VARIETAL SCREENING AND MANAGEMENT OF LEAF BLIGHT OF WHEAT CAUSED BY *BIPOLARIS SOROKINIANA*

DEPARTMENT OF PLANT PATHOLOGY

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VARIETAL SCREENING AND MANAGEMENT OF LEAF BLIGHT OF WHEAT CAUSED BY *BIPOLARIS SOROKINIANA*

BY

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A Thesis

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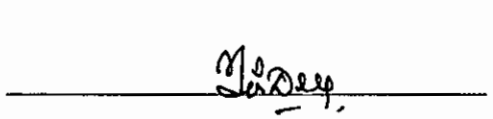

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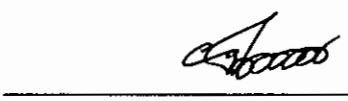

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This is to certify that the thesis entitled, "VARIETAL SCREENING AND MANAGEMENT OF LEAF BLIGHT OF WHEAT CAUSED BY *BIPOLARIS SOROKINIANA*" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in PLANT PATHOLOGY embodies the result of a piece of *bona fide* research work carried out by MOHAMMAD SHAHIDULLAH Registration No. 23867/00139 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has been duly acknowledged by him.

Dated: 10/10/2006
Dhaka, Bangladesh

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VARIETAL SCREENING AND MANAGEMENT OF LEAF BLIGHT OF WHEAT CAUSED BY *BIPOLARIS SOROKINIANA*

ABSTRACT

By

Mohammad Shahidullah

Experiments were conducted at Bangladesh Agricultural Research Institute (BARI) Joydebpur, Gazipur during 2004-2005 crop season. In field screening of 14 germplasms under natural infection pressure of Bipolaris leaf blight 3 reached as resistant (Chirya-7, Shatabdi and BAW-966) and 1 reached as moderately resistant (BAW -1006) to the disease. All the five fungicides (Avistin-0.1%, Hayconazole- 0.05%, Nuben-0.2%, Sulphotox-0.2% and Tilt-0.05%) tested against *Bipolaris sorokiniana,* showed better performance over control. Among them Tilt appeared most effective and resulted against the PDI value of 72% and increased 108% grain yield over control. While effective dose of four fungicides namely folicur (0.05 and 0.10%), Hexaconazole (0.05 and 0.1%), Fujione (0.05 and 0.1%) and Akanazole (0.05 and 0.1%) were evaluated against Bipolaris leaf blight it was found that F_2 D_2. Exhibited most effective one in reducing the disease and increasing higher yield and it showed statistically similar to F_1D_1 (Folicur, 0.05%) F_1D_2 (Folicur, 0.1%) and F_2D_1 (Hexaconazole (0.05%). In another study on determining avoidable loss of wheat due to Bipolaris leaf blight indicated avoidable loss of 27.05 and 14.20% were due to the disease respectively, in Kanchon (Susceptible) and Shatabdi (Moderately resistant) varieties.

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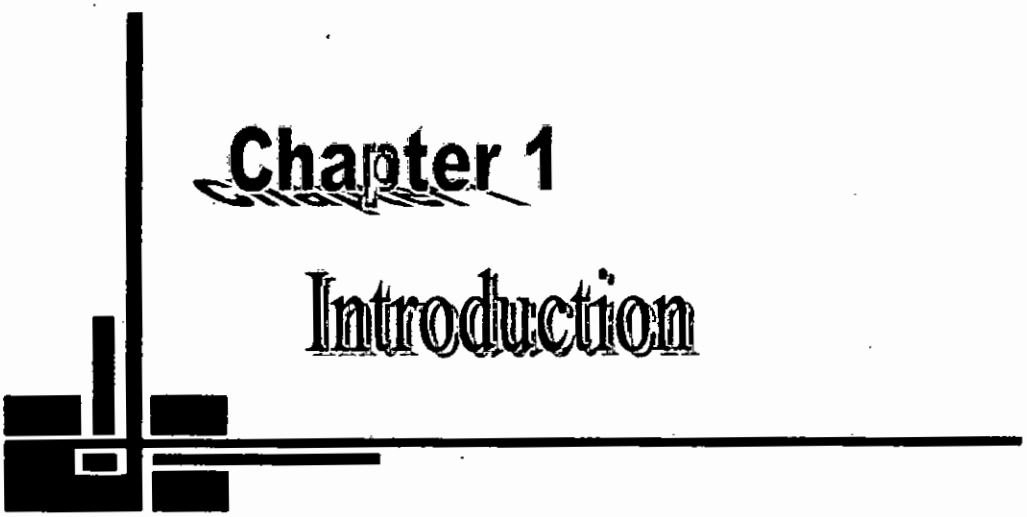
Dedicated to

My

Beloved Parents



Chapter 1

Introduction

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops in the world. It is the second major cereal crop after rice in Bangladesh. About 642.1 thousand hectares of land was covered by wheat cultivation with the annual production of 1253 thousand tons (1.95 t/ha) in Bangladesh (BBS, 2005). In the country the crop is affected by more than 17 diseases (Islam and Khan, 1982 and Ahmed and Hossain, 1985). 12 of them are caused by fungi, out of which 5 are economically most important due to their damaging nature and wider occurrence throughout the country (Ahmed and Meisner, 1996). These diseases are: leaf rust (*Puccinia recondita*), leaf blight (*Bipolaris sorokiniana),* Foot and root rot (*Sclerotium rolfsii*) and black point (*Bipolaris sorokiniana, Alternaria triticina,* and *Alternaria tenuis)*

The causal agent of Bipolaris leaf blight (BpLB), *Bipolaris sorokiniana* (Sacc.) Shoemakre is one of the most important diseases, reported to be highly seed transmitted and causes seedling blight, BpLB, head blight and black point in the growing crop (Ali and Fakir, 1992 and Rashid *et al.* 1997).

Almost all the commercial varieties have been recorded susceptible to this disease to various degrees resulting substantial losses in yield. The severity of the disease increases with plant age and reaches to its maximum towards crop maturity.

General BpLB appears at the seedling stage and increases with plant age (Alam *et al.* 1994). The pathogen attacks growing plants, panicles and

grains. It cause black point disease of wheat grains. Ear head and grain infection by *Bipolaris sorokiniana* is also common in Bangladesh. Infection in the grain results in seed discoloration which is known as black point or kernel smudges. Up to 95% of grains may be affected by black point and infected grains are not suitable for using as seed. The black point has an adverse effect on seed weight, germination and grain yield (Dey *et al.* 1992; Rahman and Islam, 1998 and Hossain, 2000).

In Bangladesh, yield loss due to BpLB has been estimated 20% (Razzaque and Hossain, 1991, Alam *et al.* 1995).

The basic principle involved in the control of *Bipolaris sorokiniana* is the reduction the population of inoculum source. Among the management approaches no doubt cultivation of resistant varieties is the most economic and eco-friendly but no cultivars have so far been found to possess high degree of resistance. Seed and soil-bone nature, wide genetic diversity and wide range of the pathogen are the main problems towards developing resistant varieties. In absence of resistance, foliar sprays with fungicides have been considered as an alternative option to reduce the disease under field condition literature indicated that the disease can be effectively controlled by using fungicides (Das, 1988, Lapis, 1985 Goyal, 1994 and Mahto, 1999).

At present foliar spray with propiconazole (Tilt 250 EC and 100 EC) successfully controlled *Bipolaris sorokiniana* infection on foliage and reduced black point incidence on grains (Dhruj, 1991 and Rashid *et al.* 2001). Indiscriminate use of same fungicide against target pathogen may

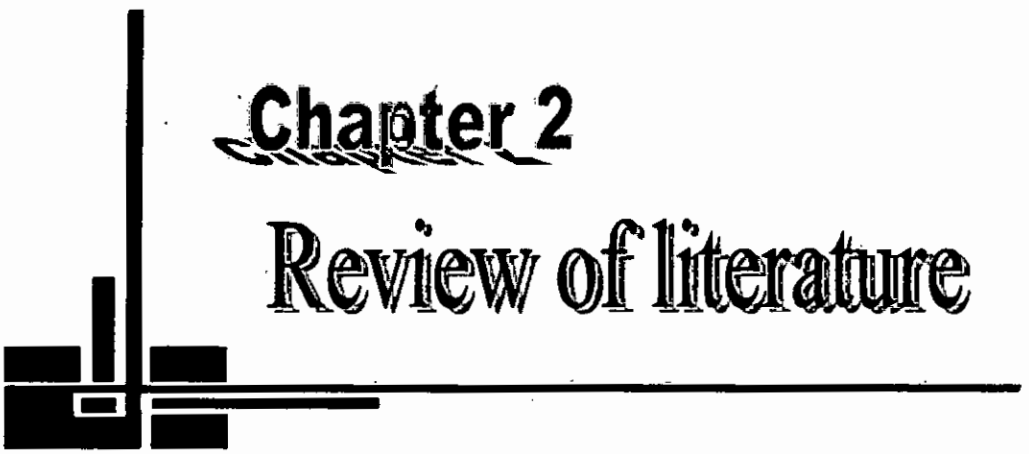
create pressure to change its virulence and stimulate to develop new resistant strains of the pathogen. So search for alternative of Tilt is necessary to combat *Bipolaris sorokiniana.*

Perusal of literature shows that studies on management BpLB of wheat are limited in Bangladesh and yield loss due to BpLB has not been fully investigated. There for the present research work was undertaken with the following objectives:

(i) To find out resistant sources against BpLB.

(ii) To search the effective fungicides and their doses against BpLB and

(iii) To determine the avoidable yield loss incurred by BpLB.



Chapter 2

Review of literature

2. REVIEW OF LITERATURE

Bipolaris sorokiniana (perfect: *Cochliobolus sativus*), the causal fungus of bipolais leaf blight of wheat is known to be a complex and variable pathogen. But its degree of variability and complexity is identified imperfectly. New isolates of *Bipolaris sorokiniana* develop in nature and showing potential high virulence on host varieties. The disease is a potential threat where ever the crop is grown through out the world. Emphasis has been given to control the disease by evolving disease resistant varieties. In parallel to resistant breeding, the possibilities of control the disease using fungicides has been and are being explored in many countries of the world. Some important literatures related to work are pertained.

2.1 YIELD LOSS:

Nestrov (1981) reported fall in germination of grains infected by *Helminthosporim sativum, Fusarium* sp. *and Alternaria alternata* as 11-19, 59-63 and 97-98% respectively.

Mehta (1985) reported that under favorable conditions for spot blotch of wheat caused by *Bipolaris sorokiniana* the losses in yield could be between 30 and 80%. Some time the losses in yield could reach up to 100%.

Above ground plant parts of wheat and its grain could become infected by *Helminthosporium sativum* (Syn.) *Drechslera sorokiniana, Bipolaris sorokiniana*). The combination of spot blotch caused by the pathogen on the leaves, head blight, stem infection and black point result in severe crop losses (Raemaekers 1985).

Frank *et al.* (1985) recorded 6.2-29% reduction in seedling stand of winter wheat due to seed borne infection of *Bipolaris sorokiniana.* Inoculated seeds produced tiller of lower height and reduced seed production (Nalli, 1986).

The effect of Drechslera leaf blight (*Drechslera sorokiniana*) on yield components of three susceptible wheat cultivars, Inia 66, Kalyansona and MSI were investigated by Rashid *et al.* (1987). Disease severities of top three leaves were estimated. The lower leaves became significantly more infected than the flag leaves. A significant relationship between the blight severity and the yield loss were found. Most infection on flag leaves occured on Kalyansona, less on cultivars MSI and the least on cultivars Inia 66. Maximum loss of grain weight per ear at the maximum disease severity score was established.

Brandle *et al.* (1987) reported that flag leaf infections by *Helminthosporium sativum* were negatively correlated with yield.

In Zambia, *Helminthosporium sativum* was the major pathogen of rain fed wheat causing spot blotch, leaf blight, stem break and black point resulting as much as 85% yield loss (Raemaekers, 1988).

Conner (1990) mentioned that the black point of wheat caused by *Cochliobolus sativus* resulted in serious losses due to down grading of the grain.

Zhang *et al.* (1990) observed that 1000-grain weight of black pointed grains infected by *Bipolaris sorokiniana* was 1.95-13.50% lower than uninfected grains.

In warmer areas of the world, 1-20% losses of wheat depending on locations caused by *Bipolaris sorokiniana* (Dubin and Ginkel, 1991).

Razzaque and Hossain (1991) estimated yield loss in wheat cultivars-Kanchon as 14% due to leaf blight disease caused by *Bipolaris sorokiniana* in Bangladesh. They also reported that the incidence of leaf blotch caused by the pathogen was higher in variety Sonalika and resulted reductions in grain yield and weight by 21% and 18%, respectively even though Tilt 250EC at 0.125 kg/ha was sprayed three times in control plots. Yield losses in the new varieties Akbar, Kanchan and Aghrani were found to be 14%, 8% and 4% respectively.

Based on various environmental conditions, the leaf blight diseases (*Bipolaris sorokiniana*) alone could reduce yield of wheat from 25 to 40% (Azhar, 1992). He also reported that the expansion of wheat production in Bangladesh reduced suddenly for a specified period due to leaf bight disease and unusual sterility.

There was no significant effect of sowing 0.6 and 12% black point affected seeds on the yield, incidence of seedling blight or leaf blight and development of black point in the harvested grains (Fakir, 1988). He showed that reduction in germination of black point affected seeds was directly related with the severity of infection. According to him, *D. sorokiniana* was responsible to cause more disease to the germinating seeds and seedlings than other black point fungi. Pathogenic effects of seed borne *D. sorokiniana* on germinating seeds resulting seed rot and seedling blight were also reported by Cook and Veseth (1991), Ali and Fakir (1992) Dey *et al.* (1992), Bazlur Rashid (1996, 1997) and Bazlur Rashid *et al.* (1997).

Bipolaris leaf blight (*Bipolaris sorokiniana*) or spot blotch is the number one disease of wheat in Bangladesh. The disease starts at the seedling stage and increases with age. Almost all commercial cultivars were either moderately susceptible or susceptible to this disease and caused 29% yield loss in Kanchan (Alam *et al.* 1994).

Rashid *et al.* (1994) reported that pre-and post ear emergence inoculations with conidial suspension of *Bipolaris sorokiniana* resulted in reduced grain weight and yield, and increased seed infection.

Alam *et al.* (1995) estimated the yield loss of wheat cultivars Kanchan due to Bipolaris leaf blight at the farmers fields of four different locations of Dinajpur, Jessore, Jamalpur and Ishurdi were 13.9, 16.2, 14.8 and 14.5 percent, respectively. The average yield loss of grains was 14.9 percent over the locations.

Leaf blight caused by *Drechslera sorokiniana* has been considered as the major disease of wheat in Bangladesh with on average yield loss of about 15% in widely cultivated wheat variety Kanchan (Anonymous, 1995).

Thousand-grain weight of black point affected seeds decreased with increasing level of disease severity (Rahman and Islam, 1998).

Infected seeds and soils infested either with conidial suspension or colonized grains may serve as potential source for the survival of *Bipolaris sorokiniana* resulting germination failure, seedling mortality and spot blotch development in wheat (Mondal, 2000).

Patil *et al.* (2001) reported that, higher losses in 1000-seed weight, grain yield, plant height and biomass due to *Bipolaris sorokiniana* were recorded for NI 5439 and DDK-1001 compared with NIAW-34 and DDK-1009, respectively. Bijaga yellow, resulted higher losses of grain yield, plant height and biomass but MACS-2846 had greater reduction is 1000 seed weight. Among all cultivars, DK-1001 had the greatest losses in 1000-seed weight (24.86%), grain yield (52.85%), and biomass (32.57%). The highest reduction in plant height (11.66%) was observed in Bijaga yellow.

Singh *et al.* (2002) reported that, the leaf blight disease reduced markedly by spraying Propiconazole (Tilt 250 EC @ 0.1%) in treated plots. The reduction in yield due to leaf blight varied with the cultivars used, crop year and location. Highest losse in grain yield was recorded in Dharwad (50.6%) followed by Fiaizabad (40.9%) and Gurdaspur (27.0%) during 1998-99. The average yield losses during the two years were 27.9, 12.6 and 12.6% at

Fiaizabad, and Kanpur in HP1633 and at Pantnagar in Up 262, respectively. The 1000-grain weight decreased significantly from 1.2 to 26.1% during 1998-99 due to leaf blight.

2.2 HOST RESISTANCE:

Sinha *et al.* (1991) reported that CPAN 1887 was very tolerant to leaf blight (*Bipolaris sorokiniana*) in the present study and should be utilized in hybridization programmers to develop leaf blight resistant varieties.

Rashid *et al.* (1992) found highest seed borne infection in Sonalika collected from Mymensingh (27.4%) and Meherpur (25.7%) and lowest (1.5%) in Kanchan collected from Pabna.

Sisterna *et al.* (1993) showed that at high infection pressure of *Bipolaris sorokiniana*, damage from the disease did not depend on the cultivars or fertilizer levels.

Pear *et al.* (1998) found that infection trends followed a linear regression model with plant aging. The probable infestation of the materials particularly under artificial infection can be predicted using these equations but infection under natural infestation may very with climatic conditions.

Leaf blight infection caused significant grain yield losses of wheat. The susceptibility of 16 wheat cultivars to *Cochliobolus sativus* was assessed and only 2 (WH 157 and WH 283) cultivars were found moderately resistant (Karwasra *et al.* 1998).

Rashid *et al.* (1998) reported that leaf spot infection severity increased significantly with increased seedling age but no significant difference was observed between disease incidence at 28 days (76.6%) and at 21 days (71.2%). Regressions of infection severity on different growth characteristics showed the highest positive relationship with seedling age. Up to 63.85% of seedlings were affected within 21-28 days.

Molan *et al.* (2001) screened a number of wheat genotypes and they found four genotypes as resistant, nine were moderately resistant and the remaining genotypes were susceptible to *Bipolaris sorokiniana.*

Prates *et al.* (2001) reported that development of lesion caused by *Bipolaris sorokiniana* on wheat cultivars BR 18 is comparatively slower where as Embrapa 15 and Embrapa 16 showed the fastest lesion growth rate. The cultivars BR 15, BR 23, BR 35, Embrapa 40 and Embrapa 49 had moderate rate of lesion development.

Morphological difference between resistance and susceptibility of wheat cultivars was studied by Joshi *et al.* (2002) using M 3109 as resistant was found unit and Sonalika as susceptible to spot blotch (*Bipolaris sorokiniana*). They found a positive correlation (0.58) between leaf angle and area under disease progress curve (AUDPC), which indicated a positive influence of leaf erectness on severity to spot blotch disease.

A good number of germplasm was tested against *Bipolaris* leaf blight under natural disease pressure and found that only six showed promising against

the disease, gave below 10% diseased leaf area. They were HRS-15, HRS-98, HRS-101, LHRN-34, LHRN-41 and chirya-7. Shatabdi showed only 20% leaf area diseased but Kanchon and Sonalika showed highly susceptible to the disease (BARI, 2004).

2.3 CHEMICAL CONTROL:

Foliar application of Brestan, Brestanot, Du-Ter, Thiram and Vitavax were found effective in controlling spot blotch of wheat caused by *Helminthosporium sativum* (Singh and Virk, 1980).

Chaudhary *et al.* (1984) conducted pot trials spraying Benlate, Captan, Dithane M-45, Dithane Z-78, Vitavax and Ziram on artificially inoculated plant for controlling leaf blight disease. They observed that all the fungicides except captan used as spray significantly reduced the leaf blight incidence.

Fakir *et al.* (1984) obtained good control of seed borne *Bipolaris sorokiniana* by treating seeds with panoctine/CG 450.

Foliar spray with Propiconazole (Tilt 250EC) successfully controlled *Bipolaris sorokiniana* infection on the foliage and reduced black point incidence on wheat grains (Lapis, 1985).

Das (1988) evaluated the fungi toxicity of nine fungicides at the initial appearance of disease on the wheat variety, Sonalika. Three sprays were done at 10 days interval. Disease intensity was recorded 10 days after the final spraying. Mancozeb gave the best control of *Drechslera sorokininna*

(*Cochliobolus sativus*) and *Drechslera hawaiiensis,* followed by zineb and captafol, with disease indexes of 24.5, 31.1 and 31.8%, respectively.

Fakir (1988) observed that Dithane M-45 sprayed at soft and hard dough stage of wheat reduced the incidence of black point significantly.

Under the study of three seasons of field experiments (1978-81) the best control of *Alternaria triticina* was obtained by Antracol (propineb) 0.3%, followed by Dithane M-45 (mancozeb) at 0.3% and Daconil (Chlorothalonil) at 0.4%. These three fungicides also gave the higher yield compared to rest tested fungicides (Verma *et al.* 1988).

Ashok *et al.* (1989) conducted an experiment with 1, 2 or 3 sprays of mancozeb applied at varying intervals to control incidence of *Alternaria triticina, Helminthosporium sativum (Cochliobolus sativus)* and *Drechslera. tritici-repentis.* All treatments reduced disease incidence and increased yield compared to untreated control. The most effective and economical treatment was 3 sprays of mancozeb at 10 days intervals, followed by 3 sprays at 15 days intervals. The percentage increase in yield following these treatments was more than double that of only 1 spray.

Dithane M-45 (0.2%), Rovral (0.2%), Tilt 250EC (0.1%) and G 698 (0.2%) were evaluated for controlling leaf blight disease of wheat. Three sprayings were done at an interval of 15 days. Both Rovral and Tilt 250EC were highly effective and reduced disease incidence casually and also increased grain yield (Anonymous, 1989).

Meyer (1990) found that artificial inoculation of winter wheat with *Cochliobolus sativus* did not affect crop development or grain yield. Carbendazim preparations used to control *Pseudocercos porella herpotrichoides* led to increased infection with *C. sativus*.

Goyal (1991) reported that spraying with Dithane M-45 at flag leaf stage and 15 days later checked black point infection to a moderate level (Goyal, 1991).

Bockus *et al.* (1992) reported that the application of Tilt 250EC as foliar spray showed increased grain number per plant, 1000 grains weight, and large seeds as a subsequent higher grain yield in comparison between sprayed and unsprayed.

Applications of Mancozeb, Iprodione, Tebuconazole and Propiconazole as foliar sprays have been found effective in reducing foliar blight caused by *Bipolaris sorokiniana* but in most instances the best results were obtained from Tebuconazole and Propiconazole as suggested by many researchers (Duriller and Gilchrist 1994, Mondal *et al.*1994, Khan and Ilyas 1996, Goswami *et al.* 1998, Goulart 1998, Chang and Wu 1998 and Mahto 1999).

Mondal *et al.* (1994) evaluated four commercial fungicides for their efficacy to control Bipolaris leaf blight of wheat under natural epiphytotic condition during 1991-92 and 1992-93. Among them, Tilt 250EC (0.05%) was the most effective and profitable one which controlled the disease significantly, producing the highest grain yield with maximum gross margin. The disease severity was also reduced by Dithane M-45 (0.2%) and Pencozeb (0.15%)

and gave profitable yield. While application of Rovral (0.2%) was found uneconomic offering the lowest gross margin.

Kabir (1997) carried out an experiment on integrated control of leaf blotch under field condition. Out of the inputs of integrated disease management programme, two applications of fungicide (Tilt 250EC) were more effective to control leaf blotch of wheat.

Under *in vitro* study a number of fungicides were screened by Pereira *et al.*(1998) against *Bipolaris sorokiniana* and reported that triadimenol (40g ai/100kg seed), Triticonazole (45 g ai/100 kg seed), triticonazole plus iprodione (30+50 g ai/100kg seed) flutriafol (7.5 g ai/100kg seed) and difenoconazole (30g ai/100kg seed) resulted 46.0, 49.5, 35.0, 40.5 and 46.5% infection respectively compared with 58.5% where no fungicidal treatment was followed under green house test, these treatments gave 79.5, 81.5, 82.5, 78.0 and 81.0% emergence compared with 74.5% for the control, and 2.5, 0.6, 0.5 and 11.1% plant infection with *Bipolaris sorokiniana* against 27.5% for the control.

The application of Tilt (Propiconazole) at 125 mg ai/ha with three sprays at two week intervals under field conditions gave effective control (Mahto, 1999). These interactions suggest that HLB can be managed through an integrated approach by use of host resistance, cultural practices and adequate fungicide application.

According to Pandey *et al.* (1999) folicur (tebuconazole) was the best followed by Tilt 25EC (Propiconazole) and Baynate 70WP (thiophanale methyl) against *Bipolaris sorokiniana.*

Rashid *et al.* (2001) reported that, Tilt 250EC (Propiconazole) was highly effective in controlling Biploaris leaf blight of wheat caused by *Bipolaris sorokiniana (Cochliobolus sativus).* Water suspension (0.1%) of the fungicide was sprayed for one to six times. The maximum percent disease index (PDI) of 58.25% was observed in plots sprayed with plain water (control). The PDI value was reduced to 21.75% when Tilt was sprayed for six times. The quantity of black pointed and shriveled grains was reduced and grain yield was increased significantly due to the fungicide. Reduction in disease severity and increase in yield were corroborated with the number of sprays.

Patil *et al.* (2002) reported that the incidence of the leaf blight disease was not observed in plants sprayed with 0.1% propiconazole. Spraying with 0.1% propiconazole also resulted in the highest 1000-grain weight (40.11g), yield (38.35 q/ha) and biomass (54.31q/ha).

Lapis (1985) reported that foliar sprays with propiconazole (Tilt 250EC) successfully controlled *Bipolaris sorokiniana* infection on the foliage and reduced black point incidence.

Chapter 3

Materials and Methods

3. MATERIALS AND METHODS

A series of experiments were conducted at Bangladesh Agricultural Research Institute (BARI) central station, Gazipur during 2004-2005 crop seasons under field condition. The experiments were as follows:

3.1. Reaction of wheat germplasm to Bipolaris leaf blight disease under field condition

3.2. Comparative effectiveness of some new fungicides in controlling Bipolaris leaf blight of wheat

3.3. Effectiveness of fungicides and their doses against Bipolaris leaf blight of wheat

3.4. Estimation of avoidable yield loss of wheat due to Bipolaris leaf blight disease

Experiment 3.1. Reaction of wheat germplasm to Bipolaris leaf blight disease under field condition

3.1. a. Soil type

The soils of the experimental plots were a medium high land with sandy loam in texture belonging to Madhupur Tract under the agro ecological zone (AEZ) 28 (Twenty eight).

3.1. b. Land preparation

The land was thoroughly prepared by well tilth using a tractor driver disc plough, rotavator and harrow. The clods were broken and clean well and the soil was leveled until the desired tilth was achieved for sowing the wheat seeds.

3.1. c. Experimental crop

The experimental crop was wheat variety.

3.1. d. Application of fertilizers and manure

Fertilizers and manure were applied as per recommendation of BARC (1989). The following doses of fertilizers and manure were applied to the plots for wheat cultivation.

Fertilizers/Manure	Dose/ha
Nitrogen (N)	100 kg
Phosphorus (P_2O_5)	40 kg
Potassium (K_2O)	60kg
Sulphur (S)	20kg
Zinc (Zn)	3kg
Cowdung	10 t

Cowdung was applied to the soil before 20 days of sowing. One third of nitrogen (N) and other fertilizers were used as basal dose at the time of final land preparation. The second and third splits of N application were done at active tillering stage and panicle initiation stage, respectively.

3.1. e. Seed samples used

Seed sample of 14 wheat germplasms cultivars were used. The seed samples were collected from wheat Research Centre, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

3.1. f. Seed sowing

The seeds were sown in line in the field on 2nd December 2004, at the rate of 120kg/ha. Seeds were sown in 2m long 2 rows plot with 20 cm row spacing. Each germplasm/cultivars was replicated thrice.

3.1. g. Weeding

Weeding was performed twice during the growing period of the crop, once after 25 days and another after 45 days of sowing.

3.1. h. Irrigation

The field plots were irrigated twice. Irrigations were done at 21 and 50 days after sowing.

3.1. i. Data Collection

Data were collected on plant height (cm), days of heading, disease severity following 0-5 rating scale, PDI (Percent Disease Incidence), TGW (Thousand Grain Weight), yield per plot, black point infected seed (%) and reaction of germplasm/cultivars to Bipolaris leaf blight. PDI was calculated by collecting 25 leaf samples randomly from each and graded at 0-5 rating scale as suggested by Hossain and Azad (1992) where

0 = Free from infection

1 = Few minute lesions on leaves

2 = Black unions lesions with number of district chlorotic nalos covering ≤ 10% of the leaf area

3 = Typical lesions surrounded by destined chlorotic halos covering 10-50% of the leaf area

4 = Severe lesions on leaves with ample nectotic zones, drying over a part of the leaf, covering ≥ 50% of the leaf area

5 = Severe infection of the leaf, spike, infected to some extent.

PDI was assessed by following formula as described by Singh (1984).

$$PDI = \frac{\text{Sum of all disease rating}}{\text{Total number ratings} \times \text{Maximum disease grade}} \times 100$$

Disease reaction of germplasm/cultivars were grades as follows:

0.1-5.0 PDI value =HR(Highly Resistant)

5.1-15.0 PDI value =R(Resistant)

15.1-25.0 PDI value =MR(Moderately Resistant)

25.1-40.0 PDI value = MS(Moderately Susceptible)

40.1-60.0 PDI value = S(Susceptible)

60.1-100.0 PDI value =HS(Highly Susceptible)

Black point seed was counted by collecting 100 seeds randomly from each plot yield.

3.1.j. Harvesting of the crop

The crop was harvested at full ripening stage on March 28, 2005.

Experiment 3.2. Comparative effectiveness of some new fungicides in controlling Bipolaris leaf blight of wheat

3.2. a. Land preparation

As mentioned in section 3.1.b

3.2. b. Application of fertilizer and manure

As described under the section 3.1.c

3.2. c. Seed sample used

Apparently healthy seed of cultivars, Kanchon was used in the study.

3.2. d. Seed sowing

Seed were sown in line on December 3, 2004. Seed rate was 120kg/ha. Unit plot size was 3.0×2.0m, keeping 20 cm row to row spacing.

3.2. e. Weeding

As illustrated under the section 3.1.f

3.2. f. Irrigation

As described under the section 3.1.g

3.2. g. Fungicidal spray

As may as five fungicides were included to determine their effectiveness against Bipolaris leaf blight. The fungicides were: Avistin, Haycoanzole, Nuben, Sulphotox 80WP and Tilt 250EC. Avistin was applied at 0.1%, Hayconazole and Tilt at 0.5% and Nuben and Sulphotox were applied at 0.2%. Proper control was maintained where equal amount of plain water was sprayed. Except Tilt, all the fungicides were new ones had been introduced in the country for registration.

3.2. h. Application of fungicides

Fungicidal solutions were prepared by dissolving definite amount of chemicals in definite quantity of plain water. The fungicides were sprayed thrice at 15 days intervals commencing from 45 days after sowing. Spray tank was thoroughly washed before filling each fungicidal solution material. Special attention was given to complete coverage of the growing plants with the fungicides. In addition adequate precaution was taken to avoid drifting of spray materials from one plot to the neighboring ones.

3.2. i. Design of the experiment

The experiment was designed following RCBD (Randomized Complete Block Design) having three replications of each treatment.

3.2. j. Data collection

Data were recorded on plant height, length of spike, number of seed per spike, disease severity (0-5 scale), PDI, TGW and seed yield. Before harvest the plant height and spike length were measured from 10 randomly selected tillers per plot. The spikes from these selected tillers were picked up for counting the number of grains per spike.

3.2. k. Analysis of data

Data were analysed using MSTAT computer program. Whenever necessary data were transformed following Arcsine transformation method. Means were compared following Duncan's Multiple Range Test (DMRT).

Experiment 3.3. Effectiveness of fungicides and their doses against Bipolaris leaf blight of wheat

3.3. a. Land preparation

Same as mentioned under the section 3.1.b

3.3. b. Application of fertilizer and manure

As stated under section 3.1.c

3.3. c. Seed sample use

As mentioned in section 3.2.c

3.3. d. Seed sowing

As illustrated under the section 3.2.d

3.3. e. Weeding

As stated under the section 3.1.f

3.3. f. Irrigation

Same as of experiment 3.1.g

3.3. g. Fungicides

Four fungicides namely Akanazole, Folicur, Fuji-one and Hexaconazole were used. All of those were used at two doses viz. 0.05 and 0.1% concentration. The specifications of the fungicides are given in Table 1.

Table 1. The trade name and common name of the fungicides used in the experiment

SL NO.	Trade Name	Common Name
1.	Folicur 250EC	Tebuconazole
2.	Confat 5EC	Hexaconazole
3.	Fuzione4EC	Isoprothiolane
4.	Akanazole 250EC	Propiconazole

3.3. h. Application of fungicides

As illustrated under the section 3.2.h

3.3. i. Design of the experiment

The experiment was laid out in RCBD-2 factors, keeping three replications where fungicides were considered as one factor and doses of fungicides treated as another factor.

3.3.j. Data collection

Same as experiment 3.2.j

3.3. k. Analysis of data

As stated in section 3.2.k

Experiment 3. 4. Estimation of avoidable yield loss of wheat due to Bipolaris leaf blight disease

3.4. a. Land preparation

Same as mentioned under the section 3.1.b

3.4. b. Application of fertilizer and manure

As stated under section 3.1.c

3.4. c. Seed sample use

Seed samples of two wheat varieties namely Kanchan and Shatabdi were used under the study. Apparently healthy seeds were used. Variety Kanchan was used as susceptible while variety Shatabdi used as resistant source to Bipolaris leaf blight.

3.4.d. Seed sowing

Seeds were sown on December 5, 2004, having unit plot size of 3.0×1.0m, keeping 20cm spacing between rows.

3.4. e. Weeding

As stated under the section 3.1.f

3.4. f. Irrigation

As stated under the section 3.1.g

3.4. g. Treatments

There were two treatments viz. sprayed and unsprayed. In sprayed treatment Tilt 250EC (0.05%) was applied four times at 15 days interval commencing from 35 days after sowing while in unsprayed plots equal quantity of plain water was sprayed.

3.4. h. Design of the experiment

Paired plot technique was followed keeping five replications.

3.4. i. Data collection

As mentioned under the section 3.2.j

3.4. j. Analysis of data

Data were analyzed following "Paired t" test.

3.5. Pathogen isolation and identification

Wheat plant leaves with typical leaf spot disease symptom were collected from the experimental site by using polyethylene bag and were taken to the Laboratory of the Division of Plant Pathology, Bangladesh Agricultural Research Institute (BARI) central station, Gazipur, Dhaka. The diseased leaves were then cut into small pieces (about 0.5 cm) with diseased portion and surface sterilized with $HgCl_2$ solution (0.01%) for 30 second. The cut pieces were then washed in water at three times and were placed onto PDA media in petridish. The plates were then incubated at 25 ± 1^0C for 7days. Later the pathogen was purified using hyphal tip culture method and grown on PDA media at 25 ± 1^0C for 2 week and identified as *Bipolaris sorokiniana* (Plate 1and 2).

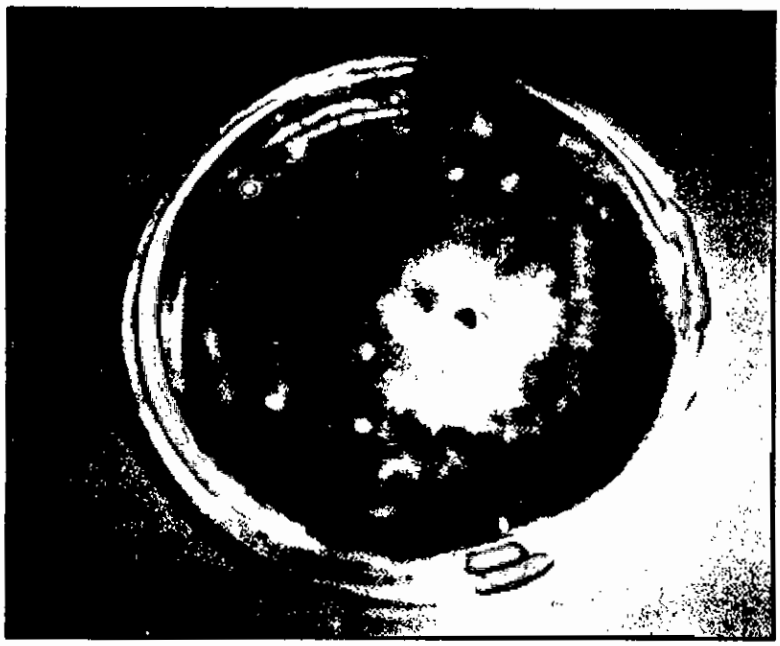


Plate 1. Pure culture of *Bipolaris sorokiniana* on PDA media

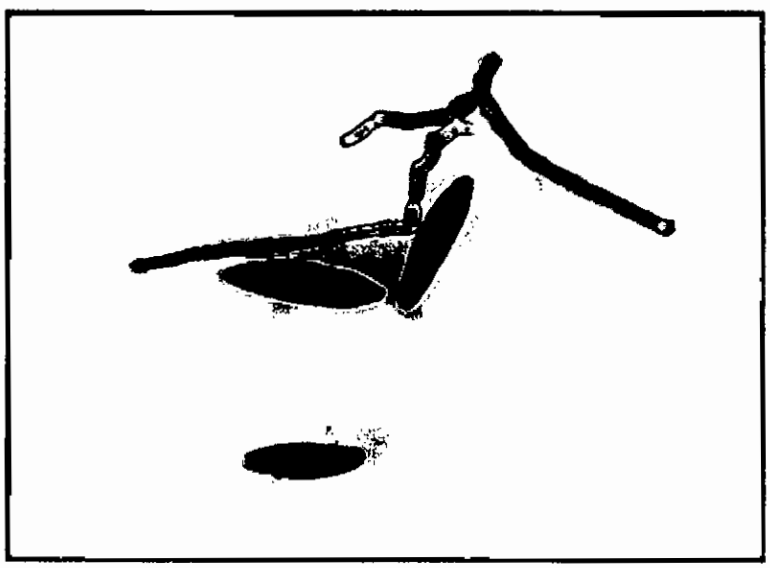
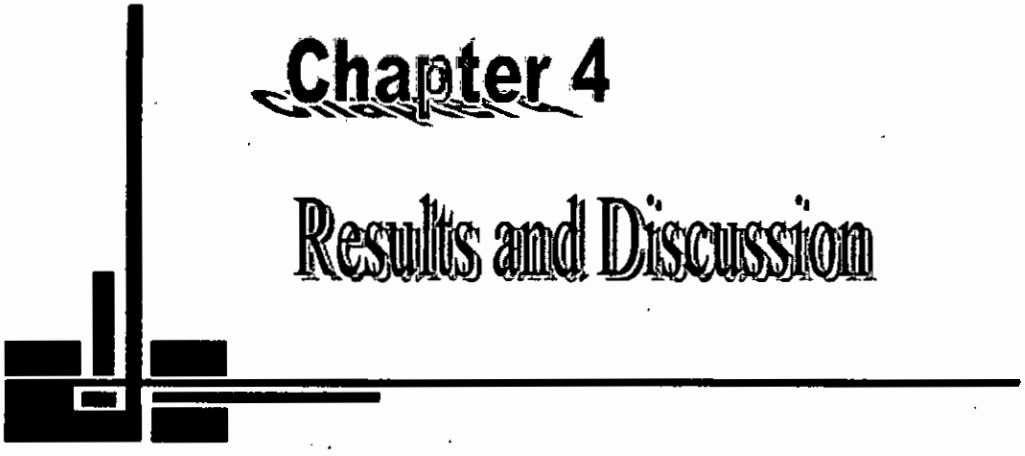


Plate.2. Mycelia and conidia of *Bipolaris sorokiniana* (×200)



Chapter 4

Results and Discussion

4. RESULTS AND DISCUSSION

Experiment 4. 1. Reaction of wheat germplasms to Bipolaris leaf blight disease under field condition

Existence of variation among the wheat germplasm to Bipolaris leaf blight become visible when they are exposed to natural infection under field condition. Differences among them to disease parameters were preset. Plant height ranged 92.0-100.2 cm (Table 2). Results showed that germplasm BAW-966 had the tall plants followed by Kanchan (99.6cm), BAW-1008 (99.4cm), Shatabdi (99.1cm), Sonalika (98.6cm), Gourab(98.1cm), Balaka (98.0cm), BAW-1006 (96.8cm), Aghrani(96.4cm), Sourav(96.4cm) and Protiva (96.2cm). Days required for heding among the germplasm varied 68 to 74 days (Table 2) where the Sonalika and BAW-966 took only minimum 68 days for heading/compared to rest germplasm. Percent disease index values among the tested germplasm ranged 11.6-71.6. Based on PDI value the germplasm may be arranged in order to ascending as chirya –7(11.6%), Shatabdi(13.0%), BAW 966(14.1%), BAW 1006 (15.7%), BAW 1008(29.6 %), Gourab(30.2%), Protiva (41.6%), Aghrani (44.3%), Kanchan (51.0%), Balaka (58.4%), Ciano-79(60.0%), Inia-66(65.4%) and Sonalika (71.6%). The maximum thousand grain weight was recorded in Shatabdi (40.6g), BAW966 (40.1g), Kanchan (39.8g), BAW1008 (39.8g), BAW1006 (39.6g), Aghrani (38.6g), Protiva (38.2g), Balaka(38.1g), Sourav(38.0g), Sonalika (37.6g), Gourav (37.4g), Inia-6 (36.8g), Chirya-7 (36.4g) and Ciano (31.2g). The maximum yield per plot (2m long 2 rows) of 531.9g was harvested from

Table 2. Germplasms evaluation against Bipolaris leaf blight of wheat under field condition.

Variety/ line	Plant height (cm)	Days to heading	PDI	TGW (g)	Yield/ Plot (g)	Black point (%)	Reaction
Aghrani	96.4	70	44.3	38.6	431.6	9.0	S
Balaka	98.0	74	58.4	68.1	420.1	13.0	S
Chirya-7	93.6	73	11.6	36.4	503.4	3.0	R
Gourab	98.1	70	30.2	37.4	481.6	7.0	MS
Inia-66	92.6	69	65.4	36.8	412.3	19.0	HS
Ciano-79	92.0	72	60.0	31.2	181.3	13.0	S
Kanchan	99.6	71	51.0	39.8	482.6	18.0	S
Protiva	96.2	70	41.6	38.2	461.3	9.0	S
Sourav	96.4	71	31.2	38.0	502.6	6.0	MS
Shatabdi	99.1	72	13.0	40.6	531.9	2.0	R
BAW-966	100.2	68	14.1	40.1	504.2	3.0	R
BAW-1006	96.8	71	15.7	39.6	476.6	5.0	MR
BAW-1008	99.4	70	29.6	39.8	529.2	2.0	MS
Sonalika	98.6	68	71.6	37.6	362.6	16.0	HS

HR =Highly Resistant
R = Resistant
MR =Moderately Resistant
MS =Moderately Susceptible
S =Susceptible
HS =Highly Susceptible
PDI =Percent Disease Index
TGW =Thousand Grain Weight

Shatabdi. Germplasm BAW-1008 ranked next to Shatabdi, gave 529.2g per plot yield which was followed by BAW-966 (504.2g), Chirya-7 (503.4g), Sourav(502.6g), Kanchan (482.6g), Gourab(481.6g), BAW-1006 (476.6g), Protiva (461.3g), Aghrani (431.6g), Balaka (420.1g), Inia-66(412.3g), Sonalika (362.6g) and Ciano (181.3g). Black point infection was found all the germplasms but there were wide variation on the incidence this disease among the germplasms. The black point incidence ranged 2.0-19.0%. Five germplasms (Chirya-7, Shatabdi, BAW-966, BAW-1006 and BAW–1008) showed less than 5.0%, 4 germplasms (Agharani, Gourab, Protiva and Sourab) gave up to 10% and rest showed more than 10% black point incidence. When the germplasm were grouped based on their susceptibility to Bipolaris leaf blight, 3 showed resistant (Chirya-7, Shatabdi and BAW-966), 1 scored moderately resistatn (BAW–1006), 3 (Gourab, Sourav and BAW-1008) moderately susceptible, 5 (Aghrani, Balaka, Ciano-79, Kanchan and Protiva) susceptible and rest 2(Inia-66 and Sonalika) appeared as highly susceptible to Bipolaris leaf blight.

Out of the germplasms tested for Bipolaris leaf blight under natural epiphytotic condition, indicate that only three germplasms recorded as resistant to *B. sorokiniana*. They were: Chirya-7, Shatabdi, BAW-966. Only one (BAW-1006) recorded as moderately resistant to *B. sorokiniana*. Rest showed moderately susceptible to highly susceptible reaction to *B. sorokiniana*. Variations of germplasm in their response to *B. sorokiniana* depend on genetical constituents of germplasm. Moreover, the fungus *B. sorokiniana* is polycyclic in nature, so there is every possibility to break up the resistance easily. As most of the varieties resistance to Bipolaris leaf blight resistant posses vertical resistance which is governed by single gene.

For instance, Kanchan is very popular variety in Bangladesh context. It was released as resistant but at present the variety is highly susceptible to Bipolaris leaf blight. Wheat Research Centre, BARI, Gazipur has already suggested for with drawn of Kanchan from cultivation. Now BADC (Bangladesh Agricultural Development Corporation) has cut the seed production area of Kanchan and inspiring the growers to cultivate Shatabdi instead of Kanchan. Throughout the world massive researches are being done to achieve Bipolaris leaf blight resistant varieties but little success has been obtained (Fader *et al.* 1989; Sinha *et al.* 1991; Sisterna *et al.* 1992, Pear *et al.* 1998, Karwasra *et al.* 1998; Molan *et al.* 2001, Prates *et al.* 2001, Joshi *et al.* 2002 and Anon. 2004).

Experiment 4.2. Comparative effectiveness of four new introduced fungicides in controlling Bipolaris leaf blight of wheat

All the fungicides significantly influenced the plant height, spike length, number of seed per spike, PDI, TGW (thousand grain weight), black point incidence and yield over control. The plant height due to application of different fungicides ranged from 90.70 to 95.03cm where the lowest and the highest plant height were recorded from control (where no fungicide applied) and Hayconazole, respectively, Fungicide Hayconazole did not show any significant variation with Nuben and Tilt (Table 3). Although control gave the lowest plant height numerically but it was statistically similar to Sulphotox and Avisten. Length of spike among the treatments varied from 10.03 to 14.20cm. Significantly higher spike length was recorded by Tilt, which differed significantly with all the rest treatments except Hayconazole.

Table 3. Comparative effectiveness of five fungicides against Bipolaris leaf blight of wheat

Treatment	Plant height (cm)	Length of spike (cm)	Number of Seed/Spike	PDI	TGW (g)	Yield (t/ha)	Black point (%)
Avistin	91.60 bc	11.27 b	21.53 bc	52.46 b (62.87)	41.63 b	2.00 bc	44.00bc
Hayconazole	95.03 a	13.93 a	29.67 a	36.39 c (35.20)	46.23 a	3.50a	19.00a
Nuben	93.53 ab	11.67 b	23.67 b	51.71 b (61.60)	39.87 c	2.23b	40.00b
Sulphotox	90.73 c	11.50 b	22.53 b	55.55 b (68.00)	38.13 d	2.16b	43.30bc
Tilt	94.00 a	14.20 a	29.70 a	26.75 d (22.27)	46.10 a	3.60a	8.00a
Control	90.70 c	10.03 c	18.67 c	64.63 a (81.63)	36.83 d	1.73c	55.67c
$S\text{-}_x$	**0.620**	**0.365**	**0.980**	**0.05**	**0.510**	**0.112**	**3.19**

Means bearing same letter within same column do not differ significantly at 5% level (DMRT).

Figure in parenthesis indicates actual value.

The fungicides Avistin, Nuben and Sulphotox were statistically similar on spike length. These three fungicides gave statistically lower spike length compared to Tilt and Hayconazole but gave statistically higher spike length over control. In case of number of seed per spike significantly higher number of (29.70) per spike was recorded in Tilt and it was statistically similar to Hayconazole. The effect of Avistin, Nuben and Sulphotox on seed number per spike ware insignificant. Control gave the lowest number of 18.67 seed per spike but it was statistically similar to Avistin only. Regarding PDI value Tilt was found most effective against Bipolaris leaf blight having (26.75%) PDI followed by Hayconazole (36.39%), Nuben (51.71%), Avistin (52.46%), Sulphotox (55.55%) and control (64.34%). Statistical analysis revealed that Tilt gave significantly lower PDI and it differed significantly with all the rest treatments. Hayconazole showed significantly higher PDI value of the disease but showed significantly lower PDI over rest treatments. The effect of Avistin, Nuben and Sulphotox were statistically similar in lowering PDI value of the disease. When effectiveness of fungicides were compared over control it was found that Avistin, Hayconazole, Nuben, Sulphotox and Tilt reduced 22.98, 56.87, 24.53, 16.69 and 72.71% PDI, respectively (Figure 1).

Thousand grain weight (TGW) ranged from 36.83g. to 46.23g. Significantly higher TGW was recorded by Hayconazole and it differed significantly with all the rest treatments except Tilt. Nuben ranked next to Tilt and it incurred significantly higher TGW compared to Sulphotox and control. The maximum yield of 3.6t/ha was harvested from Tilt treated wheat crops followed by Hayconazole (3.5t/ha), Nuben (2.23t/ha), Sulphotox (2.16t/ha), Avistin (2.0t/ha) and Control (1.73t/ha).

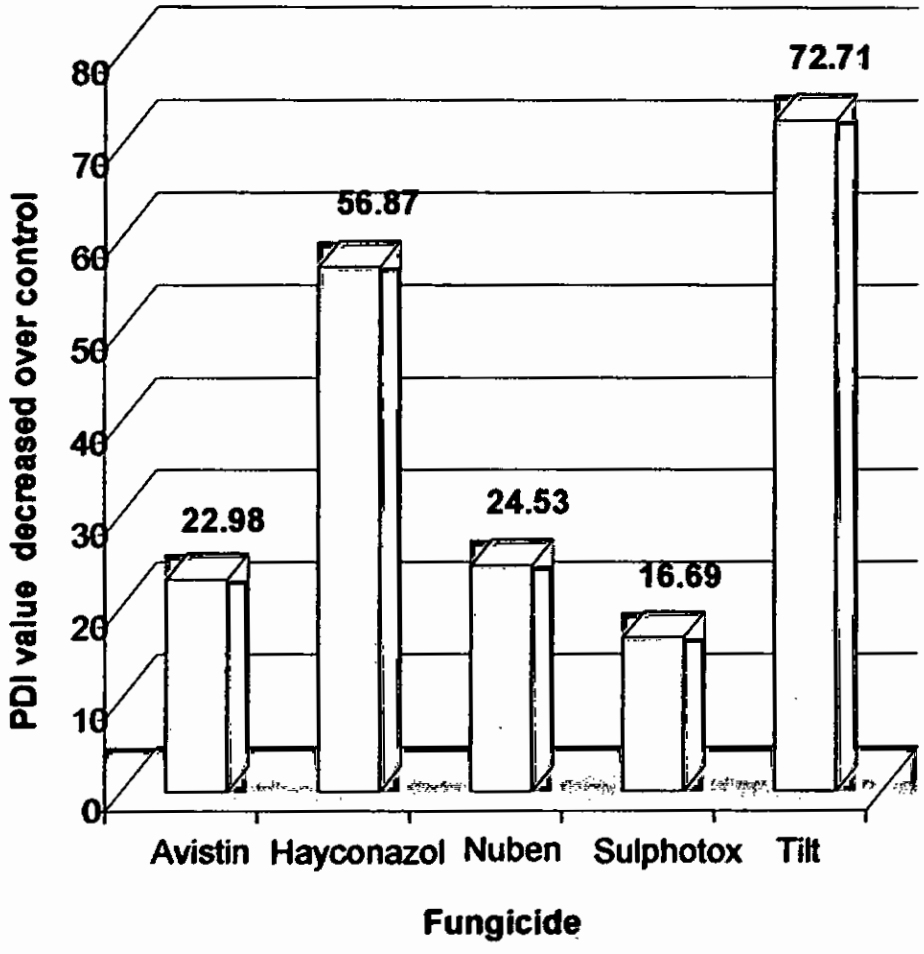


Figure 1. PDI decreased due to fungicidal spray over control

The effect of Tilt and Hayconazole on producing higher yield was insignificant and these two fungicides differed significantly with the rest fungicides. Control gave significantly lower yield but it showed statistically insignificant with Avistin. In order of descending the effectiveness of the fungicides on percent yield increase over Control can be arranged as: Tilt (108.09%), Hayconazole(102.31%), Nuben (28.90%), Sulphotox (24.85%) and Avistin (15.68%) (Figure 2).

Black point infected seed due to treatments ranged 8.0-55.67%. The minimum black point incidence was recorded from Tilt sprayed wheat crop and it showed statistically similar to Hayconazole (19.0%), Avistin, Nuben, Sulphotox and Control gave respectively of 44.0, 40.0,43.3 and 55.67% black point incidence. About 20.96, 65.87, 28.14, 22.22 and 85.62% black point infection decreased over control respectively, by using Avistin, Hayconazole, Nuben, Sulphotox and Tilt (Figure 3).

Results on the investigation of effectiveness of fungicides to minimize the incidence of Bipolaris leaf blight indicated all the fungicides significantly reduced the disease incidence and increased yield over control. Except Tilt all were introduced in the country as new for evaluating their fungi toxicity against *B. sorokiniana.* Among the fungicides tested Tilt showed best performance both in reducing disease parameters and increasing yield contributing characters, which was followed by Hayconazole. These two fungicides showed statistically similar to almost all the tested parameters. Again both of the fungicides significantly reduced the black point incidence, which is alarm for wheat seed production. This was very close agreement with the findings of Lapis (1985), Anonymos(1989), Bockus *et al.* (1992)

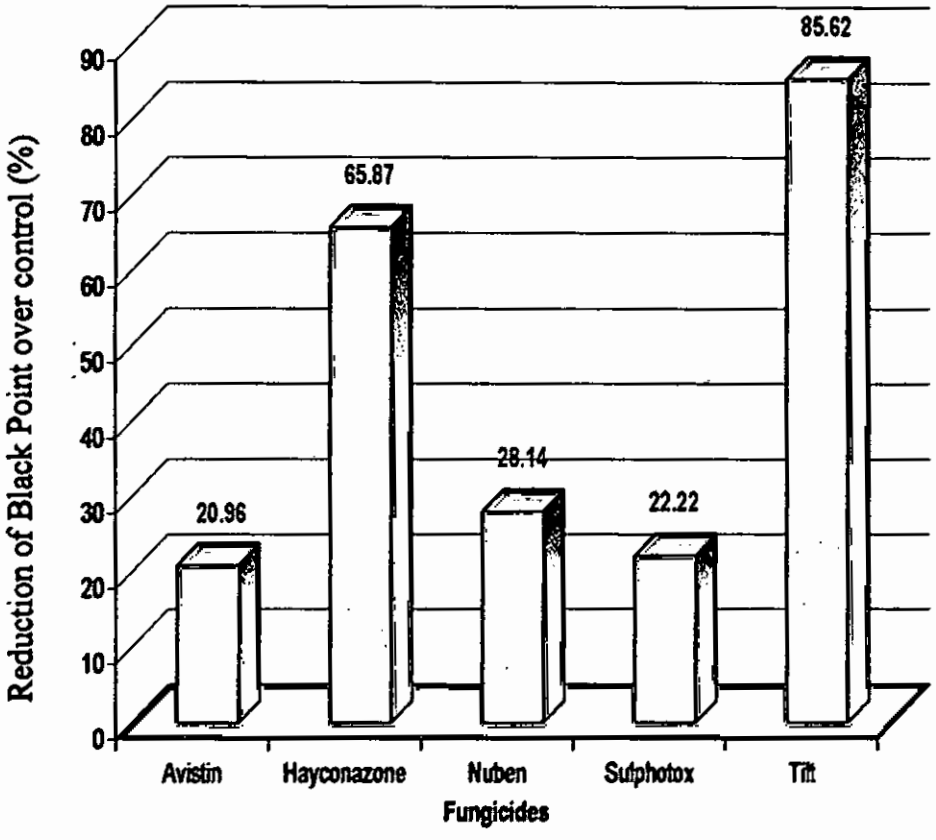


Figure 3: Black point incidence (%) reduced due to Fungicidal spray over control

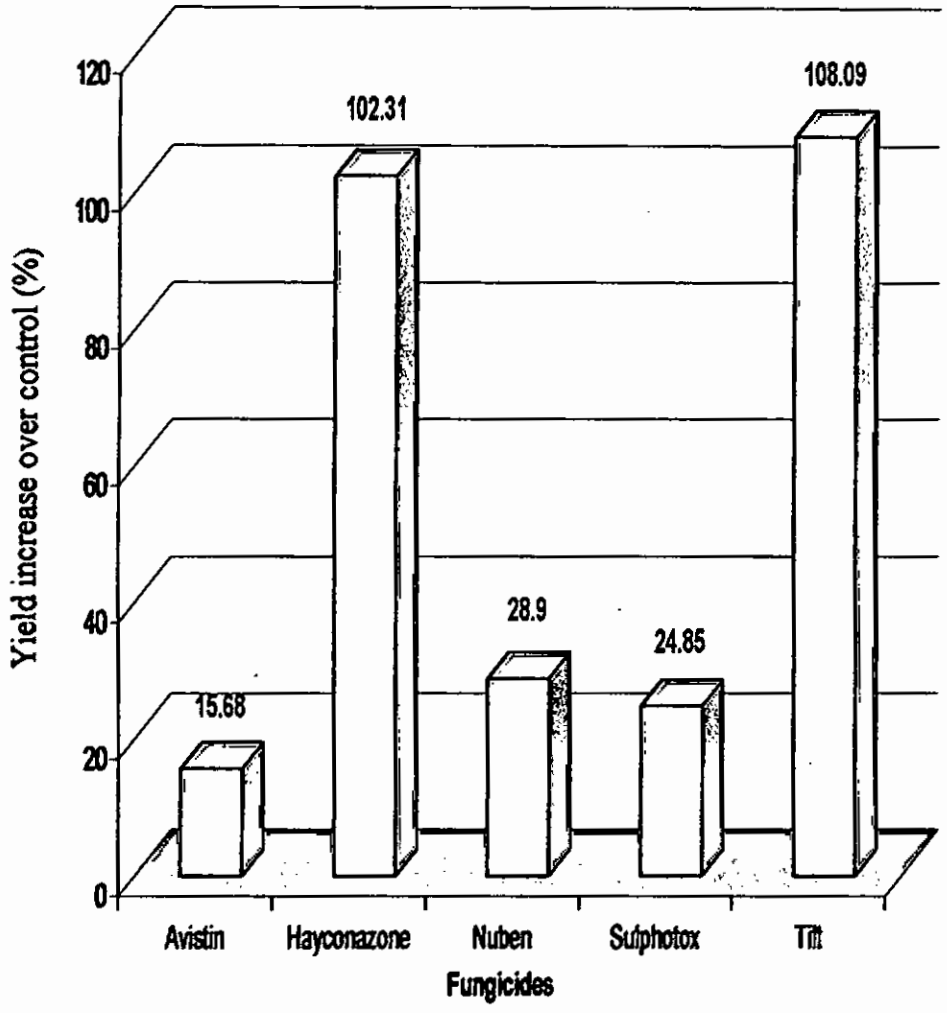


Figure 2. Percent Yield increased due to Fungicidal spray over control

Druiller and Gilchrist (1994), Mondal *et al.* (1994), Khan and Ilyas (1996), Kabir (1997), Goswami *et al.* (1998), Chang and Wee (1998), Goulart (1998), Pereira *et al.* (1998), Mahto (1999), Pandy *et al.* (1999), Rashid *et al.*(2001) and Patil *et al.* (2002). According to Pereira *et al.* (1998) fungicides belong to azole group like triticonazole, propiconazole, tebuconazole, difenoconazole etc. are more effective against *B. sorokiniana*, which clearly supports the present investigation. Mahto (1999) stated that Bipolaris leaf blight disease of wheat can be effectively managed by adopting integrating approach by use of host resistance, cultural management and adequate fungicide application like Tilt. Under the study black point incidence reduced markedly due to application of Tilt and Hayconazole. This finding was corroborated with the findings of Lapis (1985) who mentioned that foliar sprays with propiconazole (Tilt 250EC) successfully controlled *B. sorokiniana* infection and reduced black point infection. Avistin appeared less effective against the disease. This was in line with the findings of Major (1999). Nuben (mancozeb) showed moderately effective against *B. sorokiniana* under the study but many researchers reported that mancozeb is highly effective against the disease (Chaudhary *et al.* 1984, Das, 1988, Fakir, 1988, Goyal, 1991, Mondal *et al* 1994 and Ashok *et al.*1998).

Experiment 4.3. Effectiveness of four fungicides and their doses against Bipolaris leaf blight of wheat

4.3.1 Main effect of fungicides

Existence of significant difference among the fungicides in respect of effectiveness in all the tested parameters except plant height, TGW

Table 4. Main effect of fungicides on Bipolaris leaf blight and yield contributing characters of wheat

Fungicide	Plant height (cm)	PDI	Spike length (cm)	Seed/ Spike (No.)	TGW (g)	Plot yield (kg)	Straw yield (t/ha)	Grain yield (t/ha)	Black point (%)
F_1= Folicur	94.61	37.67 ab (37.35)	10.92b	25.36 bc	45.30	2.27 a	3.58	3.78 a	19.17
F_2=Hexaconazole	96.99	34.85 b (32.68)	12.29a	28.71 a	48.45	2.20ab	3.72	3.66ab	12.50
F_3= Fujione	93.44	43.07 a (46.62)	11.02b	23.10 c	46.83	1.78bc	3.73	2.96bc	31.67
F_4=Akanazole	93.08	40.60 a (42.35)	10.93b	26.19ab	46.87	1.48 c	3.38	2.46 c	18.33
$S_{-agreements}$	**NS**	**2.09**	**0.143**	**0.59**	**NS**	**0.104**	**NS**	**0.173**	**NS**

Means bearing same letter within same column do not differ significantly at 5% level (DMRT).

Figure in parenthesis indicates actual value.

NS =Non Significant

(Thousand grain weight) and straw yield were recorded (Table-4). Plant height ranged from 93.08 to 96.99cm, where Hexaconazole resulted the tallest plant. Significantly lower PDI value of 34.85 was estimated by Hexaconazole which showed statistically similar to Folicur. Again Folicur showed significantly similar PDI value with Fujione and Akanazole. Spike length due to treatments varied from 10.93 to 12.29cm. In this parameter Hexaconazole also gave significantly higher spike length and it differed significantly with rest fungicides. The effect of Folicur, Fujione and Akanazole showed statistically insignificant on such parameter. As high as 28.71 seed per spike was recorded in Hexaconazole and it differed significantly with all the rest fungicides except Akanazole. Fujione produced significantly lower seed per spike and it showed statistically insignificant with Folicur. The effect of fungicides on TGW was insignificant and it ranged 45.30-48.45g. Considering per plot yield, Folicur gave the highest yield but it was statistically similar to only Hexaconazole. Total yield due to treatments varied 2.46 to 3.78 t/ha. Folicur proved the best one in producing maximum yield but it showed statistically insignificant with Hexconazole (3.66t/ha). Fujione ranked next to Hexaconazole and it gave significantly lower yield compared to only Folicur. In case of straw yield, no significant differences among the treatments become reflected. As Hexaconazole, Fujione and Akanazole. The maximum reduction of black point infected seed was recorded in Hexaconazole treated plot (12.50%) followed by Akanazole (18.33%), Folicur (19.17%) and Fujione (31.67%).

4.3.2 Main effect of doses

There were no remarkable difference between two doses of the fungicides used to find out their influence on growth, yield and disease parameters (Table 5).

Table 5. Main effect of fungicidal doses on Bipolaris leaf blight and yield contributing characters of wheat

Fungicidal dose	Plant height (cm)	PDI	Spike length (cm)	Seed/ Spike (No.)	TGW (g)	Plot yield (kg)	Straw yield (t/ha)	Grain yield (t/ha)	Black point (%)
D_1= 0.05%	94.62	39.84 (41.04)	11.23	25.72	46.91	1.94	3.56	3.23	19.17
D_2= 0.10%	94.44	38.32 (38.45)	11.35	15.95	46.81	1.92	3.64	3.20	21.67
S-$_{agreements}$	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Figure in parenthesis indicates actual value.

NS =Non Significant

4.3.3 Interaction effect of fungicides and their doses

Interaction effect of fungicides and their doses did not exert significant effect on plant height. The treatment F_2D_2 (Hexaconazole, 0.1%) gave the maximum plant height (96.88cm) followed by F_2D_1 (Hexaconazole, 0.05%), F_1D_2 (Folicur, 0.1%), F_4D_1 (Akanazole, 0.05%), F_1D_1 (Folicur, 0.05%), F_4D_1 (Akanazole, 0.05%), F_3D_2 (Fujione, 0.10%) and F_3D_1 (Fujione, 0.05%). Among the interaction treatments PDI value ranged 27.44-36.56. The maximum reduction of Bipolaris leaf blight disease was obtained by F_2D_2 representing the minimum PDI value and it showed statistically similar to F_1D_1 (32.46%), F_1D_2 (30.77%) and F_2D_1 (29.47%) but differed with rest interacting treatments (Table 6). The treatment F_3D_2 gave significantly higher PDI value and it showed statistically at par with F_1D_1, F_3D_2, F_4D_1 and F_4D_2. In case of spike length, the maximum length of 12.33cm was recorded by F_2D_2. The F_2D_1 ranked next to F_2D_2, gave significantly similar effect and it showed significantly higher spike length over rest treatments. The treatments F_1D_1, F_1D_2, F_3D_1, F_3D_2, F_4D_1 and F_4D_2 scored statistically insignificant effect on such parameter. Number of seed per spike varied widely among the treatments, which varied 22.91 to 29.26. Significantly higher seed number per spike was recorded in F_2D_2 and it differed significantly with all the rest treatments F_2D_1 and F_4D_1. The minimum seed number per spike was recorded in F_3D_2, which was statistically similar to F_1D_1 and F_3D_1 (Figure 4). There was no statistical variation among the treatments on thousand grain weight (TGW). In order of descending the effect of treatments on TGW may be arranged as F_2D_2 (48.47g), F_2D_1 (48.43g), F_4D_1 (47.37g), F_3D_2 (46.90g), F_3D_1 (46.77g), F_4D_2 (46.37g), F_1D_2 (45.53g) and F_1D_1 (45.0g). In case of yield/plot, significantly higher yield was obtained from F_2D_2, which was statistically similar to F_1D_1, F_1D_2 and

Table 6. Interaction effect of fungicides and their doses on Bipolaris leaf blight and yield contributing characters of wheat

Treat-ment	Plant height (cm)	PDI	Spike length (cm)	TGW (g)	Yield Plot (kg)	Straw yield (t/ha)	Grain yield (t/ha)
F_1D_1	94.00	32.46 abc (28.89)	10.85 b	45.07	2.253 ab	3.40	3.75ab
F_1D_2	95.22	30.77 bc (25.82)	10.99 b	45.53	2.153abc	3.76	3.58abc
	97.11	29.47 bc (24.18)	12.25 a	48.43	2.177abc	3.46	3.62abc
F_2D_1	96.88	27.44 c (21.18)	12.33 a	48.47	2.367 a	3.96	3.94a
F_3D_1	93.22	33.68 a (37.75)	10.94 b	46.77	1.553 d	3.80	2.58d
F_3D_2	93.66	36.56 a (35.48)	11.10 b	46.90	1.413 d	3.66	2.35d
F_4D_1	94.16	35.28 ab (33.37)	10.88 b	47.37	1.793bcd	3.60	2.98bcd
F_4D_2	92.00	34.03 ab (31.32)	10.98 b	46.37	1.767 cd	3.16	2.94cd
S-agreements	**NS**	**2.109**	**0.143**	**NS**	**0.104**	**NS**	**0.175**

Means bearing same letter within same column do not differ significantly at 5% level (DMRT).

Figure in parenthesis indicates actual value.

NS =Non Significant

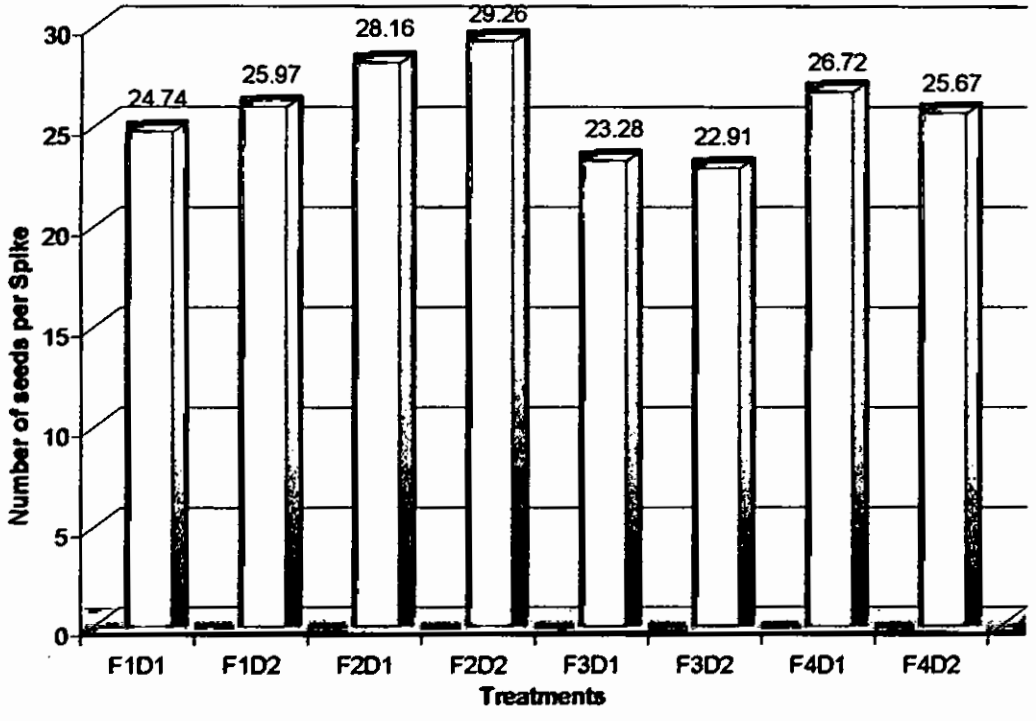


Figure 4. Interaction effect of fungicides and their doses on number of seed per spike

F_2D_1. The treatment F_3D_2 produced significantly lower plot yield and it showed statistically insignificant with F_3D_1, F_4D_1 and F_4D_2. The maximum yield per hectare was harvested from F_2D_2 (3.94t/ha) followed by F_1D_1 (3.75t/ha), F_2D_1 (3.62t/ha), F_1D_2 (3.58t/ha), F_4D_1 (2.98t/ha), F_4D_2 (2.94t/ha); F_3D_1 (2.58t/ha) and F_3D_2 (2.35t/ha). Statistical analysis revealed that F_2D_1 gave significantly higher yield and it was statistically at par with F_1D_1, F_1D_2 and F_2D_1. The effect of F_3D_1,F_3D_2, F_4D_1 and F_4D_2 on yield were insignificant. Straw yield among the treatments varied 2.35 to 3.94t/ha, with the minimum and maximum respectively, by F_3D_2 and F_2D_2. Regarding black point infected seed, percent of incidence varied 11.67 to 33.33. In order of ascending the effect of treatments such disease may be arranged as F_2D_2 (11.67%), F_2D_1 (13.33%), F_1D_1 (16.67%), F_4D_1 (16.67%), F_4D_2 (20.0%), F_1D_2 (21.67%), F_3D_1 (30.0%) and F_3D_2 (33.33%). Although the treatment F_2D_2 gave the minimum black point infected seed but it was statistically similar to F_1D_1, F_2D_1 and F_4D_1. The effect of F_1D_1 and F_4D_1 showed statistically alike with F_1D_1 and F_4D_1 on black point infection but they gave statistically higher incidence compared to F_2D_1 and F_2D_2 and statistically lower incidence than F_3D_1 and F_3D_2 (Figure 5).

Results of the present investigation indicated that the fungicides, Hexaconazole and Folicur were better compared to Fujione and Akanazole when main effect of fungicides was considered. Considering the main effect of doses there was no remarkable variation became well pronocenced between doses. The interaction effect of the fungicides was found significant variation on tested parameters under the study. All the interacting treatments showed more or less effective in reducing PDI value and yield contributing

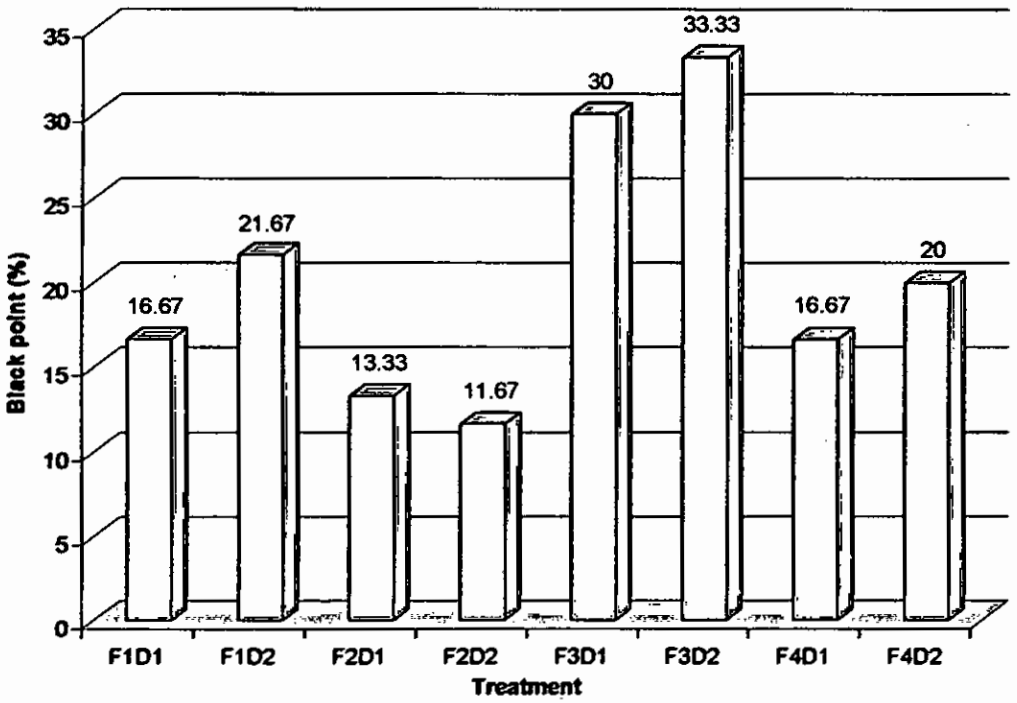


Figure 5. Interaction effects of fungicides and doses on black point

characters. But interacting treatments like F_3D_2 (Hexaconazole, 0.1%), F_3D_1 (Hexaconazole, 0.05%), F_1D_2 (Folicur, 0.1%) and F_1D_1 (Folicur, 0.05%) gave statistically better performance in reducing PDI value, enhancing yield contributing characters and reducing black point incidence compared to F_3D_1, F_3D_2, F_4D_1 and F_4D_2. In most of parameters the treatments F_1D_1, F_1D_2, F_2D_1 and F_2D_2 were statistically similar indicating both the fungicides may be used at 0.05% concentration for effective control of Bipolaris leaf blight, incurring higher yield and obtaining minimum black point infected seed grains. The findings on aforesaid events were more or less corroborated with results of Duriller and Gilchrist (1994), Mondal *et al.* (1994), khan and Ilyas (1996), Goswami *et al.* (1998), Chang and Wu (1998), Mahto (1999), Pandey *et al.* (1999); Shaheed *et al.* (2005).

Experiment 4.4. Estimation of avoidable yield loss of wheat due to Bipolaris leaf blight of wheat

Significant variation on different yield contributing characters grain yield and black point incidence became well pronunced on both Bipolaris leaf blight susceptible and moderately resistant wheat varieties in the present investigation (Table 7). In susceptible variety there was no significant variation between sprayed and unsprayed condition on plant height. Significantly higher spike length and seed number per spike were recorded in Tilt sprayed compared to Unsprayed. The PDI value of 14.14 was recorded in sprayed plants against 40.79% in unsprayed plants, which differed significantly with each other. In case of TGW (Thousand grain weight) significantly higher grain weight of 44.75 g was recorded in sprayed condition against 42.13g under unsprayed condition. As high as 3.29t/ha

Table 7. Avoidable yield loss of wheat varieties due to Bipolaris leaf blight disease

Variety	Treatment	Plant height (cm)	Spike length (cm)	PDI	Seed/ Spike (No.)	TGW (g)	Plot yield (g)	Straw yield (t/ha)	Grain yield (t/ha)	Black point (%)	Yield loss (%)
Kanchon (Susceptible)	Sprayed	92.75	12.12	14.14	28.42	44.75	987	4.79	3.29	2.25	27.05
	Unsprayed	92.14	10.79	40.79	21.64	42.13	725	4.29	2.40	21.45	
"t" Value		NS	0.89	5.63	2.13	1.28	6.51	0.32	0.61	6.32	
Shatabdi (Moderately Resistant)	Sprayed	98.29	13.06	8.44	32.40	42.28	1056	5.11	3.52	1.88	14.20
	Unsprayed	97.41	12.91	15.61	29.71	41.06	906	4.83	2.02	16.30	
"t" Value		NS	NS	2.48	1.48	NS	2.64	0.18	0.24	3.69	

NS =Non Significant

grain yield was harvested from sprayed treatments, which gave significantly, higher yield compared unsprayed treatments. Significant variation on straw yield per hectare became also distance between sprayed and unsprayed treatments. Incidence of black point infected seed varied widely between sprayed and unsprayed treatments. In sprayed treatments only 2.25% black point incidence was recorded which was 10 times lower over unsprayed treatments (21.45%). The losses in grain weight of Bipolaris leaf blight susceptible variety (Kanchon) was estimated 27.05%.While moderately resistant variety, Shatabdi was used to assess avoidable yield loss, significant variation between sprayed and unsprayed treatments prevailed in almost all used parameters except plant height, spikelength and TGW. In sprayed treatment only 8.44 PDI value of Bipolaris leaf blight was recorded whcih was significantly lower compared to unsprayed where value of same parameter was 15.61. Mean of 32.40 seed number per spike was recorded in sprayed, which was significantly higher over unsprayed. Regarding TGW, 42.28 and 41.06g seed weight was recorded respectively, by sprayed and unsprayed treatments. Significantly higher plot yield of 1056g was recorded in sprayed treatment against 906g recorded from unsprayed treatment. In case of total grain yield, 3.52 and 3.02t/ha were recorded in sprayed and unsprayed treatments respectively. While statistical analysis was performed it was found that sprayed treatment gave significantly higher yield compared to unsprayed treatment. Significant variation on straw yield became noticed between sprayed and unsprayed treatments. The percent of yield loss calculated in shatabdi was only 14.20%. Percent reduction of black point due to fungicidal spray was 89.51 and 88.46 respectively, in Kanchan and Shatabdi (Figure 6). Results on the investigation of avoidable loss in yield on two varieties (Kanchan as susceptible and Shatabdi as moderately resistant)

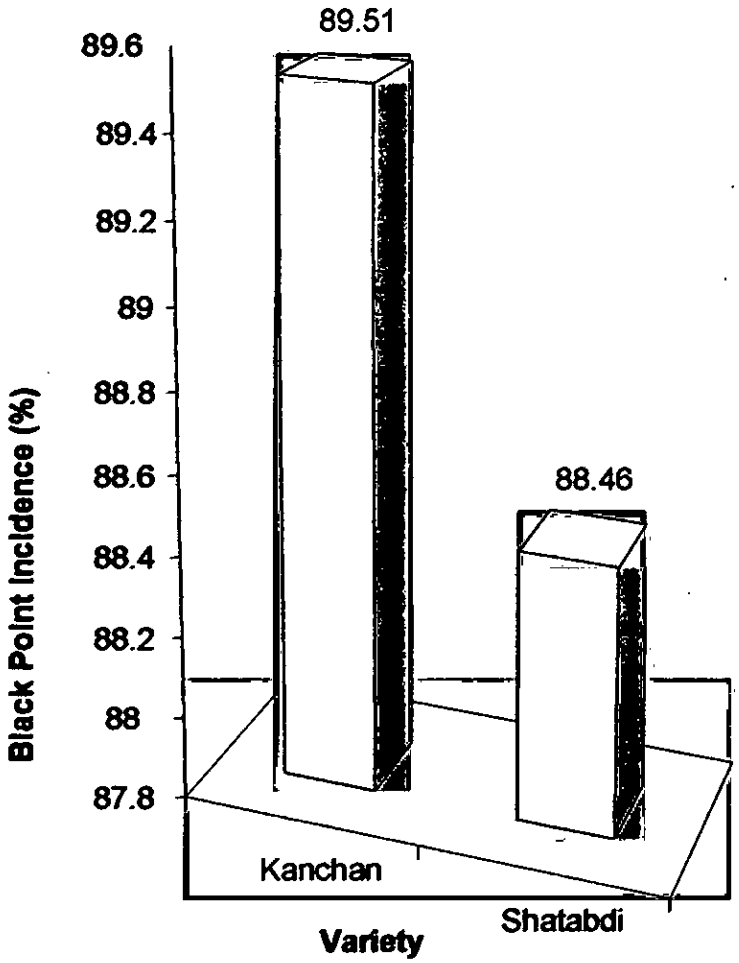
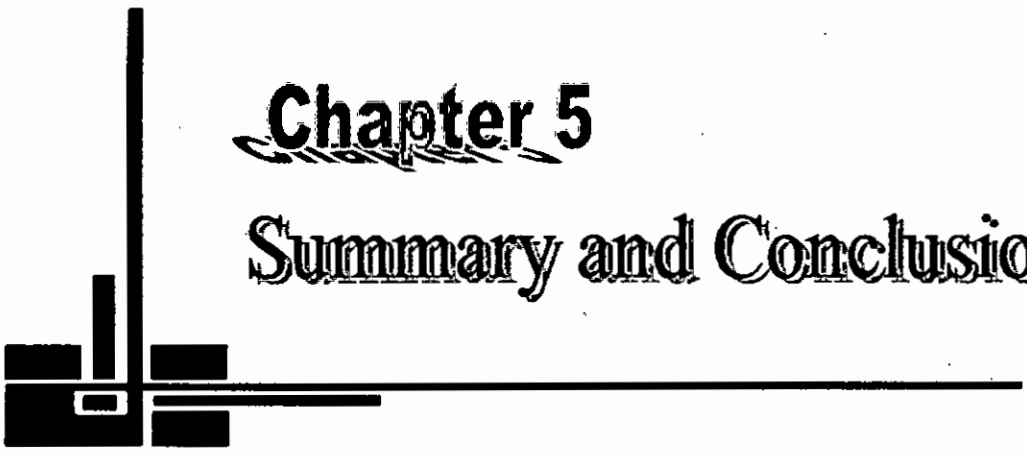


Fig. 6. Percent reduction of black point incidence over control due to fungicidal spray

against Bipolaris leaf blight indicated that significantly lower disease severity and black point incidence and higher yield were obtained in sprayed over unsprayed treatment irrespective of degree of susceptibility of varieties. In Bipolaris susceptible variety Kanchan, the avoidable yield loss was estimated 27.05% while it was only 14.20% in moderately resistant variety, Shatabdi. Adverse effect of *Bipolaris sorokiniana* on plant characters, yield contributing characters, yield loss biomass and seed infection (black point) have been documented by many researchers which clearly supports the present investigation (Raemaekers 1985 and 1988, Mehta, 1985; Brandle *et al.* 1987, Rashid *et al.* 1987, Dublin and Ginkel 199991, Razzaque and Hossain 1991, Azhar 1992, Alam *et al.* 1994 and 1995, Anonymous 1995, Patil *et al.* 2001 and Singh *et al.* 2002). Mehta stated that losses in yield due to *Bipolaris sorokiniana* could be between 30 and 80 %. In warmer areas of the world 1-20% losses, of wheat depending on locations and varieties caused by *Bipolaris sorokiniana* (Dubin and Ginkel,1991). According to Razzaque and Hossain (1991) about 21, 14, 8 and 4% yield loss occurred dut to Bipolaris leaf blight in sonalika, kanchan, Akbar and Aghrani, respectively Alam *et al.* (1995) estimated the average yield loss of 14.9% in Kanchan due to leaf blight. Almost similar observation of yield loss in Kanchan due to leaf blight has been reported Anonymous (1995).

Bipolaris sorokiniana is the most predominant fungus causing black point disease. Which resulted seed discolouration, germination failure as well as seedling infection, ultimatly cause severe damage of wheat crop. Under the present study black point incidence reduced markedly in both susceptible and moderately resistant varieties under the sprayed plots. Adverse effect of black point on seed germination, seedling mortality, leaf blotch development

and weight loss of seed have been documented by many workers (Nestrov, 1981, Frank 1985, Lin 1985, Nalli 1986, Fakir 1988, Cook and Vesath 1991, Ali and Fakir 1992, Dey *et al.* 1992, Rashid *et al.* 1994, Bazlur Rashid *et al.* 1997, Rahman and Islam 1998 and Mondal 2000).



Chapter 5

Summary and Conclusion

5. SUMMARY AND CONCLUSION

In the field, 14 wheat germplasms were evaluated to Bipolaris leaf blight (*Bipolaris sorokiniana*) under natural infection pressure in 2004-05 crop season. Germplasm were planted in 2m long 2 rows plot with 20cm row spacing having three replications. Data were taken on plant height, days to heading, disease severity (0-5 scale), PDI value, thousand grain weight, yield per plot and black point incidence. Finally reactions of germplasm to the disease were graded. Results indicated that 3 germplasms (Chirya-7, Shatabdi and BAW-966.) were resistant to Bipolaris leaf blight. Among the rest germplasms 1, 3, 5 and 2 showed moderately resistant, moderately susceptible, susceptible and highly susceptible reaction to Bipolaris leaf blight, respectively.

In 2004-05 crop season altogether five fungicides Avistin (0.1%), Hayconazole(0.05%), Nuben (0.2%), Sulphotox (0.2%) and Tilt 250EC (0.05%) were evaluated to determine their effectiveness in controlling Bipolaris leaf blight disease of Wheat variety, Kanchan under field conditions. The unit plot size was 3.0×2.0m, keeping 20 cm row to row spacing. A total of three sprays were executed at 15 days interval, initiating after 45 days of sowing. Data were taken on plant height, spike length, seed number per spike, PDI value, thousand grain weight, yield and black point incidence. Results indicated that all the fungicides significantly reduced disease parameters and enhanced yield contributing characters over control. Among the fungicides Tilt proved the most effective in reducing Bipolaris leaf blight disease incidence and increased yield followed by Hayconazole.

Tilt reduced more than 72% PDI value and increased 108.09% grain yield over control.

To determine the effective dose of fungicides against Bipolaris leaf blight an experiment was carried out with seed of susceptible variety, Kanchan during 2004-05 crop season. The unit plot size was 3.0×2.0m, keeping 20 cm row to row spacing. Four fungicides at two doses were applied. the fungicides were Folicur, Hexaconazole, Fujione and Akanazole. All of them were tested at 0.05 and 0.1% concentration. Fungicides were applied three times at an interval of 15 days, commencing after 45 days of seed sowing. Design was RCBD two factors where fungicides considered as one factor while doses treated as another factor. Replication was thrice. The treatment interactions were F_1D_1 (Folicur, 0.05%), F_1D_2 (Folicur, 0.1%), F_2D_1 (Hexaconazole, 0.05%), F_2D_2 (Hexaconazole, 0.1%), F_3D_1 (Fujione, 0.05%), F_3D_2 (Fujione, 0.1%), F_4D_1 (Akanazole, 0.05%) and F_4D_2 (Akanazole, 0.1%). Data were recorded on plant height, spike length seed number per spike, disease severity, PDI, thousand grain weight, straw and seed yield and black point incidence. Main effects of fungicides on different parameters were significant. Significant differences among the interacting treatments become evident on used parameters. Among them F_2D_2 showed most effective in reducing PDI value, gave the highest yield and minimum black point incidence but it showed statistically similar to F_1D_1, F_1D_2 and F_2D_1.
Another experiment was conducted with a view to determine the avoidable grain yield loss due to Bipolaris leaf blight. Two varieties namely, Kanchan (Susceptible) and Shatabdi (moderately resistant) were used. Unit plot size was 3.0×1.0m, keeping 20 cm spacing between rows. There were two treatments viz: Sprayed and Unsprayed. In Sprayed treatment, fungicide Tilt

250EC (0.05%) was used while Unsprayed treatment plain water was applied. The experiment was laid out following paired plot technique, keeping five replications. Data were taken on different yield contributing characters and finally grain yield loss was estimated. Results indicated that significant variation exists between Sprayed and Unsprayed treatments on used parameters regardless of tested susceptible and moderately varieties. The avoidable loss of 27.05 and 14.20% were estimated respectively, in Kanchan and Shatabdi varieties.

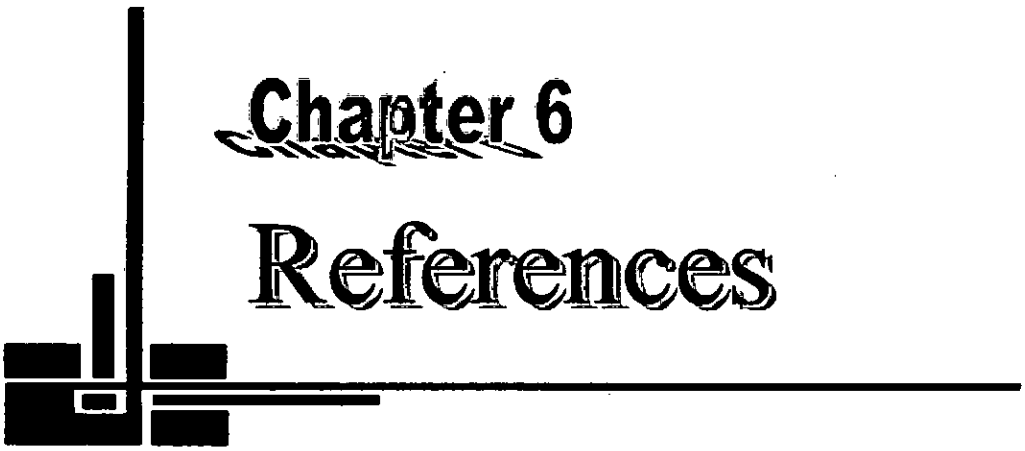
Based on the findings of the present investigation the following conclusion may be drawn:

i) Some germplasms exhibit moderately resistance reaction to Bipolaris leaf blight, be useful for plant breeders.

ii) Fungicides like Tilt 250 EC and Hayconazole are highly effective to minimize the disease incidence and incurring higher yield of wheat.

iii) Hexaconazole at 0.1% may be suggested for controlling the disease effectively, but further research need to be carried out for its recommendation.

iv) To minimize avoidable yield loss variety Kanchon susceptible to Bipolaris leaf blight should be with drawn and variety shatabdi may be advocate for cultivation by growers.



Chapter 6

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