982) where they said that irrespective of chemical sprays almost all the fruits touching the ground rotted.

The causal organism was isolated and brought into pure culture on potato dextrose agar. The morphological

characters of the organism were studied. The fungus produced numerous pycnidia which contained large number of oblong to oval pycniospores (alpha conidia) and very few filiform slightly curved stylospores (beta conidia). Pawar and Patel (1957) reported that the fungus produced elliptical pycniospores in natural and in artificial media but never produced stylospores. Based on the morphological characters the fungus was tentatively identified as Phomopsis sp. A culture of the fungus sent to C.A.B. International Mycological Institute, U.K. was identified as Phomopsis vexans (Sacc. & Sydow.) Harter by Dr. E. Punithalingam. The blight and fruit rot of brinjal caused by Phomopsis vexans has not been reported from Kerala earlier.

Good growth and sporulation of the fungus was obtained on potato dextrose, host extract and oat meal agar media. Among the liquid media tried, maximum mycelial growth was obtained in potato dextrose closely followed by host extract. Lapis and Deangiknay (1967) reported good growth of P. vexans was obtained on potato dextrose, corn meal, oat meal, Leonian and plain agars. Pawar and Patel (1957) obtained best growth of the fungus in Lima bean, potato dextrose, host decoction dextrose and oat meal agar and fair growth on Brown's and Richards's agar and very poor growth in host decoction and plain agar.

Artificial inoculations revealed that the fungus was pathogenic to brinjal and was able to incite symptoms on twigs and fruits. It was noticed that half matured and mature fruits took up infection readily than very young fruits. This may be due to the increase in surface area of the fleshy part of the fruit by which the pathogen and climatological parameters can interact well which results in increased rotting. Injury was found to be prerequisite for infection by this fungus which shows the pathogen to be a wound parasite. Singh and Chand (1986) made similar observation.

Studies on host range of the pathogen revealed that the fungus could cause rotting in tomato and carrot only under injury in addition to brinjal, and failed to cause infection in bhindi, bittergourd, carrot, onion, ginger, chilli, cowpea, clusterbean, cucumber, frenchbean, tomato and potato. Pawar and Patel (1957) reported that the pathogen could infect only Solanum melongena under artificial conditions but not Capsicum annum L., Datura fastuosa L., Lycopersicon esculentum Mill, Nicotiana tabacum L., Solanum nigrum L., Solanum tuberosum L., and Petunia sp. Chowdhury and Hasiza (1979) reported that P. vexans could infect only injured fruits of Lycopersicon lycopersicum and failed to cause infection on Capsicum annum.

Culture filtrate of the fungus induced drooping and drying of the leaves of brinjal and when culture filtrate was sprayed on to the leaves of mature plants they developed light brown spots and eventually these leaves dried up. Culture filtrate of the fungus exerted inhibitory effect on germination of brinjal, chilli, tomato and greengram seeds. There was not much difference in germination of seeds treated with fresh and boiled culture filtrate showing that the toxic effect is retained even after boiling without undergoing any chemical change.

During the present investigation the seeds extracted from infected fruits showed a reduction in germination percentage which revealed the pathogen to be seed borne. Toole et al. (1941) reported that seeds from healthy fruits of brinjal germinated much more rapidly and had higher percentage of germination than that of seeds from fruit rot affected fruits. Porter (1943) reported that brinjal seeds artificially contaminated by P. vexans when planted in sterile soil reduced the stand of the seedling by 10.7 per cent, healthy seeds in contaminated soil showed a reduction of 19.8 per cent and contaminated seed in contaminated soil a reduction of 22.5 per cent of that obtained with healthy seeds. Suryanaryana (1978) reported that heavily infected seeds failed to germinate and if at all germinated gets blighted.

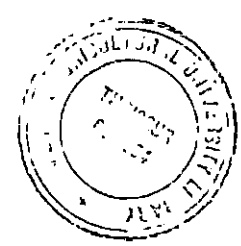



In the in vitro studies conducted with different fungicides on inhibition of the pathogen it was found that bordeaux mixture at 750 ppm and bavistin at 500 ppm concentration could completely inhibit the growth of the pathogen. Pawar and Chand (1969) reported that bordeaux mixture and copper oxychloride at 0.25 per cent were very effective in controlling P. vexans affecting egg plant under in vitro condition.

In field evaluation with different fungicides for the control of fruit rot disease of brinjal, it was found that COC-50 was the best fungicide followed by bordeaux mixture, dithane M.45, kavach, calixin, bavistin and cuman L. Similar results were reported by Palo (1936) where he could control Phomopsis fruit rot by spraying a mixture of bordeaux mixture and copper oxychloride or copper oxychloride alone at fortnightly intervals. Spencer et al. (1924) reported good results to control P. vexans by spraying bordeaux mixture with 2 lb of calcium arsenate. Maneb, mancozeb and zineb were also reported to give good results in controlling the fruit rot disease of brinjal (Singh, 1985). Grewal and Jhooty (1987) could get control of Phomopsis fruit rot of eggplant with different fungicides viz., dithane M.45, dithane Z.78, cuman L, bordeaux mixture and blitox. Besides these few workers have reported the use of

resistant varieties and hot water treatment at 50°C for 30 minutes against fruit rot of brinjal (Howard and Dessosiers, 1941; Kalda et al., 1976).

Seeds when soaked in spore suspension of the pathogen, there was a reduction in germination percentage compared to the control. Seeds soaked in the spore suspension for a period of 24 hours and planted in poisoned media with fungicides viz., dithane M.45, COC-50 and bavistin, it was found that bavistin was the best followed by dithane M.45 and COC-50 in enhancing the germination percentage of seeds. Dharam Singh and Chakrabarti (1982) reported that seed treatment with chemicals like bavistin, calixin, thiram, captan, difolatan, benlate and hot water did not have any significant effect on the emergence and stand of brinjal seedling in nursery buds. However, several workers have reported hot water treatment for control of fruit rot and blight of brinjal (Felix et al., 1965; Suryanaryana, 1978 and Singh, 1985).



# SUMMARY

SUMMARY

Symptoms of Phomopsis blight and fruit rot of brinjal caused by Phomopsis vexans (Sacc. & Sydow.) Harter was studied in detail.

The fungal mycelium consisted of fine hyaline septate hyphae. Pycnidia produced in culture are globpse immersed and partly erumpent. Conidiophores hyaline and bearing two types of spores, ovoid to fusoid alpha conidia and filiform curved beta conidia. The fungus grew well on potato dextrose, host extract, and oat meal media. Among the liquid media tried, potato dextrose, host extract and Czapek's media supported good mycelial growth.

It was found that the pathogen could attack fruits of all stages of maturity, but maximum disease development was observed in medium sized fruits. No infection was observed in uninjured fruits. The pathogen was found to cause blighting symptom on twigs.

Vegetables like bhindi, bittergourd, carrot, onion, ginger, chilli, cowpea, clusterbean, cucumber, frenchbean, tomato, and potato inoculated with the pathogen were found resistant with the exception of tomato and carrot.

The culture filtrate of the fungus caused drying of the leaves of young brinjal seedlings and on the leaves of

mature plants produced light brown spots, which later turned dark brown and eventually the leaves got dried up.

It was also observed that culture filtrate of the pathogen could exert inhibitory effect on germination of brinjal, chilli, tomato, and greengram seeds. There was no difference in germination of seeds in fresh and boiled culture filtrates.

The seeds extracted from infected fruit showed reduction in germination and the seedlings showed damping off symptoms both in blotter and sand method.

Seeds soaked in spore suspension for 24 hours showed a reduction in germination to that soaked in sterile water. Seed treatment with different fungicides showed that bavistin was the best fungicide followed by dithane M-45, and COC-50.

Laboratory evaluation of fungicides revealed that in fungicide incorporated media there was complete inhibition of growth of the fungus with 750 ppm of bordeaux mixture and 500 ppm of bavistin.

In the field evaluation, COC-50 proved to be the best fungicide in controlling the incidence of disease followed by bordeaux mixture, dithane M-45, kavach, calixin, bavistin and cuman L.

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* Original not seen

Abstract of Anova of Table 1 (Growth and sporulation of Phomopsis vexans on different solid media)

| Source | D.F. | M.S.S. | F |
|---|---|---|---|
| Treatments | 4 | 2517.23 | 37465.78** |
| Error | 10 | 0.067 | |

** Significant at 1% level

Abstract of Anova of Table 2 (Growth of the Phomopsis vexans on different liquid media)

| Source | D.F. | M.S.S. | F. |
|---|---|---|---|
| Treatments | 4 | 0.362 | 29.95** |
| Error | 10 | 0.012 | |

** Significant at 1% level

Abstract of Anova of Table 3 (Effect of culture filtrate on germination of seeds)

| Source | D.F. | M.S.S. | F. |
|---|---|---|---|
| Treatments | 11 | 1851.78 | 41.51** |
| Vegetable seeds | 3 | 22.26 | 0.50 |
| Media | 2 | 9909.95 | 222.12** |
| Vegetable seed x media | 6 | 80.48 | 1.80 |
| Error | 24 | 44.62 | |

** Significant at 1% level

Abstract of Anova of Table 4 (Effect of fruit infection in seed germination)

| Source | D.F. | M.S.S. | F. |
|---|---|---|---|
| Between sand and blotter paper | 1 | 30.54 | 0.15 |
| Between levels of sand | 1 | 6250 | 31.54** |
| Between levels of blotter paper | 1 | 6228.68 | 34.43** |
| Error | 32 | 198.18 | |

** Significant at 1% level

Abstract of Anova of Table 5 (Laboratory evaluation of fungicides on growth of Phomopsis vexans)

| Source | D.F. | M.S.S. | F. |
|---|---|---|---|
| Fungicides | 6 | 2.09 | 383.63** |
| Treated vs. control | 1 | 7.33 | 1342.06** |
| Between levels | | | |
| Bordeaux mixture | 7 | 0.12 | 21.30** |
| Bavistin | 4 | 0.20 | 35.85** |
| Dithane M.45 | 6 | 0.46 | 84.77** |
| Cuman L. | 4 | 0.29 | 53.49** |
| Calixin | 4 | 0.10 | 18.50** |
| Kavach | 6 | 0.52 | 94.34** |
| COC-50 | 4 | 0.38 | 68.87** |
| Error | 90 | 0.0055 | - |

** Significant at 1% level

Abstract of Anova of Table 6 (Effect of first spraying with fungicides on the incidence of Phomopsis fruit of brinjal)

| Source | D.F. | M.S.S. | F. |
|---|---|---|---|
| Replication | 2 | 5.55 | 3.82* |
| Treatment | 7 | 36.14 | 24.87** |
| Error | 14 | 1.45 | |

* Significant at 5% level

** Significant at 1% level

Abstract of Anova of Table 7 (Effect of second spraying with fungicides on incidence of Phomopsis fruit rot of brinjal)

| Source | D.F. | M.S.S. | F. |
|---|---|---|---|
| Replication | 2 | 2.03 | 1.20 |
| Treatment | 7 | 51.37 | 30.44** |
| Error | 14 | 1.69 | |

** Significant at 1% level

Abstract of Anova of Table 8 (Effect of third spraying with fungicides on incidence of Phomopsis fruit rot of brinjal)

| Source | D.F. | M.S.S. | F. |
|---|---|---|---|
| Replication | 2 | 3.10 | 1.76 |
| Treatment | 7 | 114.18 | 64.92** |
| Error | 14 | 1.76 | |

** Significant at 1% level

Abstract of Anova of Table 9 (Effect of fourth spraying with fungicides on the incidence of Phomopsis fruit rot of brinjal)

| Source | D.F. | M.S.S. | F. |
|---|---|---|---|
| Replication | 2 | 2.24 | 2.25 |
| Treatment | 7 | 216.20 | 217.44** |
| Error | 14 | 0.99 | |

** Significant at 1% level

Abstract of Anova of Table 10b (Effect of fungicides on seed germination)

| Source | D.F. | M.S.S. | F. |
|---|---|---|---|
| Between fungicides | 2 | 8.9 | 0.056 |
| Treatment vs. control | 1 | 994.54 | 6.23* |
| Error | 17 | 159.53 | |

* Significant at 5% level

# ETIOLOGY AND CONTROL OF BLIGHT AND FRUIT ROT OF BRINJAL

BY

JENNY JOHN

ABSTRACT OF THE THESIS
SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS
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ABSTRACT

The present investigation was undertaken to evolve an economically feasible management practice against the fruit rot and twig blight of brinjal.

Infected plant parts of brinjal showing initial stages of infection were collected from different localities and symptomatology of the pathogen was studied in detail. The pathogen was brought into pure culture and sent to C.M.I. International Mycological Institute, U.K. for identification. It was identified to be Phomopsis vexans (Sacc. & Sydow.)Harter. Pathogenicity of the fungus was studied by inoculating the fruits and stems of the host plants and typical symptom similar to natural conditions were observed. Host range of the pathogen was studied by inoculating the different vegetables with the test fungus. Only carrot and tomato was found susceptible to the pathogen.

The fungus grew well equally on potato dextrose host extract and oat meal media followed by Czapek's and Richards's media. Good sporulation of the fungus was also noticed in potato dextrose and host extract media, fair sporulation in oat meal and Czapek's media and no sporulation in Richards's media. In some cases wavy growth of the pathogen was noticed in potato dextrose agar. In liquid media good mycelial growth of the fungus was observed in

potato dextrose, host extract and Czapek's followed by oat meal and Richards's media.

Culture filtrate of the fungus caused drying of the leaves of the young seedling kept dipped in it and on leaves of matured plants it developed dark brown spots and these leaves dried up eventually. Seed treatment with culture filtrate exerted an inhibitory effect on germination of seeds of brinjal, chilli, tomato and greengram, whereas germination percentage was above 90 in seeds kept in sterile water. There was no difference in germination of seeds treated with culture filtrate fresh and that which was boiled for 10 minutes.

The germination of seeds was seen greatly reduced in seeds extracted from infected fruits both in blotter and sand method whereas the germination percentage of seeds extracted from healthy fruit was above 90 per cent. The seedlings raised from infected fruit showed damping off symptom after 2 weeks.

Laboratory evaluation of different fungicides revealed that all the fungicides could inhibit the growth of the pathogen. Bordeaux mixture gave complete inhibition of growth of fungus at 750 ppm concentration while bavistin had the same effect at 500 ppm concentration.

In field evaluation with different fungicides to control Phomopsis fruit rot it was found that spraying with COC-50 at fortnightly interval was the best fungicide as the per cent infected fruits were minimum, that is 3.9, followed by bordeaux mixture, dithane M-45, kavach, calixin, bavistin, and cuman L, with per cent infected fruits being 8.95, 10.7, 14.64, 15.35, 17.04, 20.56 respectively.

Seeds of brinjal when soaked in spore suspension for 24 hours showed a reduction in germination compared to those seeds soaked in sterile water for the same period. Seed treatment with different fungicides showed that bavistin was the best fungicide in inhibiting the effect of the pathogen on seed germination followed by dithane M-45, and COC-50.