STUDIES ON FUNGAL DISEASES OF FORAGE GRASSES

By
R. K. SASIDHARAN

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Dedicated to the memory of my father

(Late) Mr. C.S. RAMAKRISHNAN

DECLARATION

I hereby declare that this thesis entitled "Studies on Fungal Diseases of Forage grasses" 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.

(R.K. SASIDHARAN)

College of Agriculture,
Vellayani,
29-4-1989.

CERTIFICATE

Certified that this thesis entitled "Studies on Fungal diseases of Forage grasses" is a record of research done independently by Mr. R.K. SASIDHARAN under my guidance and supervision and that it has not formed the basis for the award of any degree, fellowship or associateship to him.

(G. PADMAKUMARY)
Chairman
Advisory Committee
Associate Professor
Department of Plant Pathology

College of Agriculture
Vellayani, 29-4-1989.

APPROVED BY

CHAIRMAN

G. PADMAKUMARY

MEMBERS

1. Dr. M. CHANDRASEKHARAN NAIR

2. Dr. G. RAGHAVAN PILLAI

3. ~~Sri.~~ B. BALAKRISHNAN

EXTERNAL EXAMINER

26/8/99

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INTRODUCTION

INTRODUCTION

India has the largest animal population in the world accounting for 179 million cattle and 58 million buffaloes. The main problem facing animal husbandry as well as milk production in India is the extremely low production of good quality fodder. The cattle population in Kerala is estimated to be 34 lakh heads of adult units. The requirement of dry roughages is estimated to be 56 lakh tonnes per year and the present availability is 43 lakh tonnes, of which 80 per cent is contributed by paddy straw. Thus, there is a deficit of 13 lakh tonnes of roughage or 23 per cent of the total requirement (Anon., 1977). Hence, all efforts have to be oriented to produce sufficient quantity of nutritive green roughage to meet the requirement of cattle population.

The area under fodder crops in Kerala is estimated to be 7000 ha, which constitutes only about 0.02 per cent of the gross cultivated area, while it is 1.3 per cent in Punjab and 11 per cent in Rajastan. Because of the extreme pressure exerted on the cultivated land by other crops, increasing the area for fodder cultivation is a rare possibility. As such a viable alternative is to intensify the production per unit area and utilise the interspaces of coconut plantation for cultivation of fodder grasses. There

are altogether 7.5 lakh hectares of land under coconut in Kerala State and if 1.5 to 1.8 lakh hectares are brought under fodder intercropping, the present deficit of 23 per cent in roughage availability can be made up.

Grass land production consists essentially of the conversion by solar energy of atmospheric carbondioxide, soil nutrients and water into herbage. The utilisation of solar energy depends on other climatic factors such as low temperature, water stress and shortage of soil nutrients particularly nitrogen.

Hybrid napier, evolved by crossing napier grass (Pennisetum purpureum) and bajra (Pennisetum typhoides) is a high yielding perennial nutritive grass coming up very well under Kerala conditions. This can be grown under a wide range of soils. It gives an yield of 60-65 tonnes per hectare under rainfed conditions and upto 250 tonnes under irrigated conditions . The trials conducted outside the State have shown that Hybrid napier responded upto 150 kg N/ha (Anon, 1977), while the grass has responded upto 200 kg N/ha under rainfed conditions at Vellayani. Studies conducted under the All India Co-ordinated Project for research on forage crops at Vellayani, revealed that many of the tropical grasses are suitable for growing as intercrops in coconut gardens. The commonly cultivated

popular species are Hybrid napier (Pennisetum purpureum), Guinea grass (Panicum maximum), para grass (Brachiaria mutica), Congosignal (Brachiaria ruziziensis) and Setaria (Setaria anceps). Preliminary observational trials revealed that some of these are susceptible to various fungal diseases especially when grown under high relative humidity conditions prevailing in our State. Many of the hybrid napier types so far evolved in the country and same very high yielding guinea grass strains were found to be highly susceptible to fungal diseases more so when supplied with liberal doses of nitrogen, scarcity of sufficient land area for fodder production programmes of the State, where intensive fodder cropping techniques applying heavy doses of fertilizer especially nitrogen are being practiced in coconut based homestead gardens.

A working knowledge of the common diseases of fodder grasses is desirable to pursue remedial measures effectively and without affecting the feeding quality of the fodder so produced.

Information on the common diseases of cultivated fodder grasses available in the country as well as their control measures are very rare.

A list of all the diseases occurring on common fodder grasses in India as well as in Kerala would serve the need

of scientists working on grasses with the ultimate aim of identifying and controlling them. An attempt was made in the present study to identify the common fungal foliage diseases of cultivated grasses grown all over Kerala State. A detailed survey was conducted in the Sewage Farm at Valiyathura, District Livestock Farm, Kudappanakunnu, Indo-Swiss Project Units at Mattupetti and Peerumedu in different seasons. Observations revealed the occurrence of blight caused by Helminthosporium spp. on hybrid napier with severe reduction of yield of fodder. Other pathogens isolated were Curvularia spp. from Para grass (Brachiaria mutica) and Hariyali grass (Cynodon dactylon), Fusarium spp. were isolated from Setaria (Setaria anceps), Kikyu grass (Pennisetum clandestinum) from Mattupetti. Rhizoctonia spp. were isolated from Guinea grass (Panicum maximum) which affected the sheath, collar and roots.

In these circumstances, the present investigation was carried out to assess the different diseases that affect the production of different grass varieties cultivated in Kerala with the following objectives:

1. Collection and preservation of fungal diseases of important forage grasses from different parts of the State during different seasons of the year.

2. Isolation, purification, testing pathogenicity and identification of pathogens.

3. Studies on the symptomatology, etiology and epidemiology of important diseases.

4. In vitro evaluation of fungicides against important pathogens.

5. Field control of diseases by using fungicides and by management practices.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

An investigation was conducted at the College of Agriculture, Vellayani to assess the different diseases which affect the production of different grass varieties cultivated in Kerala. The literature collected on the topic is presented hereunder. Wherever sufficient review was not available, results on related species of plants are cited.

Grasses are known to be infected by various pathogens. Several workers have reported a number of fungal diseases affecting grasses and other fodder crops. The commonly encountered fungi were Helminthosporium, Fusarium and Curvularia.

2.1.1. Helminthosporium gramineum (Rab.) Sacc.

Von Post (1886) has described the fungus as a destructive pathogen in barley. Diedicke (1903) from Germany reported the fungus as a parasite on different hosts and grouped it into a number of biological races. Padwick and Henry (1933) observed the fungus as a common component of root rot disease of grasses in the plains of U.S.A.

Nattarass (1939) reported Helminthosporium cynodontis Marig. as a causal agent of brown patch disease of Cynodon dactylon in Kenya.

Bean (1965) and Gould (1965) reported leaf blight on Poa pratensis (Kentucky blue grass) caused by Helminthosporium spp.

Misra and Misra (1968) recorded Helminthosporium [redacted] on Setaria italica and H. leucostylum on Eleusine indica from India for the first time.

Wadsworth et al. (1968) isolated Helminthosporium speciferum from rotted roots of Cynodon dactylon (Bermuda grass). While Berkenkamp (1971) isolated Helminthosporium sativum (Cochliobolus sativus) from the roots and leaves of five species of cereals and fodder crops. Misra et al. (1971) reported two new leaf spot diseases of Bermuda grass caused by Helminthosporium (Cochliobolus) cynodontis and H. (Drechslera) hawaiiense from India.

Nicholson et al. (1971) reported Helminthosporium sorokinianum from (Poa pratensis) Kentucky blue grass. Zeiders (1976) reported that switch grass, maize, rye and various other grasses were highly susceptible to the fungus.

Welling (1978) isolated Helminthosporium (Drechslera) Poae and Fusarium oxysporum from wilted plants of Poa pratensis (Kentucky blue grass).

Ricci et al. (1981) could isolate Helminthosporium cynodontis from blight infected tissues of Cynodon dactylon.

Isawa (1983) recorded several species of Helminthosporium viz. H. dictyoides and Drechslera siccans from Lolium multiforum, H. maydis from Maize and H. turcicum, (Setosphaeria turcica) from Sorghum halepense. Krupinsky (1984) pointed out that he could observe about 60 per cent leaf infection in wild rye grass by the fungus in U.S.A.

2.1.2. Fusarium spp.

Sprague (1939) and Ledingham (1942) noted the occurrence of Fusarium culmorum in the leaves of oats.

Ibrahim et al. (1964) found that Fusarium solani was more virulent on Lupin (Lupinus termis Forsk), and Horse bean, and they recommended that it is unwise to use Lupin as a green manure before horse bean crop.

Gould et al. (1965) reported the occurrence of F. nivale from Washington.

Halcrow (1965) found a correlation between the wet weather and F. nivale infection, on oats.

Cole et al. (1968) tested 22 lots of Poa pratensis for Fusarium infection and recorded Fusarium roseum and

F. tricinctum from twelve samples.

De Tempe (1968) from a pot experiment found a relation between the development of young Lolium and Fesbuca and the percentage of seed borne Helminthdsporium sp.

Bean (1969) reported blight in turf grass caused by F. roseum sp. cerealis 'Culmorum' from Washington and observed the severity of the disease to be closely correlated with available moisture.

Cutright and Harrison (1970b) found that Kentucky blue grass (Poa pratensis) having high disease rating was associated with soil temperature of 90°F and high nitrogen levels, and the plants showed resistance to disease at a temperature of 70°F and with a balanced fertilizer.

Marcley (1970) reported that a decline condition of lucerne in West Australia due to the attack of Fusarium spp. Fusarium oxysporum, the most frequent, was pathogenic to seedling roots.

Anon (1971a) reported Fusarium patch disease caused by F. nivale in turf grass.

Smiley and Craven (1979) reported 1555 identified Fusarium isolates from Poa pratensis and 23 isolates from turf grass.

Petrovskaya (1981) recorded wilt and root rot of lucerne by different species of Fusarium. Fusarium oxysporum predominated in plants of all age groups.

Schmidt (1982) reported F. nivale from 2 year old Lolium multiforum.

Anon (1982) found Fusarium nivale on Italian rye grass (Lolium multiforum var. italicum).

Pegg and Parry (1983) from a survey on lucerne (Medicago sativa) showed that Fusarium spp was wide spread on all hosts. F. avenacium was found to be the most commonly present isolate, the other species included F. graminearum, F. solani and F. tabacinum.

Gussin and Lynch (1983) found that blight of rye grass (Lolium perenne) is caused by F. culmorum.

Turner et al. (1983) found that lucerne crowns in Utah were commonly affected by a dark brown necrosis, caused by a mixture of pathogens. This included Fusarium solani and F. roseum.

2.1.3. Curvularia spp

From India, Matsura (1927) and Boedijn (1933) reported the incidence of Curvularia lunata in sorghum leaves.

Bean (1964) found Curvularia pallescens prevalent on blue grass from Washington.

Varadarajan (1966) reported leaf spot and premature defoliation of Rauwolfia serpentina caused by Curvularia lunata. Chand and Verma (1968) found leaf spot disease in Cyamopsis tetragonoloba caused by Curvularia lunata in India.

Bean (1969) reported that Helminthosporium spp and Curvularia spp were normally considered as weak pathogens of turf grass.

Singh (1971) recorded a new report of Curvularia avoide on the leaves of Chilli (Capsicum annuum).

Davis and Irwinja (1982) reported leaf lesions caused by Curvularia eragroetides on various cultivars of Stylosanthes guianensis from North Queensland. They also found that the incidence of the disease varied in different localities, with different climatic conditions.

2.1.4. Other pathogens

Singh and Seth (1971) reported white leaf blotch disease of Bermuda grass (Cynodon dactylon) in India caused by Rhizoctonia spp.

Carver et al. (1972) recorded a new leaf spot and blast disease of rye grass (Lolium multiflorum) cv gulf caused by Pyricularia sp in Louisiana.

Shipton (1979) obtained various pathogenic species of colletotrichum from the leaf lesions of Stylosanthes.

Christensen (1979) reported Rhizoctonia spp to be associated with turf grass in New Zealand. Welty and Mueller (1979) recorded a virulent isolate of Colletotrichum in alfalfa.

Wu (1979) observed a pathogenic species of Rhizoctonia solani in lawn grasses.

Traquair and Smith (1983) reported spring and summer brown patch of turf grass (Poa pratensis) caused by R. solani from Western Canada.

Chauhan and Singh (1981) reported blight of Lemon grass (Cymbopogon flexuosus) due to Rhizoctonia solani. Colletotrichum gloeosporioides was reported from stylosanthes sp. by Lenne (1982) and Santhakumary and Nair (1981).

Hodges and Coleman (1985) noticed several species of Pythium which induced root destruction in some grasses.

2.2. Morphology of the pathogens

2.2.1. Helminthosporium gramineum Rab. causing barley stripe was described by Anon., 1950; Sporophores arise in clusters of 3 to 5 or 1 to 6, yellowish, usually 1 to 5 septate conidia, sub hyaline to yellowish brown when fully mature, straight or very slightly curved, sub-cylindrical, often widest in the basal portion, tapering more or less towards the apex, 1 to 7 septate and measured 5-100 x 14-20 µm rarely constricted at the septa and germinating from any or all cells.

Saccardo (1892) described Helminthosporium sativum Pammel King & Bakke. as follows:

The spores are aerogeneous, ovate to fusoid, 80-100 x 30 µm, reddish-brown, and 5 to 10 septate.

Mourashkinski (1924) described that the spores are light olive brown at first, ovate, often sub globose but soon became fusoid or ellipsoid. Drechsler (1923) has stated that the fungus is extremely variable in pure culture.

Saccardo (1882) described the morphological features of Helminthosporium cynodontis. According to him, the conidiophores are dark-brown, emerge singly or in pairs and measure 50-150 µm in length and typically 5 µm in diametre, usually 2-5 septate. The conidia measured 11 to 14 x 27 x 80 µm

straight or curved, widest at the middle, tapering towards abruptly round ends. Usually 3 to 9 septate, and germinate by two polar germtubes.

2.2.2. Fusarium graminearum Schw.

This fungus has been described by Cappellini and Peterson (1965). According to them, macro conidia are formed from single, globose structures. Lateral phialides measured 10-14 x 3.5-4.5 µm . The conidia range from falcate, with or without an elongate apical cell, sickle shaped which in certain strains is pedicellate. Septation is rather fine and varies from 3 to 7 which measure 25-50 x 2.5-3.5 µm. In older cultures, conidia tend to be more variable in size, generally shorter, globose or bicellular, chlamydospores of 14-15 x 8-10 µm size, were often noticed.

Fusarium nivale (Fr) Ces. has been described by Anon., 1971(b) Mycelium sparse to densely fluccose, individual hyphae irregular and measure 1.5 - 5.0 µm diameter, conidia borne in aerial mycelium but in older cultures found on small sporodochia, conidia pale or orange in colour. Phialides measure 7-9 x 2.5 µm borne on branches conidiophores. Conidia curved, broadly falcate with a pointed apex and flattened wedge shaped base, 1 to 3 septate and measured 10-30 x 2.5-5 µm Chlamydospores are absent.

Fusarium culmorum (W.G. Smith) Sacc.

Anon. (1950) has described the organism. Mycelium loosely cottony, carmine red with buff mycelium. Sporodochial masses golden, which turned darker later. Conidia thick, curved bluntly pointed at the apex, slightly tapering at base with prominent foot. Usually 5 septate but often 3 to 9 septate and measured 30-60 x 4.5-6.5 µm . Smith (1884) has stated that single conidia showed rapid growth and soon produced aerial hyphae, the mycelium became yellow gradually and on the surface of the medium, a red pigmentation developed which diffused into the medium and finally turned to reddish brown. Micro conidia were absent, macro conidia were borne on loosely branched conidiophores in the aerial mycelium in phialides and later the phialides were confined to sporodochia which are 15 to 20 µm long and 5 µm at base. Macro conidia were 3 to 5 septate at maturity and slightly curved with a pointed apex and well marked foot cell, measured 26-50 x 4-7 µm. Chlamydospores were oval to globose, intercalary, often terminal, smooth to rough-walled and measured 10-14 x 9-12 µm .

2.2.3. Curvularia lunata Wakker Boedijn

Boedijn (1933) and Anon (1950) have described the morphological characters of the fungus. According to them

conidiophores were pale brown, septate, simple or branched, geniculate at the tip with a diametre of 3-5 µm and variable in length. Conidia pale brown, 3 septate and the third cell from the base is larger than the others, straight often more or less curved and measured 19-30 x 8-12 µm.

Subramonigam (1953) has pointed out that the development of conidia in Curvularia lunata is similar to that in Drechslera and Bipolaris, but the conidia are usually curved and invariably differentiated into central cells which are darker and wider than end cells.

Curvularia trifolii (Kauf) Boedijn

Curvularia trifolii was originally described by Kauffman on white clover (Bonar, 1920).

Groves and Skolko (1945) have stated that the spores of fungus are very plump, almost triangular and often this character is more pronounced than those of the related Curvularia lunata. Anon. (1950) has described the organism in detail. Conidiophores brown, septate, simple, geniculate at the tip and 5-6 µm diameter. Conidia brown to olive brown, 3 septate and the third cell much larger and darker than the others. Mostly strongly curved and measured 25-35 x 11-15 µm in culture. The pathogenic nature of certain organisms under study has been explained by various workers as follows:

2.3. Pathogenicity

Sampson and Watson (1985) tested the pathogenicity of the isolates of Cochliobolus sativus from Agropyron repens and found that the fungus could infect all the grass species tested.

Diedicke (1903) had established the pathogenicity of the fungus by inoculating the sclerotium on barley leaves.

Noack (1905) had confirmed this by inoculating barley seedlings with conidia and sporulating cultures of the fungus.

Johnson (1914) reported that inoculation of young seedlings of wheat, barley, oats and rye with spores from pure cultures of Helminthosporium gramineum produced blight symptoms.

Lenne (1982) found that the seeds of Lolium spp. infected with Cochliobolus sativus on germination, produced the typical blight symptoms of seedlings.

Muchovej (1986) determined the infective nature of Curvularia lunata in Agrostis palustris by various methods of inoculation.

Oniki et al. (1986) described a new yellow patch disease of turf grass in Japan and obtained isolates of Rhizoctonia spp. These were tested for their pathogenicity and successfully reproduced the symptoms by artificial inoculation.

Zeiders (1980) found that Drechalera spp. causing severe leaf spot and blotch were isolated from Orchard grass. The fungus regularly produced a certain proportion of abnormally curved, branched conidia in culture and on leaves of inoculated orchard grass plants. Orchard grass and Zea mays were susceptible. Sporulation was found to be favoured in light.

Matsura (1927), Boedijn (1933), Nigam (1936) isolated Curvularia lunata from sorghum leaves in India. Curvularia lunata was reported to be associated with a "going-out" or "melting out" disease of Agrostis spp. and Poa spp. in Pensylvania.

Groves and Skolko (1945) observed that Curvularia trifolii could infect soyabeans, peas, cucumbers and pumpkins in addition to white clover. Curvularia lunata has been reported as an almost omnipresent mold of rice grain [illegible].

Boothroyd (1960) showed that Fusarium graminearum occurred predominantly on cereals and other graminaceous hosts. It was also recorded on a wide range of other hosts such as coffee, Lycopersicon, Pisum trifolium and solanum sp. He also observed that this species could be transmitted from maize to tomato and from tomato to maize.

2.3. Symptomatology

2.3.1. Helminthosporium spp

Wardsworth et al. (1968) found that H. speciferum and H. (Cochliobolus) Cynodontis produced moderately severe leaf spot when inoculated on C. dactylon seedlings and he also reported that neither species caused definite leaf spot lesion on Poa pratensis, but could be recovered from in frequent discoloured areas on inoculated leaves.

Berkenkamp (1971) studied five isolates of H. sativum for pathogenicity on leaves and roots of 5 cereals and 24 grasses, and found significant differences both in resistance of leaves and roots of cereals and in pathogenicity of isolates.

The symptoms produced by Helminthosporium gramineum in barley has been described as striping of leaves and death of plants. The streaks became yellowish brown and plants died prematurely (Anon., 1950).

Krupinsky and Berdahl (1984) described the leaf blight symptoms in Elymus junceas leaves were damaged by Helminthosporium sativum. Zeiders (1980) described a spot bloach caused by Helminthosporium sativum which was the most prevalent and important disease on leaves of Panicum virgatum. He also pointed out that maize and rice were highly susceptible to the isolate. The disease severity increased with time, if plants were not clipped. The severity was also related to the duration of high relative humidity and leaf wetness. Diehl (1983) noted the common root rot symptoms by Helminthosporium sativum in grasses.

2.3.22. Fusarium spp.

Dickson (1939) found that F. graminearum could cause blight symptoms in cereals.

Sprague (1939) observed a red leaf symptom in oats. Sprague and Meiners (1948) also observed Fusarium nivale to be producing mats of dead leaves on grasses. This often caused the death of the plants.

Fusarium culmorum caused pre-emergence killing, stunting and brown root rot of various grasses. It was also reported that often fungus produced small red bordered sheath and leaf spot in wheat (Anon., 1950).

De Tempe (1968) found that F. avanaceum isolated from the seeds to be pathogenic on lolium sp.

Smily et al. (1980) found that Fusarium spp. produced blight symptoms in Kentucky blue grass. A decline condition of Lucerne caused by Fusarium spp. was reported from Western Australia by Marcley (1970).

Pegg and Parry (1983) found that Lucerne attacked by Fusarium spp. when examined at random were free from aerial symptom, but 90-100 per cent showed browning of the lower stem and tap root.

Turner et al. (1983) found that lucerne crown in Utah were affected by dark brown necrosis.

2.3.3. Other pathogens

Wu (1979) observed a pathogenic species of Rhizoctonia solani in lawn grass. Hodges and Colemann (1985) noticed several species of Pythium. These induced root destruction in some grasses.

2.4. Growth on different solid media

Johnson (1914) observed profuse mycelial growth of Helminthosporium spp. in media containing a large amount of organic matter.

Thomas (1940) stated that Helminthosporium spp. did not sporulate in most standard medium but was found to do so in maize meal sand mixture and PDA with tanic acid sporulation was more profuse in petri dishes than in tube cultures and thin layer of PDA gave better results than a thick one. Tanaka (1956) reported best growth of Helminthosporium spp. in medium containing maltose followed by fructose, sucrose, glucose, xylose and lactose.

Popescu (1966) showed that maximum growth of Fusarium graminearum on maize meal agar.

Singh (1971) reported very good growth of C. ovoides on Oat meal agar. Potato dextro agar, Richards' agar, and Czapek (Dox) agar have been reported to be very good for the growth and sporulation of Fusarium oxysporum F. niveum (Jhamaria, 1972).

Singh and Singh (1975) reported very good growth and sporulation of F. moniliforme on Czapek (Dox) agar.

Gopinath et al. (1984) and Khuna et al. (1984) reported potato dextrose agar to be a good medium for the growth of F. moniliforme but the sporulation on this medium was very poor.

2.5. Control

2.5.1. Control of Helminthosporium spp.

Bean (1965) found that leaf blight on Poa pratensis (Kentucky blue grass) can be controlled by Dithane M-45.

Gould (1965) reported the control of leaf spot caused by Helminthosporium spp.

Cheesman et al. (1965) studied the effect of nitrogen level and osmotic pressure of the nutrient solution on the incidence of Puccinia graminis and H. sativum infection in Kentucky blue grass and found that the plants remained resistant to P. graminis under all treatments. But the number of lesions per leaf blade and size of H. sativum lesions increased with increasing Nitrogen and decreasing osmotic pressure.

Nicholson et al. (1971) found that Kentucky blue grass (Poa pratensis) when treated with conidial suspension of H. sorokinianum (Cochliobolus sativus) and when treated with

Zn + Maneb effective control was obtained.

Goss and Gould (1972) found that balanced and optimum levels of N primarily and P and K secondarily reduced Corticium fuciforme on Festuca rubra (turf grass).

Welling (1978) isolated H. (Drechslera) poae and F. oxysporum from wilted plants of P. pratensis treated with large quantities of nitrogen. Hagan and Larsen (1979) tried six fungicides at field rates to Poa pratensis cv Park to test their effects on conidia of Drechslera sorokiniana and found that anilazine, maneb, & cycloheximide, reduced germtube elongation. Pawar and Patil (1980) found that under green house condition Dithane M-45 (Mancozeb) was effective against H. rostratum (Drechslera rostrata).

Under in vitro studies Dithane Z-78 and vitavax inhibited the growth and sporulation of H. rostratum. Lam and Lewis (1983) reported that when Nitrogen @ 0, 200, 400 kg/ha/yr and potash at the rate of 0, 200 kg/ha/yr was applied to a field of rye grass (Lolium perenne). Foliar diseases caused by Drechslera spp. was very serious but potash had no apparent effect on disease incidence.

2.5.2. Control of Fusarium spp.

Harper (1964) reported that seed treatment with Captan 0.2 per cent controlled Fusarium spp. in peas.

Goss and Gould (1969) reported some inter relationship between fertility level and disease incidence by Fusarium nivale in turf grass. They found at higher levels of nitrogen, the disease incidence was severe. Similarly increased levels of potassium in the absence of phosphorus also resulted in an increase in the disease intensity. But a strong P-K interaction was indicated N at 12 lbs/1000 ft^2 along with the fungicide Ziram and phosphorus and potash produced relatively disease free turf. Other nitrogen levels (b = 0020 lb.) did not reveal any promising results.

Nissinen (1970) from a pot experiment studies using NPK and micronutrients observed reduction of disease resistance by Fusarium nivale (Calonetrica nivale), while K induced resistance in plants treated. He also found increased resistance by the application of Mn, Cu and S.

Cutright and Harrison (1970a) found that Benomyl 50W (5 or 10 oz/1000 ft^2) effectively controlled, Fusarium roseum on Poa pratensis when applied as a prophylatic spray.

Of the various fungicides tried against various diseases of turf grass benomyl was found to be most effective against Fusarium nivale (Calonectria nivale and dollar spot caused by (Sclerotinia homoeocarpa).

Zengin (1978) reported that soil drenching of seed beds with 1 per cent Bordeaux mixture gave good control of damping off of capsicum caused by Fusarium sp. Vargas and Laughlin (1971) reported that F. roseum f sp cerealis and F. tricinctum f spp Poae on Poa pratensis were controlled by five application of benomyl (80Z/1000 ft^2) as a bi-weekly drench. .They were also of the opinion that foliar sprays of benomyl were ineffective as were TBZ, Zn + Maneb, MF 443 and MF 444 regardless of application methods.

Vranyz et al. (1984) reported that Bavistin (100 ppm) completely inhibited the growth of F. moniliforme on potato dextrose agar medium.

Skirde (1978) observed severe incidence of Fusarium spp. in Lolium spp. as well as Bermuda grass with higher levels of Nitrogen. Smiley and Craven (1979) found that blight of Poa pratinsis caused by Fusarium spp. can be controlled by benomyl.

Pal et al. (1980) found that pretreatment with copper sulphate as well as maneb lowered infection caused by F. oxysporum and F. roseum in red clover.

Huth and Schlosser (1980) in their experiments observed that fungicide thiobendazole 8-hydroxy quinoline sulphate along with Ferric sulphate could control Fusarium nivale. Botton and Cordukes (1981) observed that application of fertilizers decreased the incidence of Fusarium diseases in Bermuda grass in U.S.A.

Rievis (1981) recorded that the incidence of Fusarium nivale in turf grass was greater when sulphate ammonia or sulphur coated urea was used as nitrogen source than other types of urea.

Robinson and Hodges (1981) noticed that the plants of Poa pratensis treated with ammonium nitrate were susceptible to Cochliobolus sp infection as compared to plants in untreated control. Naseema (1981) observed that growth of Curvularia lunata on vegetables could be inhibited by Difolatan at 2000 ppm.

Qudri et al. (1982) reported that in in vitro trials Bavistin at 0.1 per cent, Ziride, Difolatan and Dithane M-45 at 0.2 per cent concentration inhibited the growth of F. oxysporum. They also reported that blitox at 0.2 per cent was not effective.

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

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

Vrany et al. (1984) reported that Bavistin (1000 ppm) completely inhibited the growth of F. moniliforme on potato Dextrose agar medium.

Martin & Lucas (1984) found that benomyl treatment did not prevent foliar blight incidence by Rhizoctonia like fungi in grasses. Sharma and Jain (1984) reported that Dithane M-45 and Bavistin at 500 ppm concentration was very effective in inhibiting the radial growth of F. moniliforme, F. oxysporum f sp lini, F. oxysporium f sp, Zingiberi and F. oxysporum f sp udum on potato dextrose agar medium. Hampton and Hebblethwhite (1984) observed that reduction in disease incidence along with increase in dry matter content in Lolium grass during autumn seasons when the fungicides Triademefon, Carbendazim and Captafol were used in combination.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

An experiment to evaluate the different diseases which affect the production of different forage grass varieties was conducted in the College of Agriculture, Vellayani. The materials used and the methods adopted for the conduct of the experiment are summarised below.

3.1. Survey on identifying common fungal diseases of important forage grasses in Kerala

Survey was conducted as per the schedule given below

Coastal area

Sewage Farm, Valiyathura, Trivandrum district.

Plain area

Fodder grass collections and forage crop museum of the All India Co-ordinated Project for research on forage crops, College of Agriculture, Vellayani. Fodder farm of District Livestock Farm, Kodappanakunnu.

Hilly area

Fodder farms of the Regional Stations of Kerala Livestock Development Board at (1) Mattupetti and (2) Peerumedu (Kolahalamedu) (formerly Indo-Swiss Project in Idukki district).

Forest area

Fodder farms of Regional Stations of Kerala Livestock Development Board at Kulathupuzha in Quilon district.

A detailed survey on the important common fungal diseases of cultivated fodder grasses was conducted during the period of 1984 and 1985. Variations in the occurrence of the diseases were also taken into consideration during the survey. For this purpose the whole period of survey was divided into two periods viz., pre-monsoon and monsoon.

Accordingly the survey was conducted one month before the South West monsoon and during South West monsoon of 1984 and 1985. In the survey, the fodder grass collections at Vellayani and Kudappanakunnu (plain areas), Sewage Farm at Valiyathura (coastal region), fodder farms of Kulathupuzha representing forest region and fodder farms of Mattupetti and Kolahalamedu of Idukki district which represent hilly tracts were covered so as to study the variations in the occurrence of common diseases with respect to regions.

The important grasses covered in the survey were:-

1. Turf grass (Cynodon dactylon.) Forsk.
2. Congosignal (Brachiaria ruziziansis)
3. Guinea grass (Panicum maximum) Jacq.
4. Kikyu grass (Pennisetum clandestinum) Hochst.

5. Napier grass (Pennisetum purpureum) K. sctium.
6. Para grass (Brachiaria mutica) Forsk. Stapf.
7. Setaria grass (Setaria anceps) Pallide - fussea - Schumech

During the survey, the naturally infected grass specimens from each locality were collected, packed in polythene paper and brought to the laboratory.

3.2. Isolation of various pathogens from the host grasses

Portions of the infected leaves, stems, roots and inflorescences, showing specific symptoms of the diseases were cut into small bits, surface sterilized with 0.1 per cent mercuric chloride solution for one to two minutes and washed with three changes of sterile distilled water. These bits were then planted over Potato Dextrose Agar (PDA) in sterile petri dishes and also in host extract agar medium (HEA) and incubated at room temperature (28 ± 2°C). After three days the fungal growth on the infected tissue was transferred to PDA slants. It was then purified by single spore isolation. The culture was maintained on PDA by sub culturing periodically.

3.3. Comparative studies on the symptomatology, morphology, and pathogenicity of Helminthosporium gramineum (Rab) Sacc, Fusarium graminum and Curvularia trifolii

3.3.1. Symptomatology of various diseases

Symptoms of the various diseases were studied by

observing the naturally infected plant parts of the respective grass hosts in the field and also by noting the course of development of the disease on artificially inoculated plants. Symptoms on the commonly cultivated grasses viz., guinea grass and hybrid napier grass were recorded.

3.3.2. Morphology of the causal organisms

A detailed comparative study of the morphological characters viz., nature of mycelium, hyphal thickness and conidial measurements of the major pathogens viz., Helminthosporium, Fusarium and Curvularia were carried out following standard laboratory techniques.

The morphological characters of all the species of the above mentioned isolates were studied by growing them in 90 mm petri dishes on PDA and incubated under laboratory conditions for a continuous period of seven days. The growth characteristics and the colour of mycelium were recorded. After ten days of growth, slide cultures were studied for conidial characters as per the method described by Riddel (1950).

Sterile agar medium was poured into previously sterilized petri dishes and after solidification, blocks of 6 mm square and 2 mm depth were cut out using a sterilized scalpel. One square was placed in the centre of a sterile microscopic slide and the four sides of the agar block was inoculated

with culture bits of the fungal isolate. A coverslip was placed on top of the square of agar and the slide was kept in a moist chamber (Petri dish with wet filter paper in the bottom on which two glass rods kept as supports for the slide). The dish with the slide was then incubated at room temperature for two to three days. After this the cover slip was lifted off gently, a drop of 95 per cent alcohol was placed in the centre and before drying, the cover slip was mounted using lactophenol on another slide. The square of agar was removed from the culture slide and another mount was prepared without any disturbance to the fungal growth on the slide. These slides were observed for the various morphological characters.

3.3.3. Pathogenicity

The pathogenicity of the various isolates obtained were tested by artificially inoculating them on 35 days old respective host plants. The host plants were raised in 32 x 38 cm earthen pots and were artificially inoculated with 9 days old (bits of pure) cultures grown in PDA. Inoculated plants in the pots were then covered with polythene bags to provide high humidity. Inoculations were also done with and without injury, the sporulating culture bits of the fungus on leaves, stem, sheath and at the collar regions.

Another method of inoculation tried was by spraying spore suspension of each pathogen (10^4 spores per ml of sterile distilled water) in 35 days old host plants raised and kept under similar conditions as above. Control plants were maintained on identical conditions and sprayed with sterile distilled water.

Inoculated plants were observed for the development of symptoms, and observations were recorded on initiation and course of development of symptoms starting from the 4th day of inoculation and continued up to twenty days.

3.4. Growth on different media

The following fungi were studied

1. Helminthosporium gramineum
2. Fusarium graminearum
3. Curvalaria trifolii

To study the influence of different solid media on the growth of the pathogens the following media were tried.

1. Coon's agar
2. Czapek (Dox) agar
3. Oat meal agar
4. Potato dextrose agar
5. Richards' agar
6. Sabouraud's agar

Composition of the media are given in Appendix I.

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

3.5. Effect of different temperatures on growth of the isolates

For this purpose, the fungi were grown in Czapek (Dox) agar and Richard's liquid medium and incubated at different temperatures viz., 28°C ± 2°C, 35 ± 2°C and 25 ± 2°C.

The medium prepared in conical flasks as described earlier were sterilized at 1.05 kg/cm^2 for a period of 20 minutes, the flasks were then inoculated with mycelial discs of 5 mm diametre cut out from an actively growing seven days old culture of the isolates of different test fungi and incubated at the required temperatures. After seven days of incubation, the dry weight of biomass of the isolate were determined. For each temperature level, three replications were maintained for each medium.

3.6. Host range of the pathogens

Host range of the major pathogens viz., Helminthosporium gramenium, Fusarium graminearum and Curvularia trifolii were studied by artificially inoculating them in other crops as listed below:-

1. Rice	-	Oryza sativa Linn
2. Cholam	-	Sorghum vulgare Pers
3. Maize	-	Zea mays Linn.
4. Congosignal grass	-	Brachiaria ruziziensis
5. Paragrass	-	Brachiaria mutica
6. Subabul	-	Leucaena leucocephala Lank
7. Tapioca	-	Manihot esculenta Crantz
8. Eupatorium	-	Eupatorium odoratum L.
9. Papaya	-	Carica papaya L.
10. Jack	-	Artocarpus integrifolia Auct
11. Cowpea	-	Vigna sinensis Savi
12. Coconut	-	Cocos nucifera L

The crops which come under the common homestead farming system were used for the study. The plants for this purpose were kept under controlled conditions by raising in 32 x 38 cm size earthen pots except fruit crops and plantation crops. Fruit crops and plantation crops for the purpose were selected from the Instructional Farm, College of Agriculture, Vellayani. All the plants were artificially inoculated

with the pathogen isolates as described in the case of pathogenicity test.

3.7. In vitro evaluation of fungicides

The following four fungicides at different concentrations were used for laboratory evaluations.

Fungicide		Concentration (in percentage)
1. Bordeaux mixture	Copper sulphate 1%	0.5 1.0 1.5
2. Dithane M-45 Mancozeb 80% W.P.	(Manganese ethylene bisdithio carbamate)	0.2 0.3 0.4
3. Difolatan Captafol 80% W.P.	(N-1,1,2,2-tetra chloro ethyl) thiobis-4-Cyclohexane 1,2-dicarboximide	0.2 0.3 0.4
4. Fytolan	Copper oxychloride 50% W.P.	0.2 0.3 0.4

3.7.1. Inhibition of spore germination

Spore obtained from 10 days old petridish cultures of the fungus grown on Czapek (Dox) agar medium were used to assess the effect of fungicides on the spore germination of the fungi. Spore suspension was prepared in sterile distilled water. The concentration was adjusted to 50-60 spores when a drop of spore suspension was examined under the low power of a microscope. The fungicidal solutions

were prepared in sterile distilled water in double the concentrations as that required for the experiment. Equal volumes of the fungicidal solutions and spore suspension were mixed and two drops of the same were placed on sterile clean, grease-free glass slides placed in petridish in moist chambers and incubated at room temperature. Observations were taken at 6 & 24 hours after incubation. The per cent inhibition of spore germination based on twenty microscopic fields was calculated.

3.7.2. Inhibition of growth (poisoned food technique)

Required quantity of each fungicide was weighed out and added to 50 ml of sterilized PDA medium. The media and fungicide were mixed well and poured into sterile petridishes @ 15 ml per dish. After solidification of the medium, the dishes were inoculated by mycelial discs of 5 mm diametre, cut out from an actively growing colony of the pathogen. Each treatment was replicated thrice. Controls consisted of unamended PDA inoculated in the same manner. All the dishes were incubated at room temperature (28 $\pm$ 2°C). The radial growth of the colony was noted when maximum growth was observed in control plates. The percentage inhibition of growth over control was calculated by using the following formula:

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

where C = Radial growth in control

T = Radial growth in treatment

3.8. Management of blight disease under field conditions

3.8.1. Evaluation of different doses of fertilizers combined with various fungicides

A field experiment was laid out during the period of July to October 1985 in the Instructional Farm, College of Agriculture, Vellayani to study the effect of different fertilizer doses along with common fungicides on the incidence and intensity of leaf blight disease in hybrid napier grass var. Pusagiant caused by Helminthosporium gramineum. The treatments were tested in the main crop as well as in the ratoon crop.

The details of experiment were as follows:-

Lay out	-	Randomised Block Design
Crop	-	Hybrid napier grass, variety Pusa giant
Spacing	-	60 x 30 cm
Gross plot size	-	4.5 x 3.3 m
Net plot size	-	4.2 x 3 m
Replications	-	3
Method of planting	-	Ridges and furrow system

Fertilizer levels - 4

1. N:P:K 200:50:50 (M_1)

2. 250:50:50 (M_2)

3. 150:50:50 (M_3)

4. 200:50:62.5 (M_4)

Fungicides - 3 levels

Sl. No.	Fungicides		Active ingredient	Concentration used (per cent)
1.	No fungicide	(F_0)	..	..
2.	Bordeaux mixture	(F_1)	Copper sulphate ..	1.0
3.	Difolatan/Foltaf (Captafol . 80% W.P)	(F_2)	(N-1,1,2,2-tetra chloro ethyl) thiobis-4-Cyclohexane 1,2-dicarboximide	0.3
4.	Dithane M-45	(F_3)	Zinc ion & Manganese ethylene bisdithio carbamate Mancozeb . 80% W.P.	0.3
5.	Fytolan 50 W	(F_4)	Copperoxychloride	0.3

Number of treatment combinations - 20

M_1F_0	M_1F_1	M_1F_2	M_1F_3	M_1F_4
M_2F_0	M_2F_1	M_2F_2	M_2F_3	M_2F_4
M_3F_0	M_3F_1	M_3F_2	M_3F_3	M_3F_4
M_4F_0	M_4F_1	M_4F_2	M_4F_3	M_4F_4

Main crop

Crop was raised following the cultivation methods described in package of practices recommendation of Kerala

Agricultural University for fodder crops (Anon., 1978). The planting materials (slips) were collected from the ratoon crop of the District Livestock Farm, Kudapanakunnu, Trivandrum. Each plot was given a basal dressing of cattle manure @ 10 t per hectare, irrespective of fertilizer treatment. The scheduled treatment of fertilizers were given @ 50 per cent nitrogen and 50 per cent potash and full dose of phosphorus as basal dressing. Thirty five days old rooted slips were planted in furrows of each plot in the required spacing. On 30th day of planting the crop was artificially inoculated with the spore suspension of Helminthosporium gramineum (The concentration of spore suspension was adjusted to 10^4 spores per ml). On 45th day of planting, a hand weeding was given followed by top dressing with the remaining 50 per cent N and 50 per cent K of each fertilizer doses. Nitrogen was applied in the form of urea, phosphorus in the form of superphosphate and potash in the form of muriate of potash.

3.8.2. Fungicidal application

The following schedule was followed. The first spraying was carried out on the 40th day, the second on the 60th day and third spraying on the 90th day after planting.

3.8.3. Irrigation

The crop was irrigated at weekly intervals during

August to October whenever there was no rain.

3.8.4. Observations

The intensity of attack of the disease was recorded 15 days before harvest of the fodder. Thirty random hills from each plot were selected and observed for disease intensity. The intensity was scored by applying the score chart prepared for the purpose (Fig. 1).

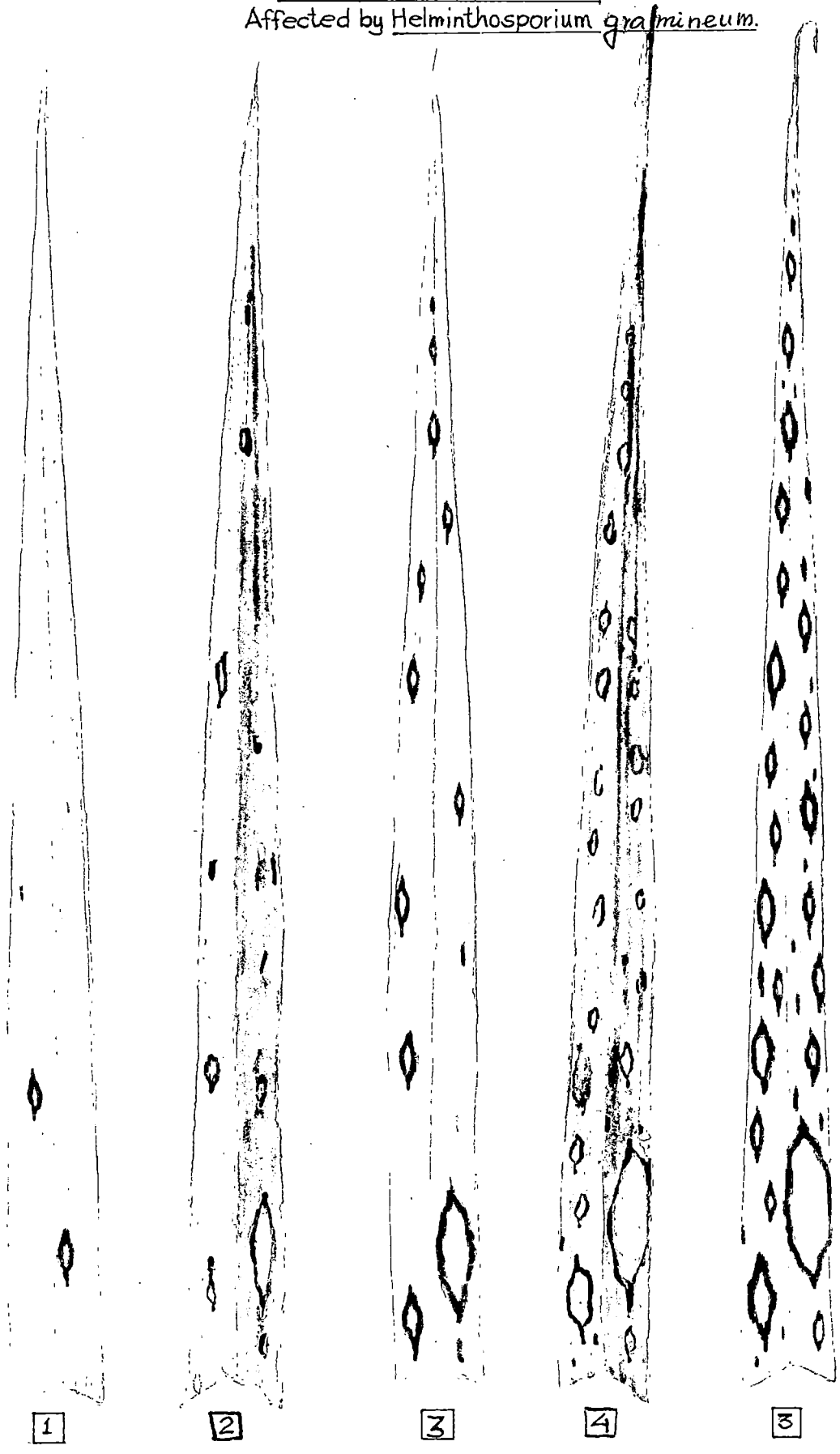
Score chart used

Disease Grade	Description
1	One or two small grey or brown spots of 0.2 mm diametre or even lower size 0.1 to 10 per cent leaf area, especially older leaves were affected but no necrotic lesions on leaves were found.
2	Eleven to thirty per cent of leaf area showed small elipsoid or irregular grey to brown spots of about 0.3 mm diametre. Few spots show yellow or brown margins with necrotic centre were noticed.
3	Thirty one to fifty per cent leaf area showed symptoms. The brown spots of about 0.5 mm diametre showed clear necrotic centres and such lesions were found on lower sheaths also.

Stages	Infection percentage
1	1 - 10
2	11 - 30
3	31 - 50
4	51 - 70
5	71 - 100

HYBRID NAPIER GRASS

Affected by *Helminthosporium graminеum.*



STAGES

Disease Grade	Description
4	Fifty one to seventy per cent leaf area affected lesions enlarged and nearby lesions coalesce and blightening of leaves started partially fully in lower leaves and sheaths. Middle leaves also showed mild symptoms of blight.
5	Seventy one to hundred per cent leaf and sheath area were affected, areas showed blighted patches. All the middle leaves and lower leaves were dried, whole plant showed a burned appearance.

3.8.5. Harvest

The fodder was harvested on 120th day. The fresh weight of fodder of each plot was taken using a spring balance and recorded.

3.8.6. Ratoon crop

After the harvest of the main crop, the stubbles were maintained for the ratoon crop. Intercultivation was done one week after harvest of the main crop followed by application of cattle manure @ 5 t/ha and an earthing up on 25th day. Fertilizers were applied @ N-50 per cent and K 50 per cent in the form of urea and muriate of potash. The crop was irrigated at weekly intervals. Artificial inoculation

with Helminthosporium gramineum (spraying spore suspension of spore concentration 10^4 per ml of spore suspension) was given to the crop as in the case of main crop on 40th day. The fungicides were applied thrice as before ie. on 50th, 60th and 70th days of crop growth.

On 80th day, observations on disease intensity was recorded following the score chart described above. Harvest of the ratoon crop was done on 95th day and fodder yield was recorded as in the case of main crop.

3.9. B. Evaluation of various fungicides against the blight disease in a standing crop of hybrid napier grass at Sewage Farm, Valiyathura

The effect of fungicides alone in controlling the blight disease of hybrid napier grass was assessed under field conditions in a standing crop at the Sewage Farm, Valiyathura, during the summer months of 1985. The crop was maintained under Sewage irrigated condition. Plots of 4.2 x 3 metre size were earmarked and outer two rows of plants were left out as boundary of each plot. All the plots were artificially inoculated on 30th days of crop growth as described earlier in this chapter.

Fungicides viz., Bordeaux mixture 1%, Fytolan 0.3%, Dithane-M-45 0.3% and Difolatan 0.3% were applied twice on

50th and 80th day of crop growth. The treatments were replicated three times.

3.10. Statistical Analysis

The data obtained from laboratory and field studies during the course of investigation were tabulated and statistically analysed.

RESULTS

4. RESULTS

An evaluation was conducted in the College of Agriculture, Vellayani to study the different fungal diseases which affect the production of different fodder grasses cultivated in the State. The data collected were recorded, analysed and the results are presented below.

4.1. A detailed survey was conducted in coastal, plain, forest and hilly areas on important fungal diseases of cultivated fodder grasses of the State. The important grasses covered in the survey were:-

Hybrid napier grass (Pennisetum purpureum K. Schm)
Guinea grass (Panicum maximum Jacq.)
Turf grass or Bermuda grass (Cynodon dactylon Forsk)
Paragrass (Brachiaria mutica) (Forsk.) Stapf.
Congosignal (Brachiaria ruziziansis)
Setaria grass (Setaria anceps. pallide-fusca-Schumach.)
Kikyu grass (Pennisetum clandestinum Hochst.)

The survey was conducted during the premonsoon and monsoon seasons of 1984 and 1985. The results are presented in Tables 1 and 2.

Observations on various diseases of the above grasses and also variations in the occurrence of major diseases from

Table 1. Fungi associated with various fodder grasses (survey 1984)

Grass investigated	Season	Place of collection			
		Coastal	Plain	Hill	Forest
Bermuda grass	Pre monsoon	H. gramineum (Rab) Sacc.	Pyricularia oryzae Sacc.	Pythium sp.	Alternaria sp.
	Monsoon	H. gramineum	H. cynodontis Marig. F. graminearum Schwabe.	Cercospora sp.	Sclerotium rolfsii Sacc.
Congosignal grass	Pre monsoon		Helminthosporium sp. Curvularia sp.		
	Monsoon		Fusarium sp. F. graminearum		
Guinea grass	Pre monsoon	H. gramineum	F. graminearum C. trifolii	Rhizoctonia sp.	Helminthosporium sp.
	Monsoon	Helminthosporium sp. C. lunata (Wakker) Boed	Helminthosporium sp. C. trifolii (Kauff) Boed.	F. graminearum F. culmorum (W.G.Smith) Sacc. R. solani Kuhn	Rhizoctonia solani Kuhn Helminthosporium sp.
Kikyu grass	Pre monsoon	C. trifolii	Alternaria sp. H. gramineum	Fusarium sp.	
	Monsoon		R. solani Kuhn	Fusarium sp.	
Napier grass	Pre monsoon	Pyricularia oryzae Sacc. Alternaria sp.	F. graminearum	F. graminearum	F. solani R. solani
	Monsoon	H. gramineum	H. gramineum Curvularia sp.	H. sativum H. gramineum Sclerotium rolfsii	H. gramineum F. gramineum
Para grass	Pre monsoon	Fusarium sp.			
	Monsoon	P. oryzae	R. solani Colletotrichum sp.	Curvularia sp. Colletotrichum glocosporioides	Pyricularia oryzae
Setaria grass	Pre monsoon		Helminthosporium sp.		
	Monsoon		Fusarium sp. F. nivale (F.R.) Ces.		

Table 2. Fungi associated with various fodder grasses (survey 1985)

Grasses investigated	Season	Place of collection			
		Coastal	Plain	Hill	Forest
Bermuda grass	Pre monsoon	H. gramineum Rabeth.	F. nivale		
	Monsoon	H. gramineum	H. cynodontis		
Congosignal grass	Pre monsoon		H. cynodontis Curvularia sp.		
	Monsoon				
Guinea grass	Pre monsoon	H. gramineum C. trifolii (Kauff) Boed	F. nivale H. sativum	F. culmorum (W.G.Smith) Sacc. F. graminearum	H. gramineum
	Monsoon	H. gramineum F. graminearum Schwabe C. trifolii			H. cynodontis Marig
Kikyu grass	Pre monsoon	C. lunata (Wakker) Boed	Helminthosporium sp.		Sclerotium rolfsii Sacc.
	Monsoon	R. solani Kuhn			
Napier grass	Pre monsoon	C. trifolii R. solani	C. trifolii Colletotrichum glocosporicides (Penz) Sacc.	F. graminearum	H. sativum Pammel, King and Bakke
	Monsoon	Helminthosporium sp.	H. gramineum	F. nivale	H. sativum
Para grass	Pre monsoon	Fusarium culmorum	Pyricularia oryzae C. lunata	Fusarium sp. F. nivale (F.R.) Ces	C. glocosporicides
	Monsoon	H. cynodontis		Pythium sp.	
Setaria grass	Pre monsoon	R. solani	Helminthosporium sp.		Curvularia sp.
	Monsoon		Pyricularia oryzae Sacc.	F. solani F. nivale	A. solani Sorauer H. gramineum

region to region and season to season were made (Tables 1 and 2).

All the major fodder grasses were found to be affected by three common diseases viz., blight, leaf spot, leaf and sheath blotch. The pathogens isolated frequently from these affected grasses showed that the blight disease was caused by different species of Helminthosporium. The major species involved were: 1. Helminthosporium gramineum (Rab) Sacc. 2. H. sativum. (Pammel) King and Bakke. 3. H. cyanodontis. Marig.

Among these, the blight caused by H. gramineum alone accounted an yield loss of about 20 per cent of green grass in majority of the areas surveyed. The other important diseases observed were leaf spot disease caused by Fusarium graminearum, F. nivale and F. culmorum. The leaf and sheath blotch were found to be caused by Curvularia lunata and C. trifolii.

Observations revealed that occurrence of the aforesaid major diseases varied from region to region and from season to season. The blight disease caused by Helminthosporium spp. could be noticed in all the above agro-climatic regions in all the major cultivated grasses, whereas leaf spot diseases caused by Fusarium spp. were more prevalent in hilly tracts as compared to the other regions. Similarly, leaf and sheath

bloth incited by Curvularia spp. was most severe in coastal regions and plains.

In addition to the above pathogens, occurrence of certain minor pathogens were also noticed during the course of observation in some of the hosts. They were, Rhizoctonia solani in guinea grass, Alternaria solani in setaria grass, Cereospora sp., Pythium spp.& Sclerotium rolfsi in turf grass and Pyricularia oryzae and Colletotrichum sp. in para grass.

Based on the above observations made in the field, the following three major pathogens causing considerable yield losses to the common cultivated fodder grasses were subjected to detailed studies, viz., 1. H. gramineum (Rab) Sacc 2. F. graminearum Schw. 3. Curvularia trifolii (Kauff) Boed.

4.2. Morphology of causal organism

Comparative morphological characters of the different isolates viz., nature of mycelium, hyphal thickness, conidial ontogeny and conidial measurements were studied (Table 3 and Fig. 2-7).

4.3. Symptomatology

4.3.1. Symptomatology under natural conditions

Symptoms under natural conditions and comparative studies on the symptomatology, morphology and pathogenicity

Table 3. Comparative morphological characters of various isolates of the major pathogens

Sl. No.	Name of isolate	Mycelium	Conidiophore	Conidia
1.	Helminthosporium gramineum	Ramifying, sporophoric hyphae from end cells, fructifications present, knotty masses of mycelium develop, sclerotial structures, yellowish, dense, velvetty layer of mycelium.	Conidiophores in clusters, yellowish, sporophores 3 to 5 septate, measure 7 µm width	Sub hyaline to yellowish brown conidia when mature cylindrical, slightly curved, tapering towards the apex 1 to 5 septate, 50-100 x 14-20 µm in size peripheral wall thin constricted at the septa. Secondary spores with 1 to 3 cross walls.
2.	Helminthosporium sativum	Hyphae branched with lobulate segments grey to olive black on PDA.	Brown, emerging from stomata single - 100 - 150 x 6-8 µm upto 8 septa.	Five to seven spores - present, curved, reddish brown, tapering towards rounded ends, ovate, bilobed 3 to 10 septate 60-100 x 15-20 µm pale green - 130 µm in length and 25 µm in width - widest at the centre. Thick peripheral wall.

Table 3 (Contd.)

Sl. No.	Name of isolate	Mycelium	Conidiophore	Conidia
3.	Helminthosporium cynodontis	Light grey in colour with fluffy mycelium at some distance from the point of inoculation.	Dark brown, found in pairs, 2-5 septate 30-130 µm in length and 5 µm in diameter.	Elongate, slightly curved, straight, tapering towards the rounded ends. Hyaline to fuligeneous 2-8 septate non-constricted at septa germinate by producing two polar germ tubes, 10-13 µm x 20-80
4.	Fusarium graminearum	Carmine red, loose, cottony, bright orange in mass. No mycelial chlamydospores, Homothallic + and - strains present, perithecia present, chlamydospores intercalary clumps hyaline, thick walled.	Multibranched, aggregate into sporodochia. Apical cells sickle-shaped with well marked foot cell, septation fine and varies from 3 to 7 septa.	Globose, bicellular, found in single thick-walled, hyaline, with roughened outer wall found on sporodochia 8-10 µm diameter, ox-horn-shaped 3 to 5 septate microconedia are found from single phialides 10-14 x 3.5 - 5 µm

Table 3 (Contd.)

Sl. No.	Name of isolate	Mycelium	Conidiophore	Conidia
5.	Fusarium nivale	Bushy aerial mycelium, hyaline with rose colour, wide spread, slimy rosy masses which turn darker, resinous on drying - pale on moist condition.	Perithecia seen on stromatic substrate oval in outline, 100-250 µm in diameter, spores in rows 6 to 8 spores in each ascus	Scattered, hyaline to rose coloured, loose, slightly curved tapering towards either end; rounded ends, not pedicellate, constricted at the base, 3 to 5 septate, 11 - 25 x 2-5 µm
6.	Fusarium culmorum	Aerial mycelium present, loose, cottony, carmine red with buff white mycelium scattered, turn yellow after 2-3 days, red pigmentation develops.	Sporodochial masses present, ochre, darker, loosely branched, oval-chlamydospores, 10-14 x 8-10 µm in size, found in chains.	Thick, curved with pointed apex, tapering at the base with prominent base, 5 septate spores, macro conidia present, curved with pointed apex and foot cell.

Table 3 (Contd.)

Sl. No.	Name of isolate	Mycelium	Conidiophore	Conidia
7.	Curvularia lunata	Septate, pale brown to pink in light, white in dark.	Pale brown, septate, simple, geniculate at the tip, 3-5 µm in diameter.	Pale brown, 3 septate, 3rd cell from the base is larger and darker 18-30 x 6-10 µm slightly curved, fusiform.
8.	Curvularia trifolii	Mycelial mass pale-brown and deep brown to dark when mature, mycelial mats thick, septate.	Brown, septate, simple geniculate at the tip 4-5 µm in diameter.	Brown to olive brown, spores plumpy, triangular, 3 septate, 3rd cell from the base is larger and darker, coloured than other cells, fusiform, lobed 30-35 x 10-15 µm in culture.

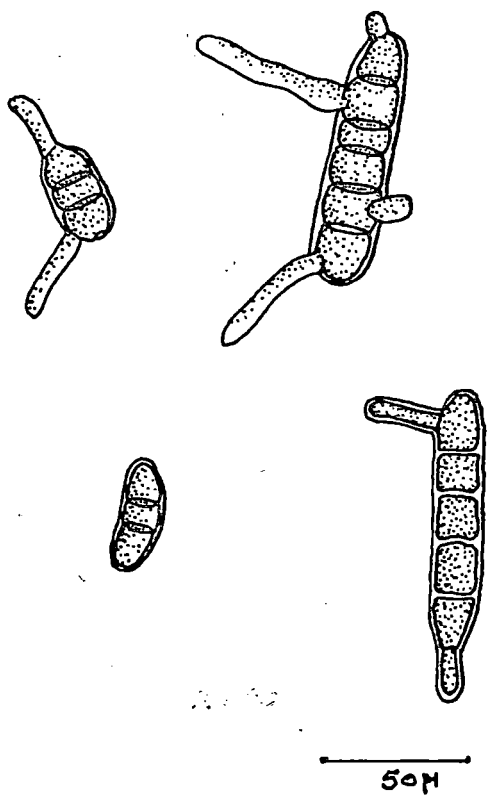


Fig. 2. *Helminthosporium gramineum*

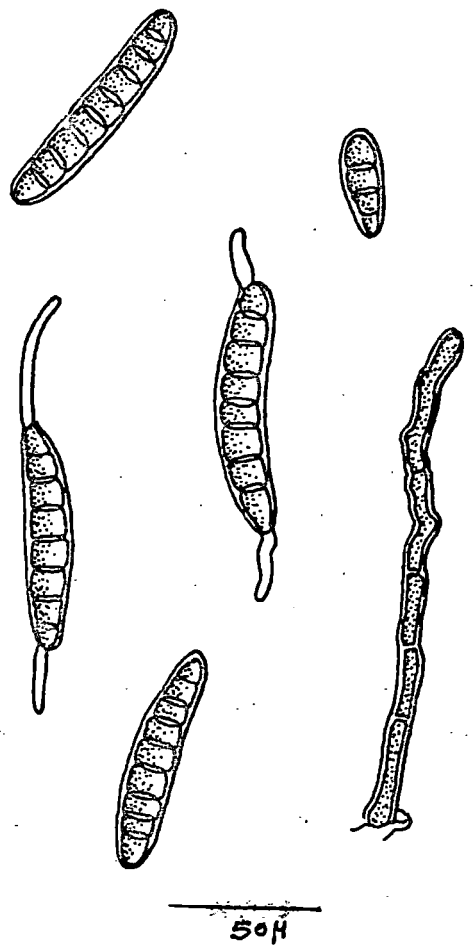


Fig.3 · *Helminthosporium cynodontis*

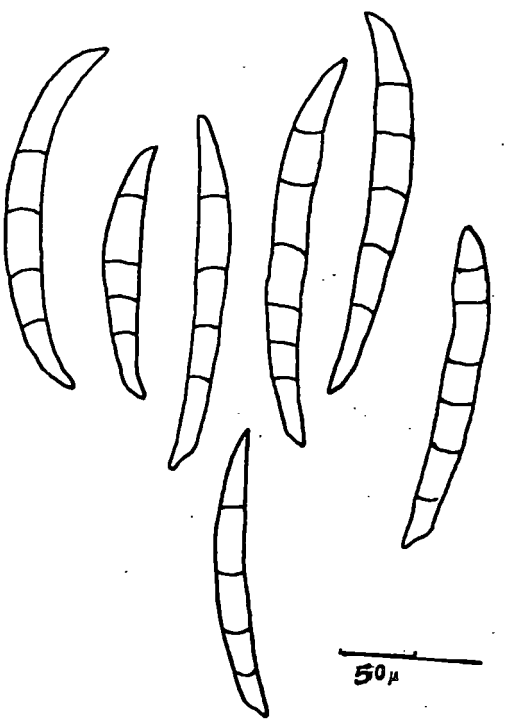


Fig. 4 *Fusarium graminearum*

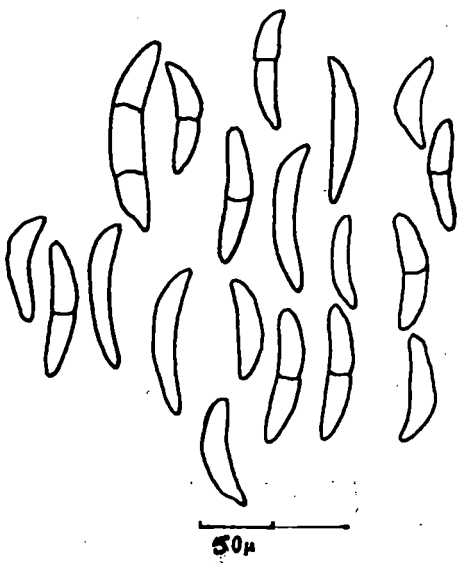


Fig.5. *Fusarium nivale*

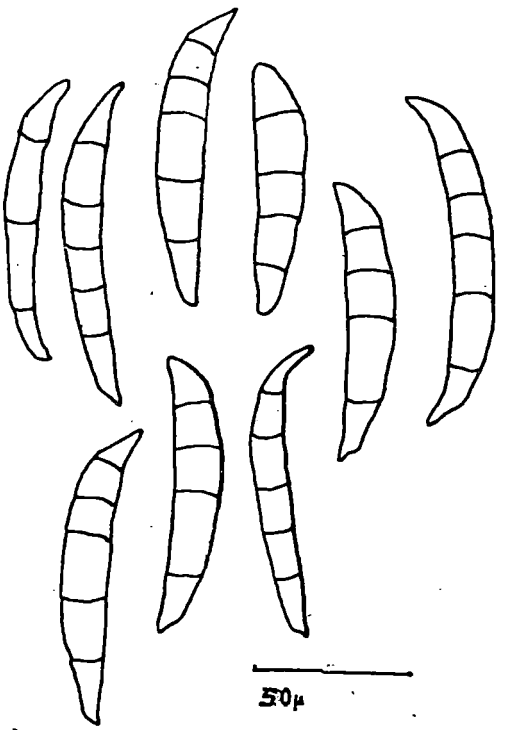


Fig. 6. *Fusarium culmorum*

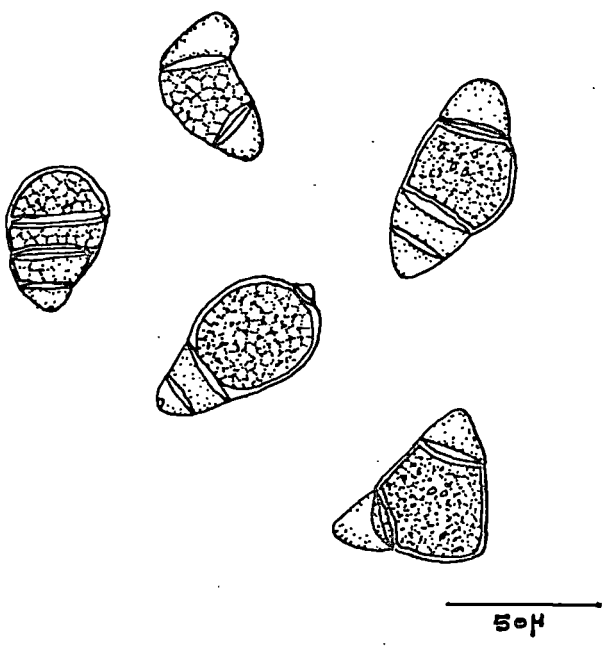


Fig. 7. *Curvularia trifolii*

of H. gramineum, F. graminearum and C. trifolii were made.

4.3.1.1. Leaf blight caused by H. gramineum

The symptoms appeared as small tiny, brownish specks, primarily on surfaces of older leaves. Sometimes they appeared on younger leaves and sheath also. When the leaf sheaths were affected, the discolouration often became increasingly diffused downwards. The base of the stem was uniformly discoloured and often extented up to the roots. The spots on the leaves were found to enlarge by 10 to 15 days of time and coalesced together to form large blighted areas. Usually, the spots were concentrated at the central portion of the leaf blades, the lower and middle leaves were found to be affected more than the younger leaves. Such leaves started blightening from margins or from tips and gradually covered the leaf blade. A severely affected hill at later stage appeared shrivelled and burnt up (Plates 1 and 2).

4.3.1.2. Leaf spot disease caused by F. graminearum

Pinkish to dark, olivaceous tiny spots, numerous in number, were found to appear on leaf blade as well as on the sheath. In leaf blades the intensity of spots were noticed more towards the tip of leaves. The surrounding areas of these spots gradually developed yellow patches and in severely

Plate 1. Leaf blight caused by *Helminthosporium gramineum* on Hybrid napier (Natural Symptom)

Plate 2. Leaf blight caused by *H. gramineum* on guinea grass (Natural Symptom)

Plate · 1

Plate · 2 ·

infected plants drying up of leaves and leaf sheath were frequently noticed. Often, the newly emerged tillers were found pale yellow in colour and the roots of such tillers became discoloured and shrunken.

4.3.1.3. Leaf and sheath blotch caused by Curvularia trifoli

Small, oblong, necrotic spots appeared on the tip and margins of leaves and on the lower sheath. In course of time, the surrounding areas of the spots became watersoaked and also gradually developed dark brown to black blotches. In certain cases, the majority of the affected area on leaf and leaf sheaths showed a blackish powdery coating on the surface, such plants appeared pale and stunted. Among the host plants observed, para grass was found to be more affected by this pathogen. Blightening, discolouration and stunting of young plants were common in grass fields due to the infection by various species of Curvularia. In severe infections, the quantity and quality of fodder was very much affected.

Among the minor pathogens observed during the survey Rhizoctonia solani in guinea grass exhibited severe symptoms. The disease was initiated on lower sheaths as water soaked oblong areas which finally turned to papery or straw coloured blighted areas. In such cases whitish fungal growth could be noticed on collar and stem portions of affected plants and sometimes on surrounding soil surface. Under moist and humid

Plate 3. Symptom produced by Helminthosporium gramineum on Hybrid napier grass (artificial inoculation)

Plate - 3.

Plate 4. Symptom produced by H. gramineum on Hybrid napier grass (artificial inoculation)

Plate 5. Symptom produced by H. gramineum on Hybrid napier grass (on leaves artificial inoculation)

conditions, sclerotia of the fungus could also be noticed on affected portions often the roots of such plants were damaged resulting in death of plants.

4.3.1.4. Diseases caused by Pythium spp and Sclerotium rolfsii were found to be severe in early stages. The infected plants wilted in circular patches.

Mixed infections were also found to occur in turf grass, guinea grass and hybrid napier grass. One or more species of Curvularia and Fusarium were noticed in most of the grass species which showed blight symptoms.

4.3.2. Symptomatology of inoculated plants

In the case of blight disease caused by Helminthosporium spp initial symptoms were noticed within 4 to 6 days after inoculation as tiny spots on leaf as well as on the leaf sheath. It was observed that the initial symptoms developed within two days. Both the leaves as well as sheath were injured. The course of development of the symptoms was observed to be same as in the case of field conditions. However, the typical blightening in artificial inoculation was noticed between 5th and 12th day after inoculation only (Plates 3-5)

In the case of leaf spots caused by Fusarium spp the three isolates tested expressed more or less identical symptoms. Development of spots could be noticed by 5th

Plate - 3.

Plate 4. Symptom produced by H. gramineum on Hybrid napier grass (artificial inoculation)

Plate 5. Symptom produced by H. gramineum on Hybrid napier grass (on leaves artificial inoculation)

Plate - 4

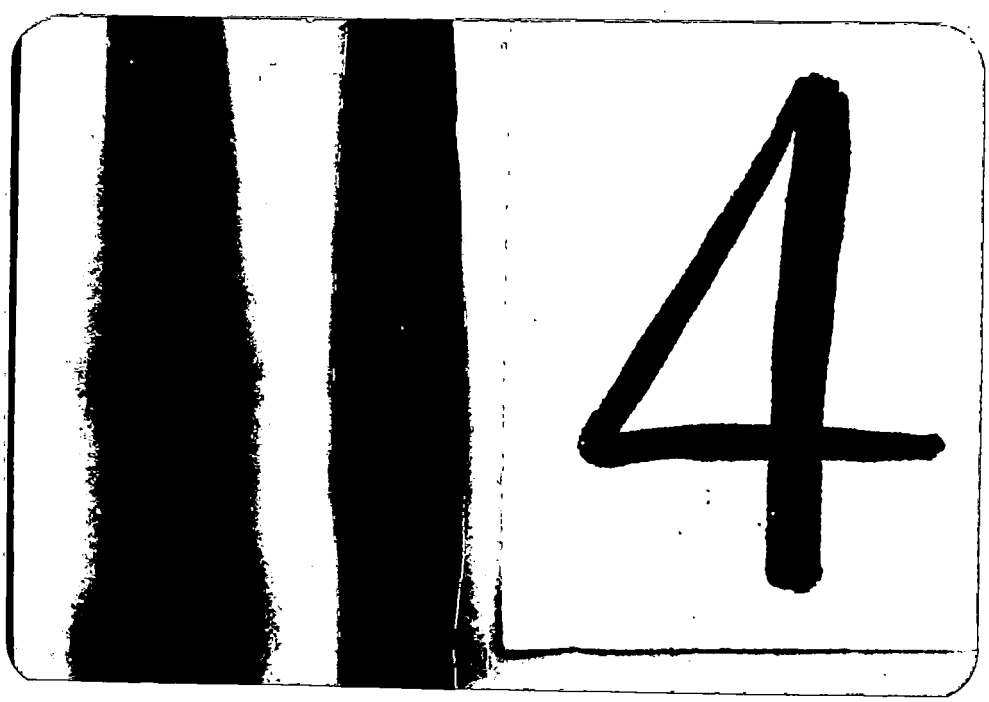


Plate. 5.

day of inoculation in uninjured host plants, whereas in injured plants, symptoms appeared even on 3rd day of inoculation. The course of further development was almost similar to that in field conditions and there were no prominent difference could be noticed between isolates (Plates 6 & 9)

In the case of sheath and leaf blotch caused by Curvularia spp., artificial inoculation yielded more or less similar symptoms as under field conditions. There was no distinct difference in the symptoms produced by C. trifolii and C. lunata. Uniform yellowing followed by blackening of leaves was noticed in the case of these isolates.

All the isolates of Curvularia initiated symptoms by within six days after inoculation, when culture bits were used. Whereas six to nine days were taken for symptom initiation in case of spore suspension spray. Here also injury in host plants was found to hasten the symptom development. The typical blotches could be noticed by 15th to 17th day after inoculation (Plates 10 & 11)

In the case of Rhizoctonia solani the initial symptom was noticed as water soaked lesions near the inoculated portions on the fifth day of inoculation. Gradually these areas turned straw coloured and complete blightening of the plants were noticed by 20th day of inoculation. The blightening which started in the

Plate 6. Symptom produced by *Fusarium graminearum* on hybrid napier grass (on leaves artificial inoculation)

Plate 7. Symptom produced by *F. graminearum* on Hybrid napier grass (artificial inoculation)

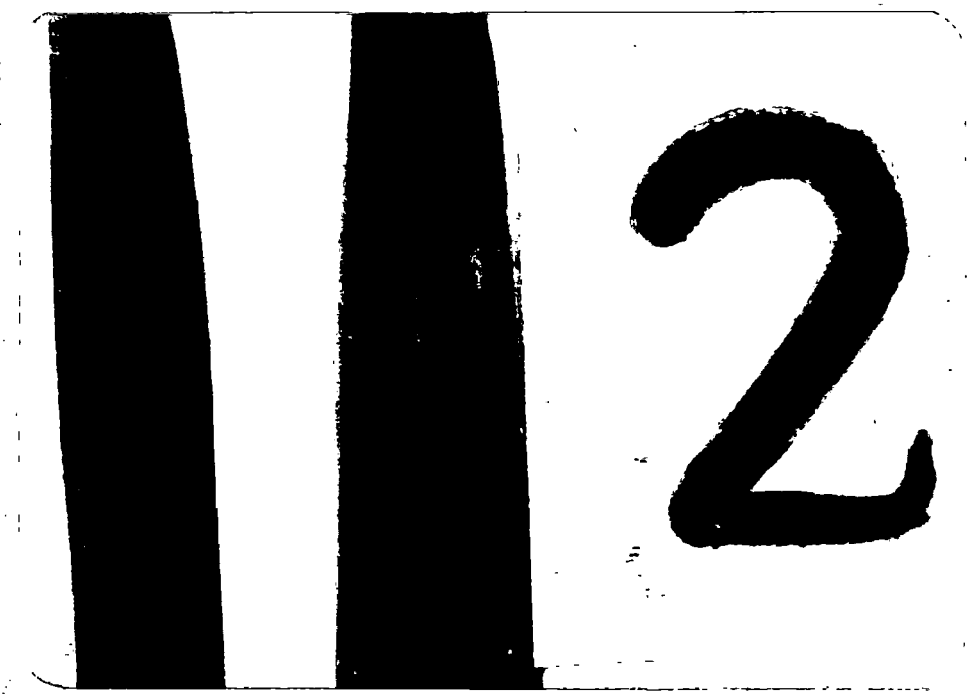


Plate. 6.

Plate. 7.

Plate 8. Symptoms produced by Fusarium nivale on Hybrid napier grass (on leaves by artificial inoculation)

Plate 9. Symptoms produced by Fusarium culmorum on congo signal grass

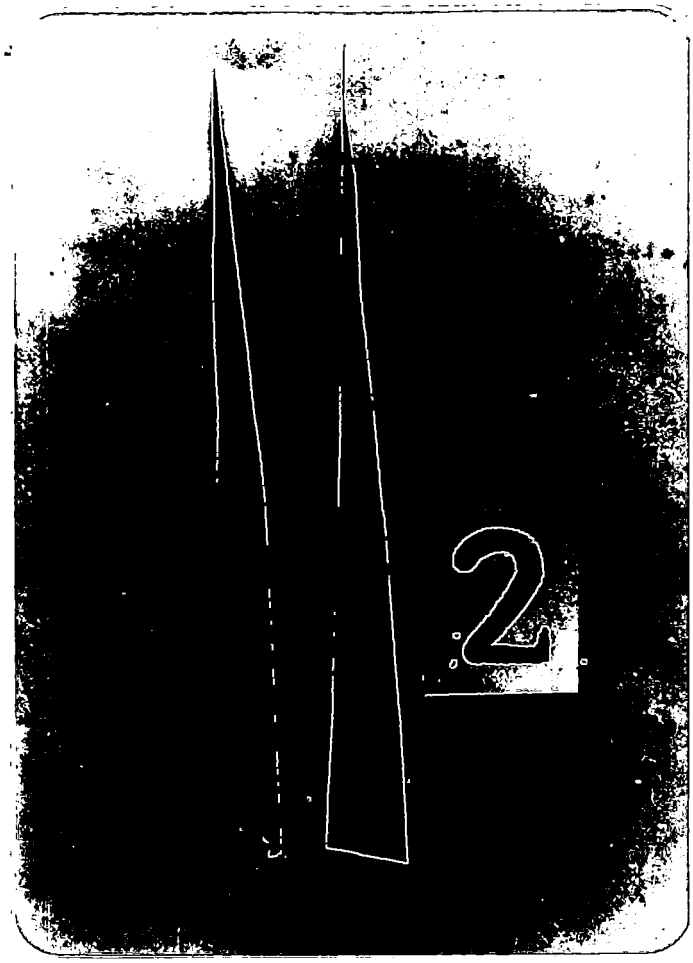


Plate. 8.

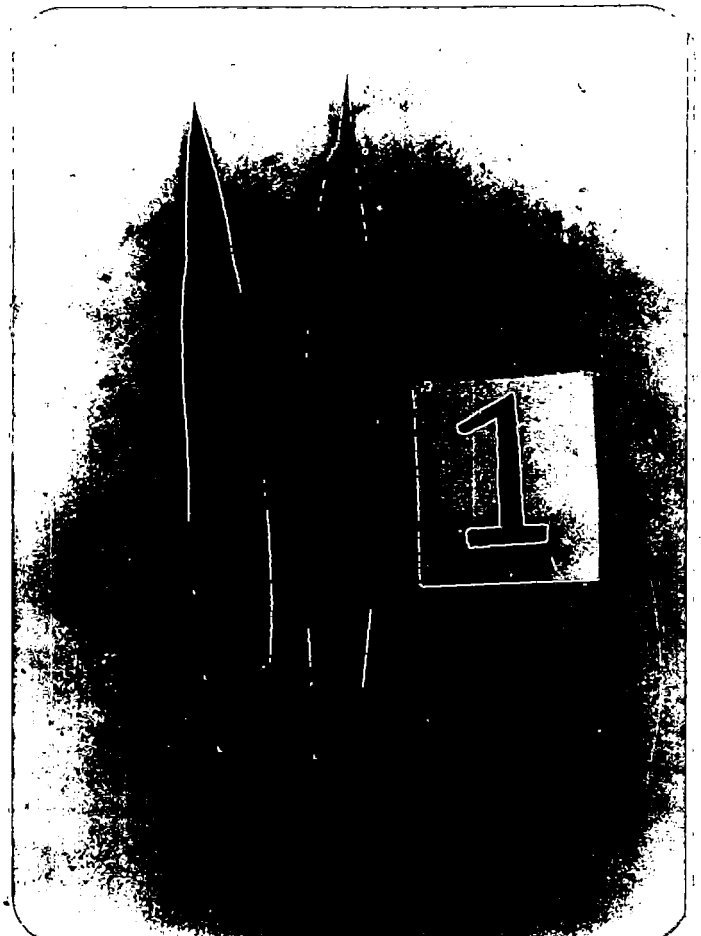


Plate. 9.

Plate 10. Symptom produced by Curvularia trifoli on Setaria grass

Plate 11. Symptom produced by Curvularia trifoli on Setaria grass (on leaves - natural symptom)

lower sheaths first was found to extent upwards in the corresponding leaves. The leaves were later got completely blighted and the whole plant showed a burnt up appearance. The blighted leaves were seen curling and drooping downwards (Plates 12 and 13).

4.3.2. Pathogenicity of the various isolates of the pathogens

The pathogenicity of the various isolates were tested by artificially inoculating them in 35 days old respective host plants. All fungi were found to be pathogenic to their respective host plants, when inoculated under artificial conditions symptoms as those observed in nature were produced after inoculation.

4.4. Growth on different solid media

4.4.1. Helminthosporium gramineum

Czapek (Dox) agar was found to be the best medium for the growth of the fungus followed by Richard's agar medium and potato dextrose agar medium. The effect of these media were on par. Sabouraud's agar medium was found to be the least effective medium for the growth of the fungus (Table 4 & Fig.8).

4.5.2. Fusarium graminearum

Czapek's Dox agar and Richard's agar medium were found to be the best medium for the growth of the fungus, followed by Coon's agar (Table 4 & Fig.9).

guinea grass (Later Symptoms)

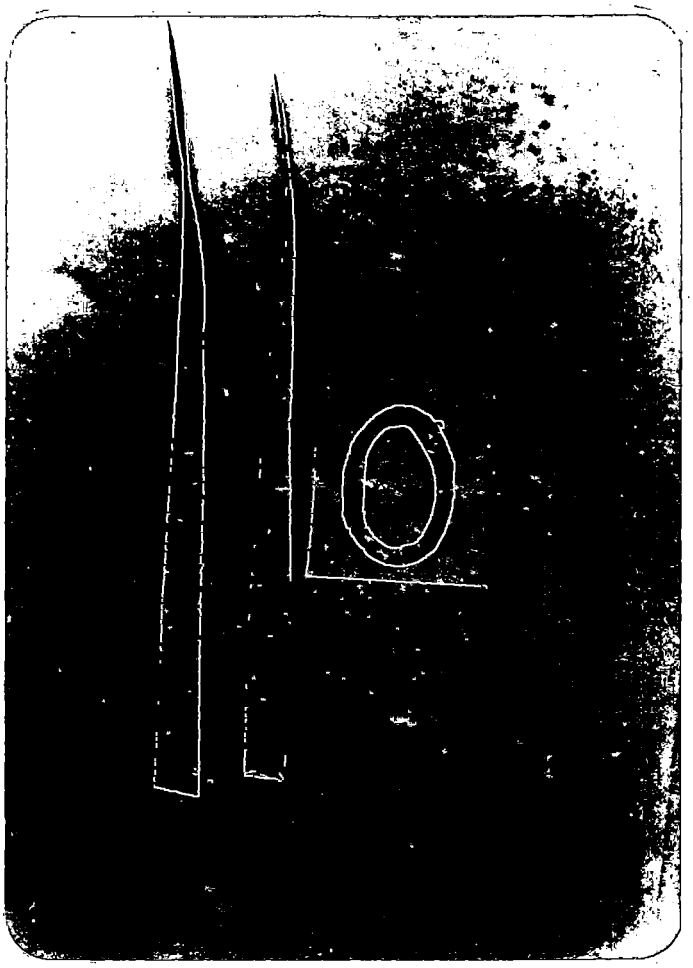


Plate. 10

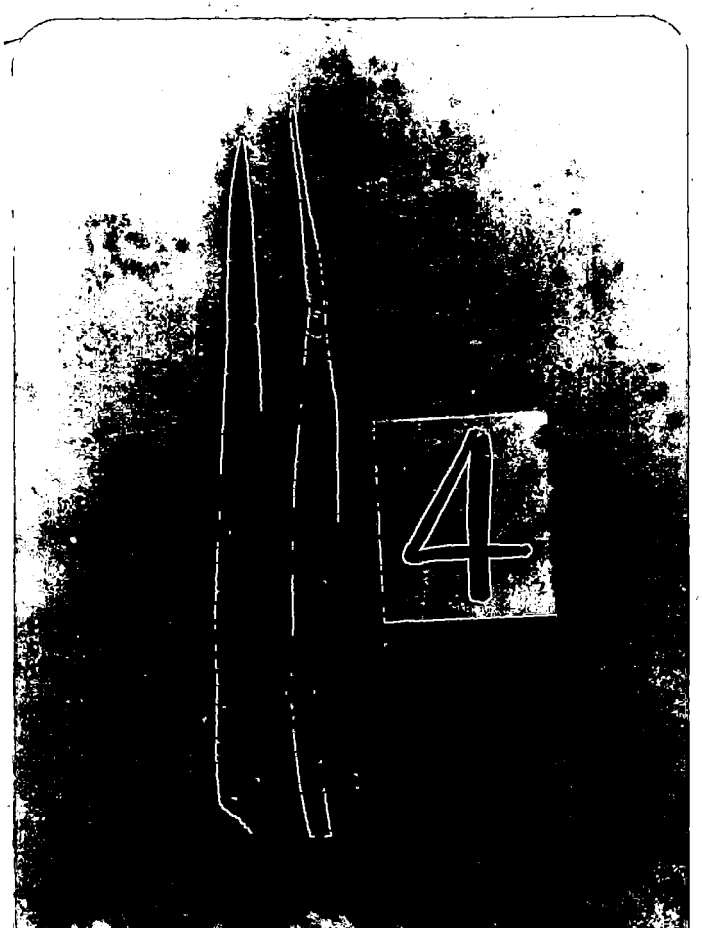


Plate. 11.

Plate 12. Symptom produced by Rhizoctonia solani on guinea grass (artificial inoculation)

Plate 13. Symptom produced by Rhizoctonia solani on guinea grass (Later Symptoms)

plate. 12.

plate. 13.

Table 4. Growth of different isolates on culture media (mean colony diameter on the seventh day in mm

Sl. No.	Treatments	H. gramineum	F. graminearum	C. trifolii
1.	Coons agar medium	78.00	86.67	70.33
2.	Czapek (Dox) agar medium	90.00	90.00	90.00
3.	Oats agar medium	82.33	68.33	90.00
4.	Potato dextrose agar medium	88.33	82.67	78.67
5.	Richard's agar medium	89.00	90.00	90.00
6.	Sabouraud agar medium	66.00	74.33	68.67
	CD (0.05)	3.61	2.65	2.72

FIG. 8 GROWTH OF *Helminthosporium gramineum* ON DIFFERENT CULTURE MEDIA

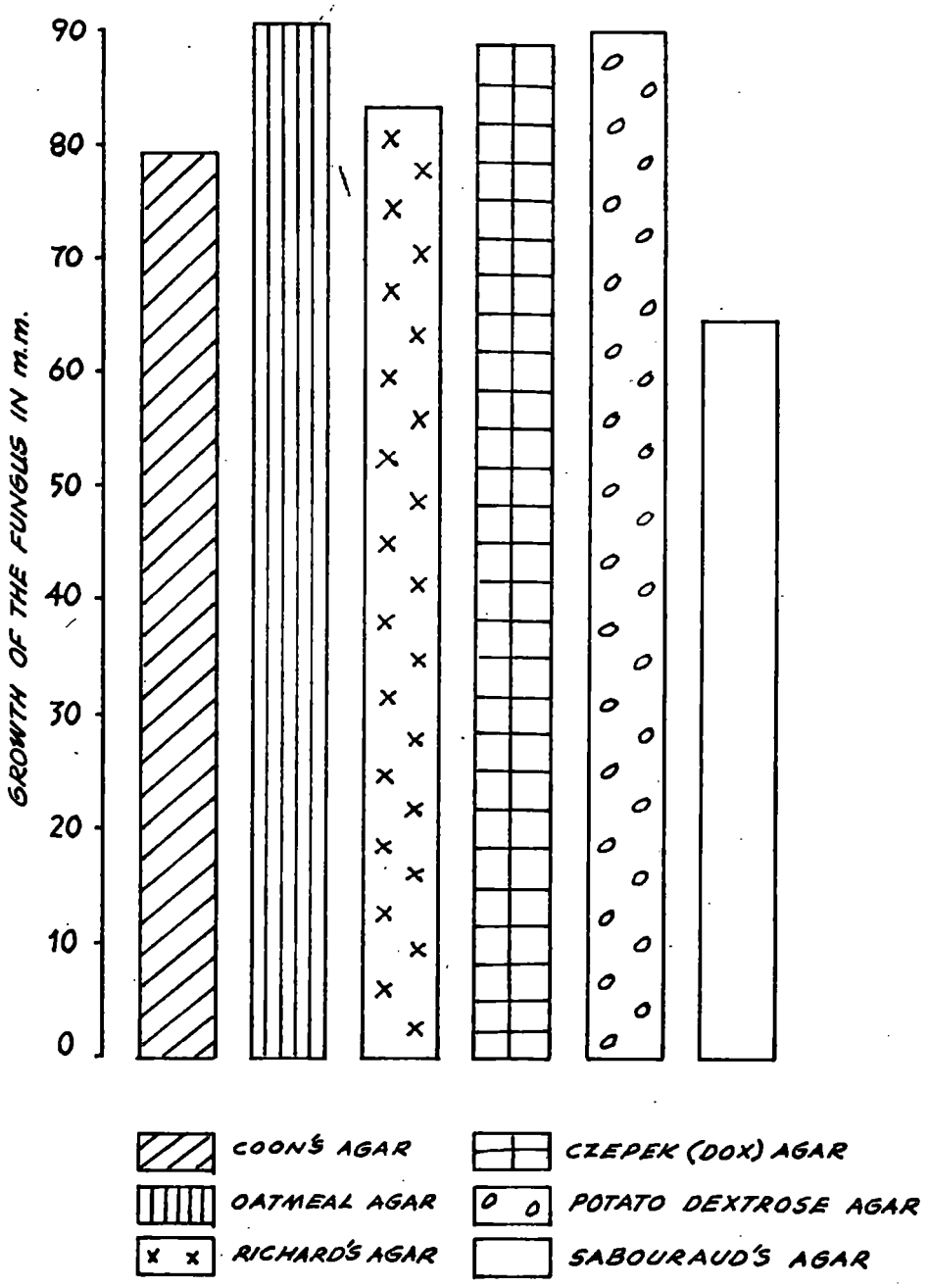
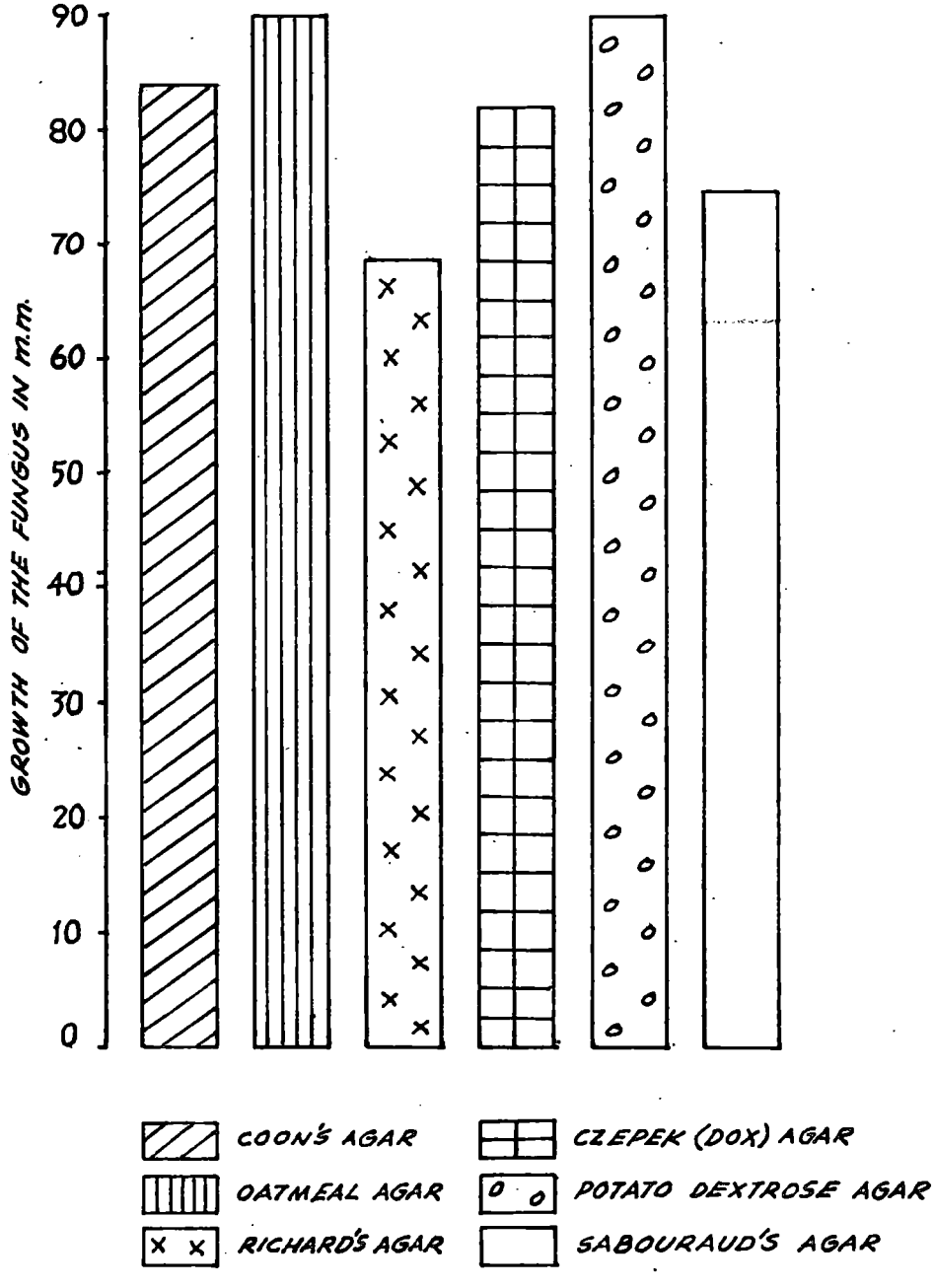


FIG. 9. GROWTH OF *Fusarium graminearum* ON DIFFERENT CULTURE MEDIA



4.5.3. Curvularia trifolii

Czapek (Dox) agar, oat meal agar and Richard's agar were found to be equally effective for the growth of the fungus, and were significantly superior to all other media tested. Sabourand's agar and Coon's agar were found to be least effective for the growth of the fungus (Table 4 & Fig. 10).

4.6. Effect of different temperatures on growth of the isolates

4.6.1. In Czapek (Dox) medium

In the case of H. gramineum, the maximum growth was obtained at 25°C followed by room temperature (Table 5). In the case of F. graminearum also same trend was noticed. In the case of C. trifolii the maximum growth was noticed at a temperature level of 35°C followed by 25°C (Table 5)

4.6.2. In Richard's medium

In the case of H. gramineum, the maximum growth was noticed at 25°C and at room temperature, the growth was found to be very poor. In the case of F. graminearum also, the temperature level of 25°C was found to be best followed by 35°C. In the case of C. trifolii also 25°C recorded maximum growth and decrease or increase of temperature recorded a reduction in the growth (Table 6).

FIG. 10. GROWTH OF *Culvularia trifolii* ON DIFFERENT CULTURE MEDIA.

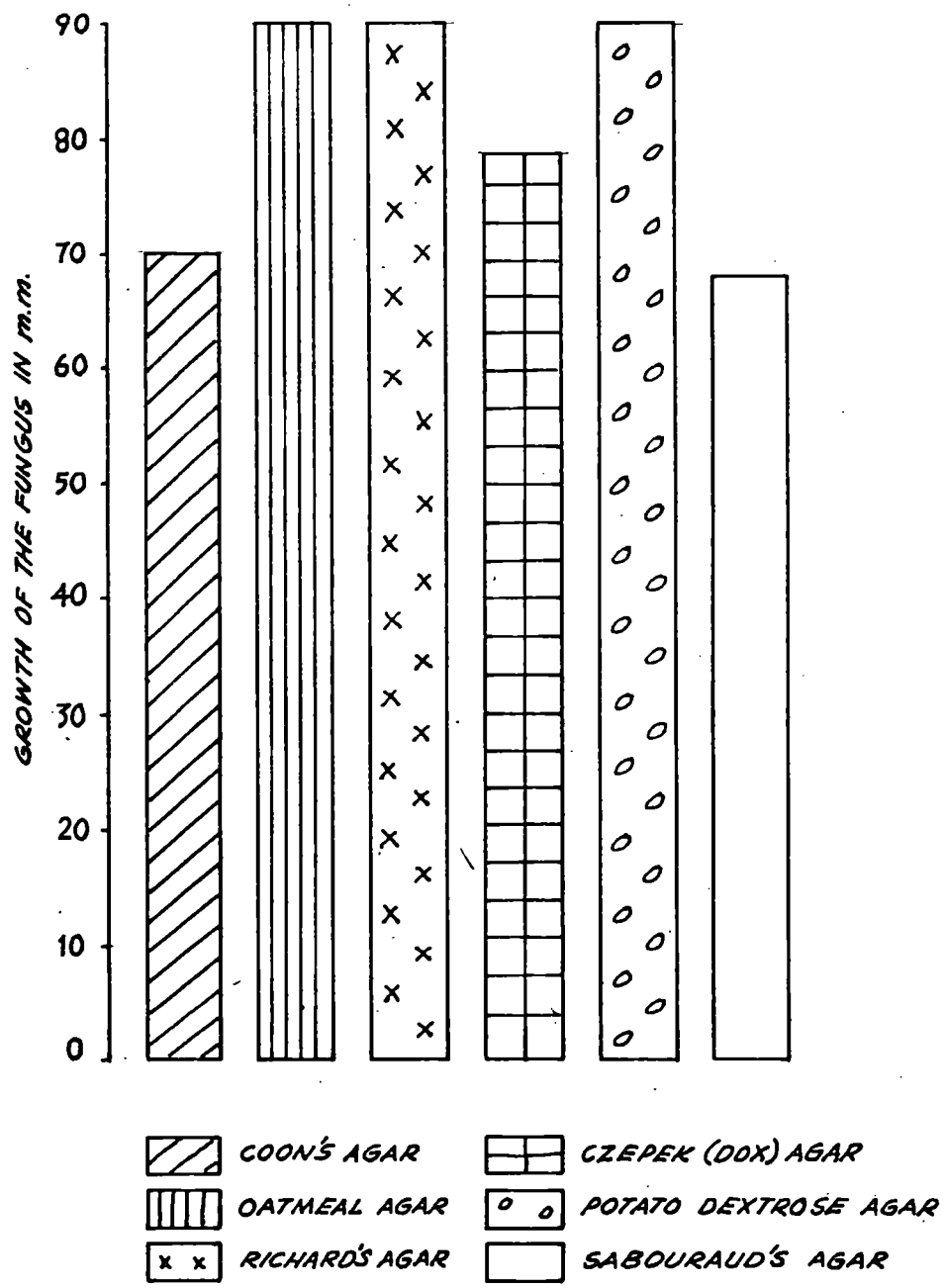


Table 5. Growth of different isolates in Czapek (Dox) medium at different temperature levels

Sl. No.	Name of isolate	Temperature level	Mean weight of mycelium in gms
1.	Helminthosporium gramineum	28 ± 2°C	1.097
2.	"	25 ± 2°C	1.261
3.	"	35 ± 2°C	1.141
4.	Fusarium graminearum	27 ± 2°C	1.105
5.	"	25 ± 2°C	1.159
6.	"	35 ± 2°C	1.117
7.	Curvularia trifolii	28 ± 2°C	1.104
8.	"	25 ± 2°C	1.176
9.	"	35 ± 2°C	1.144
CD (0.05)			0.136

Table 6. Growth of different isolates in Richards' (liquid) medium at different temperature levels

Sl. No.	Name of isolate	Temperature level	Mean weight of mycelium in gms
	Helminthosporium gramineum		
1.	"	28 ± 2°C	1.27
2.	"	25 ± 2°C	1.31
3.	"	35 ± 2°C	1.24
	Fusarium graminearum		
4.	"	28 ± 2°C	1.14
5.	"	25 ± 2°C	1.17
6.	"	35 ± 2°C	1.14
	Curvularia trifolii		
7.	"	28 ± 2°C	1.25
8.	"	25 ± 2°C	1.25
9.	"	25 ± 2°C	1.27
CD (0.05)			0.0568

4.7. Studies on the host range of pathogens

Results showed that all the graminaceous crops tested were susceptible to H. gramineum and F. graminearum. But infection by C. trifolii was noticed only on paddy, congo-signal and paragrass. None of the pathogenes could infect eupatorium, clerodendron, papaya, jack and cowpea (Table 7).

In the case of coconut, all the pathogens showed varying symptoms on young leaves. H. gramineum showed water soaked lesions on 5th day after inoculation which gradually turned to dark brown and finally typical leaf rot symptoms by about 15 to 18 days after inoculation. F. graminearum showed blackish spots at the inoculated points after 5 to 8 days of inoculation. In the case of Curvularia, the artificial inoculation caused discolouration of leaves in patches within seven days of inoculation and such discoloured areas turned necrotic within 14 days of inoculation (

It was also noticed that the respective isolates obtained from these infected host plants could again cross infect successfully and produce typical disease symptoms in the respective grass hosts.

4.8. In vitro evaluation of fungicides

4.8.1. Inhibition of spore germination

4.8.1.1. Helminthosporium gramineum

Bordeaux mixture, Dithane M-45 and Foltaf caused

Table 7. Reaction of different host plants to the isolates of the major pathogens

Sl. No.	Host plant tested	Pathogen isolates		
		H.gramineum	F.graminearum	C.trifoli
1.	Rice	+	+	+
2.	Sorghum	+	+	+
3.	Maize	+	+	+
4.	Congosignal	+	+	+
5.	Paragrass	+	+	+
6.	Subabul	+	+	-
7.	Tapioca	-	-	-
8.	Eupatorium	-	-	-
9.	Clerodendron	-	-	-
10.	Papaya	-	-	-
11.	Jack	-	-	-
12.	Cowpea	-	-	-
13.	Coconut	+	+	+

- : No infection

+ : Infected

100 per cent inhibition of spore germination at 6 and 24 hours after incubation. With the above three fungicides complete inhibition was obtained even at 50 ppm concentration, Fytolan was found to have the least inhibitory effect on the spore germination of the fungus (table 8).

4.8.1.2. Fusarium graminearum

Bordeaux mixture, Dithane M-45 and Foltaf caused 100 per cent inhibition of spore germination. Fytolan was found to be the least effective fungicide (table 9).

4.8.1.3. Curvularia trifolii

Foltaf (50 ppm), Bordeaux mixture (100 ppm) and Dithane M-45 (200 ppm) caused 100 per cent inhibition of the spore germination of the fungus. At 6 hours after incubation Fytolan at 200 ppm concentration, effected complete inhibition of the fungus (table 10).

4.8.2. Inhibition of growth (poisoned food technique)

4.8.2.1. Helminthosporium gramineum

Fungicides viz., Dithane M-45, Foltaf, Fytolan and Bordeaux mixture were tested each at three concentrations ranging from 0.2% to 0.4%. Results revealed that the fungicides

Table 8. Effect of different fungicides on the spore germination of *Helminthosporium gramineum*

Sl. No.	Treatment	Per cent inhibition of spore germination (average of 3 replications)					
		6 hours			24 hours		
		50 ppm	100 ppm	200 ppm	50 ppm	100 ppm	200 ppm
1.	Bordeaux mixture	*100.0	100.0	100.0	100.0	100.0	100.0
2.	Dithane M-45	100.0	100.0	100.0	100.0	100.0	100.0
3.	Foltaf	100.0	100.0	100.0	100.0	100.0	100.0
4.	Fytolan	62.4	76.7	82.30	58.7	69.9	78.8
5.	Control	5.0	4.0	4.0	2.3	2.4	2.3
	C.D.(0.5)		0.60			0.15	

* average of three replications

Table 9. Effect of different fungicides on the spore germination of *Fusarium graminearum*

Sl. No.	Treatment	Per cent inhibition of spore germination after (average of 3 replication)					
		6 hours			24 hours		
		50 ppm	100 ppm	200 ppm	50 ppm	100 ppm	200 ppm
1.	Bordeaux mixture	*100.0	100.0	100.0	100.0	100.0	100.0
2.	Dithane M-45	100.0	100.0	100.0	100.0	100.0	100.0
3.	Foltaf	100.0	100.0	100.0	100.0	100.0	100.0
4.	Fytolan	69.6	76.9	86.9	64.1	70.8	80.0
5.	Control	10.0	8.0	8.0	5.5	5.5	5.5
	C.D.(0.05)		0.30			0.30	

* average of three replications

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

Sl. No.	Treatments	Per cent inhibition of spore germination (average of 3 replication)					
		6 hours			24 hours		
		50 ppm	100 ppm	200 ppm	50 ppm	100 ppm	200 ppm
1.	Bordeaux mixture	*100.0	101.0	100.0	100.0	100.0	100.0
2.	Dithane M-45	88.3	98.5	100.0	86.2	94.6	100.0
3.	Foltaf	100.0	100.0	100.0	100.0	100.0	100.0
4.	Fytolan	88.5	94.6	100.0	82.3	91.4	98.2
5.	Control	8.0	8.0	8.0	6.0	6.0	6.0
	C.D (0.05)		0.85			0.12	

* average of three replications

influence significantly the growth of the pathogen. Among the fungicides, Bordeaux mixture at 1 per cent and 1.5 per cent were found superior. This was followed by Dithane M-45 at 0.4 per cent and Foltaf at 0.4 per cent concentrations which were also found to be on par. Fytolan at 0.3 per cent concentration was found least effective. With the decrease in growth inhibition of the pathogen, there was a corresponding inhibition of the pathogen. (Table 11. Fig. 11)

4.8.2.2. Fusarium graminearum

Among the four fungicides tested Bordeaux mixture at 1.5 per cent concentration recorded the maximum inhibition of growth. Next to Bordeaux mixture, Fytolan at 0.2 per cent and 0.4 per cent concentrations were found effective against the fungus. Difolatan and Dithane M-45 were found inferior (table 12, Fig. 12)

4.8.2.3. Curvularia trifolii

Results showed that Bordeaux mixture at 1.5 per cent concentration was significantly superior to all other fungicides and their levels. This was followed by Foltaf at 0.4, 0.3 and 0.2 per cent concentrations respectively. Fytolan was comparatively inferior to the other fungicides against the fungus (Table 13, Fig. 13)

1.9. Management of blight disease of Hybrid napier grass under field conditions

A randomised replicated field experiment was laid out

Table 11. *In vitro* effect of various fungicides against *Helminthosporium gramineum*

Sl. No.	Name of fungicide tested	Concentration used (per cent)	Percentage of inhibition over control (mean value of 3 replications)
1.	Bordeaux mixture	0.5	73.77
		1.0	90.00
		1.5	90.00
2.	Dithane M-45	0.2	72.62
		0.3	74.18
		0.4	76.33
3.	Foltaf	0.2	72.62
		0.3	75.02
		0.4	76.33
4.	Fytolan	0.2	58.66
		0.3	56.91
		0.4	90.00
	CD (0.05)		1.56

FIG. 11 EFFECT OF FUNGICIDES ON THE GROWTH OF *Helminthosporium graminearum* ON SOLID MEDIA

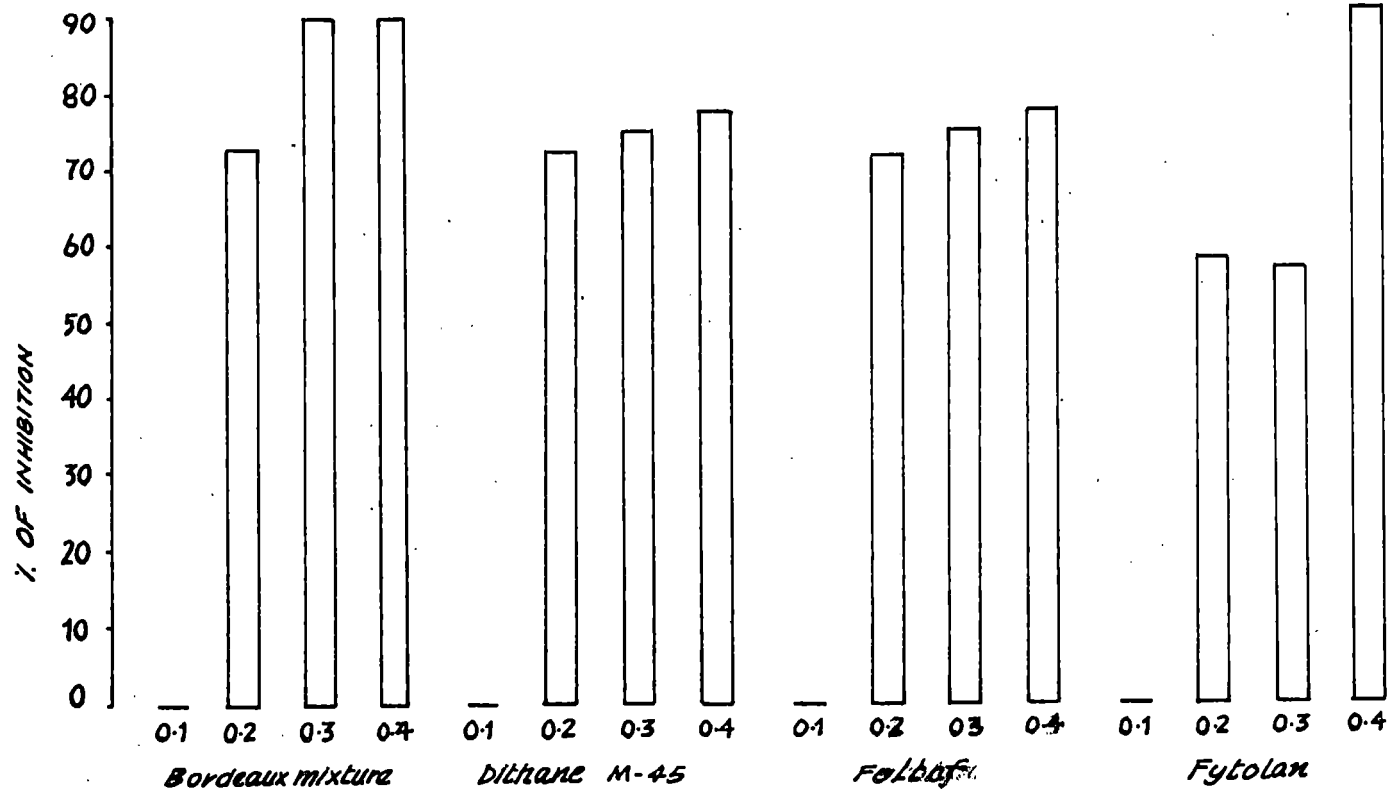


Table 12. *In vitro* effect of various fungicides against *Fusarium graminearum*

Sl. No.	Name of fungicide tested	Concentration used (per cent)	Percentage of inhibition over control (mean value of 3 replications)
1.	Bordeaux mixture	0.5	61.09
		1.0	72.81
		1.5	90.00
2.	Dithane M-45	0.2	42.75
		0.3	49.99
		0.4	48.92
3.	Foltaf	0.2	49.02
		0.3	50.42
		0.4	48.92
4.	Fytolan	0.2	52.27
		0.3	48.27
		0.4	51.95
	CD (0.05)	0.89	

FIG. 12. EFFECT OF FUNGICIDES ON THE GROWTH OF *Fusarium graminearum* ON SOLID MEDIA

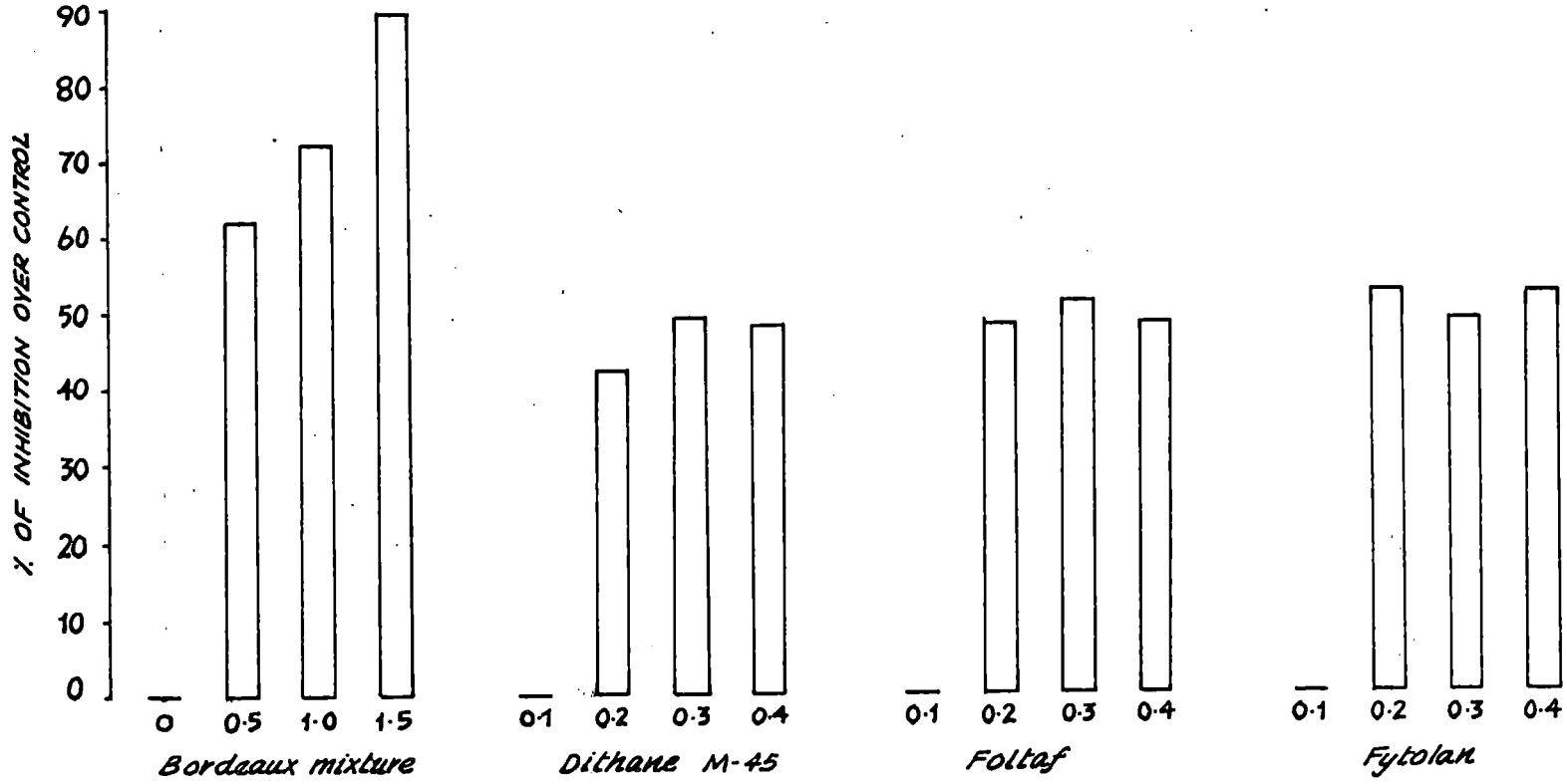
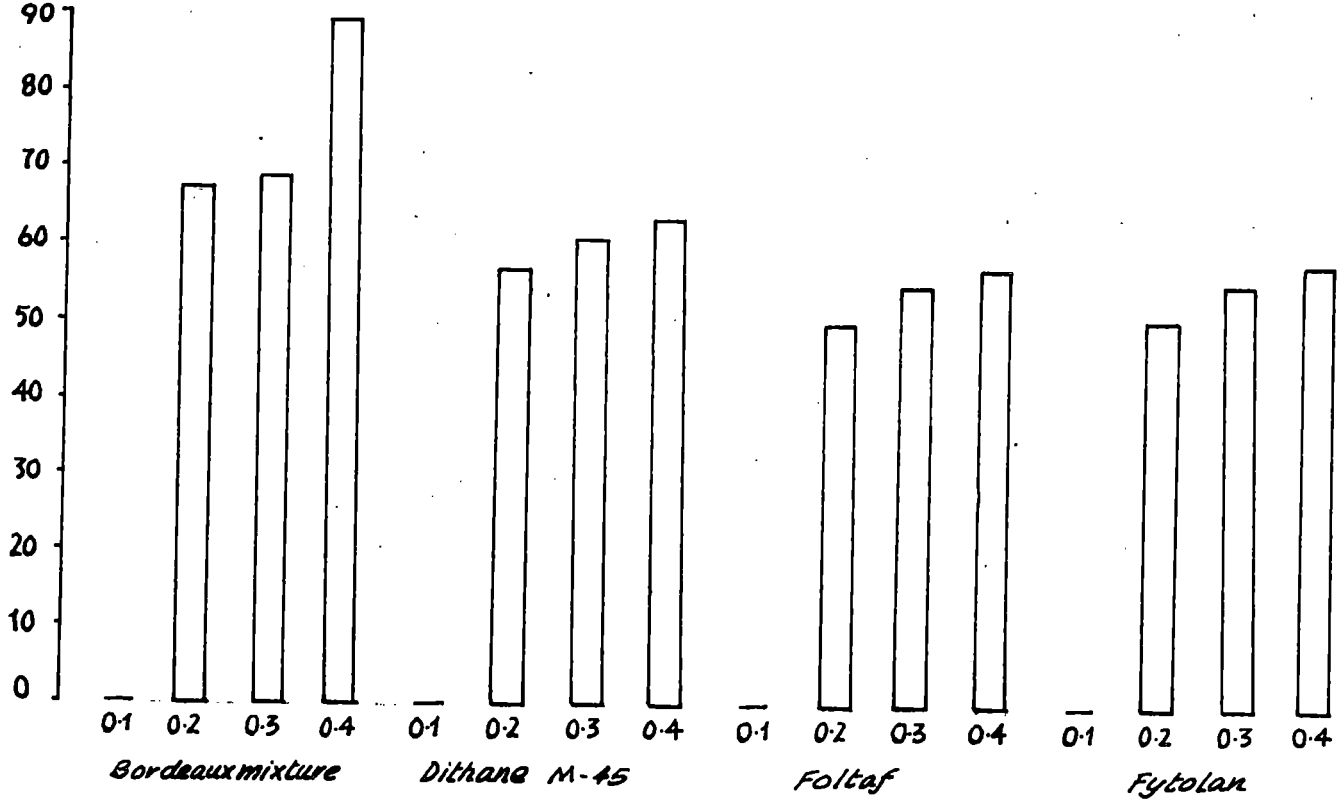


Table 13. *In vitro* effect of various fungicides against *Curvularia trifolii*

Sl. No.	Name of fungicide tested	Concentration used (per cent)	Percentage of inhibition over control (mean value of 3 replications
1.	Bordeaux mixture	0.5	68.87
		1.0	69.83
		1.5	90.00
2.	Dithane M-45	0.2	57.34
		0.3	60.33
		0.4	62.64
3.	Foltaf	0.2	73.39
		0.3	74.17
		0.4	75.00
4.	Fytolan	0.2	50.41
		0.3	56.87
		0.4	57.46
CD (0.05)		1.41	

FIG. 13 EFFECT OF FUNGICIDES ON THE GROWTH OF *Curvularia trifolii* ON SOLID MEDIA



in the Instructional Farm at College of Agriculture, Vellayani to assess the efficiency of four different fertilizer levels and four common fungicides.

4.9.1. Main crop

4.9.1.1. Disease incidence

Observations on disease index showed that various manurial levels could influence significantly on disease index. But the response of different fungicides was not significant. However, the interaction effect of manures and fungicides were found significant with respect to disease index. The fertilizer dose of NPK at the ratio 150:50:50 kg/ha recorded the maximum effect on disease control which was also on par with the NPK dose at 200:50:62.5 kg/ha. A higher dose of Nitrogen (200 kg and 250 kg/ha) and lower dose of potash (250 kg/ha) along with P and K at the rate of 50 kg/ha and were found to be less effective. Combination of 1 per cent Bordeaux mixture with 200 kg/ha N and 50 kg of potash and phosphorus each per ha was significantly superior. Combination with NPK @ 200:50:50 and 250:50:50/ha were also found equally effective and superior to all other treatments (Table 14). Bordeaux mixture at 1 percent concentration the least disease index was recorded for the first NPK dose which was significantly superior to all other fertilizer levels along with Bordeaux mixture.

Table 14. Influence of manures and fungicides in the management of leaf blight disease of Hybrid napier grass (main crop)

Fertilizers			Fungicides					
N	P	K	No fungicide	Bordeaux mixture	Captafol (0.3%)	Mancozeb (0.3%)	Copper oxychloride (0.3%)	Mean
	kg/ha							
200:	50:	50	4.85	6.65	3.14	3.52	5.04	4.64
250:	50:	50	6.44	3.52	3.13	5.02	6.75	4.97
150:	50:	50	3.23	2.85	4.66	6.37	3.52	4.13
200:	50:	62.5	3.42	4.85	6.08	3.23	3.33	4.18
Mean			4.49	4.47	4.25	4.53	4.66	

CD for comparison of treatment combination = 0.66
CD for comparison of treatment between means = 0.29
CD for comparison of treatment between fungicides = 0.33

4.9.1.2. Influence of manures and fungicides in the fodder yield of Hybrid napier grass (main crop)

Results showed that fertilizer levels could influence significantly fodder yield of the crop. N:P:K @ 200:50:50 kg per ha yielded maximum fodder yield per plot and this was significantly superior to all other fertilizer levels. N:P:K @ 150:50:50 kg per ha recorded the lowest per plot yield of fodder. With regard to fungicides, no significant difference

could be noticed, but the combination effect of fungicides along with fertilizers were significantly different. Among the treatment combinations Captafol at 0.3% concentration along with the fertilizer dose of N:P:K @ 200:50:62.5 kg per ha yielded the maximum fodder yield which was significantly superior to all other treatments. This was found to be on par with the same fungicide at N:P:K level 250:50:50 kg per ha, as well as with Bordeaux mixture in combination with the N:P:K dose of 200:50:50 kg per ha, N:P:K dose of 150:50:50. One notable observation is that among the treatment combinations where the higher potash was received, recorded the maximum fodder yield with respect to all other single or combined treatments. (Table 15)

Table 15. Influence of manures and fungicides in the fodder yield of Hybrid napier grass (Main crop) (yield in kg/plot)

Fertilizers			Fungicides					
N	P	K	No fungicide	Bordeaux mixture (1%)	Captafol (0.3%)	Mancozeb (0.3%)	Copper oxychloride (0.3%)	Mean
kg/ha								
200:	50:	50	7.67	14.20	5.33	10.30	7.00	8.89
250:	50:	50	13.33	5.63	11.80	5.33	11.43	9.51
150:	50:	50	5.00	9.39	8.00	10.10	8.10	8.12
200:	50:	62.5	11.23	8.95	14.90	6.63	13.07	10.96
Mean			9.31	9.55	10.01	8.09	9.90	

CD for combination (0.05) = 4.62

CD (0.05) for combination of fertilizer levels= 2.07

CD (0.05) for combination of fungicides = 2.31

4.9.2. Ratoon crop

4.9.2.1. Disease incidence

Results indicated that the effect of fertilizer levels differed significantly and the fertilizer dose N:P:K @ 200:50:62.5 kg/ha showed the least disease index and was superior to all other fertilizer levels. With regard to fungicides, no significant difference could be obtained between them, but the combination effect of fungicides along with fertilizers showed significant differences in disease index. The maximum reduction in disease index was noticed in presence of the fungicide copper oxychloride (Fytolan) at 0.3% concentration, where the fertilizer dose of N:P:K received @ 200:50:62.5 kg/ha and this was followed with the fertilizer level N:P:K @ 250:50:50 kg per ha in presence of same fungicide. The same fertilizer level could show a significant reduction in disease index along with the fungicide Captafol (Foltaf) @ 0.3% concentration. In the case of Bordeaux mixture, the combination of N:P:K dose @ 150:50:50 kg per ha was the most superior combination which was followed by the fertilizer dose of N:P:K @ 200:50:50 kg per ha with respect to disease index. Another notable observation was that in the fertilizer combination where the potash was higher, the disease could be minimised to significant level even without the application of any fungicide (Table 16).

Table 16. Influence of manures and fungicides in the management of leaf blight disease of hybrid napier grass (Ratoon crop)

Fertilizers			Fungicides					
N	P	K	No fungicide	Bordeaux mixture (1%)	Captafol (0.3%)	Mancozeb (0.3%)	Copper oxychloride (0.3%)	Mean
kg/ha								
200	50	50	3.90	2.38	4.94	1.43	4.09	3.34
250	50	50	2.38	4.94	1.62	3.99	2.47	3.08
150	50	50	4.81	1.71	3.80	2.45	4.75	3.51
200	50	62.5	1.52	3.80	2.28	4.94	1.33	2.77
Mean			3.16	3.21	3.16	3.20	3.16	

CD (0.05) for combinations = 0.409
CD (0.05) for comparison of manures = 0.183
CD (0.05) for comparison of fungicides = 0.204

4.9.2.2. Influence of manures and fungicides in the fodder yield of hybrid napier grass (Ratoon crop)

Among fertilizer levels N:P:K @ 250:50:50 gave maximum fodder yield in the ratoon crop and this was superior to all other fertilizer levels. Among the fungicides Captafol (Foltaf) treated plots yielded the maximum fodder and this was followed by copper oxychloride and these two fungicides were found equally effective with respect to fodder yield.

With regard to the combined effect of fertilizers and fungicides, as in the case of main crop, Captafol treated plots recorded the maximum yield and again this trend of response was almost equal for all the fertilizer levels tried. Similarly, the treatment combinations viz., copper oxychloride in presence of the fertilizer level N:P:K @ 200:50:50 and 200:50:62.5 kg per ha were also equally effective (Table 17).

Table 17. Influence of manures and fungicides in the fodder yield of hybrid napier grass (Ratoon crop)

Fertilizers		Fungicides					
N P K kg/ha		No fungicide F_0	Bordeaux mixture F_1	Captafol (0.3%) F_2	Mancozeb (0.3%) F_3	Copper oxychloride (0.3%) F_4	Mean
200:50:50	M_1	15.00	10.61	15.33	12.33	8.00	12.27
250:50:50	M_2	9.00	12.67	22.00	8.33	19.00	14.20
150:50:50	M_3	11.00	11.67	16.33	13.00	12.33	12.87
200:50:62.5	M_4	9.00	10.00	13.33	11.67	17.33	12.27
Mean		11.00	11.25	16.75	11.33	14.17	

CD (0.05) for M x F = 7.89
CD (0.05) for M levels = 3.53
CD (0.05) for F levels = 3.94

4.9.3. Evaluation of fungicides against blight disease

Evaluation of various fungicides against the blight disease caused by Helminthosporium gramineum in a standing crop of hybrid napier grass at Sewage Farm, Valiyathura.

Among the four fungicides tested, Dithane M-45 0.3 per cent could minimise the disease to significant level. Bordeaux mixture 1 per cent spray was also found equally effective as Dithane M-45. Difolatan was found to be inferior (Table 18).

Table 18. Evaluation of fungicides against blight disease

Sl. No.	Treatments		Mean disease index (Average of three replications)
1.	Bordeaux mixture	(1%)	6.180
2.	Dithane M-45	(0.3%)	3.810
3.	Foltaf	(0.3%)	24.205
4.	Fytolan	(0.3%)	12.670
	CD		2.660

DISCUSSION

DISCUSSION

The results of the studies on the diseases of major fodder grasses viz., Hybrid napier, Guinea grass, Turf grass, Para grass, Congosignal grass, Setaria grass and Kikyu grass collected from different localities in Kerala showed the common pathogens to be Helminthosporium spp., Fusarium spp. and Curvularia spp. Besides these, several minor pathogens like Alternaria, Cercospora, Pythium, Sclerotium etc. were also encountered.

The common species of Helminthosporium identified in the present study were H. gramineum, H. sativum and H. cynodontis. The destructive nature of Helminthosporium was reported by Von Post as early as 1920 from Barley. Shands (1934) attributed this to its adaptability to varying temperatures and other atmospheric conditions. The occurrence of Helminthosporium as a pathogen on a wide variety of graminaceous and other forage crops is already reported (Bean, 1965) on Kentucky blue grass, Wadsworth et al. (1968) and Berkenkamp (1971) on cereals and fodder crops, Krupinsky (1984) on rye grass. In the present study also, the blight disease caused by Helminthosporium spp. was present in all the agroclimatic regions on all the fodder crops tried.

The next important pathogen observed in the survey was Fusarium spp. Three species of Fusarium viz.,

F. graminearum, F. nivale and F. culmorum were encountered. Sprague (1939) and Ledingham (1942) recorded F. culmorum on oats while Bean (1969) found that the blight of turf grass was caused by F. roseum f. sp. cereals. Occurrence of F. nivale on Lolium multiforum was also reported (Schmidt, 1982).

Two species of Curvularia viz., C. lunata and C. trifolii were also frequently observed. Matsura (1927) and Boedijen (1933) has recorded C. lunata from Sorghum leaves in India. Similarly Bean (1969) and Davis & Irwinja (1982) reported the occurrence of C. pallescens and C. eragroetides on blue grass and stylosanthes respectively.

In addition to the above certain minor pathogens were also frequently encountered during the survey. This included Alternaria solani on Setaria grass Cercospora sp., Pythium sp. and Sclerotium rolfsii on Cynodon dactylon and Piricularia oryzae and Colletotrichum gloeosporioides on para grass.

1. Leaf blight caused by Helminthosporium sp.

The present study showed that different spp. of Helminthosporium caused more or less similar blight symptoms initially in all the fodder grass hosts, except with differences in colour, size and shape of blighted areas on the

leaves and sheath. In all the fodder grasses studied, the final symptom observed was the blightening of infected area. Blightening due to Helminthosporium has been reported by Mebalds and Kellocka (1983) and Zeiders (1980).

2. Leaf spot caused by Fusarium spp.

In the present study Fusarium spp. caused various types of leaf spot. In the initial stages, symptom appeared as tiny spots. This was followed by drying up of leaves, with yellow patches on sheath. At the final stage, the tillers became pale with discoloured, shrunken & rotten roots. Seedling blight followed by discoloured and blighted leaves, stunting and brown root rot in various grass species have been described by Dickson, 1939; Sprague, 1939 and Smily et al., 1980.

3. Leaf and sheath blotch caused by Curvularia spp.

It was observed that various species of this pathogen

caused different types of spots on leaves and sheath of the fodder grasses at the early stage. Severe blightening of affected plants were also been noticed and stunting of young plants was also a common symptom. Production of various types of symptoms viz., seedling blight, seedling rot and various types of leaf-spots by the pathogen on graminaceous hosts has been reported earlier (Bonar, 1924; Martyn, 1936; Nigam, 1936.)

Among the minor pathogens observed in the present study R. solani was found to cause blightening and wilting in guinea grass. Chauhan and Singh (1981) reported that R. solani caused leaf blight in lemon grass. Hurd and Grisham (1983) observed that Rhizoctonia spp. could produce brown patch symptoms on Saint Augustine grass. Ryker (1939) observed severe blightening of leaves and leaf sheath which bear large, irregular, bleached spots with reddish-brown margin due to infection by R.solani on Bermuda grass. Further, the symptoms produced by the other minor pathogens noticed viz., Pythium spp. or S. rolfsii were also more or less in agreement with the findings of the earlier workers (Shipton, 1979, Kenishi, 1933; and Abe, 1935). In the present study, certain mixed infections were also found on Cynodon dactylon. guinea grass and Napier grass due to more than one species of Curvularia and Fusarium.

Several species of Curvularia were reported to occur on rice grains and incited leaf spots. Blightening of seedlings has also been reported in rice due to mixed infection (Boedijn, 1933; Groves and Skolko, 1945; Padwick, 1950 and Wei, 1957).

Morphology of causal organisms

The comparative morphological characters viz., nature of mycelium, hyphal thickness and conidial ontogeny of various pathogens have studied. The results endorsed the views expressed by earlier workers. The cases were in full agreement with the earlier findings (Boedijn, 1923; Drechsler, 1923; Mourashkinski (1924); Groves and Skolko, 1945; Peterson and Davis, 1965 and Saccardo, 1892).

Pathogenicity of various isolates of the pathogens

The results of the nature of pathogenicity revealed that various species of pathogens could produce the characteristic respective symptoms under artificial inoculation tests. The course of development of the symptoms was more or less similar to the field conditions and the initiation of the symptoms varied from 3 to 5 days of artificial inoculation. The typical symptom development could be observed from 10th to 17th day of inoculation which varied

with the pathogen as well as host species. These results were found to be in agreement with the observations of the earlier findings (Diedicke, 1903; Zeiders, 1980; Lenne, 1982 and Muchovej, 1986).

The studies on the temperature requirement of the isolates revealed that the temperature levels could influence significantly the growth of the isolates. The growth of H. gramineum was maximum at 25°C in Richards medium as well as in Czapek(Dox)medium. At room temperature, the growth in Czepek(Dox)medium was poor, whereas in Richards medium the growth at room temperature was on par with 25°C. This showed that the source of nutrients had maximum influence on the growth of the pathogen under room temperature. In the case of Curvularia trifolii and Fusarium graminearum, the optimum temperature level for both the medium was the same as that for Helminthosporium spp., but an increase or decrease in temperature level recorded a drastic reduction of growth.

Misra and Chatterjee (1963) noted that the optimum temperature of Helminthosporium spp. for growth and sporulation was 30°C. This has also been recorded by Ono and Suzuki, 1960.

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

The growth of H. gramineum on Czapek (Dox) Agar, Richard's agar, and potato dextrose agar were found to be equally good. Thomas (1940) could obtain better growth of Helminthosporium spp. in petri dishes on PDA than in the tube cultures and thin layer of PDA gave better results than thick one.

Very good growth of Fusarium graminearum was obtained on Czapek (Dox) Agar and Richards' agar followed by Coon's agar, potato dextrose agar, Richards' agar and Czapek (Dox) Agar have been reported to be very good for the growth of Fusarium oxysporum f. niveum (Jhamaria, 1972), Singh and Singh (1975) reported very good growth of F. moniliforme on Czapek Dox agar medium. Gopinath et al. (1984) reported potato dextrose agar to be a good medium for the growth of F. moniliforme.

In the case of Curvularia lunata, Czapek (Dox) agar, oat meal agar and Richard's agar were found to be equally good for the growth of Curvularia trifolii. Chand and Varma (1968) obtained good growth of Curvularia trifolii on potato dextrose agar, oat meal agar, Czapek (Dox) agar and Richard's agar. Singh (1971) reported very good growth of C. trifolii on oat meal agar.

H. gramineum and F. graminearum were able to produce typical lesions in paddy, sorghum, maize, congosignal, para grass, subabul and coconut. Association of various Helminthosporium spp. on leaves and root diseases of maize, sorghum and so many other graminaceous hosts has already been reviewed by various workers on different host plants. Paddwick and Henry (1933) on grass of U.S.A., Nattrass (1939) and Ricci et al. (1981) on Cynodon dactylon in Keniya, Bean, (1965) and Welling (1978) on Poa pratensis; Krupinsky (1984) on rye grass. In the present, study also the pathogen could not infect tapioca, eupatorium, clerodendron, papaya and jack. Curvularia trifolii successfully infected paddy, congosignal, paragrass and tender coconut leaves.

The occurrence of Fusarium spp. on different hosts had been reported by various workers. Sprague (1939), and Bean (1969) reported F. culmorum on oats and turf grass respectively. Boothroyd (1960) reported the pathogenic nature of F. graminearum on various graminaceous hosts and cereals. Anon (1982) isolated F. nivale from rye grass. Turner et al. (1983) found Fusarium solani and F. roseum from Lucerne. Matsura (1927) and Boedijin (1933) reported Curvularia lunata from sorghum leaves. Curvularia pallescens on blue grass, and Rauwolfia serpentina was reported by Bean (1964) and Varadarajan (1966).

Varadarajan (1966). Spore germination of H. gramineum was completely inhibited by Bordeaux mixture, Dithane M-45 and Foltaf even at 50 ppm. Of the six fungicides tested, Fytolan was the least effective causing 82.30 and 78.80 per cent inhibition respectively at 6 and 24 hours after incubation even at the highest concentration tested.

Maximum inhibition of growth of the fungus was recorded by Bordeaux mixture 1 and 1.5 per cent respectively. The effect of Bordeaux mixture was on par with Dithane M-45. 0.4 per cent and Foltaf 0.4 per cent concentration.

The effect of copper sulphate on growth and conidial germination of various Helminthosporium spp. of graminaceous hosts has already been pointed out by Akai et al. (1954). Complete inhibition of spore germination of Curvularia trifoli was obtained with even at 50 ppm concentration of Bordeaux mixture and Foltaf 200 ppm Dithane M-45. Fytolan was the least effective fungicide.

Growth of the fungus on solid media was significantly inhibited by Bordeaux mixture 1.5 per cent concentration and Foltaf 0.4 per cent. Fytolan was not very effective. The effect of Foltaf in inhibiting the growth of Curvularia trifoli f. sp eladioli was reported by Zamoraki and Bielska (1983). The effect of Foltaf and Dithane M-45 at varying concentrations in inhibiting the growth of Curvularia spp has been

reported. Conidial germination of Fusarium graminearum was completely inhibited by 50 ppm, 100 ppm and 200 ppm each of Bordeaux mixture, Dithane M-45, and Foltaf. Fytolan was the least effective among the fungicides tested. The effect of various fungicides in inhibiting the growth of Fusarium spp. has been reported by Quadri et al. (1982) and Sharma and Jain (1984).

The observations made in the present study revealed that the fungicides like Bordeaux mixture and Captafol at various concentrations are effective against Fusarium spp. and Curvularia spp. for inhibiting the growth under laboratory conditions.

Management of the blight of hybrid napier caused by H. gramineum was studied in field using four common fungicides. In the main crop season, it was observed that various fertiliser levels and their interaction effect with fungicides were found statistically significant with respect to the disease index. The fertiliser dose of N P K @ 150:50:50 kg/ha recorded the maximum effect on disease control and this was

equally effective to the dose of N P K @ 200:50:62.5 kg/ha.

A higher dose of nitrogen and lower dose of potash were found to enhance the disease. In the case of interaction effect, it was noticed that a lower dose of nitrogen combined with the application of Bordeaux mixture 1 per cent concentration recorded the least disease index.

In the ratoon crop also, the effect of fertilizer doses was found significant with respect to the disease. A slight enhancement in the potash dose (N, P, K 200:50:62.5 kg/ha) recorded the maximum disease control. In ratoon crop also, the trend of the interaction effect was same as that of the main crop. A higher dose of nitrogen along with the fungicide copper oxychloride showed maximum disease control. This trend was noticed with the fungicide Captafol also. But in the case of Bordeaux mixture, the lower doses of fertilizer levels gave maximum interaction effect.

Influence of manures and fungicides in the fodder yield of hybrid napier grass was also observed. In the main crop, it was noticed that a higher dose of nitrogen ie. NPK @ 200:50:50 kg/ha yielded maximum fodder. The interaction effect of fertilizers and fungicides was found to be significant. The fungicide-fertilizer combinations of Captafol 0.3 per cent and NPK 200:50:62.5 kg/ha yielded maximum fodder

yield. The important observation in this case also indicated that wherever higher dose of potash was given along with fungicides, the fodder yield was also enhanced. The same trend of the fertilizer and fungicidal management could be observed in the ratoon crop also with respect to fodder yield.

In an experiment, the fungicides alone were tested in the control of the blight disease of hybrid napier grass in a standing crop at Valiyathura. The results revealed that the fungicidal application could influence the disease. Among the four fungicides tested, Mancozeb at 0.3 per cent concentration showed maximum disease control followed by Bordeaux mixture 1 per cent concentration.

Richm (1920) observed that seed treatment with copper sulphate 1 per cent or 0.5 per cent solution for 30 minutes was effective in controlling the Helminthosporium disease in graminaceous crops.

Lee and Martin, 1928 Martin, 1933 has pointed out that application of higher nitrogen favoured the disease intensity of certain foliage diseases of graminaceous crops caused by Helminthosporium in Hawai.

Reeleder (1982) stated that disease severity of grasses was closely related to soil nutrient conditions.

Skirde (1978) found that leaf damage and disease severity by Fusarium spp. in turf grass was favoured by heavy nitrogen application. In another instance, Dernoeden (1987) observed that fertilization with Urea and Ammonium sulphate reduced disease severity of take-all patch disease in creeping bent grass.

WoolHose (1986) observed in perennial rye grass that the susceptability to red-thread disease was favoured when the level of nitrogen application was drastically reduced. Similar observations on the effect of varying fertilizer applications on the incidence and intensity of foliage diseases have been discussed by Chattopadhyay and Dickson (1960), Tanaka and Akai (1963), Horino and Akai (1966).

The influence of higher levels of potash and its interaction effect with various fungicides on foliage fungal diseases of rice and similar other graminaceous crops were discussed (Anon., 1982).

Goss and Gould (1969) reported the inter relationship between fertility level and disease incidence by Fusarium nivale in turf grass.

Skirde (1978) observed severe incidence of Fusarium spp. in Lolium spp. and Bermuda grass. Cheesman et al., 1965

reported that with increased application of nitrogen, the number of lesions per leaf blade and size of the lesions caused by H. sativum were increased.

Dhalsson (1975) and Mariappan and Viswanathan (1986) found that infection by R. solani is favoured by the application of higher levels of N. A similar trend is observed in the present study also.

Balakrishnan and Nair (1985) reported that application of slow release nitrogen by utilising neem coated urea and an enhanced rate of potash application were found to have pronounced effect in reducing the severity of sheath blight and sheath rot of rice.

The observations made in the present study also showed that in the main crop as well as in ratoon crop, various levels of N & K considerably influenced Helminthosporium blight of hybrid napier. The observations indicated that a medium dose of N and a higher dose of potash always helped to minimise the disease severity as well as an increased fodder yield.

The present observations revealed that foliar application of Bordeaux mixture 1% and Mancozeb 0.3% was effective in the management of Helminthosporium blight in napier grass.

The effect of Mancozeb, Captafol and Copper oxychloride preparations and various other contact as well as systemic fungicides on foliage diseases of different fodder grasses

has already been reported by earlier workers (Harper, 1964; Bean (1965), Gangopadhyay and Kapoor, 1978; Tandon et al., 1976. Hagan and Larsen (1979) maneb for Drechslera sorokiniana, Pawar and Patil (1980), Dithane M-45 against H. rostratum.

With regard to the fodder yield in the main crop as well as ratoon crop, the fertilizer-fungicide treatment combination gave better yield. In both the cases, Captafol involved fertilizer treatment responded more, whereas in the case of fertilizer levels in the main crop, a lower N level along with fungicide responded more with respect to yield. At the same time in the ratoon crop, a higher level of N was needed for better yield. This may be due to the fast removal of the nitrogen from the soil by the main crop.

SUMMARY

SUMMARY

An investigation was carried out at the College of Agriculture, Vellayani, Trivandrum, Kerala to assess the different diseases which influence the production of different grasses cultivated in Kerala. The various fungi isolated from different forage grasses include Alternaria solani, Cercospora sp., Colletotrichum gloeosporioides, Curvularia lunata, C. trifolii, Fusarium culmorum, F. graminearum, F. nivale, Helminthosporium gramineum, H. cynodontis, H. sativum, Sclerosporium rolfsii and Rhizoctonia solani. Among the pathogens, the most prominent were H. gramineum, F. graminearum and Curvularia trifolii. The morphology, symptomatology, and epidemiology of these three pathogens were investigated in detail.

The effect of different solid media on the growth of the pathogens revealed that Czapek (Dox) agar was found to be the best [illegible] for the growth of H. gramineum, and F. graminearum followed by Richards agar and potato dextrose agar media. For the growth of Curvularia trifolii Czapek (Dox) agar, oat meal agar and Richards agar were found to be equally effective.

A laboratory study indicated that a temperature of 25±2°C was ideal for all the pathogens under study.

A host range study conducted has shown that all the graminaceous hosts were susceptible to H. gramineum and F. graminearum, while C. trifolii infected paddy, congosignal grass and para grass only, among the graminaceous hosts. Susceptibility to non-graminaceous host indicated that H. gramineum and F. graminearum could not infect any of them. But, none of the pathogens could infect Eupatorium, Clerodendron, Papaya and Jack.

In vitro evaluation of fungicides revealed that Bordeaux mixture 1 per cent was found to be superior in inhibiting the growth of H. gramineum and F. graminearum and C. trifolii.

From the field experiment, it was observed that the blight disease of hybrid Napier was minimum in treatment combination of Captafol 0.3 per cent along with a fertiliser dose of NPK at the rate of 200:50:62.5 kg/ha. In general, a higher dose of potash favoured disease management.

A fungicidal trial carried out revealed that Dithane M-45 0.3 per cent and Bordeaux mixture (B.M) 1 per cent were effective in controlling the blight disease of hybrid napier.

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* Originals not seen

APPENDICES

APPENDIX I

COMPOSITION OF CULTURE MEDIA

Coon's agar

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

Czapek (Dox) agar

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

Oatmeal agar

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

Potato dextrose agar

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

Richards' agar

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

Sabouraud's agar

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

STUDIES ON FUNGAL DISEASES OF FORAGE GRASSES

By
R. K. SASIDHARAN

ABSTRACT OF THESIS
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ABSTRACT

A study of different fungal diseases of various forage grasses cultivated in Kerala showed that H. gramineum, F. graminearum and C. trifolii are prominent pathogens.

Best growth of H. gramineum and F. graminearum were in Czapek (Dox) agar, while Curvularia trifolii grew best in Richards medium.

All the pathogens were favoured by a temperature of 25°C.

All the graminaceous hosts studied were susceptible to H. gramineum and F. graminearum. However, Curvularia trifolii infected paddy, congosignal and para grass, among the graminaceous hosts.

Susceptibility to non-graminaceous hosts indicated that none of the pathogens could infect eupatorium, clerodendron, Papaya and Jack.

In vitro evaluation of fungicides revealed that Bordeaux mixture 1 per cent and 1·5 per cent were found to be superior in inhibiting the growth of H. gramineum, F. graminearum, and C. trifolii.

A field trial carried out has shown that blight disease caused by H. gramineum in hybrid napier was least

in treatment combination of Dithane M-45 0.3 per cent, with NPK @ 200:50:62.5 kg/ha.

In general, higher dose of potash favoured disease management. A fungicidal trial carried out revealed that Dithane M-45 0.3 per cent and Bordeaux mixture 1 per cent were effective in controlling blight disease of hybrid napier.