STUDIES ON THE EFFECT OF STRIPE DISEASE OF BARLEY *[DRECHSLERA GRAMINEA* (RABENH.) SHOEMAKER] ON SEED QUALITY AND ITS MANAGEMENT

By

JITENDER KUMAR
(99A59D)

Dissertation submitted to the Chaudhary Charan Singh Haryana Agricultural University in partial fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

PLANT PATHOLOGY

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DEDICATED
TO
MY PARENTS

CERTIFICATE – I

This is to certify that this dissertation entitled, "**Studies on the effect of stripe disease of barley [*Drechslera graminea* (Rabenh.) Shoemaker] on seed quality and its management**", submitted for the degree of **Doctor of Philosophy**, in the subject of **Plant Pathology** of the Chaudhary Charan Singh Haryana Agricultural University, Hisar is a bonafide research work carried out by **Jitender Kumar** under my supervision and that no part of this dissertation has been submitted for any other degree.

The assistance and help received during the course of investigation has been fully acknowledged.

[L.S. SUHAG]
MAJOR ADVISOR
Director of Extension Education
CCS Haryana Agricultural University
Hisar-125 004, INDIA

CERTIFICATE – II

This is to certify that this dissertation entitled, "**Studies on the effect of stripe disease of barley [*Drechslera graminea* (Rabenh.) Shoemaker] on seed quality and its management**", submitted by **Jitender Kumar,** to the Chaudhary Charan Singh Haryana Agricultural University, Hisar, in partial fulfilment of the requirements for the degree of **Doctor of Philosophy**, in the subject of **Plant Pathology**, has been approved by the Student's Advisory Committee after an oral examination on the same in collaboration with an External Examiner.

24/12/03
MAJOR ADVISOR

24.12.03
EXTERNAL EXAMINER

27.12.03
HEAD OF THE DEPARTMENT

30/12
DEAN, POSTGRADUATE STUDIES

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[JITENDER KUMAR]

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CHAPTER - 1

INTRODUCTION

Barley (*Hordeum vulgare* L.) belongs to family Gramineae and is very important crop of temperate regions. It is one of the important rabi cereals grown for feed and fodder. This crop is also important for its good quality malt which in turn is used in various industries dealing with production of beer, whisky, food supplements/baby foods, etc.

In Haryana, barley is grown in an area of about 34.7 thousand hectares with an annual production of 102 thonsand tonnes, with an average productivity of 2889 kg/ha (Anonymous 2001-2002). The barley growing states in India are Madhya Pradesh, Bihar, Rajasthan, Uttar Pradesh, Punjab, Haryana and Himachal Pradesh. Average yield of crop in India is lower than several other countries mainly due to poor crop management and heavy biotic stress. Insects, diseases and nematodes attack the crop and affect the quality as well as qnantity of the produce. Among the fungal diseases, stripe disease [*Drechslera graminea* (Rabenh) Sheomaker] is an important seed borne disease which may cause crop loss to the tune of 70-72 per cent under epiphytotic conditions (Pant and Bisht, 1983). It also affects the quality of foliage as well as grains. The problem of stripe disease has become a serious limiting factor with the extensive cultivation of high yielding barley varieties.

The causal organism of the stripe disease of barley is *Drechslera graminea* (Rabenh) Sheomaker which was previously named as *Helminthosporium gramineum* Rabenh. The fungus belongs to class *Deuteromycetes* whereas the perfect stage is [*Pyrenophora graminea* (Ito and Kuribay)] belong to class Ascomycetes. The disease is seed borne in nature and pathogen survives exclusively as mycelium on pericarp or hull. On newly developed leaves the symptoms of the disease appear in the form of yellow stripes, on the leaf sheath and basal portion of the leaf blade. These stripes gradually extend to the full length of leaf and become necrotic. The fungus sporulates extensively on such infected leaves. In such plants spikes either failed to emerge or they emerge blighted, twisted and shrivelled. Grains in such spikes are undeveloped and shrivelled. The variation in symptoms depends upon the pathogen virulence, host susceptibility, amount of inoculum and environmental factors.

Diseased plants arise only from infected seeds and they become systemically infected, senesce early and produce a poor yield of shrivelled seed. There is no spread of infection between plants during the growing season. The fungus produces masses of conidia (*anamorph* of *Drechslera graminea*) on leaves of diseased plants. These conidia are carried by the wind to developing seed on the ears of healthy plants within the crop and in neighbouring crops. Developing barley seed is susceptible to infection from anthesis to soft dough stage (Teviotdale and Hall, 1976). Since some of the spores germinate and infect the developing seed, there is potential for infection to multiply significantly from one season to the next season.

The pathogen has been reported as an obligate parasite, and practically no authentic records have been produced yet that conidia are produced on artificial media. But on the other hand, it has been reported that this pathogen successfully sporulates on the lesions on the foliage and glumes under natural conditions.

In Haryana, the disease was first time reported in 1974 by Tyagi on variety C-138 and later on in 1976 by Harichand on many commonly grown varieties. After that, not much published account of disease is available in the Haryana state. Little is known about the prevalence and severity of disease. Similarly adequate data are not available on resistant genotypes and biochemical basis of disease resistance in host parasite combination. Sporadic information is available on effect of disease on quality of seeds.

Keeping in view the importance of disease and gaps in our knowledge, the present investigation has been taken up with the following specific objectives.

1. Evaluation of barley germplasm against stripe disease (*Drechslera graminea*) under field conditions.
2. Comparison of seed health testing methods and to determine the quantitative and qualitative losses iu grain yield.
3. To study the role of seed leachates in determining resistance and susceptibility of varieties.
4. Management of disease by cultural and chemical means.

CHAPTER - 2

REVIEW OF LITERATURE

Stripe disease of barley caused by *Dsechslera graminea* (Rabenh) Shoemaker is posing a threat to barley cultivation in the recent years. It has assumed significant importance with the introduction of some of the new high yielding varieties.

In India, the disease was first time reported by Butler (1918). Since then considerable work has been carried out on various aspects of this disease in different countries (Grachev, 1964; Kline, 1972; Gorden *et al.*, 1985; El. Ghamry *et al.*, 1991; Vivek *et al.*, 1999a). However, information is very less in India on key aspects of the disease.

2.1 EVALUATION OF BARLEY GERMPLASM AGAINST STRIPE DISEASE UNDER FIELD CONDITIONS

Use of resistant varieties has always been important measure to counteract the attack of pathogen due to its long lasting nature. Varietal resistance to stripe disease has been studied by several workers (Mehta *et al.*, 1953; Grachev, 1964; Singh and Atheya, 1970; Bisht and Mittal, 1991; Vivek *et al.*, 1999a). A number of varieties were screened by Mehta *et al.* (1953). They found that varieties C 292, 42/72 and K 12 were highly resistant; C 84, C 235, NP 13, C 50 and K 2 moderately resistant while, C 251 and NP 21 proved to be susceptible. In Argentina, Grachev (1964) reported K 499, K 4997, K 5006 and K 529 to be highly resistant to stripe disease of barley. Singh and Atheya (1970) tested 62 barley varieties and strains of barley against the disease and observed that varieties EB 438, EB 873, EB 928, K 12, K 24 and selection 64/24 were highly resistant. Singh (1971) studied reaction of 20 high yielding barley varieties under field conditions against a mixture of 13 parasitic races of *Helminthosporium gramineum*. Eight varieties viz., K 41, K 24, KN 30, K 572-22-64/29, K 40, K 69, K 572-17-64-24 and K 572-28/35 showed resistant type of reaction, while three others namely C 50, K 19 and K 572-6-64/6 were highly resistant with only traces of infection. The remaining nine varieties were susceptible to this pathogen. Mohammad and Mahmood (1974) tested 73 Indian and American varieties against isolates of *Helminthosporium gramineum* and found that most of the varieties were moderately to highly susceptible, however varieties Trebi, K 572/13, K 572/23, K 572-3-64/10 and NP 104 were immune to the disease. Negligible infection was observed in varieties Velvet, K 12, K 18 and R 56. Atheya (1974) screened 46 varieties and strains of barley and reported that varieties K 24, K 125, K 129, K 133, K 441-7, K 436-7, K 464/11, K 572/119, K 427-13 were highly resistant where as C K 78, K 99, K 127, K 139, K 140, K 142, K 143, K 144, K 148, K 15-96/1, K 19-98/2 and K 145 were resistant to moderately resistant and rest showed susceptible type of reaction. In Canada, Tekauz (1983) inoculated 57 barley varieties with *D. graminea* to test their relative resistance or susceptibility to the pathogen and found that varieties Betzes, Diamond, Elerose, Argus, Stepoe and Polliser were resistant; Abee, Birka, Bonanza, Herta, Klages, Lager, Otal, Perth, Sophis and BT 506 were intermediate in reaction and rest were susceptible. Cserhati (1984) in Hungry screened 13 local varieties against the barley stripe and reported that none was found resistant but the least susceptible varieties were Marton, Vasari 50, Mars, Favorite and Opal. Out of more than 1000 barley accessions grown under green house in 1983 and 1984 screened against *D.* graminea. Skou and Haahr (1985) found that 22.3 per cent classed as resistant (0-5% attack) and 19.8 per cent as partially resistant (6-10% attack). Behar and Aulakh (1988) screened 40 barley varieties against 6 different isolates of *D. graminea* by artificial inoculation method under green house conditions and reported that none was found immune. However varieties like PL 238, PL 1, PL 9, PL 156, PL 162, PL163, PL164, PL236, PL238, PL273 and cv. RL were significantly less susceptible than the remaining 30 cultivars. Out of 19 different varieties investigated , Singh and Srivastava (1986) reported that K12, K226, K 341, and Azad were highly resistant and K 50, K 71, K 141 and K 318 resistant, while K 311 and Jagrati were highly susceptible. Bisht and Mittal (1991) evaluated indigenous barley germplasm maintained at NBPGR, IARI, New Delhi and found that out of 1500 lines ,100 were quite promising and had resistance against the pathogen. Out of 120 genotypes evaluated by El-Sayed *et* al. (1991) for resistance to *Drechslera graminea* at adult stage, 18 were found resistant. Mathur and Bhatnagar (1992) found that four two-rowed (EB 7055, HQ 01165, Japani and Nigrate) and three six-rowed (Lion, Marocaine 079 C18334 and Volla) barley lines were categorized as highly resistant and eight lines were resistant. Remaining, 13 lines were moderately resistant, 22 moderately susceptible, 47 susceptible and 220 were highly susceptible. In indigenous lines, BHS and HBL series had showed some resistance against the disease. El-Sayed *et* al. (1995) found that out of 200 barley cultivars 125 showed considerable resistance to *D. graminea* both at seedling and adult stages of the crop in the pot experiments. Studies were made during 1990-95 by Winter *et* al. (1995) on the susceptibility of 4 winter barley cultivars to *Drechslera graminea* (*Pyrenophora graminea*) and found that Conversely, Narcis were found most resistant to *P. graminea*, while Manitou was the most susceptible. Vivek *et al.* (1999a) screened 128 varieties/lines against *D. graminea*, 53 of them were found highly resistant, 11 resistant, 6 moderately resistant, 11 moderately susceptible, 6 susceptible and rest were highly susceptible.

2.2 COMPARISON OF SEED HEALTH TESTING METHODS AND TO DETERMINE THE QUANTITATIVE AND QUALITATIVE LOSSES IN GRAIN YIELD

2.2.1 Comparison of Seed Health Testing Methods

So far, no specific method has been applied for seed health test against this disease. Whereas, Brodal (1997) studied the detection of *Drechslera* spp. in barley seeds was assessed based on tests carried out by 13 laboratories using the osmotic blotter, freezer blotter and agar plate methods. The osmotic blotter method gave reproduciable results for *Drechslera* spp. in barley seeds when used by experienced laboratories and was more sensitive than the freezing blotter or agar plate method. It is concluded that the osmatic blotter technique would be ideal for routine, low-cost barley seed testing against infection by *Drechslera* spp.

2.2.2 Rate of Seed Transmission

Capoelli and Torre (1988) reported that weather conditions, especially low temperature after sowing, were favourable for *D. graminea* to penetrate embryo during seed germination. The transmission rate of infection from seeds to tillers reached 60.9 per cent. But when temperature was higher after sowing, the percentage transmission was reduced to 35.5 per cent. It was concluded that sowing winter barley at temperature <12°C may cause severe yield losses when seeds are infected by *D. graminea*.

2.2.3 Determination of the Quantitative and Qualitative Losses in Grain Yield

Many workers have tried to assess quantitative as well as qualitative losses caused by this disease in barley. Singh and Mathur (1953) and Mehta *et al.* (1953) assessed 20-30 per cent reduction in the yield in the affected varieties. Mathur *et al.* (1964) found that affected plants produced 54 per cent less tillers, 27.5 per cent fewer grains with 14.2 per cent disease incidence. Pant and Bisht (1983) reported that disease reduced the barley yield by 70 to 72 per cent under epiphytotic conditions. Similarly economic loss of 4.6 per cent with 4.41 per cent disease intensity was reported by Singh and Siddiqui (1986). Behar and Aulakh (1988) reported 15.2 per cent and 18.47 per cent disease incidence with 13 per cent and 16.5 per cent yield losses during 1982-83 and 1983-84, respectively.

Babadoost and Torby (1991) from East Azerbaijan reported reduction of 36 per cent in tiller production, 37 per cent in spike length and 79 per cent on 1000 grain weight basis. Sudheer and Jain (1996) observed that *D. specifera* [*Cochliobolus spicifer*] caused pre- and post-emergence mortality, leaf streak, leaf blotch and leaf spot symptoms on seedlings. Vivek *et al.* (1998) found that diseased plant of susceptible variety C 138 produced 45.5 per cent less ears , 47.6 per cent fewer grains with 3.7 per cent disease incidence thus causing yield losses of 105.7 kg/ha. The diseased plants of variety BG 25 produced 35.3 per cent less ears, 51.0 per cent fewer grains with 5.4 per cent disease incidence thus resulting in a loss of 189.2 kg/ha . The per cent economic loss calculated for these two varieties was found to be 3.9 per cent and 5.7 per cent, respectively. The economic loss due to stripe disease in these two varieties was more or less similar in comparison to disease incidence. Disease incidence on plant basis was higher than that on tiller basis . Grain weight in diseased plants of varieties C138 and BG25 was reduced by 92.4 per cent and 86.11 per cent, respectively. Seed germination decreased by 16.3 per cent and 6.9 per cent, respectively, in these varieties in comparison to controlled plots.

Pillai and Rao (1990) suggested that high germination and superior vigour of the seedlings showed positive correlation with their resistance to stripe disease and rate of electrolyte leakage during pathogencity was directly related to susceptibility of a variety.

2.3 EFFECT OF SEED LEACHATES ON DISEASE RESISTANCE

Gulati and Mathur (1983) found that seed leachates of barley collected 10, 20, 30 and 40 days after sowing inhibited conidial germination of *D. (Pyrenophora) graminea*. Qualitative analysis of the leachates revealed 15 amino acids, 13 sugars, 7 organic acids and 7 phenols. Seed leachates from all the varieties stimulated the fungal growth. However, stimulation of growth in resistant varieties BG 1 and BG 105 was less than susceptible varieties BG 25 and C 138 . Resistant varieties had higher amount of phenols and sugars than susceptible varieties. Less stimulation of fungal growth by seed leachates of resistant varieties and higher amount of phenols and sugars present in them indicated that there was a positive correlation between phenols and sugars contents and disease resistance (Vivek *et al.*, 1999b).

2.4. CULTURAL AND CHEMICAL MANAGEMENT OF THE DISEASE

2.4.1 Cultural Management

Various cultural practices for the management of diseases have been reported by various workers. Mathur and Bhatnagar (1993) observed maximum disease incidence at the level of 20 kg N and 10 kg P and minimum disease incidence was in 80 kg N and 40 kg P, which was at par with N_{60} and P_{30} . In sowing date studies, early sowing checked the disease. Minimum disease incidence was recorded in 10th October, sown crop and it increased significantly with each succeeding date of sowing. It was concluded that the early sowing together with application of recommended dose of fertilizers (N_{80} and P_{40} for irrigated) helps in minimizing the disease.

The role of minor elements in controlling the disease has been studied by different workers. Grebenchuk (1962) made an attempt to check the disease with minor elements and found that moistening the seeds with sulphates of Mn and Co before sowing could control the disease significantly. Encouraged by these findings Kratsova (1969) tried different minor elements against the disease and reported that application of copper sulphate with fertilizer was helpful in checking the disease significantly. Mathur and Bhatnagar (1990) found that zinc and boron were the most effective in reducing the disease incidence, followed by iron and copper. Remaining mineral elements, hormone 2,4-D and urea were less effective and were at par in their efficacy.

Mathur and Bhatnagar (1991) reported that calcium and iron salt were helpful in controlling the disease. Pillai (1989) reported that smoke treatment controlling the disease upto some extent, whereas, hot water treatment and solar heat treatments were ineffective in controlling the disease.

2.4.2 Chemical Control

Lot of work has been carried out worldwide on the chemical control of stripe disease of barley. Porter (1957) tested a number of fungicides as seed treatment against the disease and reported that Cersan M, Panogen, Merculene, Emmi aud Merlane check the disease effectively, reducing the total number of diseased plants from 827 (untreated) to 52 or less .

Grewal and Vir (1958) made an attempt to control the disease chemically and found that seed treatment with Agrosan G.N., Agrosan SW and Fusariol controlled the disease significantly. Later on Chohan *et* *al.* (1966) studied relative efficacy of some fungicides for the control of stripe disease. Their results were in accordance with those reported by Grewal and Vir (1958). Kline and Roane (1972) treated the infected barley seed with several non- mercurial fungicides to check their relative efficacy against the *D. graminea* and they found that combination of Carboxin + Thiram and Captan + DCNA were most effective in controlling the disease. A mixture of carboxin and thiram as seed treatment was also found to control the disease successfully (Efremova, 1975). Harichand (1976) reported that disease can be controlled under green house as well as field conditions by seed treatment with Cerasan or Sclex. Hall *et al.* (1978) tried a number of chemicals and observed that there was considerable reduction in disease incidence when infected seeds were treated with Mancozeb and Carboxin, respectively . Evaluation of 8 different fungicides against *H. gramineum* by Navusch-Chanov (1978) revealed that best control of the disease was obtained with FL 129 (containing carboxin) and Vitavax 200. Golovnya *et al.* (1980) tried a number of chemicals against the disease and reported good control of disease with Thiram. Vanhanen (1981) reported that grain yields of barley were increased by 45 per cent when treated against leaf stripe (*Drechslera graminea*), the best compound being 200 ml Panoctine Universal ((guazatine + imazalil + fenfuram)/100 kg seed, and the best compound being 200 g Baitain F-powder (triadimenol + fuberidazole)/100 kg seed. Kovacs (1982) observed that chlormequat alone did not reduce *P. graminea* incidence but all the fungicides, except Thiram + Carboxin, showed increased activity when mixed with chlormequat as shown by a reduction in number of plants infected or in number of empty ears. Mixed chlormequat and fungicide seed treatment showed promise for leaf stripe control and lodging reduction. Singh and Rai (1982) found that Cupramar, Dithane M-45 (mancozeb), Dithane Z-78 (zineb) and Zincop suppressed the growth of *A. brassicae* and *D. (Pyrenophara) graminea,* inhibition being maximum with zineb. Mycostatin and griseofulvin reduced radial growth, griseofulvin being less effective. Growth inhibition by urea was significant at higher concentration. Gorden *et al.* (1985) found that imazalil, CGA 64251 and iprodione gave the best results without any phytotoxicity. Maric *et al.* (1985) reported that in field trials against *D. (Pyrenophora) graminea,* iprodione + carbendazim gave the best results. Seed treatment with imazalil based fungicides also provided good control. Singh (1986) found Dithane Z-78 very effective in controlling the disease followed by Dithane M-45. The results of *in vitro* tests were confirmed by Singh (1986) in field trials when the best control of *A. brassicae* on mustard cv YS-42 and *D. (Pyrenophora) graminea* on barley cv. Amber was given by Dithane Z-78 (zineb) followed by Dithane M-45 (mancozeb). Applications 3 days before inoculation were more effective than those 3 days after. Eight different chemicals as seed treatment were tested by Singh and Siddiqui (1986) on a susceptible variety DL 70 and reported that best control of the disease was obtained with ceresan dry followed by panoctin plus seed treatment. Mathur and Bhatnagar (1990) tried 10 different seed treatment fungicides against the *D. graminea* and reported that best control of the disease was obtained with mixture of thiram + carboxin or carboxin + mancozeb (2g/ kg). El Ghamry *et al.* (1991) evaluated 8 different systemic fungicides against the *H. germanium* and found that best control of the pathogen was achieved with prulude (prochlaraz + carboxin), Vitavax 20 FF (carboxin+ thiram) and Rexil (tebuconazole) . Vivek (1994) tested 11 different (mercurial and non-mercurial) fungicides against *D. graminea* and observed that among mercurial fungicides Emisan was best in controlling the disease, but it can be replaced by more safe non-mercurial fungitoxicants like Demosan and Rovral which gave more than 95 per cent disease control.

Sharma *et al.* (1996) reported that Vitavax and Emisan were very effective against stripe disease whereas, Derosal was not effective and Thiram showed a considerable control of stripe disease. Behroozin and Assadi (1997) observed that iprodione + carbendzim, imazalil and mancozeb when applied at 250 g /100 kg seeds gave complete control of stripe disease of barley whereas, Benomyl was least effective fungicide when applied at 250 g/100kg seeds. Gilchrist and Christie (1998) studied a low cost alternative, dithiocarbamate based products were used to treat a range of infected cereal seed. In a series of trails between 1992 and 1995, these low cost treatments proved to be effective in controlling the leaf stripe disease in spring barley. This control was similar to that provided by commercial treatments tested alongside. Winter *et al.* (1998) reported that average efficacy of warm water (45°C for 2 hours), hot water (52°C for 10 minutes) and chemical seed treatment [Vitavax fluid (45% carboxin) at 4 ml/kg seeds, Prelude UW (29.5% carboxin + 6.19% prochloraz) at 3 ml/kg seed, Beret Spezial 060 FS (4.7% fenpiclonil + 0.95% imazalil) at 4 ml/kg seed, Panoctine Universal (27% guazatine + 13.5% fenfuram + 3.6% imazalil) at 2 ml/kg seed and Panoctine DL (18.9% guazatinet 2.36% difenoconazole) at 3 ml/kg seed] for control of stripe disease of barley was 80, 90 and 99 per cent, respectively. Madsen and Hvelplund (1998) observed that the efficacy of Rexil RIM 035 ES against *Drechslera graminea* (*Pryrenophora graminea*) is satisfactory.

Varshney and Varshney (2001) found that all extracts (*Azadirachta indica*, *Lantana camara*, *Pinus roxburghii* and *Tagetes erecta*) were generally inhibitory to sporulation, spore germination and growth of mycelium of the pathogen. In almost all cases, undiluted extracts were the more effective. Results indicate that the diluted neem and marigold extracts may be used effectively for control of this disease.

CHAPTER - 3

MATERIALS AND METHODS

ISOLATION OF PATHOGEN

Leaf bits (1-2 mm long) showing typical symptoms of stripe disease were sterilized in mercuric chloride (0.1%) solution for one minute followed by a thorough washing with sterilized distilled water. The bits were then carefully transferred to petriplates containing potato dextrose agar (PDA) medium under aseptic conditions and petriplates were kept in BOD incubator at 25±1°C for 5-6 days. The isolated fungus was observed under microscope and its typical characters were noted down.

PATHOGENICITY TEST

Seeds of a well-known susceptible variety C-138 were taken to carry out pathogenicity test. Pathogenicity was tested by the method given by Mohammad and Mahmood (1974) was followed with a little modification for artificial inoculation of seeds with *D. graminea.* The seeds were disinfected with mercury chloride (0.1%) and washed with sterilized water. The seeds were soaked in sterilized water for 24 h to make them soft. After that seeds were carefully placed at the margin of actively growing five days old culture of isolated fungus for germination. After germination the seeds were carefully transferred to earthen pots containing sterilized soil in green house. A control was kept side by side with uninoculated seeds. Observations on disease development were started from 15 days after sowing. Fungus was reisolated from infected leaves and observed under microscope. Its characters were noted down and compared with the fungus originally used for inoculation of the seeds.

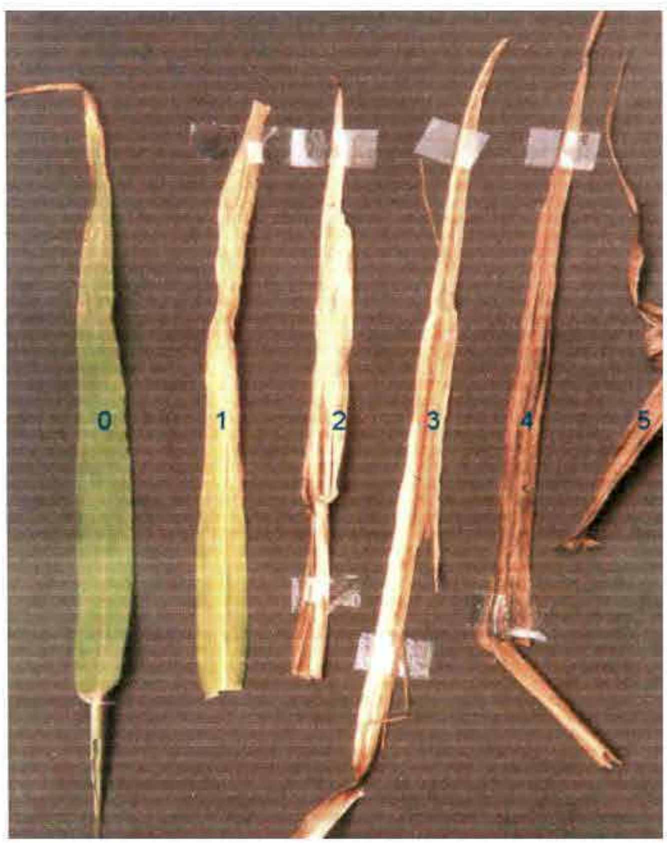
3.1 EVALUATION OF BARLEY GERMPLASM LINES FOR RESISTANCE AGAINST *D. GRAMINEA*

3.1.1 Under Field Conditions

Seeds of 130 barley germplasm were received from Barley Section, Department of Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University, Hisar. These germplasm lines were sown in plot size 1.5 x 3 m having 7 rows in randomized manner and replicated four times during crop season of *rabi* 2000-01. After 10 days of germination, thinning was done to maintain approximately 200 plants in each plot. Observations were taken on 60 plants at three location in each plot at maturity by counting the number of plants infected and number of tillers, were also counted in each plot. Per cent infected plants and tillers were calculated. The barley germplasm lines were classified as:

Per cent diseased plants		Category
No disease	:	Highly resistant (HR)
0-1	:	Resistant (R)
1-5	:	Moderately resistant (MR)
5-10	:	Moderately susceptible (MS)
10-15	:	Susceptible (S)
More than 15 per cent	:	Highly susceptible (HS)

Plat.1. (A) Healthy plant, (B) Plant showing typical symptoms of *Drechslera graminea*



Plat.2. *Drechslera graminea* infected leaves showing typical symptoms of different grades

Suitable indices were formulated to assess disease infection. Disease intensity was determined using method given by Mohammad and Mahmood (1974). Score card used was (Plate 2):

Grade	Symptoms	Severity	Mean value
0	Leaves with no disease	Nil	0
I	Leaves with light brown stripes	1-20	10
II	Leaves with dark brown stripes	21-40	30
III	Leaves with dark brown to black stripes	41-60	50
IV	Leaves beginning to lose normal green colour with rather long stripes	61-90	75
V	Leaves drying with stripes running through the leaf	91-100	95

The infection values were obtained by multiplying the number of leaves in each grade 0, 1, 2, 3, 4 and 5 by the corresponding mean value of each grade 0, 10, 30, 50, 75 and 95, respectively, summing up all the resulting figures and dividing by total number of leaves in all grades. Thus formula followed was:

$$\text{Infection value} = \frac{\left[\begin{array}{l}\text{Number of diseased}\\ \text{leaves in each grade}\end{array}\right] \times \left[\begin{array}{l}\text{Mean values of}\\ \text{each grade}\end{array}\right]}{\text{Total number of leaves in all grades}}$$

On the basis of comparative susceptibility and resistance determined by mean infection values, these germplasm lines were grouped into different categories.

These germplasm lines were also grouped into different categories on the basis of per cent plant showing infection in a variety.

3.1.2 Under Green House Conditions

Seeds of 130 barley germplasm lines were collected from the crop raised in *rabi* 2000-01. The seeds were sown in 22 cm pots having three replications during *rabi* 2001-02. After 10 days of germination, thinning was done to maintain 5 seedlings per pot. Observations were taken at maturity on plant or tiller infected in each pot and per cent infected plants and tillers were calculated. The barley germplasm lines were classified in the same way as under field conditions (Section 3.1.1). Disease intensity was determined using method given by Mohammad and Mahmood (1974). Score card used was same as used under field conditions. The formula for calculating the mean infection value was also same as mentioned under field conditions (Section 3.1.1).

On the basis of comparative susceptibility and resistance determined by mean infection values, these germplasm lines were grouped into different categories as given under field conditions.

These germplasm lines were also grouped into different categories on the basis of per cent plant showing infection in a variety.

3.2 SEED HEALTH TESTING

Seeds were collected from healthy and diseased plants of two variety from each category [BH-75(c) and C-138(c) (HS); DWR-28(c) and K-669 (S); BH-393(c) and BH-510 (MS); RD-2552(c) and RD-2628 (MR); BH-590 andBH-591 (R)] to test their health by using different detection methods.

3.2.1 Blotter Paper Method

Twenty-five seeds from healthy and diseased lots from each category were placed at equal distance on a well water soaked Whatman's blotter paper in 18 cm petriplates in 4 replications and incubated at 20±2°C for 10 days in alternating cycles of 12 h light and 12 h darkness. Then individual seed was examined under stereo-microscope and per cent infected seeds were counted after 10 days.

3.2.2 Seedling Symptom Test

Fifteen seeds were sown in pots in five replications containing autoclaved soil and incubated at 20°C for 21 days under 12 h of alternating cycles of artificial light and darkness. After incubation, individual seedlings were examined for disease symptoms and per cent infection was estimated.

3.3 RATE OF SEED TRANSMISSION

The experiment was conducted in green house. Fifteen infected seeds from barley varieties (same as given in the seed health testing experiment) of each category were sown in pots (22 cm diameter) in three replications maintaining 5 seeds per pot containing sterilized soil and data were recorded on (a) per cent plant infected and (b) per cent tiller infected.

3.4 DETERMINATION OF QUANTITATIVE AND QUALITATIVE LOSS IN SEED YIELD

Quantitative and qualitative losses were determined by using healthy and diseased plants from each category as given in the seed health testing and observations were recorded on the following aspects:

3.4.1 Quantitative Losses

(a) 1000-grain weight (g)

Random samples of 1000-grain were taken from healthy and diseased plants and weighted in grams.

(b) Grain density (g/cc)

Weight of fifty seeds and their volume was measured by displacement of water. The seed density was calculated by using the following formula:

$$\text{Grain Density (g/cc)} = \frac{\text{Seed weight (g)}}{\text{Seed volume (cc)}}$$

(c) Number of grains per ear

From susceptible and resistant genotypes, number of grain per ear were counted both in healthy and diseased plants in ten replications.

3.4.2 Qualitative Losses

(a) Seed germination (%)

One hundred healthy and diseased (25 per replication) seeds of each genotypes were placed in between sufficient moistened rolled towel paper and replicated thrice and kept at 25°C in tbe seed germinator (BP 25°C). Final count was taken on 10th day and normal seedlings were expressed as per cent germination (ISTA, 1985).

(b) Seedling vigour indices

The vigour indices (VI-I and VI-II) were calculated by the following formulae:

(i) Vigour index - I : Standard germination (%) x Seedling length (cm)

The seedling length was measured as the average length of ten randomly taken normal seedlings recorded at final count of seed germination test.

(ii) Vigour index-II : Standard germination (%) x Seedling dry weight (g) Average dry weight of the normal seedlings was taken for measuring seedling length and kept in the hot air oven at 80°C for 48 h.

(c) Respiration rate of seeds (O_2 uptake)

The O_2 uptake was measured by Gilson Differential Respirometer. The seeds were soaked in the towel paper containing sufficient moisture for 48 h and then five sprouted seeds were placed in a reaction flask containing 2 ml of distilled water outside and 0.2 ml of 10 per cent KOH solution inside the central well. A rolled filter paper strip of equal dimension was also placed in the central well for increasing the surface area for absorption of Co_2. The temperature of water bath of respirometer was set at 25°C and the reaction flask were acclimatized by shaking at 78 occilation per minute for half an hour. The O_2 uptake was recorded after half an hour and estimated as microlitres of O_2 absorbed per seed per hour (μl O_2/seed/h).

3.5 EFFECT OF SEED LEACHATES ON DISEASE RESISTANCE

100 g seed from each reaction category (same as in Section 3.2) were disinfected with 0.1 per cent mercuric chloride solutions and soaked in 40 to 50 ml sterilized distilled water in a sterilized Erlenmgyer flask. The amount of water taken was just sufficient for seed imbibition and germination initiation. After the desired period, liquid was removed and seeds were washed in a small amount of distilled sterilized water and washed water was pooled with liquid collected earlier. The collection period was

the time taken by radicle to reach the length of the seed. The total volume of the liquid containing leachates was made 150 ml. The method employed was described by Kraft and Erwin (1967). The leachates for each variety were divided into two parts. One part was sterilized and used to determine its effects on the growth of the fungus. The other part was used for estimation of total phenols, orthodihydric phenols, total sugars and reducing sugars.

3.5.1 Effect on fungal growth

The leachates and double strength potato dextrose agar (PDA) medium were mixed in a ratio of 1:1 and autoclaved for fifteen minutes. PDA containing leachates was poured in petriplates and inoculated with mycelial bits of 5 mm size. A suitable control was kept using PDA without leachates. Observations on growth were taken after 6 days of incubation at 25±1°C.

3.5.2 Biochemical analysis of seed leachates

(a) Digestion of samples

Five ml of the seed leachates solution was added to 10 ml of 80 per cent ethanol for extraction on a water bath fixed at 80-85°C for 30 minutes. The process was repeated thrice and the supernatant was collected separately. The supernatant was filtered first through muslin cloth and then through Whatman's filter paper No. 1 to get a clear extract. Distilled water was used to make the volume of this extract 50 ml. This extract was used for further estimation of total phenols, orthodihydric phenols, total sugars and reducing sugars.

(b) Estimation of total phenols

The method described by Bray and Thorpe (1954) was followed for the estimation of total phenols as per details given below:

Reagents

(i) Folin Cicolteu reagent

Sodium tungstate	:	100 g
Sodium molybdate	:	25 g
Phosphoric acid	:	50 ml
Hydrochloric acid	:	100 ml
Lithium sulphate	:	150 g
Liquid bromide	:	4-6 drops
Distilled water	:	750 ml

(ii) Sodium carbonate : 20 per cent

Procedure

For estimation of total phenols, one ml of Folin Ciocolteu reagent and 2 ml of 20 per cent sodium carbonate were added to 2 ml alcoholic extract taken in 25 ml volumetric flask. Volumetric flask was then heated in boiling water bath for one minute for development of blue colour. The volume was made to 25 ml and absorbance was measured at 725 nm Shimadzu Digital double beam spectrophotometer UV-150-02. Phenol concentration was calculated with reference to the standard curve prepared with tannic acid.

(c) Estimation of orthodihydric phenols

The method described by Johnson and Schaal (1952) was followed for the estimation of orthodihydric phenols.

Reagents

(i) Arnow reagent

Sodium nitrate		10 g
Sodium molybdate	:	10 g
Distilled water	:	100 ml

Stored in amber coloured bottle.

(ii)	Hydrochloric acid	:	0.5 N
(iii)	Sodium hydroxide	:	1.0 N

Procedure

Two ml of alcoholic extract was taken in 25 ml volumetric flask to which 2 ml of 0.5 N hydrochloric acid, one ml Arnow reagent and 2 ml of 1.0 N sodium hydroxide were added. The volume was made to 25 ml with distilled water. The absorbance of pink colour developed was determined at 450 nm using a Shimadzu Digital double bean spectrophotometer UV-150-02. The amount of ortho-dihydric phenols was calculated by preparing standard curve with caffeic acid as standard.

(d) Estimation of total sugars

For the estimation of total sugar, the method described by Dubois *et al.* (1956) was followed.

Half ml of alcoholic extract, 1 ml of 5 per cent phenol and 5 ml concentrated H_2SO_4 were added. After keeping it at 28°C for 20 minutes, the extract was cooled. The volume was made 25 ml by adding distilled water and the colour intensity was recorded at 490 nm wavelength using Shimadzu Digital double bean spectrophotometer UV-150-02. The amount of total sugars was calculated by preparing standard curve with glucose as standard.

(e) Estimation of reducing sugars

The method described by Paleg (1960) was used.

Reagents

Somogyii Reagent

Solution A

Sodium bicarbonate	:	1.6 g
Sodium potassium tartrate	:	12. g
Sodium carbonate	:	2.4 g
Distilled water	:	50 ml

Solution B

Copper sulphate	:	0.4 g
Sodium sulphate	:	3.6 g
Distilled water	:	20 ml

Solutions A and B were mixed and their volume was made to 100 ml.

Nelson reagent

Solution A

Ammonium molybdate	:	2.4 g
Concentrated sulphuric acid	:	2.5 ml
Distilled water	:	45 ml

Solution B

Sodium hydrogen arsenate	:	3 g
Distilled water	:	25 ml

Solutions A and B were mixed and allowed to stand for 24 h at 37°C.

One ml of Somogyii reagent was added to 0.5 ml of alcoholic extract. The mixture was kept in boiling water bath for 10 minutes and then cooled. In this extract one ml of Nelson reagent was added and final volume was raised to 25 ml. The colour intensity was measured at 560 nm wavelength using Shimadzu Digital double beam spectrophotometer UV-150-02. The amount of reducing sugars was calculated from a standard curve prepared with glucose.

3.6 MANAGEMENT OF DISEASE THROUGH CULTURAL METHOD

3.6.1 Cultural Management

(a) Nutrient management

Fifteen seeds of susceptible barley variety C-138 were sown in first week of November in pots of 22 cm diameter 15 seed per replication. Four levels of nitrogen viz., 20,40, 60 and 80 kg per ha were combined with four levels of phosphorus (0,20, 30 and 80 kg per ha). The recommended amount of the nutrients were calculated per kg of soil and applied to the upper 2 cm soil in the pots. Total amount of phosphorus in the form of SSP (Single Super Phosphate) and half amount of nitrogen in the form of urea were applied at the time of sowing. Remaining amount of nitrogen was applied at the time of tillering. Data on disease incidence were recorded at maturity.

(b) Effect of date of sowing

In sowing dates experiment, seeds of susceptible barley variety C-138 were sown in three replications on five different dates viz. Nov. 3,10, 17, 24 and Dec. 1 keeping plot size 3 x 1.5 m. Disease incidence and severity were recorded at maturity. Yields were also recorded.

3.6.2 Evaluation of seed dressing fungicides

Fungitoxicants

Ten fungitoxicants systemic and non-systemic were used in disease control studies. The fungitoxicants were Vitavax, Emisan, Raxil, Dithane M-45, Daconil, Topsin-M, Captan, Thiram, Vitavax + Thiram and Vitavax + Dithane M-45. Chemical name, active ingredient and other characteristics of these chemicals are given in Appendix-I.

In vitro **studies**: Stock solutions (1000 µg/ml) of the fungitoxicants were prepared by dissolving the calculated amount of active ingredient in 20 ml of acetone and the final volume was made to 100 ml with sterilized distilled water. Stock solutions so prepared were stored in refrigerator at 5°C till further use and renewed after every 4 weeks. The required dilutions (50, 100, 250, 500 and 1000 ppm) were subsequently made from stock solutions by adding distilled sterile water as and when required.

In vitro studies were carried out by poisoned food technique which is based on the widely used method of Schmitz (1930) modified by Carpenter (1942) and Grover and Moore (1962). The potato dextrose agar medium,served as 20 ml of double strength medium amended with each concentration of fungitoxicant,was poured in each petriplate under aseptic conditions. Each treatment had three replications. Suitable control without fungitoxicant was maintained simultaneously. Each petriplate was then inoculated with mycelia discs(5 mm dia.) taken from the periphery of an actively growing five days old culture of *D. graminea*. The inoculated petriplates were incubated at 25±1°C for 6 days. Observations on the radial growth of the fungus were taken and per cent growth inhibition was calculated on the basis of the mycelial growth in the control. Toxicity index was calculated by summing up the percentage inhibition figures for the five concentrations (Rich and Horsfall, 1961).

In vivo studies: Field trials using a susceptible variety C-138 were conducted to evaluate the relative efficacy of different fungitoxicants in controlling the stripe disease. The fungitoxicants used were same as used for *in vitro* studies. Seed dressed with fungitoxicants at the rate of 0.2 per cent were sown in three replications in completely randomized plots of 3 x 1.5 m size with a row to row distance of 25 cm. The plant to plant distance was kept 4-5 cm. Check (with untreated seed) was maintained side by side. Diseased plants were tagged after the symptoms had appeared. Observations on disease incidence were taken 30 days after sowing (seedling stage). Second observation on infected plants and tillers in each plot was recorded at maturity and per cent disease control was calculated on the basis of disease in controlled plots.

CHAPTER - 4

EXPERIMENTAL RESULTS

Stripe disease is occurring regularly in different barley growing areas of the state. Due to continuous cultivation of susceptible varieties under favourable conditions, it has emerged as a serious problem. The information on sources of stable resistance, seed health testing methods, rate of seed transmission and on its management, is limited. Hence, the present investigation was aimed to obtain information on the above aspects and the results have been presented as under:

ISOLATION OF PATHOGEN

The fungus was isolated from barley leaves showing typical symptoms of stripe disease. The fnngus was identified as *D. graminea* on the basis of growth and other characteristics. The mycelium was dark grey, olive to black in colour (Plate 3). The fungus did not sporulate and produce only long mycelial threads on potato dextrose agar medium.

PATHOGENICITY TEST

The pathogenicity of the isolated fungus was tested on susceptible barley variety (C-138) under green house conditions by artificially inoculating the seeds with pathogen during the month of February 2000-01. Observations on disease development were recorded starting from 15 days

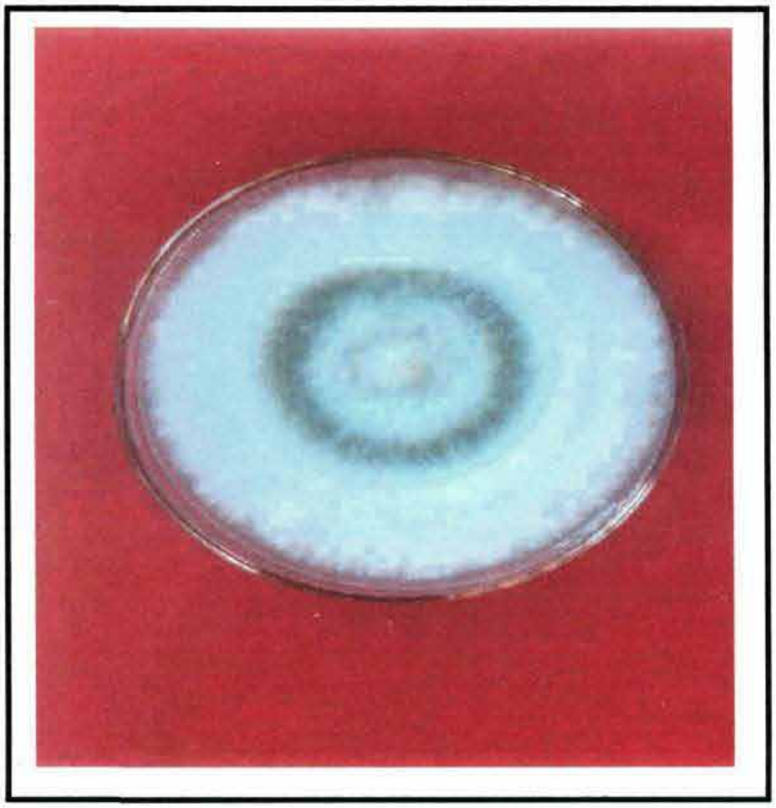


Plate 3. Seven days old mycelial culture of *D. graminea*

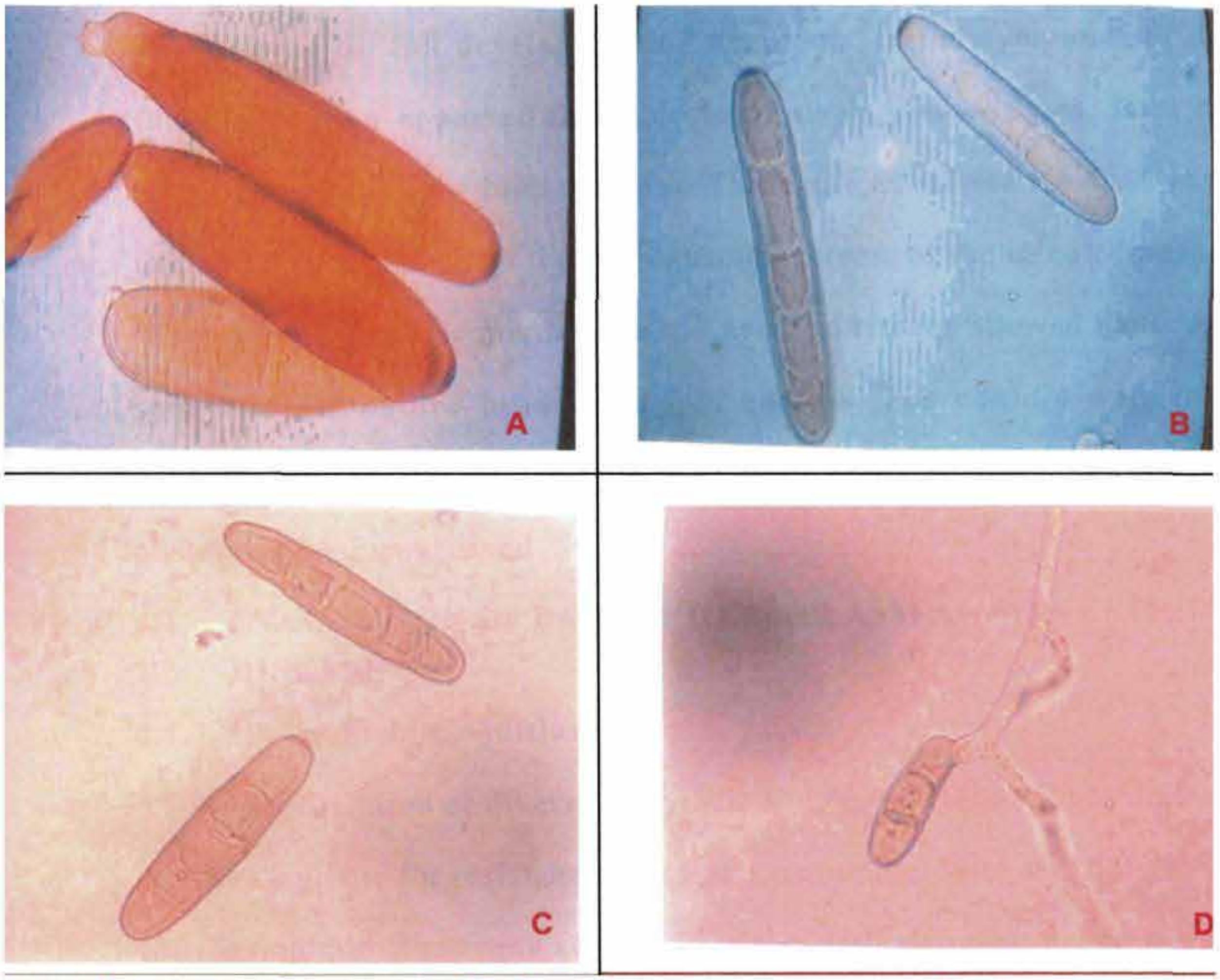


Plate 4. (A); Conidia of *D. graminea*, (B&C); conidia showing septation, (D); germinating conidia

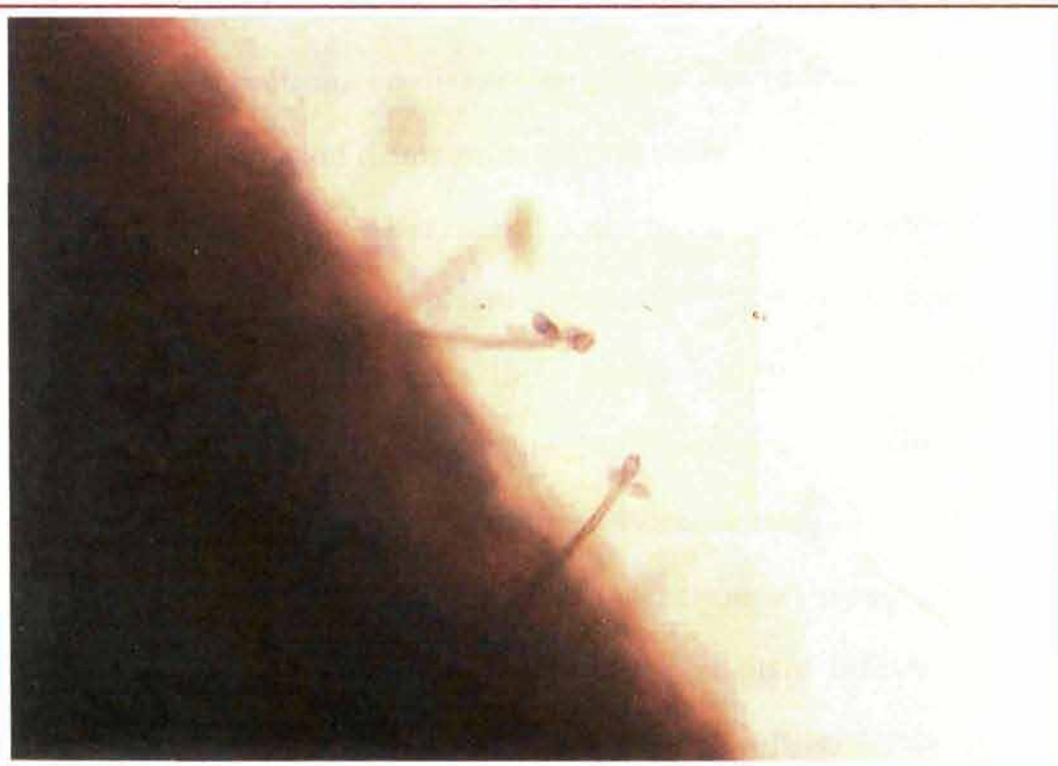


Plate 5. Typical conidia and conidiophore of *D. graminea* on seed

after sowing till full development of symptoms. Initial symptoms of the fungal infection appeared in the form of small yellow spots, later on elongated into yellow brown stripes. These stripes started from the base and extended to the tip of the leaf causing necrosis of the infected tissue. When observed under microscope the necrotic tissues showed abundant subhyaline to yellow brown coloured conidia. The conidia were thin walled, 2 to 7 septate and cylindrical in shape (Plate 4 and 5). The Koch's postulates were confirmed.

4.1 EVALUATION OF BARLEY GERMPLASM AGAINST STRIPE DISEASE

4.1.1 Under Field Conditions

Identification of diverse and stable sources of resistance to disease is a pre-requisite for resistance breeding programme. With this objective, 130 germplasm lines were screened for testing their reaction against *D. graminea* under natural conditions in the field during *rabi* 2000-2001 crop season. Observations on disease incidence were recorded on the basis of number of plants and tillers infected and mean infection value. The results on per cent plant and tiller infected and mean infection value are given in Table 1. Out of 130 germplasm lines tested under field conditions during *rabi* 2000-2001, eighty-one lines found highly resistant, whereas, 49 showed 0.47 to 35.08 and 0.17 to 26.65 per cent infection on plant and tiller hasis, respectively. Among these 49 germplasm lines, 7 showed 16.00 to 35.08 and 9.41 to 26.65 per cent infection on plant and tiller basis, respectively. In 6 germplasm lines per cent plant infected ranged from 10.92 to 14.68 and 7.24 to 9.88 on plant and tiller basis, respectively.

Table 1. Screening of barley germplasm lines against *Drechslera graminea* under field conditions during 2000-01

Sr. No.	Germplasm lines	Plant infected (%)	Tiller infected (%)	Mean infection value
1	BH-75 (c)	18.26	13.56	40.53
2	BH-331	11.11	9.32	23.16
3	BH-393 (c)	4.75	2.17	8.16
4	BH-446	0.00	0.00	0.00
5	BH-449	21.20	16.28	32.29
6	BH-495	0.00	0.00	0.00
7	BH-499	22.84	15.96	39.56
8	BH-510	5.17	3.78	11.02
9	BH-512	10.92	7.24	22.56
10	BH-515	5.45	3.82	18.16
11	BH-522	12.40	7.50	27.75
12	BH-529	0.00	0.00	0.00
13	BH-532	0.00	0.00	0.00
14	BH-535	1.75	1.35	3.39
15	BH-544	0.00	0.00	0.00
16	BH-546	0.00	0.00	0.00
17	BH-548	3.50	2.27	7.62
18	BH-549	12.93	7.72	29.56
19	BH-550	0.00	0.00	0.00
20	BH-553	0.00	0.00	0.00
21	BH-554	8.33	3.15	20.80
22	BH-559	0.00	0.00	0.00
23	BH-580	1.66	1.05	2.65
24	BH-581	0.00	0.00	0.00
25	BH-586	0.00	0.00	0.00

26	BH-588	0.92	0.42	2.16
27	BH-589	0.00	0.00	0.00
28	BH-590	0.86	0.17	2.00
29	BH-591	0.47	0.29	1.87
30	BH-592	3.70	2.22	7.00
31	BH-594	0.00	0.00	0.00
32	BH-597	3.62	2.07	6.64
33	RD-2035 (c)	0.00	0.00	0.00
34	RD-2503 (c)	0.00	0.00	0.00
35	RD-2552 (c)	2.85	1.37	5.60
36	RD-2592	0.00	0.00	0.00
37	RD-2606	0.00	0.00	0.00
38	RD-2617	0.00	0.00	0.00
39	RD-2618	0.49	0.28	1.94
40	RD-2619	0.00	0.00	0.00
41	RD-2620	0.00	0.00	0.00
42	RD-2627	0.00	0.00	0.00
43	RD-2628	3.94	1.85	7.19
44	RD-2629	0.00	0.00	0.00
45	RD-2630	0.00	0.00	0.00
46	DWR-28 (c)	12.93	9.48	29.56
47	DWR-32	0.00	0.00	0.00
48	DWR-35	0.00	0.00	0.00
49	DWR-37	0.00	0.00	0.00
50	DWR-38	0.00	0.00	0.00
51	DWR-39	8.96	7.14	22.33
52	DWR-40	1.96	0.57	3.62
53	DWR-41	7.64	7.03	21.92
54	K-551 (c)	5.00	3.96	16.23

55	K-669	14.68	9.88	30.28
56	K-670	0.00	0.00	0.00
57	K-671	16.00	9.41	29.16
58	K-677	5.94	4.12	16.72
59	K-678	0.00	0.00	0.00
60	K-679	0.00	0.00	0.00
61	K-687	3.12	2.76	8.12
62	K-696	0.00	0.00	0.00
63	PL-706	0.00	0.00	0.00
64	PL-707	21.21	15.00	39.76
65	PL-710	22.83	16.56	39.16
66	C-138 (c)	35.08	26.65	52.25
67	BH-607	0.00	0.00	0.00
68	BH-605	4.16	3.03	6.12
69	BH-608	1.78	0.39	3.19
70	BH-600	0.00	0.00	0.00
71	BH-609	1.26	0.85	3.50
72	BH-602	0.00	0.00	0.00
73	BH-601	0.00	0.00	0.00
74	BH-604	4.49	3.55	10.19
75	BH-603	0.00	0.00	0.00
76	BH-01-50	2.32	1.78	3.64
77	BH-514	0.00	0.00	0.00
78	BH-01-95	0.84	0.54	2.20
79	BON (MRA-99)-30	0.00	0.00	0.00
80	22 IBYT-2	0.00	0.00	0.00
81	22 IBYT-3	0.00	0.00	3.48
82	22 IBYT-8	1.83	0.82	3.48
83	22 IBYT-110	0.00	0.00	0.00

84	22 IBON-99-20	0.00	0.00	0.00
85	22 IBON-99-23	0.00	0.00	0.00
86	22 IBON-99-32	0.00	0.00	0.00
87	26 IBON-16	0.00	0.00	0.00
88	26 IBON-27	0.00	0.00	0.00
89	BH-597	0.00	0.00	0.00
90	BH-596	0.00	0.00	0.00
91	UBE-441	1.63	0.63	3.26
92	UBE-1005	0.00	0.00	0.00
93	UBE-1008	3.52	2.10	6.63
94	NDB-1172	0.00	0.00	0.00
95	NDB-1187	5.27	4.21	14.53
96	HUB-166	0.00	0.00	0.00
97	HUB-167	3.42	2.06	6.80
98	JB-15	1.66	1.32	2.72
99	JB-16	1.85	1.48	3.07
100	JB-17	1.75	1.40	2.67
101	BK-0001	0.00	0.00	0.00
102	BK-0002	0.00	0.00	0.00
103	BK-0003	0.00	0.00	0.00
104	BK-0004	0.00	0.00	0.00
105	BK-0005	0.00	0.00	0.00
106	BK-0006	0.00	0.00	0.00
107	BK-0007	0.00	0.00	0.00
108	BK-0008	0.00	0.00	0.00
109	BK-0009	0.00	0.00	0.00
110	BK-0010	0.00	0.00	0.00
111	BK-0011	0.00	0.00	0.00
112	BK-0012	0.00	0.00	0.00

113	BK-0013	0.00	0.00	0.00
114	BK-0014	0.00	0.00	0.00
115	BK-0015	0.00	0.00	0.00
116	BK-0016	0.00	0.00	0.00
117	BK-0017	0.00	0.00	0.00
118	BK-0018	0.00	0.00	0.00
119	BK-0019	0.00	0.00	0.00
120	BK-0020	0.00	0.00	0.00
121	BK-0021	0.00	0.00	0.00
122	BK-0022	0.00	0.00	0.00
123	BK-0023	0.00	0.00	0.00
124	BK-0024	0.00	0.00	0.00
125	BK-0025	0.00	0.00	0.00
126	BK-0026	0.00	0.00	0.00
127	BK-0027	0.00	0.00	0.00
128	BK-0028	0.00	0.00	0.00
129	BK-0029	0.00	0.00	0.00
130	BK-0030	5.64	4.66	19.16

Eight germplasm lines showed 5.17 to 8.96 and 3.15 to 7.14 per cent infection on plants and tillers basis, respectively. Twenty-three germplasm lines showed 1.26 to 4.75 and 0.39 to 3.96 per cent infection on plants and tillers basis. Rest of the 5 germplasm lines had 0.47 to 0.92 per cent plants infected and 0.17 to 0.54 per cent tillers infected.

Table 2 depicted the grouping of germplasm lines on the basis of disease reaction. Out of 130 germplasm lines, 81 did not show any symptoms of disease under natural field conditions during *rabi* 2000-2001. Therefore, these 81 germplasm lines categorised into highly resistant group. Five germplasm lines showed less than one per cent infection on plant basis, hence grouped into resistant category and 23 germplasm lines exhibited less than five but more than one per cent infection and categorised under moderately resistant group, 8 germplasm lines showed more than 5 per cent but less than 10 per cent infection in plants and they were put under moderately susceptible group, 6 germplasm lines grouped under susceptible category as they showed more than 10 per ceut but less than 15 per cent infection on plant basis, whereas, rest of germplasm lines viz., BH-75(c), BH-449, BH-499, K-671, PL-707, PL-710 and C-138(c) were found highly susceptible as they showed more than 15 per cent infection on plant basis.

Data presented in Table 3 showed the mean infection value of all the 130 germplasm lines tested and these are categorised as follows:

Eighty-one germplasm lines were found having zero mean infection value and therefore, put under highly resistant category. Sixteen germplasm

Table 2. **Grouping of barley germplasm on the basis of infected plant to leaf stripe reaction under field conditions during 2000-01**

Reaction Category	Per cent infected plant (Range)	No. of germplasm in each category	Germplasm
Highly resistant	0	81	BH-446, BH-495, BH-544, BH-553, BH-559, BH-581, BH-586, BH-594, RD-2035(c), RD-2503(c), RD-2592, RD-2606, RD-2617, RD-2619, RD-2620, RD-2627, DWR-32, DWR-35, DWR-38, K-670, K-678, K-679, K-696, PL-706, BH-607, BH-600, BH-602, BH-601, BH-603, BH-594, BON (MRA-99)-30, 22IBYT-2, 22IBYT-3, 22IBYT-110, 22IBON-99-20, 22IBON-99-23, 22IBON-99-32, 26IBON-16, 26IBON-27, BH-597, BH-596, UB-1005, NDB-1172, HUB-166, BK-0001, BK-0002, BK-0003, BK-0004, BK-0005, BK-0006, BK-0007, BK-0008, BK-0009, BK-0010, BK-0011, BK-0012, BK-0013, BK-0014, BK-0015, BK-0016, BK-0017, BK-0018, BK-0019, BK-0020, BK-0021, BK-0022, BK-0023, BK-0024, BK-0025, BK-0026, BK-0027, BK-0028, BK-0029
Resistant	0-1	5	BH-588, BH-590, BH-591, RD-2618, BH-0195
Moderately resistant	1-5	23	BH-393 (c), BH-535, BH-548, BH-580, BH-592, BH-597, RD-2552 (c), RD2628, DWR-40, K-551 (c), K-687, BH-605, BH-608, BH-609, BH-604, BH-01-50, 22IBYT-8, UBE-441, UBE-1008, HUB-167, JB-15, JB-16, JB-17
Moderately Susceptible	5-10	8	BH-510, BH-515, BH-554, DWR-39, DWR-41, K-677, NDB-1187, BK-0030
Susceptible	10-15	6	BH-331, BH-512, BH-522, BH-549, DWR-28(c), K-669
Highly susceptible	>15	7	BH-75(c), BH-449, BH-499, K-671, PL-707, PL-710, C-138(c)

Table 3. Grouping of barley germplasm on the basis of mean infection value to leaf stripe reaction under field conditions during 2000-01

Reaction Category	Mean infection value	No. of germplasm in each category	Germplasm
Highly resistant	0	81	BH-446, BH-495, BH-529, BH-532, BH-544, BH-546, BH-550, BH-553, BH-559, BH-581, BH-586, BH-589, BH-594, RD-2035(c), RD-2503(c), RD-2592, RD-2606, RD-2617, RD-2619, RD-2620, RD-2627, RD-2629, RD-2630, DWR-32, DWR-35, DWR-37, DWR-38, K-670, K-678, K-679, K-696, PL-706, BH-607, BH-600, BH-602, BH-601, BH-603, BH-594, BON (MRA-99)-30, 22IBYT-2, 22IBYT-3, 22IBYT-110, 22IBON-99-20, 22IBON-99-23, 22IBON-99-32, 26IBON-16, 26IBON-27, BH-597, BH-596, UB-1005, NDB-1172, HUB-166, BK-0001, BK-0002, BK-0003, BK-0004, BK-0005, BK-0006, BK-0007, BK-0008, BK-0009, BK-0010, BK-0011, BK-0012, BK-0013, BK-0014, BK-0015, BK-0016, BK-0017, BK-0018, BK-0019, BK-0020, BK-0021, BK-0022, BK-0023, BK-0024, BK-0025, BK-0026, BK-0027, BK-0028, BK-0029
Resistant	0-5	16	BH-535, BH-580, BH-588, BH-590, BH-591, RD-2618, DWR-40, BH-608, BH-609, BH-01-50, BH-01-95, 22IBYT-8, UBE-441, JB-15, JB-16, JB-17
Moderately resistant	5-10	10	BH-393(c), BH-548, BH-592, BH-597, RD2552, RD-2628, K-687, BH-605, UBE-1008, HUB-167
Moderately susceptible	10-25	12	BH-331, BH-510, BH-512, BH-554, DWR-39, DWR-551, K-551(c), K-677, BH-604, NDB-1187, BK-0030
Susceptible	25-40	9	BH-449, BH-499, BH-549, DWR-28(c), K-669, K-671, PL-707, PL-710
Highly susceptible	>40	2	BH-75(c), C-138(c)

lines grouped under resistant category having mean infection value from 0 to 5, 10 lines having mean infection value more than 5 but less than 10 categorised as moderately resistant, twelve lines having mean infection value more than 10 but less than 25 were categorised as moderately susceptible, 9 lines exhibited mean infection value more than 25 but less than 40 grouped under susceptible category, rest of two germplams lines viz., BH-75(c), C-138(c) were found highly susceptible as they showed mean infection value more than 40.

4.1.2 Under Greenhouse Conditions

All the 130 germplasm lines screened during *rabi* 2000-2001 under field conditions were also tested under green house conditions during *rabi* 2001-02 for their reaction to *D. graminea*. Observations on disease incidence were recorded on the basis of number of plants and tillers infected and mean infection value. The results on per cent plant and tiller infected and mean infection value are given in Table 4. Out of 130 germplasm lines tested under green house conditions during *rabi* 2001-2002, seventy-one lines found with no infected plant, whereas, 59 showed 0.78 to 38.84 and 0.12 to 29.67 per cent infection on plant and tiller basis, respectively. Among these 59 germplasm lines, 9 showed 14.59 to 38.84 and 11.13 to 29.67 per cent infection on plant and tiller basis, respectively. In 7 lines per cent plant infected ranged from 10.01 to 14.96 and tiller 4.26 to 9.33 per cent infected. Twelve lines showed 5.26 to 9.44 and 3.62 to 7.63 per cent infection on plant and tiller basis, respectively. Twenty-six lines showed 1.19 to 4.75 and 0.72 to 3.88 per cent infection on plant

Table 4. Screening of barley germplasm lines against *Drechslera graminea* under green house conditions during 2001-02

Sr. No.	Germplasm lines	Plant infected (%)	Tiller infected (%)	Mean infection value
1	BH-75 (c)	24.51	15.84	46.78
2	BH-331	15.59	11.13	32.16
3	BH-393 (c)	5.45	3.82	18.16
4	BH-446	0.00	0.00	0.00
5	BH-449	28.55	20.00	48.71
6	BH-495	0.00	0.00	0.00
7	BH-499	10.18	4.26	21.62
8	BH-510	9.12	4.78	14.12
9	BH-512	14.96	8.74	26.49
10	BH-515	7.16	4.19	21.76
11	BH-522	17.40	12.78	29.20
12	BH-529	1.63	0.72	7.62
13	BH-532	0.86	0.52	2.10
14	BH-535	4.75	2.17	8.16
15	BH-544	0.00	0.00	0.00
16	BH-546	2.12	1.88	4.92
17	BH-548	4.62	3.64	8.64
18	BH-549	16.16	12.64	32.62
19	BH-550	4.19	3.88	8.72
20	BH-553	0.00	0.00	0.00
21	BH-554	9.44	6.14	26.62
22	BH-559	0.00	0.00	0.00
23	BH-580	3.63	2.07	4.69
24	BH-581	0.00	0.00	0.00
25	BH-586	0.00	0.00	0.00

26	BH-588	3.16	2.72	7.12
27	BH-589	1.26	0.78	3.02
28	BH-590	0.92	0.36	3.16
29	BH-591	0.78	0.52	2.83
30	BH-592	7.16	4.12	11.11
31	BH-594	0.00	0.00	0.00
32	BH-597	5.26	4.27	8.46
33	RD-2035 (c)	1.26	0.63	4.14
34	RD-2503 (c)	1.19	0.76	3.12
35	RD-2552 (c)	3.76	2.09	6.14
36	RD-2592	0.00	0.00	0.00
37	RD-2606	0.00	0.00	0.00
38	RD-2617	0.00	0.00	0.00
39	RD-2618	0.81	0.47	2.15
40	RD-2619	0.00	0.00	0.00
41	RD-2620	0.00	0.00	0.00
42	RD-2627	0.00	0.00	0.00
43	RD-2628	4.49	2.81	9.17
44	RD-2629	2.33	1.83	4.16
45	RD-2630	1.72	0.98	2.63
46	DWR-28 (c)	14.12	9.14	28.62
47	DWR-32	0.00	0.00	0.00
48	DWR-35	0.00	0.00	0.00
49	DWR-37	1.64	0.73	4.62
50	DWR-38	0.00	0.00	0.00
51	DWR-39	11.64	8.63	26.07
52	DWR-40	3.69	3.57	14.20
53	DWR-41	8.12	7.63	24.69
54	K-551 (c)	11.06	8.88	22.00

55	K-669	14.62	9.33	36.63
56	K-670	0.00	0.00	0.00
57	K-671	19.06	11.60	32.33
58	K-677	7.49	5.42	19.21
59	K-678	0.00	0.00	0.00
60	K-679	0.00	0.00	0.00
61	K-687	3.64	2.67	9.16
62	K-696	0.00	0.00	0.00
63	PL-706	0.00	0.00	0.00
64	PL-707	24.94	17.64	32.72
65	PL-710	26.26	19.62	42.16
66	C-138 (c)	38.84	29.67	58.20
67	BH-607	0.00	0.00	0.00
68	BH-605	10.01	6.00	20.14
69	BH-608	5.78	3.62	13.19
70	BH-600	0.00	0.00	0.00
71	BH-609	2.53	1.90	4.90
72	BH-602	0.00	0.00	0.00
73	BH-601	0.00	0.00	0.00
74	BH-604	6.64	4.33	14.16
75	BH-603	0.00	0.00	0.00
76	BH-01-50	3.33	2.66	7.16
77	BH-514	0.00	0.00	0.00
78	BH-01-95	0.94	0.69	3.12
79	BON (MRA-99)-30	0.00	0.00	0.00
80	22 IBYT-2	0.00	0.00	0.00
81	22 IBYT-3	0.00	0.00	0.00
82	22 IBYT-8	3.83	2.22	7.48
83	22 IBYT-110	0.00	0.00	0.00

84	22 IBON-99-20	0.00	0.00	0.00
85	22 IBON-99-23	0.00	0.00	0.00
86	22 IBON-99-32	0.00	0.00	0.00
87	26 IBON-16	0.00	0.00	0.00
88	26 IBON-27	0.00	0.00	0.00
89	BH-597	0.00	0.00	0.00
90	BH-596	0.00	0.00	0.00
91	UBE-441	2.64	1.76	5.78
92	UBE-1005	0.00	0.00	0.00
93	UBE-1008	4.25	2.35	7.92
94	NDB-1172	0.00	0.00	0.00
95	NDB-1187	7.16	5.12	17.33
96	HUB-166	0.00	0.00	0.00
97	HUB-167	4.32	3.26	8.06
98	JB-15	2.06	1.76	3.88
99	JB-16	1.93	1.33	3.67
100	JB-17	2.07	1.93	3.91
101	BK-0001	0.00	0.00	0.00
102	BK-0002	0.00	0.00	0.00
103	BK-0003	0.00	0.00	0.00
104	BK-0004	0.00	0.00	0.00
105	BK-0005	0.00	0.00	0.00
106	BK-0006	0.00	0.00	0.00
107	BK-0007	0.00	0.00	0.00
108	BK-0008	0.00	0.00	0.00
109	BK-0009	0.00	0.00	0.00
110	BK-0010	0.00	0.00	0.00
111	BK-0011	0.00	0.00	0.00
112	BK-0012	0.00	0.00	0.00

113	BK-0013	0.00	0.00	0.00
114	BK-0014	0.00	0.00	0.00
115	BK-0015	0.00	0.00	0.00
116	BK-0016	0.00	0.00	0.00
117	BK-0017	0.00	0.00	0.00
118	BK-0018	0.00	0.00	0.00
119	BK-0019	0.00	0.00	0.00
120	BK-0020	0.00	0.00	0.00
121	BK-0021	0.00	0.00	0.00
122	BK-0022	0.00	0.00	0.00
123	BK-0023	0.00	0.00	0.00
124	BK-0024	0.00	0.00	0.00
125	BK-0025	0.00	0.00	0.00
126	BK-0026	0.00	0.00	0.00
127	BK-0027	0.00	0.00	0.00
128	BK-0028	0.00	0.00	0.00
129	BK-0029	0.00	0.00	0.00
130	BK-0030	7.01	5.61	22.13

and tillers basis, respectively. Rest of the five lines had 0.78 to 0.94 per cent plant infected and 0.47 to 0.78 per cent tiller infected.

Table 5 depicted the grouping of germplasm lines on the basis of disease reaction. Out of 130 germplasm 71 did not show any symptoms of disease under green house conditions during *rabi* 2001-2002. Therefore, these 71 germplasm lines categorised into highly resistant group. Five germplasm lines showed less than one per cent infection on plant basis, hence grouped into resistant category and 26 lines exhibited less than five but more than one per cent infection and categorised as moderately resistant, 12 lines showed more than 5 but less than 10 per cent infection in plants and they were put under moderately susceptible group, 7 lines grouped under susceptible category as they showed more than 10 per cent but less than 15 per cent infection on plant basis, whereas, rest of the lines viz., BH-75 (c), BH-331, BH-449, BH-522, BH-549, K-671, PL-707, PL-710 and C-138(c) were found highly susceptible as they showed more than 15 per cent infection on plant basis.

Data presented in Table 6 showed the mean infection value of all the 130 germplasm lines tested and these are categorised as follows:

Seventy-one germplasm lines were found having zero mean infection value and therefore, put under highly resistant category. Seventeen lines exhibited mean infection value less than five grouped under resistant category, 14 lines showed more than 5, but less than 10 mean infection value and they put under moderately resistant group, 14 lines grouped under moderately susceptible category as they showed more than 10 but

Table 5. **Grouping of barley germplasm on the basis of plant infected to leaf stripe reaction under green house conditions during 2001-02**

Reaction Category	Per cent infected plant (range)	No. of germplasm in each category	Germplasm
Highly resistant	0	71	BH-446, BH-495, BH-544, BH-553, BH-559, BH-581, BH-586, BH-594, RD-2592, RD-2606, RD-2617, RD-2619, RD-2620, RD-2627, DWR-32, DWR-35, DWR-38, K-670, K-678, K-679, K-696, PL-706, BH-607, BH-600, BH-602, BH-601, BH-603, BH-594, BON (MRA-99)-30, 22IBYT-2, 22IBYT-3, 22IBYT-110, 22IBON-99-20, 22IBON-99-23, 22IBON-99-32, 26IBON-16, 26IBON-27, BH-597, BH-596, UB-1005, NDB-1172, HUB-166, BK-0001, BK-0002, BK-0003, BK-0004, BK-0005, BK-0006, BK-0007, BK-0008, BK-0009, BK-0010, BK-0011, BK-0012, BK-0013, BK-0014, BK-0015, BK-0016, BK-0017, BK-0018, BK-0019, BK-0020, BK-0021, BK-0022, BK-0023, BK-0024, BK-0025, BK-0026, BK-0027, BK-0028, BK-0029
Resistant	0-1	5	BH-532, BH-590, BH-591, R.D. 2618, BH-01-95.
Moderately resistant	1-5	26	BH-529, BH-535, BH-546, BH-548, BH-550, BH-580, BH-588, BH-589, RD-2035(c), RD-2503(c), RD-2552(c), RD-2628, RD-2629, RD-2630, DWR-37, DWR-40, K-687, BH-609, BH-01-50, 22IBYT-8, UBE-441, UBE-1008, HUB-167, JB-15, JB-16, JB-17
Moderately susceptible	5-10	12	BH-393(c), BH-510, BH-515, BH-554, BH-592, BH-597, DWR-41, K-677, BH-608, BH-604, NDB-1187, BK-0030.
Susceptible	10-15	7	BH-499, BH-512, DWR-28(c), DWR-39, K-551(c), K-669, BH-605
Highly susceptible	>15	9	BH-75(c), BH-331, BH-449, BH-522, BH-549, K-671, PL-707, PL-710, C-138 (c)

Table 6. **Grouping of barley germplasm on the basis of mean infection value to leaf stripe reaction under green house conditions during 2001-02**

Reaction Category	Mean infection value	No. of germplasm in each category	Germplasm
Highly resistant	0	71	BH-446, BH-495, BH-544, BH-553, BH-559, BH-581, BH-586, BH-594, RD-2592, RD-2606, RD-2617, RD-2619, RD-2620, RD-2627, DWR-32, DWR-35, DWR-38, K-670, K-678, K-679, K-696, PL-706, BH-607, BH-600, BH-602, BH-601, BH-603, BH-594, BON (MRA-99)-30, 22IBYT-2, 22IBYT-3, 22IBYT-110, 22IBON-99-20, 22IBON-99-23, 22IBON-99-32, 26IBON-16, 26IBON-27, BH-597, BH-596, UB-1005, NDB-1172, HUB-166, BK-0001, BK-0002, BK-0003, BK-0004, BK-0005, BK-0006, BK-0007, BK-0008, BK-0009, BK-0010, BK-0011, BK-0012, BK-0013, BK-0014, BK-0015, BK-0016, BK-0017, BK-0018, BK-0019, BK-0020, BK-0021, BK-0022, BK-0023, BK-0024, BK-0025, BK-0026, BK-0027, BK-0028, BK-0029
Resistant	0-5	17	BH-532, BH-546, BH-580, BH-589, BH-590, BH-591, RD-203 (c) 5, RD-2503 (c), RD-2616, RD-2629, RD-2630, DWR-37, BH-608, BH-01-95, JB-15, JB-16, JB-17
Moderately resistant	5-10	14	BH-529, BH-533, BH-548, BH-550, BH-588, BH-597, RD-2552 (c), RD-2628, K-687, BH-01-50, 22IBYT-8, UBE-441, UBE-1008, HUB-167,
Moderately Susceptible	10-25	14	BH-393 (c), BH-499, BH-510, BH-515, 592, DWR-40, DWR-41, K-551 (c), K-677, BH-605, BH-608, BH-604, NDB-1187, BK-0030
Susceptible	25-40	10	BH-331, BH-512, BH-522, BH-549, BH-554, DWR-28 (c), DWR-39, K-669, K-671, PL-707
Highly susceptible	>40	4	BH-75 (c), BH-449, PL-710, C-138 (c)

less than 25 mean infection value, 10 lines exhibited mean infection value more than 25 but less than 40 grouped under susceptible category, rest of four germplasm lines viz., BH-75(c), BH-449, PL-710 and C-138(c) were found highly susceptible as they showed mean infection value more than 40.

4.2 COMPARISON OF SEED HEALTH TESTING METHOD AND DETERMINATION OF RATE OF TRANSMISSION

4.2.1 Seed Health Testing

Various seed health testing methods have been developed by different workers to detect seed borne pathogens in several crops. Unless the health status of seed lots is known, it is not possible to manage the seed borne pathogens/diseases. Keeping this objective in view blotter and seedling symptom tests were carried out on 10 genotypes comprising of two genotypes from each reaction category (Highly susceptible, susceptible, moderately susceptible, moderately resistant and resistant) to detect *D. graminea.*

Data presented in Table 7 revealed that 15 to 34 per cent seed showed infection of *D. graminea* when tested by blotter paper method, whereas, 12 to 29 per cent infection recorded by seedling symptom test method. Highest percentage of seed infection (34%), by blotter paper method, was recorded in C-138(c) (HS) followed by BH-75(c) (30%), whereas, minimum infection (15%) recorded in BH-590 (R). As compared to blotter method seedling symptom test exhibited less incidence of disease in all the tested genotypes.

Table 7. Detection of *Drechslera graminea* in barley seed by different seed health testing methods

Genotypes	Blotter paper method*		Seedling symptom tests**	
	No.of seed plated	Infection (%)	No. of seeds sown	Infection(%)
BH-75(c)	50	30	50	26
C-138(c)	50	34	50	29
DWR-28(c)	50	28	50	24
K-669	50	25	50	22
BH-510	50	24	50	22
BH-393(c)	50	22	50	19
RD-2552(c)	50	25	50	21
RD-2628	50	21	50	19
BH-590	50	15	50	12
BH-591	50	18	50	14

*Observations were taken after 7days.

**Observations were taken 30 days after sowing.

4.2.2 Rate of Seed Transmission

The rate of seed to plant transmission was studied under green house conditions in sterilized soil in pots. Infected seeds were collected from field from five different reaction category (Highly susceptible, susceptible, moderately susceptible, moderately resistant and resistant). Data on plant and tiller basis was recorded and presented in Table 8. On plant basis 56.66 to 93.33 per cent seed transmission was recorded, whereas, 50.85 to 82.69 per cent seed transmission was recorded on tiller basis. The highly susceptible genotypes namely BH-75 (c) and C-138(c) showed 86.66 and 93.33 per cent seed transmission on plant basis, respectively. Whereas, resistant genotypes namely BH-590 and BH-591 showed 56.66 and 63.33 per cent seed transmission, respectively. On the other hand, the same set of genotypes exhibited 75.92 and 82.69 per cent seed transmission on tiller basis in highly susceptible genotypes[BH-75(c) and C-138(c)], whereas, 50.85 and 56.66 per cent seed transmission was recorded in BH-590 and BH-591 (resistant), respectively on tiller basis.

4.3 QUANTITATIVE AND QUALITATIVE LOSSES IN SEED YIELD

4.3.1 Quantitative Losses

The same set of genotypes as used in seed health testing experiment used in this study. At maturity the seeds were collected from diseased as well as healthy plants from the field and different quantitative parameters namely 1000-grain weight, grain density and number of grains per ear were recorded and data of which presented in Table 9.

Table 8. Effect of rate of seed transmission of *Drechslera graminea* to plants and tillers on different genotypes of barley

Genotypes	Seed germinated	Infected plants	Healthy plants	Seed transmission on plant basis (%)	Seed transmission on tiller basis (%)
BH-75(c)	15	13	2	86.66	75.92
C-138(c)	14	13	1	93.33	82.69
DWR-28(c)	14	12	2	85.00	76.92
K-669	15	12	3	80.00	73.58
BH-510	15	11	4	73.33	72.72
BH-393(c)	14	11	3	78.57	71.42
RD-2552(c)	13	10	3	76.66	72.22
RD-2628	15	10	5	66.66	64.40
BH-590	14	8	6	56.66	50.85
BH-591	14	9	5	63.33	56.66

Twenty seed sown (5 seed in 4 replication).

Table 9. Effect of stripe disease of barley (*Drechslera graminea*) on quantitative parameters

Genotypes	1000-grain weight (g)		Per cent loss	Grain density		Per cent loss	Number of grains/ear		Per cent loss
	Healthy	Diseased		Healthy	Diseased		Healthy	Diseased	
BH-75(c)	49.53	31.54	36.32	0.97	0.91	6.18	62.40	20.90	66.50
C-138(c)	50.02	34.42	31.81	0.83	0.78	6.02	64.50	22.50	65.11
DWR-28(c)	47.45	32.02	31.37	0.93	0.88	5.37	66.30	24.40	63.19
K-669	38.46	27.51	28.47	0.92	0.87	5.43	68.50	29.20	57.37
BH-510	42.26	29.50	30.19	0.90	0.85	5.55	67.60	30.50	54.88
BH-393(c)	34.59	24.88	28.07	0.97	0.92	5.15	63.80	29.88	53.16
RD-2552(c)	42.68	30.33	28.93	0.87	0.83	4.59	65.10	31.10	52.22
RD-2628	40.15	28.87	28.09	0.95	0.91	4.21	62.50	31.90	48.96
BH-590	39.72	29.05	26.86	0.96	0.92	4.17	65.70	35.30	46.27
BH-591	40.25	30.96	23.08	0.95	0.92	3.15	65.50	37.40	42.90
Mean	42.40	30.00		0.92	0.88		65.14	31.22	

A = Healthy, B = Diseased

C.D. at 0.05%	1000-grain weight	Grain density	Number of grains/ear
	A – 0.668	A – 0.009	A – 4.355
	B – 1.495	B – 0.022	B – 4.227
	A x B - 2.115	A x B- 2.308	A x B – 2. 183

(a) 1000-grain weight (g)

The perusal of data (Table 9) revealed that the disease significantly reduced the 1000-grain weight. 1000-grain weight of diseased seed ranged betweeu 24.88 to 34.42 g as compared to 34.59 to 50.02 g of healthy seeds. The per cent loss was maximum (36.82%) in seeds of susceptible genotype [BH-75(c)], whereas, it was minimum (23.08%) in seeds of resistant genotype (BH-591).

(b) Grains density (g/cc)

Grains density of diseased seeds was significantly low as compared to healthy seeds in all the genotypes. Per cent loss in grains density of these genotypes ranged from 3.15 to 6.18. The highly susceptible genotypes BH-75(c) and C-138(c) showed more than 6 per cent loss in grain density, whereas, resistant genotypes, BH-590 and BH-591, recorded 4.17 and 3.15 per cent loss in grain density, respectively.

(c) Number of grains per ear

From the same set of genotypes 10 earheads from diseased and healthy plants were collected and threshed separately and number of grains were counted in each earhead. Data presented in Table 9 revealed that disease significantly reduced the number of grains per ear in all the genotypes. The number of grains from healthy earheads ranged between 62.40 to 68.50, whereas, from diseased earheads number of grains ranged between 20.90 to 37.40. Highest per cent loss (66.50%) was recorded in highly susceptible genotype BH-75(c) followed by C-138(c) (65.11%), whereas, minimum loss in number of grains was recorded in resistant genotypes (BH-590 and BH-591)

Table 10. **Effect of stripe disease of barley (*Drechslera graminea*) on seed germination and respiration rate**

Genotypes	Seed germination (%)		Per cent loss	Respiration rate		Per cent loss
	Healthy	Diseased		Healthy	Diseased	
BH-75(c)	94.00	66.33	29.43	121.33	93.73	22.74
C-138(c)	95.00	69.00	27.36	121.73	95.06	21.90
DWR-28(c)	95.66	71.33	25.43	120.13	96.96	19.28
K-669	94.33	72.00	23.67	117.73	96.00	18.45
BH-510	93.00	71.33	23.30	117.20	97.26	17.01
BH-393(c)	93.00	72.33	22.22	116.46	96.80	16.88
RD-2552(c)	95.33	74.66	21.68	112.93	101.13	10.45
RD-2628	90.00	71.33	20.74	111.73	102.20	8.52
BH-590	89.66	71.33	20.44	110.13	104.46	5.15
BH-591	90.00	72.66	19.27	107.93	100.93	6.48
Mean	93.00	71.16		115.66	94.45	

A = Healthy, B = Diseased

C.D. at 0.05%	Seed germination	Respiration rate
	A – 0.906	A – 0.729
	B – 2.027	B – 1.632
	A x B - 2.86	A x B- 2.308

4.3.2 Qualitative Losses

The same set of genotypes as used in seed-health testing experiment were used in this study. At maturity, the seeds were collected from diseased as well as healthy plants from the field and different qualitative parameters viz., seed germination, respiration rate and vigour indices were observed.

(a) Seed germination (%)

Seed germination test was conducted by rolled towel method (ISTA, 1985). The data presented in Table 10 revealed that seed germination of healthy seeds ranged between 89.66 to 95.66 per cent which was above the ISTA standard (85%) in all the genotypes, whereas, it ranged between 66.33 to 74.66 per cent of diseased seeds. The per cent loss in germination was highest (29.43%) in BH-75(c) (Highly susceptible) followed by C-138(c) (highly susceptible), whereas, it was minimum in highly resistant genotypes viz., BH-591 (19.27%) followed by BH-590 (20.40%). Other showed 20.74 to 25.43 per cent loss in seed germination.

(b) Respiration rate

Five sprouted seeds of two genotypes from each reaction category namely, highly susceptible, susceptible, moderately susceptible, moderately resistant and resistant were taken out after the seeds were soaked in the towel paper containing sufficient moisture for 24 h, the respiration was measured by Gilson Differential Respirometer. The results obtained presented in Table 10. Tbe data pertaining to seeds respiration revealed that repetition in all the genotypes respiration rate of diseased seeds decreased significantly as compared to healthy seeds. The respiration rate of healthy seeds ranged between 107.93 (resistant) to 121.73 (highly susceptible), whereas, in diseased seedlings the respiration ranged between .93.73 (BH-75) to 104.46 (BH-590). The per cent loss in respiration rate of seeds was maximum (22.74%) in highly susceptible genotypes i.e. BH-75(c) followed by C-138(c) (21.90%), whereas, loss was minimum (5.15%) in resistant genotypes i.e. BH-590 followed by BH-591 (6.48%).

(c) Seedling vigour indices

Vigour Index-I

The same set of 10 genotypes, was used in the seed health listing method are also used in this study and results of which are presented in Table 11. The data revealed that vigour index-I of healthy seedling ranged between 2302.86 to 3084.20, whereas it ranged between 1384.93 to 1725.33 in diseased seedlings. The vigour index-I of healthy seedlings of all the genotypes differ significantly from diseased seedlings. Within highly susceptible genotypes [BH-75(c) and C-138(c)] seedlings, vigour index-I did not differ significantly from each other. Whereas, it differed significantly from resistant genotypes (BH-590 and BH-591). The per cent loss in vigour index-I ranged between 39.23 to 46.93. The maximum loss in vigour index-I was recorded in highly susceptible genotypes, whereas, per cent loss decreased in a descending order in susceptibe, moderately susceptible, moderately resistant and resistant genotypes.

Vigour Index-II

Vigour index-II of healthy seedlings of all the genotypes also calculated and it varied from 11.784 to 17.181 and it differed significantly from each other. The vigour index-II of diseased seedlings reduced

Table 11. **Effect of stripe disease of barley (*Drechslera graminea*) on vigour indices**

Genotypes	Vigour Index-I		Per cent loss in vigour index-I	Vigour Index-II		Per cent loss in vigour index-II
	Healthy	Diseased		Healthy	Diseased	
BH-75(c)	3018.60	1601.76	46.93	16.548	9.655	41.65
C-138(c)	2988.53	1618.55	45.84	15.926	9.400	40.97
DWR-28(c)	2664.13	1441.60	45.89	14.560	8.715	40.14
K-669	3018.20	1631.53	45.94	17.81	10.645	38.04
BH-510	3084.20	1725.33	44.05	14.313	9.167	35.95
BH-393(c)	2852.40	1613.66	43.42	15.152	9.837	35.07
RD-2552(c)	2527.73	1457.86	43.29	11.784	7.721	34.47
RD-2628	2955.60	1705.93	42.28	14.076	9.122	35.19
BH-590	2302.86	1384.93	39.86	13.171	8.713	33.84
BH-591	2497.76	1517.93	39.23	13.249	8.853	33.17
Mean	2791.00	1576.57		14.61	9.20	

A = Healthy, B = Diseased

C.D. at 0.05%	Vigour Index-I	Vigour Index-II
	A – 13.607	A – 0.245
	B – 30.426	B – 0.548
	A x B – 43.209	A x B- 0.775

significantly and it ranged between 7.721 to 10.645. The per cent loss in vigour index-II ranged between 33.17 to 41.65 (Table 11). The maximum loss in vigour index-II was recorded in highly susceptible and susceptible genotypes as compared to moderately susceptible, moderately resistant and resistant genotypes.

4.4 SEED LEACHATE STUDIES

4.4.1 Effect on Fungal Growth

For determining the effect of seed leachates on growth of *D. graminea,* an experiment was laid out under laboratory conditions. The medium was amended by adding seed leachates of all the 10 genotypes separately, than fungus was grown and colony diameter was measured. The data pertaining to colony diameter of fungus in mm is presented in Table 12. The data revealed that the seed leachates of highly susceptible genotypes [BH-75(c) and C-138(c)] exhibited maximum colony growth of the fungus. Whereas, the colony diameter of the fungus was minimum in resistant genotypes. The colony diameter ranged between 81.66 to 87.00 mm and colony diameter of all the genotypes differ significantly from control (79.33 mm).

4.4.2 Biochemical Analysis of Seed Leachates

Total phenols, ortho-dihydric phenols, reducing sugars, non-reducing sugars and total sugars of seed leachates were analysed by standard techniques and results of these are presented in Table 12. The data revealed that total phenols in highly susceptible genotypes was less as compared to susceptible, moderately susceptible, moderately resistant and resistant

Table 12. Biochemical assay of seed leachates from different varieties and their influences on mycelial growth of *Drechslera graminea*

Genotypes	Colony diameter (mm)	Total phenols (µg/g seed)	O-D phenols (µg/g seed)	Reducing sugars (µg/g seed)	Non-reducing sugars (µg/g seed)	Total sugars (µg/g seed)
BH-75(c)	87.00	613.66	30.33	993.00	66.33	1059.33
C-138(c)	86.33	590.33	22.66	1006.66	61.00	1067.66
DWR-28(c)	85.33	633.00	31.33	992.00	69.66	1061.66
K-669	84.33	828.66	90.33	1058.33	1119.00	2177.33
BH-510	84.00	832.35	99.33	1059.66	1133.33	2192.99
BH-393(c)	84.00	831.00	105.55	1073.33	1142.66	2215.99
RD-2552(c)	83.00	1004.33	191.66	1130.66	1712.33	2842.99
RD-2628	82.66	1038.33	234.33	1182.33	1755.00	2937.33
BH-590	82.33	1026.00	244.66	1186.33	1776.33	2962.66
BH-591	81.66	1014.66	230.33	1202.66	1789.66	2992.32
Control	79.33	-	-	-	-	-
LSD (P=0.05)	1.543	13.351	2.273	2.247	2.374	2.774

categories and it differed significantly from resistant genotypes. The total phenols ranged between 590.33 to 1038.33 µg/g seed. The ortho-dihydric phenols were also found maximum in resistant genotypes and significantly higher than highly susceptible, susceptible, moderately susceptible and moderately resistant genotypes. The ortho-dihydric phenols of different genotypes ranged between 22.66 to 244.66 µg/g seed. Similarly, reducing, non-reducing and total sugars decreased in seed leachates of highly susceptible, susceptible, moderately susceptible and moderately resistant category, whereas, it increased manifold in resistant genotypes. The reducing sugars ranged between 992.00 to 1202.66 µg/g seed in different genotypes and non-reducing sugars ranged from 61.00 to 1789.66 µg/g seed. The total sugars of all these genotypes ranged between 1059.33 to 2992.32 µg/g seed and differed significantly from each others.

4.5 MANAGEMENT OF DISEASE

4.5.1 Cultural Method

(a) Effect of nutrient

Inadequate and imbalanced doses of fertilizers aggravate disease during crop cultivation. Therefore, a study was undertaken to see the effect of different combination of nitrogen and phosphorus level on the disease incidence. Disease incidence was maximum when nitrogen and phosphorus were applied @ 20 and 10 kg/ha (Table 13). Minimum disease incidence was observed at 80 kg nitrogen and 40 kg phosphorus/ha. There was significant difference in disease incidence at N_{20} and P_{40} kg/ha over N_{80} P_{40}. However, there was no significant difference at this level of nitrogen and phosphorus (P_{20} and P_{30}). Similar trend on disease incidence was

Table 13. Effect of nitrogen and phosphorus application on the incidence of stripe disease of barley on susceptible variety C-138 in pots

Nutrient/dose	Disease incidence (%)				
	P_{10}	P_{20}	P_{30}	P_{40}	N means
N_{20}	26.10	24.44	24.91	23.16	24.65
N_{40}	25.55	23.80	22.69	22.61	23.66
N_{60}	24.91	22.69	22.61	21.97	23.05
N_{80}	24.36	22.61	21.97	19.82	22.19
P Mean	25.23	23.39	23.05	21.89	-

N = Nitrogen, P = Phosphorus

C.D. at 0.05%

P = 0.439

N = 0.439

N x P = 0.879

observed at other doses of nitrogen and phosphorus. The effect of interaction between higher doses of nitrogen (N_{60} and N_{80} kg/ha) and phosphorus (P_{40} kg/ha) on disease incidence was significant as compared to lower doses (N_{20}, N_{40} and P_{20} kg/ha) with the increase of dose (N_{20} to N_{80} and P_{10} to P_{40} kg/ha) the disease incidence was reduced significantly.

(b) Date of sowing

Adjustment of sowing date has been an age old practice with the farmers for the prevention of crop losses due to diseases. Crop was sown on five different dates and disease development in all the treatments was studied and data pertaining to it presented in Table 14. The data indicated that no significant differences were observed in disease incidence at 30 days after sowing (seedling stage) in all the dates of sowing. However, there was significant difference in disease incidence at maturity in all dates of sowings. The trend of disease severity at both the stages i.e. at seedling and maturity stages was similar as in case of disease incidence.

Maximum disease severity (84.16) was observed at maturity stage when crop was sown on 18th December and minimum (21.94) on 19th November sown crop. Maximum yield (2960.9 kg/ha) was observed when the crop was sown on 19th November and minimum was (2630.7 kg/ha) when crop was sown on 18th December. The figures of yield were corresponding to figures of disease incidence and severity on all the dates of sowing.

Table 14. Effect of date of sowing on the stripe disease incidence, severity and yield on susceptible variety C-138

Date of sowing	Incidence (%)		Severity		Yield (kg/ha)
	At seedling stage	At maturity	At seedling stage	At maturity	
19th November	1.38	11.84	1.42	21.94	2960.9
26th November	1.51	13.33	1.66	23.07	2870.9
3rd December	1.58	15.26	1.66	23.98	2827.3
10th December	1.62	15.55	2.28	26.12	2720.3
18th December	1.66	18.88	2.85	84.16	2630.7

CD at 0.05%

	Incidence:		Severity:	
	Seedling stage (A)	0.158	Seedling stage (A)	0.525
	At maturity(B)	0.249	At maturity(B)	0.830
	A x B	0.353	A x B	1.174

4.5.2 Management of Disease

(a) *In vitro*

Relative efficacy of ten fungicides to inhibit/check the fungal growth under laboratory conditions was studied by poisoned food techniques. These fungicides were tested at different concentration viz. 50, 100, 250, 500, 1000 ppm. The data pertaining to the inhibition of mycelial growth of the fungus is presented in Table 15. The data revealed that all the fungicides tested except Topsin-M and Captan completely inhibited the growth of the fungus at 500 ppm. Whereas, except Topsin-M, all the fungicides inhibited the growth of the fungus at 1000 ppm. Around 80 per cent inhibition was recorded at 250 ppm by all the fungitoxicants. Further toxicity index was calculated and it was found that Daconil (408.78) stand first, followed by Emisan (397.91) and Vitavax + Thiram (390.03). The toxicity index ranged between 332.12 to 408.78. It was minimum in Captan.

(b) *In vivo*

Chemical protection is unavoidable in standing crop unless true resistance in the crop is assured. A high uniform germinability is desired for a quality seed. Same fungicides as used in *in vitro* were evaluated for their relative efficacy to control the disease through seed treatment under field conditions during *rabi* 2001-02. Observations were recorded at maturity on per cent disease control on plant and tiller basis. All the fungicides reduced the disease significantly over the control (Table 16) on plant basis. Maximum disease control i.e. 84.58 and 84.13 per cent

Table 15. Inhibition of mycelial growth of *Drechslera graminea* by fungitoxicants on PDA medium

Fungitoxicants	Inhibition of mycelial growth (%)					Toxicity index
	Concentration (ppm)					
	50	100	250	500	1000	
Vitavax	15.70	69.77	88.63	100	100	374.10
Emisan	39.35	71.58	86.98	100	100	397.91
Raxil	25.35	64.70	79.16	100	100	369.21
Dithane M-45	24.76	67.71	81.48	100	100	373.95
Daconil	48.49	73.61	86.68	100	100	408.78
Topsin-M	43.86	51.62	79.16	83.41	98.72	356.77
Thiram	34.60	51.38	80.90	100	100	366.88
Captan	23.61	49.07	67.01	92.43	100	332.12
Vitavax + Thiram	43.28	62.96	83.79	100	100	390.03
Vitavax + Dithane M-45	42.69	60.12	84.14	100	100	386.95

Table 16. Effect of fungicide seed treatment to control barley stripe disease (*Drechslera graminea*) on susceptible var.C-138 under field conditions

Fungitoxicants	Plant infected (%)	Disease control (%) (Plant basis)	Tiller infected (%)	Disease control (%) (Tiller basis)
Vitavax	3.10	58.5	1.68	67.18
Emisan	1.51	74.4	1.24	75.78
Raxil	1.85	71.0	1.28	75.00
Dithane M-45	3.50	60.89	2.42	52.73
Daconil	3.17	64.58	2.27	55.66
Topsin-M	4.78	46.59	2.86	44.16
Thiram	3.42	61.78	2.19	57.22
Captan	3.51	60.78	2.50	51.17
Vitavax + Thiram	1.38	84.58	1.01	80.27
Vitavax + Dithane M-45	1.42	84.13	1.15	77.54
Control	8.95		5.12	
CD (at 0.05%)	0.181		0.083	

Seed were treated with 0.2% of fungitoxicants.

was recorded on plant basis when the seeds were treated with Vitavax + Thiram and Vitavax + Dithane M-45, respectively, which were having minimum plant infection i.e. 1.38 and 1.42 per cent as compared to control (8.95%) and they were at par but differ significantly from others. The per cent disease control on plant basis ranged between 46.59 to 84.58. Topsin-M gave minimum (46.59%) disease control. The disease was also calculated on tiller basis, it ranged between 1.01 to 2.86 as compared to 5.12 per cent in control. Highest disease control (80.27%) on tiller basis was also recorded with Vitavax +Thiram followed by Vitavax + Dithane M-45 (77.54%). Vitavax in combination with Thiram (84.58) and Dithane M-45 (84.13) gave maximum disease control.

CHAPTER - 5

DISCUSSION

Stripe disease induced by *Drechslera graminea* (Rabenh) Shoemaker is very destructive disease of irrigated barley crop. This disease is very serious throughout the world. It is also common in North India, particularly in Haryana and Rajasthan and causes huge loss in grain yield. It has been reported from Europe, U.S.A., South Africa, China and Japan. Keeping this view in mind, an attempt was made to identify the sources of stable resistance in indigenous barley lines for incorporating the resistance in improved cultivars, to compare seed health testing method, rate of seed transmission and its management.

A greyish black fungus was isolated from barley leaves showing typical symptoms of stripe disease and identified as *Drechslera graminea* on the basis of growth and other morphological characters. Similar observations were also reported by Butler (1918), Drechsler (1923), Hari Chand (1976) and Vivek (1994). Seeds of susceptible variety, C-138, when artificially inoculated with the isolated fungus produced typical symptoms of the disease which appeared in the form of yellow spots to yellow brown stripes on the seedlings. The symptoms started from base and extended to tip of the leaf causing necrosis of the infected tissues. The fungus sporulated extensively on such infected leaves and microscopic examination showed that spore characters were similar to the earlier description of this pathogen (Drechsler, 1923; Subramanium and Jain, 1966; Vivek, 1994).

Many workers reported that fungus sporulates extensively on the infected leaves but either poorly or does not sporulate on culture media (Ravn, 1900; Dickson, 1939; Mohammad and Mahmood, 1974 and Vivek, 1994). On the other hand, successful sporulation of the fungus on artificial media has been reported by Houston and Oswald (1946) and Lecicowa (1966). Similarly, in present investigations there was no sporulation when the fungus was grown on PDA. Failure in sporulation in the present studies might be due to differences in isolates of pathogen, since pathogenic variability exist in the fungus as reported by various workers (Singh, 1971; Singh and Saksena, [illegible]; Mohammad and Mahmood, 1974).

Under present investigations, the fungus sporulates extensively on the infected leaves. These findings are in agreement with those of Ravn (1900), Dickson (1939), Mohammad and Mahmood (1974) and Vivek (1994) who later reported abundant sporulation on leaves.

Use of resistant varieties is one of the most economical and efficient way to counteract the pathogen due to its long lasting nature. Lot of work has been done by several workers (Mehta *et al.*, 1953; Grachev, 1964; Singh and Atheya, 1970; Bisht and Mittal, 1991 and Vivek *et al.*, 1999a) on varietal resistance against stripe disease in India and abroad. In the present study 130 barley genotypes were screened against *D. graminea* under field and green house conditions during 2000-01 and 2001-02 crop seasons. When these genotypes were categorised under field conditions on the basis of per cent plant infection, 81 genotypes were found highly resistant, 5 resistant, 21 moderately resistant, 8 moderately susceptible, 6 susceptible and 7 highly susceptible. Present investigations are in confirmation with Hari Chand (1976) and Vivek *et al.* (1998) who have also reported C-138 and BH-75 highly susceptible. Under green house conditions the trend of resistance and susceptibility was similar as under field conditions. However, per cent infection was on higher side. It might be due to high inoculum load/density. It was generally observed that low and high percentage of infected plants/tillers were corresponding to low and high mean infection value. Screening of genotypes revealed that there is sufficient material with the barley breeders, which can be utilized for incorporating resistance against stripe disease.

In the present study the detection of *Drechslera graminea* in barley seeds was assessed by blotter and seedling symptom test. Out of these two methods, blotter method was more sensitive/superior than seedling symptom test. The infection percentage of seed was higher in blotter paper as compared to seedling symptom test. It might be due to more conducive condition for development of pathogen than the seedling symptom test. Similar observations were made by Brodal (1997) where he has detected the pathogen by osmotic blotter, freezer blotter and agar plate method. He further reported that osmotic blotter paper gave reproducible results. The present study suggests that blotter paper method would be ideal for routine low cost barley seed testing against *D. graminea* infection.

In the present investigation, the seed to plant transmission rate varied from 56.66 to 93.33 per cent. These findings are in agreement with those of Capelli and Torre (1988) where they have reported the rate of seed transmission upto 60.9 per cent.

1000-grain weight was influenced by the disease and per cent loss in grain weight ranged between 23.08 to 36.32 in different varieties. Present findings are in agreement with Babadoost and Toraby (1991) who have reported 79 per cent reduction in 1000-grain weight. Differences in the losses might be due to genetic make up of the genotypes. Grain density of diseased seeds was significantly low as compared to healthy in all the genotypes. It varied from 3.15 to 6.18 per cent.

The per cent loss in 1000-grain weight ranged between 23.08 to 86.32 depending upon genotypes. The maximum loss was recorded in BH-75, susceptible genotype whereas, minimum loss was recorded in BH-591. These findings are in confirming with the observation of Vivek *et al.* (1998), where he has reported 46.7 per cent grain loss in a susceptible genotype C-138. They further reported that yield reduction (1000-grain weight) varied from variety to variety depending upon varietal susceptibility. The reduction was more significant in susceptible and highly susceptible variety as compared to resistant one.

Number of grains per ear was also influenced by the host susceptibility. The per cent loss in number of grains per ear varied from 42.90 to 66.50. These results are in confirmity with the findings of Vivek *et al.* (1998), where he has reported the loss in grain yield more than 40 per cent and had used only a highly susceptible variety C-138, whereas, in present investigation 10 genotypes were studied. Generally, healthy seeds of the crop are supposed to show high germination and good crop stand under lab as well as field conditions. In the present investigation seed germination of all the healthy genotypes ranged from 89.66 to 95.66 per cent which was above the ISTA standard, whereas, seed germination reduced significantly in susceptible genotypes. These findings are in accordance with those of Pillai and Rao (1990), where they have found higher germination in resistant varieties. The respiration rate of diseased seedling decreased significantly and loss in respiration ranged between 5.15 to 28.74 per cent depending upon host resistance/susceptibility. These results are in agreement with those of Kiraly and Farkas (1957), where they have reported 35 to 40 per cent inhibition of respiration rate in rusted and mildew leaves of wheat. Similarly, Shaw and Samborski (1957), Grimm and Wheeler (1963), Swamy (1964) reported higher rate of respiration in rusted leaves. It appears that plants invaded by pathogenic organism not only stimulate higher respiration but also activate enzyme system and thus alter respiration pathway. Toxins have also been reported to induce respiration changes (Lakshmanan and Venkataram, 1957; Andal, 1959).

The vigour index-I and II was calculated on the basis of seed germination, seedling length and seedling dry weight. Vigour index-I and II of all the susceptible genotypes decreased significantly and the per cent loss in vigour index-I and II ranged from 39.23 to 46.93 and 33.17 to 41.65, respectively. The present findings are in agreement with Pillai and Rao (1990) where they have showed higher germination and superior vigour of the seedlings in resistant cultivar as compared to susceptible cultivar.

Since barley varieties varies in degree of resistance to *D. graminea*, studies were conducted to know the quantitative differences in the level of phenols and sugars and their effect on fungal growth in the seed leachates of resistant and susceptible genotypes. Seed leachates obtained from all genotypes stimulated the fungal growth. However, the stimulation of fungal growth in resistant genotypes (BH-590 and BH-591) was less than the susceptible genotypes (BH-75 and C-138). This was due to higher amount of phenols, ortho-dihydric phenols, reducing sugars and non-reducing sugars. These studies indicate that there was a positive correlation between phenols, sugars and resistance of genotype. The present findings are in corroboration with those of Kuc (1966), Kumar and Jalali (1985), Parashar *et al.* (1991), and Vivek *et al.* (1990), where they have reported that phenols play an important role in confirming the resistance to a variety.

Studies were carried out to manage the disease by cultural practices viz. applying of nitrogen and phosphorus fertilizer at different levels and adjusting the date of sowings. Disease incidence was maximum at low level of nitrogen (20 kg/ha) and phosphorus (10 kg/ha). Minimum disease incidence was observed at higher level of nitrogen (80 kg/ha) and phosphorus (40 kg/ha). With the increase in doses of nitrogen and phosphorus the disease incidence was significantly reduced. The results of present findings confirm the findings of Mathur and Bhatnagar (1990a). The low incidence of disease at higher level of nitrogen and phosphorus was due to adequate and balanced dose of nitrogen and phosphorus because of fast growth and vigour of the plant.

Different dates of sowing, starting from 19th November at weekly interval were tried to check the stripe disease. Among the dates of sowings, 19th November sown crop showed minimum disease incidence and the disease increased significantly with each succeeding date of sowing. Early sown crop gave highest yield 2960.9 kg/ha as compared to late sown crop. These findings are in confirmity with those of Mathur and Bhatnagar (1990a) where they have reported that early sown crop with recommended dose of balanced fertilizer reduce the disease significantly.

Among the various methods available for disease management, seed treatment with fungitoxicant has attracted considerable significance. Since *D. graminea* is a seed borne fungus, therefore, different fungicides were tested as seed dressers under field conditions. The same set of fungitoxicants were also evaluated by poisoned food technique under lab conditions. Daconil and Emisan proved to be superior under laboratory conditions. These results are in agreement with the observation of Vivek *et al.* (1995) where they have reported that Emisan was found to be the best in controlling the disease.

Therefore, different fungicides were tested for the inhibition of fungal growth under laboratory conditions. These fungicides were also tested as seed treatment for the control of disease under field conditions. Among the fungitoxicants, Daconil with the toxicity index (408.78) proved best in inhibiting the mycelial growth of the fungus. Vitavax + Thiram were next to Daconil in inhibiting the mycelial growth. The effectiveness of these fungicides against *D. graminea* under lab conditions was contrary to the observation of Vivek *et al.* (1995).

Under field conditions, Vitavax in combination with Thiram proved to be best with 80.27 per cent disease control. Results of present findings are in accordance with Klin and Roane (1972) and Efremova (1975) where they reported good control of disease with Vitavax when used in combination with other fungitoxicants. The similar observations were reported by other workers (Porter, 1957; Grewal and Vir, 1958; Chohan *et al.*, 1966; Singh and Siddiqui, 1986 and Vivek *et al.*, 1995).

CHAPTER - 6

SUMMARY

In the present investigation a fungus was isolated from barley leaves showing typical symptoms of stripe disease. On the basis of its morphological characters the fungus was identified as *D. graminea* and its pathogenicity was proved.

A total of 130 barley germplasm lines were screened under field and greeu house conditions during *rabi* 2000-01 and 2001-02 crop seasons, respectively. Observations on disease incidence were recorded on the basis of plant and tiller infected and mean infection value. Under field conditions, 81 lines found higbly resistant with no diseased plants, whereas, rest 49 lines showed 0.47 to 35.08 and 0.17 to 26.65 per cent infection on plant and tiller basis, respectively. Among these 49 lines, 5 lines found resistant, 23 moderately resistant, 8 moderately susceptible, 6 susceptible and 7 highly susceptible on the basis of plant infected. On the other hand, when these lines were grouped on the basis of mean infection value, 81 lines found highly resistant having zero mean infection value, 16 resistant, 10 moderately resistant, 12 moderately susceptible, 9 susceptible and 2 highly susceptible having mean infection value more

than 40.

When same 130 germplasm lines were screened under green house conditions, 71 lines having no infected plant and put under highly resistant group, whereas, 59 showed 0.78 to 38.84 and 0.12 to 26.67 per cent infection on plant and tiller basis, respectively. Among these 59 lines, 9 were resistant, 26 moderately resistant, 12 moderately susceptible, 7 susceptible and 9 highly susceptible having more than 15 per cent plant infected. But when grouped on the basis of mean infection value out of 130 lines, 71 lines were found having zero mean infection value considered as highly resistant, 5 resistant, 14 moderately resistant, 14 moderately susceptible, 10 susceptible and 4 highly susceptible.

Out of two methods used for detection of *D. graminea*, blotter paper method was found superior than seedling symptom test. In blotter paper method 15 to 34 per cent seed showed infection as compared to 12 to 29 per cent infection in seedling symptom test. The rate of seed transmission of pathogen was 56.66 to 93.33 and 50.85 to 82.69 per cent on plant and tiller basis, respectively. Quantitative losses viz., reduction in 1000-grain weight (23.00 - 36.32%), grain density (3.15 - 6.18%) and number of grains per ear (42.90 - 66.50%) were observed in all the test genotypes, but the loss was higher in highly susceptible genotypes than the other reaction categories. Similarly, qualitative losses were also observed for seed germination, respiration rate and vigour indices. The per cent loss in germination was highest (29.43%) in BH-75(c) (HS). Whereas, it was minimum in resistant genotype viz., BH-591 (19.27%). Per cent loss in respiration rate was also maximum (22.74%) in highly susceptible genotypes viz., BH-75(c), whereas it was minimum (5.15%) in resistant genotype i.e. BH-590 followed by BH-591 (6.48%). The per cent loss in vigour index-I was minimum (39.23%) minimum in resistant genotype (BH-591) as compared to other categories. Same trend was observed in vigour index-II.

Seed leachates of highly susceptible genotypes viz., BH-75(c) (87.00 mm) and C-138 (c) (86.33 mm) exhibited maximum colony growth of the fungus as compared to resistant genotype i.e. BH-591 (81.66 mm). Seed leachates of all the genotypes enhanced the growth of the fungus as compared to control (79.33 mm). Total phenols, ortho-dihydric phenols, reducing sugars, non-reducing sugars and total sugars was significantly less in highly susceptible genotypes as compared to resistant genotypes.

Higher dose of nitrogen (80 kg/ha) and phosphorus (40 kg/ha) was effective in reducing the disease incidence over low doses of nitrogen (20, 40 and 60 kg/ha) and phosphorus (10, 20 and 30 kg/ha). The disease incidence was less in early sown crop i.e. 19th November as compared to late sown crop. Seed yield was also maximum in early sown crop.

Under lab conditions, Daconil with the toxicity index 408.78 proved to be most effective in controlling the fungus growth followed by Emisan (397.91), Vitavax + Thiram (390.03), Vitavax + Dithane M-45 (386.95). However, when these fungicides were tested under field conditions as seed treatment, Vitavax + Thiram gave maximum disease control 84.58 and 84.13 on plant and tiller basis, respectively, followed by Vitavax + Dithane M-45 84.13 and 77.54 on plant and tiller basis, respectively.

LITERATURE CITED

Andal, R. 1959. Studies on foot-rot disease of rice. Ph.D.Thesis, University of Madras, Madras.

Anonymous. 2002. Statistical Abstract of Haryana. Issued by Economic and Statistical Organisation, Planning Department, Govt. of Haryana, Chandigarh.

Atheya, S.C. 1974. Resistance of barley varieties to stripe disease in U.P. *Indian J. Mycol. Plant Path.* **4**: 83.

Babadoost, M. and Toraby, E. 1991. Barley stripe disease (*Drechslera graminea*) in East Azerbaijan, Iran. Incidence and yield losses. *Rachis* **10**: 19-22.

Behar, D.S. and Aulakh, K.S. 1988. Incidence of stripe disease of barley in Punjab. *Plant Dis. Res.* **3**: 82-83.

Behroozin, M. and Assadi, P. 1997. Evaluation of the efficacy of four fungicides as seed treatment for control of barley leaf stripe in East Azerbaijan and Ardebil. *Seed and Plant* **13**(1): 23-28.

Bisht, I.S. and Mittal, S.K. 1991. Evaluation of barley germplasm for resistance against stripe disease. *Indian Phytopath.* **44**: 516-517.

Bray, H.G. and Thorpe, W.V. 1954. Analysis of phenolic compounds of interest in metabolism. *Meth. Biochem.Anal.* **1**: 27-50.

Brodal, G. 1997. Comparative tests with the osmotic blotter methods for detection of *Drechslera* spp. in barley seeds. In : *Seed health testing:* Progress towards the 21st century (Eds: Hutchins, J.D.; Reeves, J.C.) Wallingford, U.K.; CAB International 211-218.

Butler, E.J. 1918. Fungi and diseases in plants. Thacker Spinck and Co. Calcutta, India. 547 pp.

Capelli, C. and Torre,G. della 1988.*Drechslera graminea* (Rabenh. Ex.Schlecht.) Shoemaker in barley seed samples and its transmission in the field in the years 1984-86. *Annali della Facolta di Agraria, Universita degli Studi di Perugia* b40b: 85-94.

Carpenter, J.B. 1942. A toximetric study of some eradicants fungicides. *Phytopathology* **32**: 845-856.

Chohan, J.S.; Rai, I.S. and Kang, M.S. 1966. Relative efficacy of some fungicides for the control of stripe disease of barley caused by *Helminthosporium gramineum* Rabh. *J. Res. Ludhiana* **3**: 297-300.

Cserhati, Z. 1984. (Helminthosporium leaf stripe disease on spring barley) Tavasgi arpafajtak helminthosporumos levelcsikol stage fertozottsegenck alakulasa. *Novenyvedelum* **20**: 465-466.

Dickson, James, G. 1939. *Outline of diseases of cereal and forage crop plants of the northern part of the United States.* Burgess Pub. Co. Minneapolis, Minn. 259 p.

Drechsler, C. 1923. Some graminicolous species of *Helminthosporium. Indian J. Agric. Res.* **24**: 641-740.

Dubois, M.; Gills, K.A.; Hamilton, J.K.; Rabarg, P.A. and Smith, F. 1956. Colorimetric methods for determination of sugars and related substance. *Anal. Chem.* **28**: 350-356.

Efremova, Z. 1975. Investigation on new toxic chemicals against the leaf stripe of barley used in the pre-sowing treatment of seeds under conditions of Kirov region. *Referactivnyizhurnal* **12**: 14, 1856.

El-Ghamry, M.; Rizk, R.A.; Sherif, S.; Mostafa, E.E. and El-Nashar. F. 1991. Integrated control of barley leaf stripe in Egypt. *Assiut. J.Agric. Sci.* **22**: 89-104.

El-Sayed, A.A.; El-Nashar, F.; El-Ghamry, M.; Mostafa, G.E. and Rizk, R.A. 1991. Disease resistance of barley genotypes under the conditions of northwestern coast of Egypt. *Assiut J. Agric. Sci.* 22(1): 127-142.

El-Sayed, A.A.; Ghobrial, E.; Noaman,M.M.; Rizk, R.A. and Mostafa, E.E. 1995. Evaluation of some barley varieties against major disease in the Northwestern coastal region. *Egyptian J. Agri. Res.* 73(4): 897-911.

Foister, C.E. 1961. *Economic Plant Diseases of Scotland, Technical Bulletin No.* 1, Edinburgh: Department of Agriculture and Fisheries for Scotland, HMSO.

Gilchrist, A.D. and Christie, A.G. 1998. Low cost mercury replacement cereal seed treatment. London, U.K.; Home Grown Cereals Authority (HGCA) Project Report No. 153, 12 pp.

Golovnya, T.I.; Karako, N.S. and Buga, S.F. 1980. Sowing material should be of high quality. *Zashchita Rastenii* **11**: 8-9.

Gorden, T.R.; Webester, R.K.; Jackson, L.F. and Hall, D.H. 1985. Chemical seed treatment for control of barley leaf stripe in California. *Plant Dis.* 64: 474-477.

Gorden, T.R.; Webster, R.K.; Jackson, L.F. and Hall, D.H. 1985. Chemical seed treatment for control of barley leaf stripe in California. *Plant Dis.* **64**: 474-477.

Grachev, A.F. 1964. Ustoichivost yachmenei, K. polosatoi pyantistosi Vuslviyakh primosskago kraya (Resistance of barleys to streak spot under the conditions of primorsk region Sb. Trud Uses Inst. *Rasteniev* **1**: 82-85.

Grebenchuk, E.A. 1962. Trud-khorhov Sel. *Khoz. Inst.* **38**: 188-193.

Grewal, J.S. and Vir, D. 1958. Efficacy of different fungicides seed treatment in relation to stem rot of jute and stripe disease of barley. *Indian Phytopath.* **11**: 175-178.

Grimm, R.a nd Wheeler, H. 1963. Respiratory and enzymatic changes in Victoria blight of oats.*Phytopathology* **53**: 436-440.

Grover, R.K. and Moore, J.D. 1962. A toximetric studies of fungicides against brown rot organism *Sclerotia sclerotinia* and *S. laxa*.. *Phytopathology* **52**: 876-880.

Gulati, S.B. and Mathur, S.K. 1983. Effect of barley seed leachates on the spore germination of *Drechslera graminea*. *Journal of the Indian Botanical Society* **62**(1): 101-105.

Hall, D.H.; Teviotdale, B.L. and Paulus, A.O. 1978. Chemical control of seed borne disease of wheat and barley. *California Agri.* **32**: 14-15.

Harichand. 1976. *Studies on Helminthosporium diseases of barley in Haryana.* M.Sc. Thesis, Haryana Agricultural University, Hisar, India.

Hauston. B.R. and Oswald,J.W. 1946. The effect of light and temperature on conidia production by *Helminthosporium gramineum* in culture. *Phytopathology* **36**: 1049-1055.

Johnson, G. and Schaal, L.A. 1952. Relation of chlorogenic acid to scab resistance in potato. *Science* **115**: 627-629.

Kiraly, Z. and Farkas, G.L. 1957. On the role of ascorbic oxidase in parasitically increased respiration of wheat. *Arch. Biochem. Biophys.***66**: 474-485.

Kline, D.M. 1972. Helminthosporium stripe resistance in spring barley cultivars. *Plant Dis.Reptr.* **56**: 891-893.

Kline, D.M. and Roane, C.W. 1972. Fungicides for the control of *Helminthosporium* stripe of barley. *Plant Dis. Reptr.* **56**(2): 183-185.

Kovacs,A.I. 1982. The effect of seed treatment with chlormequat on the control of barley leaf stripe [*Drechslera gramiena* (Rabenh. & Schlect.) Shoemaker] with fungicides. *Crop Protection* **1**(3): 369-372.

Kraft, J.M. and Erwin, D.C. 1967. Stimulation of *P. aphani* by exudates from mung bean seeds. *Phytopathology.* **57**: 866.

Kratsova, T.I. 1969. *Mokol I. Fitopathol.* **3**: 187-188.

Kuc, J. 1966. Resistance of plants to infectious agents. *Ann. Rev.Microbiol.***20**: 337-370.

Kumar, A. and Jalali,B.L. 1985. Differential effects of seed leachates on seed borne pathogens associated with chickpea. *Indian Phytopath.***38**: 99-103.

Lakshmanan, M. and Venkata-Ram, C.S. 1957. Influence of *Fusarium* culture filtrates on respiratory changes in cotton. *Proc. Indian Acad. Sci.***46**: 131-137.

Lecicowa, B. 1966. *Annals Univ. Marial. Curies todowska* **21**: 157.

Madsen, E. and Hvelplund, N.J. 1998. Raxil RIM 035 ES – a new standard against *Ustilago nuda.* 15th Danish Plant Protection Conference. *Pests and Diseases. DJF – Rapoort, Markburg.* **3**: 39-48.

Maric, A.; Mikic, K. and Masirevic, S. 1985. Effectiveness of some fungicides in controlling leaf stripe (*Drechslera graminea* Rab. & Schlecht) and net blotch (*Drechslera teres* Sacc. Shoemach.) on winter barley. *Zastita-Bilja* **36**(1):19-26.

Mathur, A.K. and Bhatnagar, G.C. 1990a. Effect of Mineral Element, Hormone and Urea on Stripe Disease Infection in Barley. *Indian J. Mycol. Pl. Pathol.* **20**(2): 192-193.

Mathur, A.K. and Bhatnagar, G.C. 1990b. Field evaluation of different fungicides in controlling stripe disease of barley. *Indian J. Agric. Sci.* **60**: 564-565.

Mathur, A.K. and Bhatnagar, G.C. 1991. Management of barley stripe with minor elements. *Indian Phytopath.***43**: 383-386.

Mathur, A.K. and Bhatnagar, G.C. 1992. Sources of resistance in barley against stripe disease caused by *Helminthosporium gramineum. Indian Phytopath.* **45**: 115-116.

Mathur, A.K. and Bhatnagar, G.C. 1993. Effect of fertilizers and sowing date on the incidence of barley stripe. *Indian J. Mycol. Pl. Pathol.* **23**(3): 307-310.

Mathur, R.S.; Mathur, S.C. and Bajpai, G.K. 1964. An attempt to estimate losses caused by the stripe disease of barley. *Plant Dis. Reptr.* **48**: 708-710.

Mehta, P.R.; Singh, B.; Mathur, S.C. and Singh, S.B. 1953. Varietal reaction to stripe disease of barley. *Sci & Cult.* **19**: 252-263.

Mohammad, A. and Mahmood, M. 1974. Sporulation in *Helminthosporium gramineum* Rabh. in culture. *Indian Phytopath.* **26**: 729-730.

Navaschchanov, S. 1978. Results of tests with some fungicides in the control of barley stripe disease. *Rastenievdni Nauki* **15**: 134-140.

Paleg, L.G. 1960. Physiological effect of gibberellic acid on carbohydrate metabolism and amylase activity of barley endosperm. *Pl. Physiol.* **35**: 293.

Pant, S.K.and Bisht, K.K.S. 1983. Effect of stripe disease of barley on yield components. *Indian Phytopath.* **36**: 103-105.

Parashar, R.D.; Indra Hooda and Sindhan, G.S. 1991. Penetration and infection of different chickpea cultivars by *Rhizoctonia solani. Plant Dis. Res.* **7**: 60-63.

Pillai, P.K. 1989. Management of stripe disease of barley by physical and chemical methods. *Indian Phytopath.* **36**: 103-105.

Pillai, P.K. and Rao, R. 1990. Seedling vigour as parameter in assessing resistance of barley stripe disease. *Indian Phytopath.* **43**: 242.

Porter, R.H. 1957. Seed treatment for stripe and covered smut of barley. *Pl. Dis. Reptr.* **40**: 112-117.

Ravn, M.N. 1980. Mogle *Helminthosporium* arter og de of dem fremkaltde sygd oome, hos Byg og Havre. *Bot. Tidsskr.* **23**: 101-132.

Rich, S. and Horsfall, J.G. 1961. Fungitoxicity of carbamic and thiocarbamic acid esters. *Bull. Connecticut Agr. Exp.Sta.* New Haven, 639.

Schmitz, H. 1930. A suggested toximetric method for wood preservations . *Indst. And Engg. Chem.Analyst.*Ed. **2**: 361-363.

Sharma, R.C.; Gill, S.S. and Randhawa, H.S. 1996. Vitavax – An effective seed dresser for combined control of stripe disease and smuts of barley. *Seed Res.* **22**(2): 177-178.

Shaw, M. and Sambarski, D.J. 1957. The physiology of host-parasite relations-III. The pattern of respiration in rusted and mildewed cereal leaves. *An. J. Bot.* **35**: 389-405.

Singh, B.and Mathur, S.C. 1953. Stripe disease of barley. *J. Agric. Anim. Husbandry* (U.P.) **10**: 11-12.

Singh, D. and Siddiqui, M.R. 1986. Stripe disease of barley; its effects on tillering and grain yield and its control. *Indian Phytopath.* **39**: 102-104.

Singh, D.B. 1986. Evaluation of fungicides for the control of *Alternaria brassicae* and *Drechslera graminea. Iranian J. Pl. Path.* **22**: 39-43.

Singh, D.B. and Rai, B. 1982. Effect of certain agro-chemicals on growth behaviour of *Alternaria brassicae* and *Drechslera gramiena. Acta-Botanica-Indica* **10**(1): 4-7.

Singh, D.V. 1971. Studies on cultural and pathogenic variability in *Helminthosporium gramineum. Agra Univ. Res.* **20**: 95-100.

Singh, D.V. and Atheya, S.C. 1970. Resistance of barley varieties to stripe disease in U.P. *Indian J. Microbiol.* **10**: 87-88.

Singh. S. and Srivastava, K.C. 1986. Varietal resistance of barley to stripe disease. *Farm Sci. J.* **3**: 86.

Skou, J.P. and Haahr, V. 1985. The barleys in Nordic Gene Bank screened for resistance against barley leaf stripe (*Drechslera graminea*). *Nordisk-Jordbrugsforsckning* **67**(2): 262-263.

Subramanium, C.V. and Jain, B.L. 1966. A revision of some graminicolous Helminthosporia. *Curr. Sci.* **14**: 352-355.

Sudheer Kumar and Jain, S.C. 1996. Effect of *Drechslera* spp. on seed germination and seedling of barley. *Annals of Agri. Bio Research* **1**(½): 169-171.

Swamy, R.N. 1964. Respiration in *Cercospora* infected groundnut tissues. II. Effect of some enzyme inhibitors and 2, 4-Dinitrophenol on respiration. *Indian J. Exp. Biol.* **3**: 8-12..

Tekauz, A. 1983. Reaction of Canadian barley cultivars to *Pyrenophora graminea*, the incitant of leaf stripe. *Canadian J. Pl. Path.***5**: 297.

Teviotdale, B.L. and Hall, K.H. 1976. Effect of light and temperature on number and length of *Helminthosporium gramineum* conidia produced in culture. *Journal of Botany* **45**: 644-648.

Tyagi, P.D. 1974. Barley diseases situation in Haryana during 1973-74. All India Barley Workshop, New Delhi.

Vanhanen, R. 1981. Experiments with non-mercury seed dressings on spring cereals. *Annales-Agriculturae-Fenniae* **20**(2): 89-101.

Varshney, Vibha and Varshney, V. 2001. Effect of plant extracts on *Drechslera graminea*, the causal agent of stripe disease of barley. *Indian Phytopath.* **54**(1): 88-90.

Vivek Kumar. 1994. Studies on stripe Disease of Barley (*Hordeum vulgare* L.) Caused by *Drechslera gramiena* (Robenh.) Shoemaker. M.Sc. Thesis, CCS Haryana Agricultural University, Hisar.

Vivek Kumar; Indra Hooda and Saharan, G.S. 1995. Seed treatment for stripe disease of barley caused by *Drechslera graminea*. *Plant Dis. Res.* **10**(2): 126-129.

Vivek, Kumar; Indra, Hooda and Sindhan, G.S. 1998. Estimation of yield losses in barley due to *Drechslera graminae* the causal agent of stripe disease. *Indian Phytopath.* **51**(4): 365-366.

Vivek, Kumar; Indra, Hooda and Sindhan, G.S. 1999b. Role of seed exudates in differential behaviour of barley varieties to *Drechslera graminea* infection. *J. Mycol. Pl. Pathol.* **29**(1): 121-122.

Vivek, Kumar; Indra, Hoods and Sindhan, G.S. 1999a. Assessment of resistauce in barley varieties to stripe disease caused by *Drechslera graminea. J. Mycol. Pl. Pathol.* **29**(1): 122-124.

Winter, W.; Banziger, I.; Krebs, H.; Ruegger,A.; Frei, P. and Gindrat, D. 1998. Alternative methods of control of cereal bunts and barley stripe disease. *Agrarforschung* **5**(1): 29-38.

Winter,W.; Krebs, H. and Banziger, I. 1995. Smut fungi and leaf stripe : Varietal susceptibility. *Agrarforschung.* **2**(8): 325-328.

APPENDIX – I

List of chemicals tested against *D. graminea*

Trade name (Common name)	Chemical name	Formulations (%)
Vitavax (carboxin)	2, 3 dihydro-6 methyl-5 phenyl carboxymoyl-1, 4	75 W.P.
Emisan	Methoxy ethyl mercury chloride	6 Hg
Raxil (tebuconazole)	(RS)-1-p-chlorophenyl-4, 4-dimethyl-e-3-(1H-1,2, 2, 2 triazole)	2 W.P.
Dithane M-45 (mancozeb)	Mangnese ethylene bis-dithio-carbamate plus zinc	80 W.P.
Daconil (chlorothalonil)	Tetrachloro isophthalo-nitrite	75 W.P.
Topsin M (thiophanate-methyl)	Dimethyl 4,4-(0-phenylene) bis (3-thioallophanate)	70 W.P.
Captan	N-trichloromethylthio-4-chelohexane-1, 2-dicarboxamide	50 W.P.
Thiram	Tetra methyl thiuram disulphide	75 D.S.

ABSTRACT

Title of Thesis	:	Studies on the effect of stripe disease of barley [*Drechslera graminea* (Rabenh.) Shoemaker] on seed quality and its management
Full Name of Degree Holder	:	**Jitender Kumar** (99A59D)
Title of Degree	:	Doctor of Philosophy
Name and Address of Major Advisor	:	Dr. L.S. Suhag Director of Extension Education CCS Haryana Agricultural University Hisar–125004, India
Degree awarding University/Institute	:	CCS Haryana Agricultural University Hisar-125 004, India
Year of award of degree	:	2003
Major subject	:	Plant Pathology
Total number of pages in Thesis	:	79+ix

Number of words in abstract: Approx. 300

A greyish black fungus isolated from barley leaves was identified as *D. graminea* on the basis of its growth and morphological characters. Out of 130 barley germplasm lines screened, 81 were found highly resistant under field and 71 germplasm lines under greenhouse conditions. These germplasm lines need further screening for 2-3 years to confirm their resistance. Out of two methods used for detection of *D. graminea*, blotter method was superior over seedling symptom test. The rate of seed transmission of pathogen varied from 50.82 to 82.69 per cent on tiller basis. Per cent loss in 1000-grain weight and grain density was more in susceptible genotypes i.e. BH-75(c) and C-138(c) than resistant genotypes BH-590 and 591. Per cent loss in grains per ear was correspondingly increased with the increase in disease. Seed germination, respiration rate and seedling vigour indices were less in diseased seeds as compared to healthy seeds in all the genotypes. Varietal resistance was directly related with the quantity of total phenols, ortho-dihydric phenols, reducing,non-reducign and total sugars present in seed leachates. Higher dose of nitrogen and phosphorus was more effective in reducing the disease incidence over lower dose of nitrogen and phosphorus. Crop sown on 19th November contracted less disease as compared to late sown crop. Grain yield was also maximum in early sown crop. For the control of *D. graminea* Vitavax + Thiram proved to be most effective followed by Emisan and Rexil which gave more than 75 per cent disease control.

MAJOR ADVISOR

STUDENT

HEAD OF DEPARTMENT