YIELD LOSS ASSESSMENT OF WHEAT DUE TO LEAF BLIGHT DISEASE CAUSED BY *Bipolaris sorokiniana*

SANTA ISLAM NOWRIN

DEPARTMENT OF PLANT PATHOLOGY
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA-1207

JUNE, 2015

YIELD LOSS ASSESSMENT OF WHEAT DUE TO LEAF BLIGHT DISEASE CAUSED BY *Bipolaris sorokiniana*

BY

SANTA ISLAM NOWRIN
Reg. No. 09-03518

A Thesis
Submitted to the Faculty of Agriculture, Dept. of Plant Pathology
Sher-e-Bangla Agricultural University, Dhaka,
in partial fulfillment of the requirements
for the degree
of

MASTER OF SCIENCE
IN
PLANT PATHOLOGY

SEMESTER: JANUARY - JUNE, 2015

Approved by:

Dr. Md. Rafiqul Islam
Professor
Department of Plant Pathology
Supervisor

Abu Noman Faruq Ahmmed
Associate Professor
Department of Plant Pathology
Co-supervisor

(Dr. Md. Belal Hossain)
Associate Professor
Chairman
Department of Plant Pathology
Sher-e-Bangla Agricultural University

DEPARTMENT OF PLANT PATHOLOGY
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207
Fax : +88028155800
Web site : www.sau.edu.bd

CERTIFICATE

*This is to certify that the thesis entitled, "**YIELD LOSS ASSESSMENT OF WHEAT DUE TO LEAF BLIGHT DISEASE 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 (M.S.) IN PLANT PATHOLOGY**, in, embodies the result of a piece of bona fide research work carried out by **SANTA ISLAM NOWRIN**, Registration No. **09-03518** 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 duly been acknowledged.

Dated: 26 may, 2016

Place: Dhaka, Bangladesh

(Prof. Dr. Md. Rafiqul Islam)

Supervisor

Dedicated to

My

Beloved Parents

ACKNOWLEDGEMENT

*All praises to the "**Almighty Allah**" who enable me to complete a piece of research work and prepare this thesis for the degree of Master of Science (M.S.) in Plant Pathology.*

*I feel much pleasure to express my gratefulness, sincere appreciation and heartfelt liability to my venerable research supervisor **Professor Dr. Md. Rafiqul Islam**, Department of Plant Pathology, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, Bangladesh for his scholastic guidance, support, encouragement, valuable suggestions and constructive criticism throughout the study period.*

*I also express my gratitude to reverend co-supervisor **Abu Noman Faruq Ahmmed**, Associate Professor, Department of Plant Pathology, Sher-e-Bangla Agricultural University (SAU), Dhaka-1207 for his constant inspiration, valuable suggestions, cordial help, heartiest co-operation and supports throughout the study period.*

It is also an enormous pleasure for the author to express her cordial appreciation and thanks to all respected teachers of the Department of Plant Pathology, Sher-e-Bangla Agricultural University, for their encouragement and co-operation in various stages towards completion of this research work.
The author deeply acknowledges the profound dedication to her beloved Father, Mother and Sisters for their moral support, steadfast encouragement and continuous prayer in all phases of academic pursuit from the beginning to the completion of study successfully.

Finally, the author is deeply indebted to her friends and well-wishers for their kind help, constant inspiration, co-operation and moral support which can never be forgotten.

The Author

YIELD LOSS ASSESSMENT OF WHEAT DUE TO LEAF BLIGHT DISEASE CAUSED BY *Bipolaris sorokiniana*

ABSTRACT

The experiment was conducted in the farm of Sher-e-Bangla Agricultural University and central laboratory of the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka-1207 during the Rabi season from November 2014 to June 2015. The experiment was laid out in a RCBD (one factor) with three replications. Multiple treatment experiment with 11 treatments, viz. T_0 (control); T_1 (1 spray with Tilt 250 EC @ 0.1%); T_2 (2 sprays with Tilt 250 EC @ 0.1%); T_3 (3 sprays with Tilt 250 EC @ 0.1%); T_4 (4 sprays with Tilt 250 EC @ 0.1%); T_5 (5 sprays with Tilt 250 EC @ 0.1%); T_6 (6 sprays with Tilt 250 EC @ 0.1%); T_7 (7 sprays with Tilt 250 EC @ 0.1%); T_8 (8 sprays with Tilt 250 EC @ 0.1%); T_9 (9 sprays with Tilt 250 EC @ 0.1%); T_{10} (10 sprays with Tilt 250 EC @ 0.1%) were applied in the experiment to make the variation in the disease severity and respective yield of treated plot. Different treatment comprising different number of spraying had remarkable influence the disease severity of leaf blight, yield and yield contributing characters of wheat. The lowest (0.0%) percent disease index (PDI) and the highest yield (5.35t/ha) was recorded in case of treatment T_{10} where 10 spraying were done with Tilt-250 EC @ 0.1%. The highest PDI and the lowest yield were counted in case of treatment T_0 (control). The disease severity and yield was varied significantly on the basis of number of spraying. Using the varied disease severity (PDI) and the corresponding yield the regression equation for yield loss assessment was constructed as $\hat{Y} = 2.58 + 0.40X_i$ where 0.4 % loss of yield would be incurred for increasing each percent of disease severity (PDI).

CONTENTS

CONTENTS (CONTD.)

CONTENTS (CONTD.)

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

Some abbreviations and symbols was used in the body of the thesis

ABBREVIATION	ELABORATION
%	Percent
@	At the rate of
AEZ	Agro-ecological Zone
Agric.	Agriculture
Agril.	Agricultural
ANOVA	Analysis of variance
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistic
BD	Bangladesh
BSMRAU	Bangabandhu Sheikh Mujibur Rahman Agricultural University
Conf.	Conference
CIMMYT	International Maize & Wheat Improvement Centre
Cm	centimeter
CV%	percentage of co-efficient of variation
DAS	Days after sowing
df	Degrees of freedom
DMRT	Duncan's Multiple Range Test
EC	Emulsifiable Concentrate
et al.	And Others
etc.	Etcetera
g	Gram
Int.	International

ABBREVIATION	ELABORATION
ISBN	International Standard Book Number
J.	Journal
t/ha	Tons per hectare
LAD	Leaf area diseased
m	Meter
m^2	Square meter
MSE	Mean Square of the error
No.	Number
NUV	Near Ultra Violet
Patho.	Pathology
PDI	Percent disease index
Phytopath.	Phytopathology
Prod.	Production
RCBD	Randomized complete block design
Rep.	Replication
Res.	Research
SAU	Sher-e-Bangla Agricultural University
Sc.	Science
SE	Standard Error
Tech.	Technology
Univ.	University
Var.	Variety
WP	Wetable powder

Chapter 1

Introduction

CHAPTER 1

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the one of most important and staple cereal food crop for the majority of world's populations. About two billion people (36% of the world population) consume wheat as staple food Worldwide, wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally (Breiman and Graur, 1995). It exceeds in acreage and production every other grain crop (including rice, maize, etc.) and is cultivated over a wide range of climatic conditions. Wheat is the second most important cereal crop in Bangladesh and its production is expanding rapidly. Though the crop has been introduced in 1961 in the country, its popularity has gained after 1975. Between 1970-71 and 1980-1981, the cropped area wheat under jumped from 0.126 million ha to 0.591 million ha and production rose 10 fold from 0.11 million tons to 1.07 million tons, a 24% annual growth rate (BARI, 2010). Presently, Bangladesh is nearing self-sufficiency in rice, the major staple food. Production of wheat, the second most important cereal, has also increased, although the country still imports significant quantities of wheat to meet rapidly growing domestic demand. In the mid-1970s Bangladesh was producing only about 15 percent of its wheat requirements, by the early 1990s about 45 percent of domestic demand were being met from local production. Yet, domestic production of wheat composed only 9 percent of total cereal production (IFPRI Research report 106). The government of Bangladesh continues to provide strong support to rice producers while the wheat grower supposed to give less attention.

In Bangladesh, the total acreage of land was 429607 hectare and production 1302998 metric tons indicating 3.033 Mt/ha yields during 2013-14 cropping season (BBS 2015), where the average yield of wheat in China was 5 Mt/ha, India 3.2Mt/ha and the world average yield was 3.11Mt/ha (NASS 2015). The national yield is lower compared to other wheat growing countries.

Wheat suffers from as many as 26 seed borne pathogens causing 14 seed borne diseases. Among them leaf blight / spot and black point caused by *Bipolaris sorokiniana* has become a serious concern in the recent years in Bangladesh (Fakir, 1988). General observation indicate that *Bipolaris* leaf blight appears at the seedling stages and increased with increasing plant age and finally the pathogen attacks wheat grain (Alam *et al.*, 1994). Disease symptoms appeared as numerous small, circular to oval and grey-brown eye-shaped spots on green leaves. The centers of the spot soon faded, becoming light gray to straw colored with distinct dark brown margins. This pathogen causes seed rot, reduces seedling emergence and yield of subsequent crop (Aulakh *et al.,* 1988; Chaudhary *et al.*, 1984; Gill and Tyagi, 1970; Nestrov, 1981).

Black pointed seeds give seedling with reduced vigor (Rahman and Islam, 1998). Black point disease is characterized by a brown-black discoloration of the embryos of the wheat (Culsha *et al.*, 1988). The disease reduces the quality of bread wheat causing economic losses to producers. Black point disease incidence exceeding 10% results in downgrading of the grain (Canadian Grain Commission, 1983). Black pointed grains affected adversely on the quality of the wheat flour (Lorenz, 1986; Wang *et al.,* 2003).

Recent yield trials conducted by different breeding centers around the world have shown that the production of bread wheat (*Triticum aestivum L.)* is being constrained by several biotic and abiotic stresses (Dubin and van Ginkel 1991; Hobbs and Giri 1997; Dubin and Duveiller 2000; Regmi *et al.*, 2002; Sharma and Duveiller 2004; Duveiller, 2004). The warmer parts of the world like Latin America, Africa, Asia, Southern Asia etc., are mainly affected by *Bipolaris sorokiniana* (Sacc.) Shoemaker [teleomorph, *Cochliobolus sativus* (S. Ito & Kurib.) Drechsler ex Dastur] a notorious wheat fungal pathogen (Dubin and van Ginkel 1991). *Bipolaris* leaf blight caused by *Bipolaris sorokiniana* is the most important biotic constraint affecting wheat production in Bangladesh (Ahmed and Meisner, 1996). The hot and humid environment of the country is very much congenial for the development of this pathogen. In Bangladesh mean temperature in winter has risen by 0.66^0C since 1990 and a further warming of 2.13^0C by 2050 is predicted (Poulton and Rawson 2011). Rising of temperature can be expected to increase the severity of *Bipolaris* leaf blight and the other disease in future because a warm and humid climate favors the development and spread of the pathogen.

The yield loss in wheat due to leaf blight / spot disease in the farmer's field in our country have been reported to be 14.97% (Alam *et al.*, 1995). In case of severe attack, it may result 100% yield loss (Hossain and Azad, 1994). Leaf blight disease is considered to be a threat to the wheat cultivation all over the world (Duveiller and Gilchrist, 1994). The yield loss in wheat due to leaf blight / leaf spot / leaf blotch disease has been reported to be 20% in Sonalika, whereas 14% and 8% in Akbar and Kanchan, respectively (Razzaque and Hossain, 1991). In farmer's field, 29% yield reduction was estimated during 1991-1992 in cv. Kanchan (Alam *et al.*, 1994). Rashid and Fakir (1998) estimated yield reduction of wheat due to *Bipolaris sorokiniana* as high as 57.6% and 64.5%, in cvs. Kanchan and Sonalika, respectively, at maximum disease incidence.

Management of leaf blight is difficult as the fungus is seed-borne, soil borne as well as air borne. Several approaches have been practiced, such as use of cultural control, biological control, resistant variety, chemical control, and use of plant extract etc. Though growing resistant varieties is chief and eco-friendly, the level of resistance in high-yielding wheat genotype is still unsatisfactory and needs to be improved significantly in the warmer humid region in South Asia (Joshi *et al.* 2007a, b, c). Consequently, an integrated approach with host resistance as a major component is generally considered best for controlling the disease (Joshi and Chand 2002). The application of fungicides is an important practice to control the disease. Fungicidal approach is an alternative approach through which the disease can be minimized effectively. Foliar spray with fungicide can *control B. sorokiniana* infection on foliage and reduce leaf blight severity of wheat (Rashid *et al.* 2001). Many workers used of different chemicals against the disease and Tilt-250 has been proved effective (Aannonymous, 1989).

For the national import policy of wheat in the country, national crop assessment due to leaf blight of wheat is essential. But such an important attempt for crop loss assessment of wheat due to *Bipolaris* leaf blight is not yet been taken constructively. The government needs to have the picture about national yield status of wheat prior to harvesting the crop for taking necessary step to meet up the national wheat deficit for management of market crisis.

Considering the above facts, the present investigation was undertaken with the following objectives:

1. To calculate the disease severity in the critical stage.

2. To calculate yield loss of wheat due to leaf blight caused by *Bipolaris sorokiniana.*

3. To construct a regression equation for yield loss assessment of wheat due to leaf blight.

Chapter 2

Review of literature

CHAPTER 2

REVIEW OF LITERATURE

Wheat is the second most important cereal crop in Bangladesh. The crop has acknowledged much concentration by the researcher on various aspects of its production. Very few studies on to the related to the assessment of yield loss leaf blight of wheat caused by *Bipolaris sorokiniana* have been carried out in many countries of the world .The work is so far done in Bangladesh and is not adequate and conclusive. Nevertheless, some of the important and informative works and research findings so far been done at home and abroad on this aspect have been reviewed in this chapter.

Islam *et al.* (2015) carried out an experiment of different seed borne fungi on germinating wheat seed and their effect when it treated with chemical. He found *Bipolaris sorokiniana, Alternaria tenuis, Curvularia lunata, Fusarium* spp. *Aspergillus* spp., *Penicillium* spp. and *Rhizopus* spp on germinating wheat seed and treated seeds with Vitavax 200, Bavistin and Captan. it was observed that the treated seeds showed significantly higher rate of germination than untreated seeds and The highest infection of *Bipolaris sorokiniana* was recorded in control and it was 7.75%. *Bipolaris sorokiniana* was found to be 0.25% when seeds were treated with Vitavax 200. The treatment Bavistin was also very effective when only 1.75% infection was recorded. Next chemical Captan treated seed showed 3.00% seed infection.

Kumar *et al.* (2014) suggested that a combination of seed treatment by Carboxin (37.5%) + Thiram (37.5%WS) @ 2.5gm kg^{-1} seed + two foliar sprays of Propiconazole 25 percent EC @ 0.1percent one at boot leaf stage and another 20 days after 1st spray gave best result in reducing the spot blotch of wheat as well as increasing the 1000 grain weight and grain yield of wheat.

Iqbal *et al.* (2014) evaluated the efficacy of fungicide i.e. (Propiconazole @ 500 ml/ha), (Metiram @ 625 g/ha), (Difenaconazol @ 325 ml/ha) and (Propineb @ 1250 g/ha) used for controlling black point (*Bipolaris sorokiniana*) of wheat at Adaptive Research Farm, Gujranwala during Rabi 2010-11; 2011-12 and 2012-2013 compared to Control. They showed that all the fungicides (Propiconazole @ 500 ml/ha, Metiram @ 625 g/ha, Difenaconazol @ 325 ml/ha, Propineb @ 1250 g/ha) were involved for controlling disease but Metiram gave maximum control against grain infection followed by Difenaconazole and Propiconazole at milking stage to overcome the problem.

Rahman *et al.* (2013) working with eight fungicide of three groups against leaf blight disease caused by *Bipolaris sorokiniana*, reported that the highest yield of 61.96% increase compared to control by Tilt 250 EC followed by Sunconazole 250 EC, Shadid 250 EC and Propicon 250 EC and the range of 8.10 to 20.60% of grain number/plot increased over control due to application of fungicide.

Singh *et al.* (2012) conducted an experiment disease of wheat include the leaf blight and blotches which are caused by *Alternaria* and *Helminthosporium* species respectively. Monitoring of foliar blights of wheat in 5 districts viz.,Agra, Mathura, Firozabad, Mainpuri and Etah of Agra region revealed that *Helminthosporium sativum* (Syn. *Bipolaris sorokiniana*) is the most predominant pathogen of wheat followed by *Alternaria triticina* in this region. However, *Alternaria triticina* is less significant. The average incidence of *Bipolaris sorokiniana* and *Alternaria triticina* at maturity of the crop was 62% and 43% respectively but *Alternaria alternata* showed average incidence of 14.4% in the month of April.

Germán *et al.* (2011) found that leaf rust can cause wheat grain yield losses higher than 50% in severe epidemics if fungicides are not applied.

Zaman *et al.* (2010) found that highest seed germination and lowest incidence of *Bipolaris sorokiniana* was recorded under apparently healthy seeds treated with Bavistin 50WP. Farmer's saved seed always resulted significantly lower seed germination and higher incidence of *Bipolaris sorokiniana*. All the eco-friendly seed treatments significantly increased seed germination and reduced incidence of *Bipolaris sorokiniana*.

Rahman, *et al.* (2009) conducted an experiment on integrated approach in controlling Bipolaris leaf blight (BpLB) and Foot and root rot diseases of wheat under field condition in the cropping season 2007-08. He used chemical fertilizer alone in combination with soil treatment (poultry refuse) and fungicide (Tilt 250EC) were considered for the management of *Bipolaris* leaf blight and Foot and root rot diseases of wheat caused by *Bipolaris sorokiniana* and *Sclerotium rolfsii* or *Rhizoctonia solani* respectively and found that the disease severity was significantly higher with both higher (150 kg N/ha) and lower (0 Kg N/ha) doses of N than the recommended dose i.e. 100 kg N/ha. The disease severity was reduced significantly under the recommended doses (N-100kg/ha, P-26kg/ha, K-50kg/ha, S-20kg/ha, B-1 kg/ha) of chemical fertilizers. The lowest plant height, spikes/m^2, grains/spike and grain yield were reduced with the treatment where N was not applied at all.

Zaman *et al.* (2009) observed that seed treatment with Bavistin 50 WP had the lowest percent leaf infection which was followed by hot water treated, sun drying, polythene solarization, brine solution treated seeds and apparently healthy seeds.

Panna *et al.* (2009) suggested that using pathogen free seed is the best option to control this disease.

Paradeshi *et al.* (2008) stated that wheat grains are susceptible to the infection during grain filling or at milking stage.

Malakar *et al.* (2008) conducted an experiment to control black point disease through seed dressing and foliar spray with different fungicides and found seed treatment with Vitavax-200 and foliar spray with Propiconazol was the most effective in reducing black point incidence in harvested seeds.

Kabir *et al.* (2007) recorded that farmer's stored seed always resulted significantly highest leaf spot severity at all growth stages whereas apparently healthy wheat seeds treated with Vitavax 200 @ 0.4% resulted significantly lower disease severity.

Sharma and Duveiller (2007) conducted an experiment under rice-wheat cropping system. He found that spot blight severity went up to 100% and 70% in 2004 and 2005 respectively.

Ahmed *et al.* (2007) reported in an experiment that Tilt-250 EC (0.1%) sprayed plots increased 36% grain yield over unsprayed plots in wheat var. Sonalica.

Zamal (2007) conducted an experiment to the comparative efficacy of Vitavax-200 as seed treating chemical; Tilt-250 EC, Bavistin and Pencozeb as foliar spray in controlling leaf spot of wheat caused by *B. sorokiniana* under field condition. He reported that effect of seed treatment with Vitavax-200 followed by subsequent three times foliar spray with Tilt-250 EC was found significantly more effective than the other single and combined effects in reducing leaf spot severity and increasing yield of wheat.

Zobaer *et al.* (2007) reported that apparently healthy wheat seeds treated with hot water at 52^0C for 5 min significantly reduced leaf spot severity of wheat over control.

Mak *et al.* (2006) and Sadasivaiah *et al.* (2004) stated that cause of black point had been associated with extreme environmental conditions (heavy rain, high humidity and extreme temperature) during the grain filling duration.

Islam *et al.* (2006) applied eight plant extracts and Vitavax-200 for treating against leaf spot (*Bipolaris sorokiniana*) of wheat. Among eight plant extracts, onion, garlic, kalijira, ginger, biskatali and neem extract showed statistically similar grain yield like the seed treatment with vitavax-200.

Reza *et al.* (2006) carried out an experiment to evaluate the effect of different levels of seeds and plants infection by *Bipolaris sorokiniana* on wheat. He found that the maximum of 15.73% seed rot/seedling mortality followed by subsequent leaf blight severity of 75.4% was recorded as a result of sowing of 30%infected seeds. While minimum of 5% infected seeds resulted respectively 3.1% and 57.53% of the disease.

Shahidullah (2006) conducted an experiment against bipolaris leaf blight of wheat by different fungicides such as Avistin 0.1%, Hyconazole 0.05%, Nuben 0.2%, Sulphotox 0.2% and Tilt 0.05%. He reported that Tilt-250 EC appeared most effective against the disease reduced PDI value of 72% and increased more than 108% grain yield over control.

Sharma *et al.* (2006) found grain yield loss due to spot blotch in South Asia ranged from 4% to 38% and 25% to 43% in the year 2004 and 2005 respectively and the number of kernels per spike as well as thousand-kernel weight were reduced respectively by 10% and 15% in 2004 and 11% and 18% in 2005.

Özer (2005) found that black point had been associated with some species of fungi called *Alternaria*; *Bipolaris*; *Fusarrium*; *Cladosporium* and *Sclerotium*.

Singh *et al.* (2005) reported that fungicide belongs to the Propiconazole group was found as effective fungicide in controlling leaf blight disease and increasing the grain yield significantly.

Sharma-Poudyal *et al.* (2005) conducted an experiment to determine the effect of seed treatment and foliar fungicide on disease and performance of wheat. Seed was treated with Vitavax 200, Bavistin and Simonis carbendazim in 2002, and Areestin instead of Simonis carbendazim in2003. One and two foliar sprays with Opus, Allegro, Horizon and Tilt were tested, along with control treatment. Vitavax 200B increased germination by up to 43% in both years and reduced seedling infection by C. sativas in 2003. The foliar fungicides reduced HLB severity and increased grain yield. The highest increase in grain yield over the control due to fungicide spray was 38% in 2002 and 83% in 2003. Grain infection in 2002 (39%) and 2003 (70%) in the control plot was reduced to 16 and 24%, respectively.

Sharma and Duveiller (2004) and Saari (1998) stated that grain yield reductions due to spot blotch are variable but are of great significance in warmer areas of South Asia.

Malakar (2003) found that when black pointed seeds were sown; emergence of seedling, seedling vigor, plant growth and grain yield was reduced and post emergence mortality, disease severity of *B. sorokiniana*, incidence of black pointed seed was increased.

Wang *et al.* (2003) reported that application of fungicides at or after head emergence could reduce the incidence of black point.

Patil *et al.* (2002) reported that the efficiency of 0.1% Propiconazole (tilt) 250 EC & 25% EC, 0.1% Hexaconazole 25% EC, 0.05% Tridemorph 200WC, 0.1% Tridemefon, 0.1% carbendazim 50WP (Bavistin), 0.025% Mancozeb (pencozeb), 0.020% Chlorothalonil, 0.3% Copper oxycloride 50 WP and 0.03% Nimbicidine in controlling leaf blight of wheat. The incidence of the disease was not observed in plant sprayed with 0.1% Propiconazole and increased the yield and biomass.

Hossein (2002) reported that farmer's clean seed, washed farmer's seed, washed clean seed and seed treated with Vitavax-200 increased grain yield by 16.62%, 16.45%, 23.39% and 26.60%, respectively over farmer's saved seed of rice (cv. BR11).

Giri *et al.* (2001) reported that Mancozeb and Thiram reduced seed-borne infection by *C. sativus* in wheat by 90.5 and 84.2%, respectively; the corresponding increases in seed germination were 34.7 and 34.2%. Carbendazim did not control seed-borne infection.

Rashid *et al.* (2001) reported that the severity of *Bipolaris* leaf blight (BpLB) and black pointed were significantly reduced over control when 0.1% Tilt 250 EC was sprayed on the leaf of wheat for 2 to 6 times and seed vigor in terms of 1000-seed weight were increased significantly over control.

Mondol (2000) reported that infected seeds and soil infested either with conidial suspension or colonized grains may serve as potential source for the survival of *B. sorokiniana* resulting germination failure, seedling mortality and spot blotch development of wheat.

Kabir and Hossain (2000) showed that the effect of different combinations of nutrients, irrigation and fungicides controlled *Bipolaris* leaf blight caused by *Bipolaris sorokiniana* in wheat cv. Kanchan. Treatments with nutrient + irrigation + Tilt (twice) reduced or controlled the disease and increased yield.

Hossain (2000) reported that seed germination and seedling emergence were significantly decreased with the increase in number of black pointed seed. The sample having 28% black pointed seed resulted maximum affected grain observed at the full and dead ripe stage 6.25 and 37.08%, respectively.

Mahto (1999) reported that three sprays of Propiconazole provided the best protection against HLB.

Rashid and Fakir (1998) reported that development of black point infection in the field was due to seed to plant to seed transmission of black point pathogen.

Murray *et al.* (1998) reported that fungicides groups like Mancozeb, Propiconazole and Tebuconazole were effective in controlling the disease and reducing inoculums pressure.

Nagaranjan and Kumar (1998) studied the foliar leaf blights of wheat caused by *Bipolaris sorokiniana* and found that the pathogen is capable of causing damage from the primary leaf stage, and the plants tend to become more susceptible to flowering.

Shabeer and Bockus (1998) recorded the highest yield losses for inoculations at the boot and flowering stages, indicating that plants were most susceptible physiologically to losses at those stages. Losses were the result of a significant reduction in grain weight and number of grains.

Rahman (1998) carried out an experiment on foliar spray in controlling *Bipolaris* leaf blight of wheat and found that Tilt-250 EC (0.1%) more effective as foliar spray than the effect of seed treatment with Vitavax-200. The maximum percent disease (PDI) of 58.25% was observed in control plots. The PDI value was reduced to 21.75% when Tilt was sprayed six times.

Singh *et al.* (1998) reported low incidence of leaf blight when wheat was sown on 4th week of Nov. as compared to late sown wheat.

Shrestha *et al.* (1998) noted that Rovral (Iprodione) and Vitavax-200 (Carboxin + Thiram) were effective in controlling wheat grain infection by *B. sorokiniana*, they did not quantify the level of effectiveness.

Viedma and Kohli (1998) conducted a research in Paraguay demonstrated that under severe disease pressure, fungicide application can result in a grain yield increase of 38-61%.

Zhimin *et al.* (1998) observed that seed germination and seedling growth decreased with the increase of susceptibility of a variety to black pointed infection.

Hossain *et al.* (1998) observed that leaf infection at flowering stages has direct effect on the reduction of formation of healthy grains with the increase in number of black pointed as well as discolored grains.

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

Mehta (1997) stated that seed treatment should not be applied if the seed infection level is less than 20% and germination is within standards. Seed lots with less than 20% infection should be treated only if percent germination is lower than the standard and there is shortage of seed.

Rashid *et al.* (1997) reported a highly significant effect of seed borne infection by *Bipolaris sorokiniana* on the germination of seeds of wheat cvs. Kanchan and Sonalika recorded by rolled paper towel germination test as well as pot experiment. At the maximum seed borne infection level (90%) both the cultivars yielded the minimum germination of 30.25% and 26.50%, respectively. Relationship between the level of seed borne infection and present seed germination showed gradual reduction in germination of seed with the increase in seed borne infection level. There was a trend of decrease in seed germination with the increase in seed borne infection in both the cultivars. The maximum germination reductions were affected grains observed at the full and dead ripe stage were 6.25 and 37.08%, respectively.

Ellis *et al.* (1996) suggested that use of late fungicide application targeted to control black point disease of wheat.

Ahmed and Meisner (1996) reported that seed treating with fungicide increase 74.5% seed emergence compared to control. Seed treating fungicide is an option to reduce primary inoculum of *Bipolaris sorokiniana* and some other seed and soil borne fungi.

Khan and Ityas (1996) applied Tilt and Folicur (Tebuconazole) at growth stage 10.1(heading) and 10.5 (anthesis) on FSD-85, LU-26 and pak-81 in the spraying of 1996 to determine their effect on *Drechslera sorokiniana* in wheat. A single application of either Tilt or Folicure gave significant reduction of spot blotch development

Alam *et al.* (1995) estimated the yield loss of wheat (KANCHAN) due to *Bipolaris* leaf blight at the farmer's field of four different locations. The average yield losses of wheat due to *Bipolaris* leaf blight at Dinajpur, Jessore, Jamalpur and Ishurdi were 13.9, 16.2, 14.8, and 14.5 percent respectively. The average losses of grains were 14.9% over the locations.

Goulart *et al.* (1995) evaluated the effect of fungicides spraying on above ground part of wheat on the incidence of *Bipolaris sorokiniana*. The best disease control was obtained with 3 applications, when wheat was sprayed with Tebuconazole and Flutriatol.

Singh *et al.* (1995) used four fungicides namely Mancozeb, Tilt-250 EC, Topsin-M and Rhilex to manage yield the foliar blight of wheat. Among the four tested fungicides, maximum yield, grain weight and minimum disease were found with 4 spraying of tilt (500ml/ ha) starting at disease initiation following by 3 spraying of Tilt. The 3 sprays of tilt was good as four sprays in respect of yield, grain weight and disease severity. Second effective fungicides was Mancozeb (2.5kg/ha) with four sprays starting at disease initiation.

Singh and Chauhan (1995) studied the efficacy of Dithane M-45 (0.25% and 0.30%), Tilt (0.025% and 0.05%) and Topsin-M (0.05% and 0.1%) against Helminthosporium leaf blight of wheat in vitro and in vivo. Tilt (500ppm) provided significant control the pathogen. Tilt (0.05%) provided significant control as foliar application in the field after 3 spraying at 10 days interval, with a cost ratio of 1:2:69.

Alam *et al.* (1994) reported that *Bipolaris* leaf blight is currently number one diseases of wheat in Bangladesh. The disease starts at the seedling stage and increases with age. Almost all commercial cultivars are moderately susceptible or susceptible to this disease.

Duveiller and Gilchrist, (1994) reported that *Bipolaris sorokiniana* attacks wheat plants from seedling to grain maturing stage causing foot rot, seedling blight, leaf spot, leaf blight, spot blotch head blight etc. it shows profound effect by reducing the yield of wheat. It considered a major pathogen of wheat and also other crops under Graminae family.

Rashid *et al.* (1994) reported that the relationship of leaf blight incidence with seed quality. They reported that seed quality deterioration is positively associated with the incidence of leaf blight by *B. sorokiniana* under field conditions.

Mondol *et al.* (1994) evaluated four commercial fungicides to evaluate their efficacy in controlling *Bipolaris* leaf blight of wheat natural epiphytic conditions during 1991-1992 and 1992-1993. Among them, tilt-250 EC (0.05%) was the effective and profitable one, which controlled the disease significantly producing the high 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.

Duveiller and Gilchrist, (1994) stated that almost all commercial cultivars were either moderately susceptible to leaf blight disease. Up to 29% yield loss was estimated during 1990-1992.

Orsi *et al.* (1994) found a positive correlation between *Drechselera sorokiniana* (*Cochliobolus sativus*) and black point incidence.

Bockus *et al.* (1992) found that the application of Tilt 250EC as foliar spray gave increased grain number per plant, 1000 grain weight and higher grain yield over unsprayed plots.

Anonymous (1992a) conducted to assess the yield loss due to *Biolaris* leaf blight at three locations with four sprays of Tilt @ 1.25% at an interval of 15 days commencing form 1st appearance of disease symptoms. It was reported that sprays reduced the percent of leaf blight and the percent loss in grain yield estimated as 25%.

Anonymous (1992b) reported that Tilt application (3 times) with seed treatment had lower yield loss than the other application. Tilt application at post anthesis increased yield by 17% which significantly differ from booting stage. Three applications of Tilt with or without seed treatment were similar to post anthesis application.

Hossain and Azad (1992) reported that higher age of crop plant resulted higher incidence of leaf spot (*B. sorokiniana*).

Peltonen and Karjalainen (1992) observed that application of Tilt increased grain yield. They also found that Tilt significantly increased nitrogen uptake, grain weight and protein quality in a good growing season but in a cold and wet weather Tilt did not increase yield or quality of cultivars.

Mironova (1991) found that Vitavax-200 was most effective in reducing seed borne infection of *Bipolars sorokiniana* and *Fusarium* spp.

Stack and McMullen (1991) reported that seed treatment with triadimenol and difenoconazole controlled seedling infection in wheat and increased grain yield by 7 and 9%, respectively.

Razzaque and Hossain, (1991) reported that the yield loss of wheat due to leaf blight disease was reported to be 20% in Sonalica, whereas 14% and 8% in Akbar and Kanchan, respectively.

Entz *et al.* (1990) conducted an experiment to determine the effect of foliar fungicides on grain yield, grain size and seed size in wheat. Tilt-250 EC rarely increased grain yield, but frequently increased the number of large grain.

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

Ashok *et al.* (1989) followed economical spray schedule for management of leaf blight/ blotch of wheat in the field and he found that the most effective and economical control was Mancozeb 3-sprays applied at 10 days interval followed by 3-sprays at 15 days interval with Mancozeb.

Das (1988) sprayed Sonalika wheat with 9 test fungicides at the initial appearance of disease at approximately 2-month-old plants where subsequently sprayed twice at 10-12days intervals. Disease intensity was recorded 10 days after final spraying Pencozeb gave the best control of *Bipolaris sorokiniana.*

Fakir (1988) observed that in Bangladesh, 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. However, he showed that reduction of germination of black point affected seeds was directly related with the severity of infection.

Khanum *et al.* (1987) stated that black point is responsible for the germination failure of grain in the field. Visual observation indicated that natural infection of grains of the cultivars Lyp-73, Pai-73, and Pka-81 were 58%, 35% and 15% respectively. The germination of healthy grains was 55-96.5% and that of diseased grains 34.5-71%.

Rashid *et al.* (1987) determined the effect of *D. sorokiniana* on some yield components of susceptible wheat cultivars under induced epiphytotic conditions. The lower leaves become significantly more infected than the flag leaves, but the infection of flag leaves caused the highest yield loss and infection of flag leaves caused the highest yield and infection of third leaves caused the least. The maximum loss was incurred in grain weight per ear at maximum disease severity score.

Frank (1985) and Lin (1985) found 6.2-29% reduction in seedling stand of winter wheat due to seed borne infection of *Bipolaris sorokiniana* alone.

Nalli (1986) stated that plants grown from *Bipolaris sorokiniana* inoculated seeds produced tiller of height and reduced yield.

Lorenz (1986) and Wang *et al.* (2003) conducted that black pointed grains affected adversely on the quality of the wheat flour.

Schmidt (1986) observed that sowing black pointed wheat seeds at various infestation levels had no effect on plant stand, yield and transmission of the disease to the subsequent crops in Bangladesh.

Lapis (1985) reported that three sprays of Propiconazole gave the best control of spot blotch and increased grain yield by 65%.

Sinha and Thapliyal (1984) found maximum reduction (38%) in germination of wheat seed infested with black pointed pathogen.

Jones (1983) and Peltonen and Karjalainen (1992) observed that foliar spray of Tilt-250 EC (Propiconazole) significantly decreased the pathogen population and percent blighted leaf area compared to non-sprayed control.

Jones (1983) reported that three times spraying with Tilt-250 EC at maximum tillering stage, 50% flowering stage and milk ripening stage were reported to control leaf blight caused by *Bipolaris sorokiniana*.

Vir *et al.* (1968) stated that the average incidence of disease as based on preliminary surveys was from 5-10 percent although considerable variation had been noticed in different samples collected from various sources. Investigations were also made to study the effect of this disease in seed germination. The data showed that presence of black point on the seed does not in any way impair seed germination.

Chapter 3

Materials and Methods

CHAPTER 3

MATERIALS AND METHOD

The details of the materials and methods of this research work were described in this chapter. The experimental site, weather, land preparation, experimental design, data collection on disease incidence and severity, growth parameters, yield and yield contributing character etc. are discussed under the following sub-heading:

3.1 Experimental sites

The experiment was conducted in the farm of Sher-e-Bangla Agricultural University, Dhaka. The location of the site was 23° 74N latitude and 90° 35 longitudes with an elevation of 8.2 meters from sea level. (Appendix I)

3.2 Experimental period

The experiment was carried out during the Rabi season from November 2014 to April 2015. Seeds of wheat were sown on 20 November 2014 and were harvested on 27 March 2015.

3.3 Soil type

The experimental site was situated in the subtropical zone. The soil of the experimental site lies in Agro-ecological region of "Madhupur tract" (AEZ no. 28). Its top soil is clay loam in texture and olive gray with common fine to medium distinct dark yellowish brown mottles. The pH 4.47 to 5.63 organic carbon contents is 0.82 (Appendix II).

3.4 Weather

The monthly mean of daily maximum, minimum and average temperature, relative humidity, monthly total rainfall and sunshine hours received at the experimental site during the period of the study have been collected from Bangladesh Meteorological Department, Agargaon, Dhaka and presented in Appendix III.

3.5 Variety

BAW-28 (KANCHAN), the variety of wheat was used for this experiment. Seed was collected from wheat research center of BARI (Bangladesh Agricultural Research Institute), Gazipur, Dhaka.

3.6 Treatment

Multiple treatments were applied in the experiment as mentioned below:

T_0= control
T_1= 1 spray with Tilt 250 EC @ 0.1%
T_2 = 2 sprays with Tilt 250 EC @ 0.1%
T_3= 3 sprays with Tilt 250 EC @ 0.1%
T_4= 4 sprays with Tilt 250 EC @ 0.1%
T_5 = 5 sprays with Tilt 250 EC @ 0.1%
T_6= 6 sprays with Tilt 250 EC @ 0.1%
T_7= 7 sprays with Tilt 250 EC @ 0.1%
T_8= 8 sprays with Tilt 250 EC @ 0.1%
T_9= 9 sprays with Tilt 250 EC @ 0.1%
T_{10}=10 sprays with Tilt 250 EC @ 0.1%

3.7 Experimental Design and Layout

Field layout was done after final land preparation. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The whole plot was divided into three blocks each containing 11 plots of 3m×1.5m size, comprising 33unit plots. The space was kept 1m between the blocks and 0.5m between the plots, 20 cm from row to row and 10 cm from plant to plant were maintained. Seeds were sown in lines in the experimental plots. The seeds were placed at about 3 cm depth in the soil.

3.8 Land preparation

The experimental field was thoroughly ploughed and cleaned prior to seed sowing and applied fertilizer dose and manure in the field as per recommended doses (BARI, Krishi Projucti hatboi, 2005).

3.9 Applications of fertilizers

In field fertilizer and manure were applied at the rate of 220 kg urea, 180 kg TSP, 50 kg MP, 120 kg Gypsum and 10 tons cow dung per hectare Two third of urea, full dose of TSP, MP, Gypsum and cow dung was applied at the time of final land preparation. Remaining one third of urea applied at 21 days after seed sowing.

3.10 Intercultural Operation

Intercultural operation, such as weeding, thinning, irrigation, pest management, etc. were done uniformly in the plots. Three irrigations were done, first were 20 days, second were 55 days and third were 75 days after sowing. Weeding was performed twice during the growing period.

3.11 Preparation and application of spray solution

The fungicidal suspension was prepared by mixing required amount of fungicide (Tilt 250 EC @ 0.1%) with tap water. The first spray was started from 30 days after sowing and rest were sprayed with 7 days interval. Every time the fungicide was freshly prepared prior to application and the spray tank was thoroughly cleaned before filling with new materials. Adequate precaution was taken to avoid drifting of spray materials from one plot to neighboring ones.

Table. 1: Details of fungicide

Common name	Chemical name	Active ingredients %	Doses used
Tilt 250 EC	1-[[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]methyl]-1H-1,2,4-triazole	Propiconazole (25%)	0.1% of the commercial formulation

3.12 Tagging and data collection

Randomly 5 plants were selected from each plot tagged for data collection. Mean values were determined to get rating score of each treatment.

3.13 Isolation and identification of pathogens from leaf

From experimental plot, diseased leaves were collected and cut into pieces (4 cm diameter) and surface sterilized with $HgCl_2$ (1:1000) for 30 seconds. Then cut into pieces were washed in sterile water thrice and then blot dry and placed into acidified PDA media in Petridish. The plate containing leaf pieces were placed at room temperature for seven days for incubation. When the fugus grew well and sporulated, the slide was prepared from the pure culture and was identified under microscope with the help of relevent literature.

3.14 Harvesting of crops

When 80% of the plants showed the symptom of maturity i.e. stem, spike, leaves was noticed, the crop was harvested. 5 plants was uprooting from each plot and they were tagged properly. Data was recorted on different parameters from these harvested plants.

3.15 Collections of data

The following parameters were considerd for data collection

a. Disease incidence and severity

- i. Percent leaf infection
- ii. Percent leaf area diseased (disease severity)
- iii. Percent black pointed seed

b. Growth parameter

- i. Number of tiller/plant
- ii. Plant height
- iii. Number of leaves/ plant
- iv. Spike length/plant

c. Yield contributing character

- i. 1000 seed weight
- ii. Yield (t/ha)
- iii. Number of seeds/ plant

d. Seed health of harvested seed

- i. Percent seed germination
- ii. Percent seed infection

3.16 Procedure of data collection

3.16.1 Percent leaf infection

Five plants per plot were selected and tagged for collection of data. All leaves were considered for data collection. Data on % leaf infection were recorded at 75, 90 and 105 days after sowing by visual observation of symptoms. Percent leaf infection was calculated by the following formula:

$$\% \text{ Leaf infection} = \frac{\text{Number of infected leaf}}{\text{Number of total leaf inspected}} \times 100$$

3.16.2 Percent leaf area diseased

Data on percent leaf area diseased was recorded at 75, 90 and 105 days after sowing by visual observation of symptoms. Percent leaf area was calculated by the following formula:

$$\% \text{ Leaf area diseased} = \frac{\text{Percent leaf area Infected}}{\text{Total leaf area inspected}} \times 100$$

3.16.3 Percent black pointed seed

Data percent seed infection was recorded after harvest by visual observation of symptoms.

$$\% \text{ Seed infection} = \frac{\text{Total number of infected seed}}{\text{Total number of inspected seed}} \times 100$$

3.16.4 Number of leaves per plant

Data of leaves per plant also recorded after flowering from randomly selected plants of each plot.

3.16.5 Number of tiller per plant

Number of tiller per plant was also recorded after flowering from randomly five selected plants of each plot.

3.16.6 Plant height (cm)

Plant height was measured by a meter scale at reproductive stage and their average data was recorded per replication. Data were also recorded as the average of randomly selected five plants from each plot. For plant height the ground surface to the top of the plant and the mean height were expressed in cm.

3.16.7 Spike Length/Plant (cm)

Spike length was measured by a meter scale at ripening stage and average data was recorded per plot.

3.16.8 Number of seeds/plant

Number of seeds per plant was recorded as the average of randomly selected five plants from each plot.

3.16.9 Thousand seed weight (g)

Thousand grains were randomly counted and selected from the stock seed and taken weight in by digital electric balance. It was expressed as 1000-seed weight in gram (g).

3.36.10 Yield (t/ha)

Seed yield were recorded from each plot. After harvesting the plants were sundried and threshed. Seed were properly sundried and their weights recorded. Seed yield was then converted in t/ha.

3.16.11 Estimation of percent disease index (PDI)

Percent disease index (PDI) is the measurement of the amount of a diseased in a population. It is also named as percent diseased index (PDI) and measured by the following formula-

$$\text{Percent diseased index} = \frac{\text{Sum of total disease ratting}}{\text{Total no. of observation} \times \text{maximum grade in the scale}} \times 100$$

3.16.11(a) Disease severity scale:

Disease severity was calculated by using "0-5" scale (Harsfall and barnet, 1945) is given below:

% Leaf Area Disease (LAD)	Grade
0	0
0.1-5	1
5.1-12	2
12.1-25	3
25.1-50	4
>50	5

3.16.11(b) Regression equation:

For simulation of mathematical point model for estimation of yield loss, regression equation was used as below

$$\hat{Y} = \bar{Y} + b\,(X_i - \bar{X})$$

Here,

$\hat{Y}$= Predicted yield loss (%)

$\bar{Y}$= Estimated yield loss (%)

X_i= Disease severity (i=1, 2, 3, ...)

$$b = \frac{\sum XY - \frac{\Sigma X \Sigma Y}{n}}{\Sigma(Xi - \bar{X})2} \quad \text{(regression value)}$$

Calculation of disease severity for the construction of regression equation for yield loss assessment was presented in Appendix VI.

3.17 Seed health test

For germination and seed health testing 100 seeds were randomly drawn from each sample and were tasted using the standard technique (ISTA, 2000). Seeds were placed on three layers of moist blotting paper (Whatman no. 1) contained in petridishes. In each petridish, 25 seeds were placed in equidistance. All the plates with seeds were incubated at room temperature (25 ± 2^0C) under 12 hours cycle of alternate Near Ultra Violate (NUV) light and darkness. Watering was done as and when required. Germination of seedling was recorded. Results were expressed as percent seed germination. After 7-10 days of incubation, each seed was observed under stereo-binocular microscope to detect the presence of *Bipolaris sorokiniana*.

3.18 Statistical analysis

The collected data for different parameters were compiled and tabulated. Statistical analysis was made by MSTAT-Computer package program. The treatments were compared by Duncan's Multiple Range Test (DMRT). ANOVA table was shown in Appendix V.

Chapter 4

Results

CHAPTER 4

RESULTS

4.1 Percent Leaf Infection

The effect of different treatments on leaf infection of wheat at different days after sowing (DAS) were summarized and presented in table 2. Percent leaf infection of wheat increased gradually with the advancement of crop growth. At 105 days after sowing, the highest percent leaf infection 91.84% was found in T_0 (control) and no leaf infection was (0.00%) was recorded in treatment T_{10} where ten spraying were done with Tilt 250-EC (0.1%). The leaf infection gradually decreased with the increase of number of sprays (Fig 1).

Table 2. Effect of different treatments on leaf infection of wheat at different days after sowing (DAS)

Treatment	%Leaf Infection			%Inhibition of leaf infection over control at 105 DAS
	75 DAS	90 DAS	105 DAS	
T_0	52.42 a	71.60 a	91.84 a	0
T_1	45.69 b	59.05 b	84.17 b	8.35
T_2	36.95 c	49.14 c	74.91 c	18.43
T_3	26.33 d	37.40 d	64.30 d	29.99
T_4	19.21 e	25.42 e	52.96 e	42.33
T_5	12.47 f	17.55 f	43.31 f	52.84
T_6	4.33 g	10.94 g	35.51 g	61.33
T_7	0.00 h	4.433 h	24.58 h	73.24
T_8	0.00 h	0.00 h	16.25 i	82.31
T_9	0.00 h	0.00 h	6.70 j	92.7
T_{10}	0.00 h	0.00 h	0.00 k	100
CV %	8.76	7.16	3.98	
LSD	3.653	4.166	4.155	

In a column means having same letter(s) do not differ significantly at 1% level.

DAS = Days after sowing
T_0 = Control
T_1 = 1 spray with Tilt 250 EC @ 0.1%
T_2 = 2 sprays with Tilt 250 EC @ 0.1%
T_3 = 3 sprays with Tilt 250 EC @ 0.1%
T_4 = 4 sprays with Tilt 250 EC @ 0.1%
T_5 = 5 sprays with Tilt 250 EC @ 0.1%
T_6 = 6 sprays with Tilt 250 EC @ 0.1%
T_7 = 7 sprays with Tilt 250 EC @ 0.1%
T_8 = 8 sprays with Tilt 250 EC @ 0.1%
T_9 = 9 sprays with Tilt 250 EC @ 0.1%
T_{10} = 10 sprays with Tilt 250 EC @ 0.1%

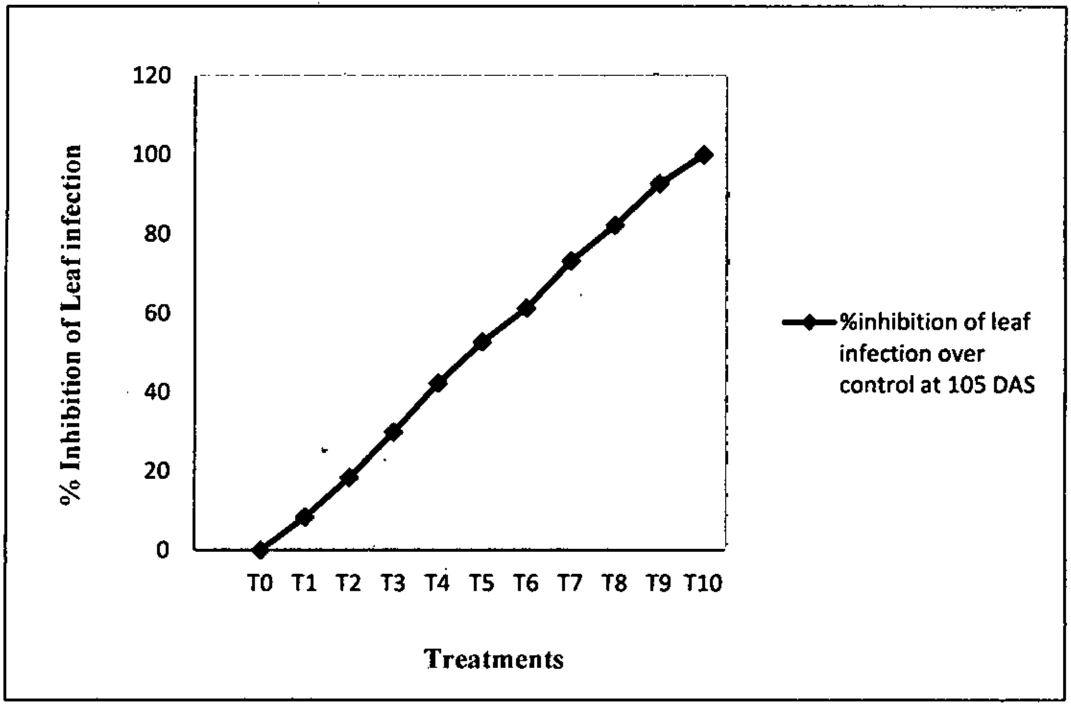


Fig 1. Effect of different treatments on percent inhibition of leaf infection over control at 105 DAS

DAS = Days after sowing
T_0 = Control
T_1 = 1 spray with Tilt 250 EC @ 0.1%
T_2 = 2 sprays with Tilt 250 EC @ 0.1%
T_3 = 3 sprays with Tilt 250 EC @ 0.1%
T_4 = 4 sprays with Tilt 250 EC @ 0.1%
T_5 = 5 sprays with Tilt 250 EC @ 0.1%
T_6 = 6 sprays with Tilt 250 EC @ 0.1%
T_7 = 7 sprays with Tilt 250 EC @ 0.1%
T_8 = 8 sprays with Tilt 250 EC @ 0.1%
T_9 = 9 sprays with Tilt 250 EC @ 0.1%
T_{10} = 10 sprays with Tilt 250 EC @ 0.1%

4.2 Percent Leaf Area Diseased

Different treatments on leaf area diseased (LAD) had an effect on wheat at different days after sowing (DAS) summarized and presented in Table 3. Different treatments had significant influence on percent leaf area diseased of wheat (KANCHAN) at different days after sowing (DAS). Percent leaf area diseased of wheat increased gradually with the advancement of crop growth. At 105 days after sowing, the highest percent leaf area diseased 57.60 % was found in T_0 (control) and no leaf area diseased was (0.00%) was recorded in treatment T_{10} where ten spraying were done with Tilt 250-EC (0.1%). The Percent leaf area diseased was reduced with the increase of number of sprays. (Fig 2.)

Table 3. Effect of different treatments on leaf area diseased of wheat at different days after sowing (DAS)

Treatments	% Leaf area diseased			%Inhibition of leaf area diseased over control at 105 DAS
	75 DAS	90 DAS	105 DAS	
T_0	17.26 a	27.30 a	57.93 a	0
T_1	13.27 b	22.61 b	52.66 b	9.1
T_2	10.07 c	17.77 c	43.74 c	24.5
T_3	7.13 d	12.56 d	31.07 d	46.37
T_4	4.99 e	8.64 e	24.02 e	58.54
T_5	1.70 f	4.68 f	14.37 f	75.19
T_6	0.26 g	1.24 g	11.07 g	80.89
T_7	0.00 g	0.10 g	4.887 h	91.56
T_8	0.00 g	0.00 g	1.413 i	97.57
T_9	0.00 g	0.00 g	0.213 i	99.64
T_{10}	0.00 g	0.00 g	0.00 i	100
CV %	10.45	8.55	5.71	
LSD	1.207	1.715	2.909	

In a column means having same letter(s) do not differ significantly at 1% level.

DAS = Days after sowing
T_0 = Control
T_1 = 1 spray with Tilt 250 EC @ 0.1%
T_2 = 2 sprays with Tilt 250 EC @ 0.1%
T_3 = 3 sprays with Tilt 250 EC @ 0.1%
T_4 = 4 sprays with Tilt 250 EC @ 0.1%
T_5 = 5 sprays with Tilt 250 EC @ 0.1%
T_6 = 6 sprays with Tilt 250 EC @ 0.1%
T_7 = 7 sprays with Tilt 250 EC @ 0.1%
T_8 = 8 sprays with Tilt 250 EC @ 0.1%
T_9 = 9 sprays with Tilt 250 EC @ 0.1%
T_{10} = 10 sprays with Tilt 250 EC @ 0.1%

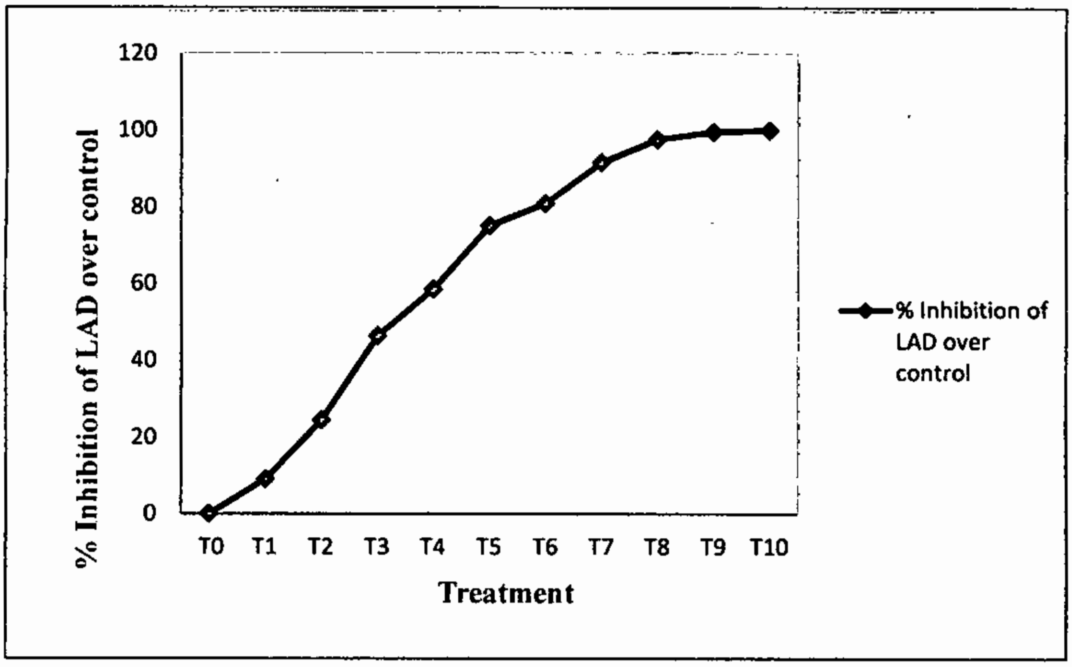


Fig 2. Percent inhibition of leaf area diseased over control at 105 DAS

T_0 = Control
T_1 = 1 spray with Tilt 250 EC @ 0.1%
T_2 = 2 sprays with Tilt 250 EC @ 0.1%
T_3 = 3 sprays with Tilt 250 EC @ 0.1%
T_4 = 4 sprays with Tilt 250 EC @ 0.1%
T_5 = 5 sprays with Tilt 250 EC @ 0.1%
T_6 = 6 sprays with Tilt 250 EC @ 0.1%
T_7 = 7 sprays with Tilt 250 EC @ 0.1%
T_8 = 8 sprays with Tilt 250 EC @ 0.1%
T_9 = 9 sprays with Tilt 250 EC @ 0.1%
T_{10} = 10 sprays with Tilt 250 EC @ 0.1%

4.3 Percent Black Pointed Seed

Different treatments had significant influence on percent black pointed seed. Percent black pointed seed of wheat decreased gradually with the increase number of spray. At 105 days after sowing, the highest percent black pointed seed (26.58%) was found in T_0 (control) and no such seed was recorded in treatment T_{10} where ten spraying were done with Tilt 250-EC (0.1%). The percent diseased seed was reduced with the increase of number of sprays. (Fig. 3)

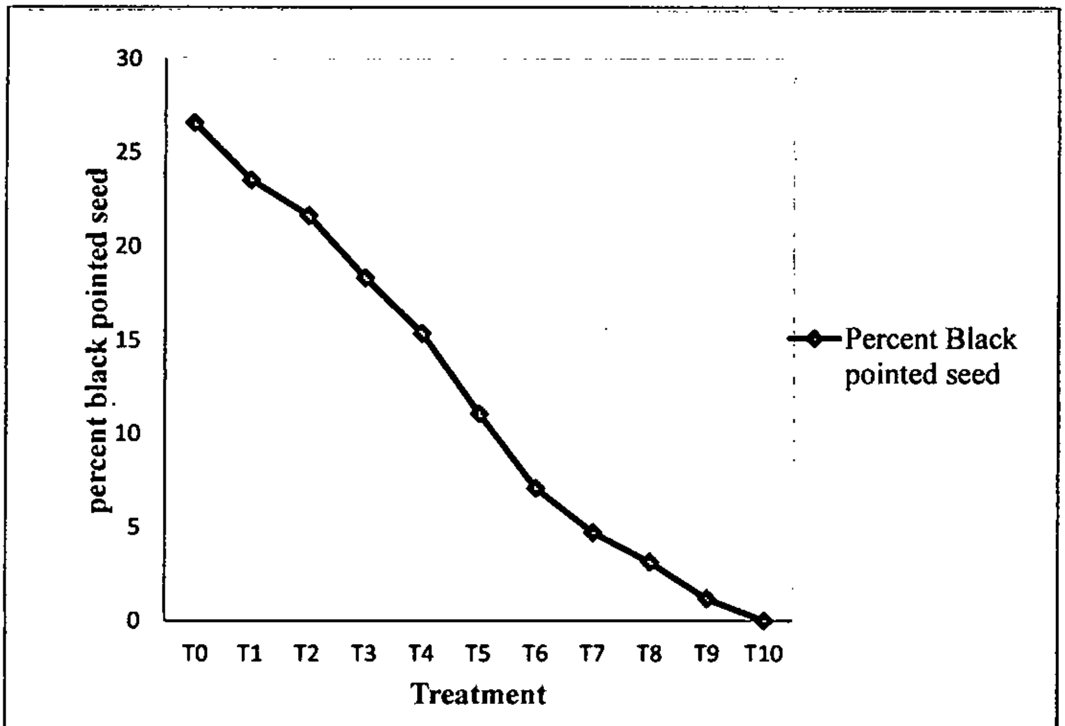


Fig 3. Effect of different treatments on percent black pointed diseased seed of wheat

T_0 = Control
T_1 = 1 spray with Tilt 250 EC @ 0.1%
T_2 = 2 sprays with Tilt 250 EC @ 0.1%
T_3 = 3 sprays with Tilt 250 EC @ 0.1%
T_4 = 4 sprays with Tilt 250 EC @ 0.1%
T_5 = 5 sprays with Tilt 250 EC @ 0.1%
T_6 = 6 sprays with Tilt 250 EC @ 0.1%
T_7 = 7 sprays with Tilt 250 EC @ 0.1%
T_8 = 8 sprays with Tilt 250 EC @ 0.1%
T_9 = 9 sprays with Tilt 250 EC @ 0.1%
T_{10} = 10 sprays with Tilt 250 EC @ 0.1%

4.4.1 Number of Tillers/Plant

Significant variation was found on the number of tillers/plants as a result of treatments. The highest number of tiller per plant (10.00) was recorded in case of T_{10} (10 field sprays with Tilt 250 EC) treatment and the lowest number of tiller was found (4.33) and was recorded from T_0 (control) treatment. However, number of tiller of T_1,T_2; T_8,T_9,T_{10} treated plot were statistically similar (Table 4).

4.4.2 Plant Height (cm)

Different treatments had significant influence on plant height. The tallest plant (102.6cm) was obtained from T_{10} (10 field sprays with Tilt 250 EC) treatment and the lowest height (84.43cm) was found from T_0 (control) treatment (Table 4). Plant heights were increased with the increase of the number of spray.

4.4.3 Spike Length/Plant (cm)

Spike length per plot was recorded that differed due to different treatment. The highest spike length (16.17cm) was observed at T_{10} (10 field sprays with Tilt 250 EC) treatment. The lowest number of spike length (10.47cm) was found from T_0 (control) treatment (Table 4). Spike length/ plant were gradually increased with the increasing number of spray.

Table 4. Effect of different treatments on growth parameter of wheat against leaf blight

Treatments	Growth parameters		
	No. of tiller/plant	Plant height (cm)	Spike Length/ Plot (cm)
T_0	4.33 g	84.43 e	10.47 i
T_1	5.00 fg	83.97 e	10.90 hi
T_2	5.67 ef	86.83 e	11.53 gh
T_3	6.00 e	88.83 de	12.20 fg
T_4	6.00 e	93.07 cd	12.60 ef
T_5	7.00 d	94.50 c	13.23 e
T_6	7.00 d	96.93 bc	14.07 d
T_7	8.00 c	98.10 abc	14.67 cd
T_8	8.67 bc	100.7 ab	15.03 bc
T_9	9.33 ab	101.4 ab	15.47 b
T_{10}	10.00 a	102.6 a	16.17 a
CV %	4.65	2.37	2.21
LSD	0.76	5.164	0.6852

In a column means having same letter(s) do not differ significantly at 1% level.

T_0 = Control
T_1 = 1 spray with Tilt 250 EC @ 0.1%
T_2 = 2 sprays with Tilt 250 EC @ 0.1%
T_3 = 3 sprays with Tilt 250 EC @ 0.1%
T_4 = 4 sprays with Tilt 250 EC @ 0.1%
T_5 = 5 sprays with Tilt 250 EC @ 0.1%
T_6 = 6 sprays with Tilt 250 EC @ 0.1%
T_7 = 7 sprays with Tilt 250 EC @ 0.1%
T_8 = 8 sprays with Tilt 250 EC @ 0.1%
T_9 = 9 sprays with Tilt 250 EC @ 0.1%
T_{10} = 10 sprays with Tilt 250 EC @ 0.1%

4.5.1 Thousand seed weight (g)

Thousand seed weight differed significantly as a result of application of different treatments. The maximum 1000-seed weight (46.30 g) was obtained from T_{10} treatment followed by T_9 (45.80 g), T_8 (45.20 g), T_7 (44.32 g), T_6 (43.43 g) and T_5 (42.60 g) while minimum 1000-seed weight (34.90 g) was found from T_0 (control) treatment which statistically differ from all other treatment (Table 5).

4.5.2 Yield (t/ha)

Significant variation of different treatment was found on yield (t/ha). Maximum yield (5.35 t/ha) was recorded from T_{10} (10 field sprays with Tilt 250 EC) treatment. The amount of yield was decreased with the decreasing number of spray. The minimum yield (2.99) was found from T_0 (control) treatment (Table 5).

Table 5. Effect of different treatments on yield and yield contributing character of wheat

Treatments	Yield and yield contributing character		% Yield increased over control
	1000 seed weight (g)	Yield (t/ ha)	
T_0	34.90 h	3.44 h	0
T_1	36.37 g	3.67 gh	6.69
T_2	37.37 g	3.84 fgh	11.63
T_3	39.93 f	4.08 efg	18.6
T_4	41.27 ef	4.23 def	22.97
T_5	42.60 de	4.44 cde	29.07
T_6	43.43 cd	4.63 bcd	34.59
T_7	44.32 bc	4.80 abc	39.53
T_8	45.20 ab	5.02 ab	46.22
T_9	45.80 ab	5.20 a	51.16
T_{10}	46.30 a	5.35 a	55.52
CV %	1.51	3.90	
LSD	36.37 g	0.3956	

In a column means having same letter(s) do not differ significantly at 1% level.

T_0 = Control
T_1 = 1 spray with Tilt 250 EC @ 0.1%
T_2 = 2 sprays with Tilt 250 EC @ 0.1%
T_3 = 3 sprays with Tilt 250 EC @ 0.1%
T_4 = 4 sprays with Tilt 250 EC @ 0.1%
T_5 = 5 sprays with Tilt 250 EC @ 0.1%
T_6 = 6 sprays with Tilt 250 EC @ 0.1%
T_7 = 7 sprays with Tilt 250 EC @ 0.1%
T_8 = 8 sprays with Tilt 250 EC @ 0.1%
T_9 = 9 sprays with Tilt 250 EC @ 0.1%
T_{10} = 10 sprays with Tilt 250 EC @ 0.1%

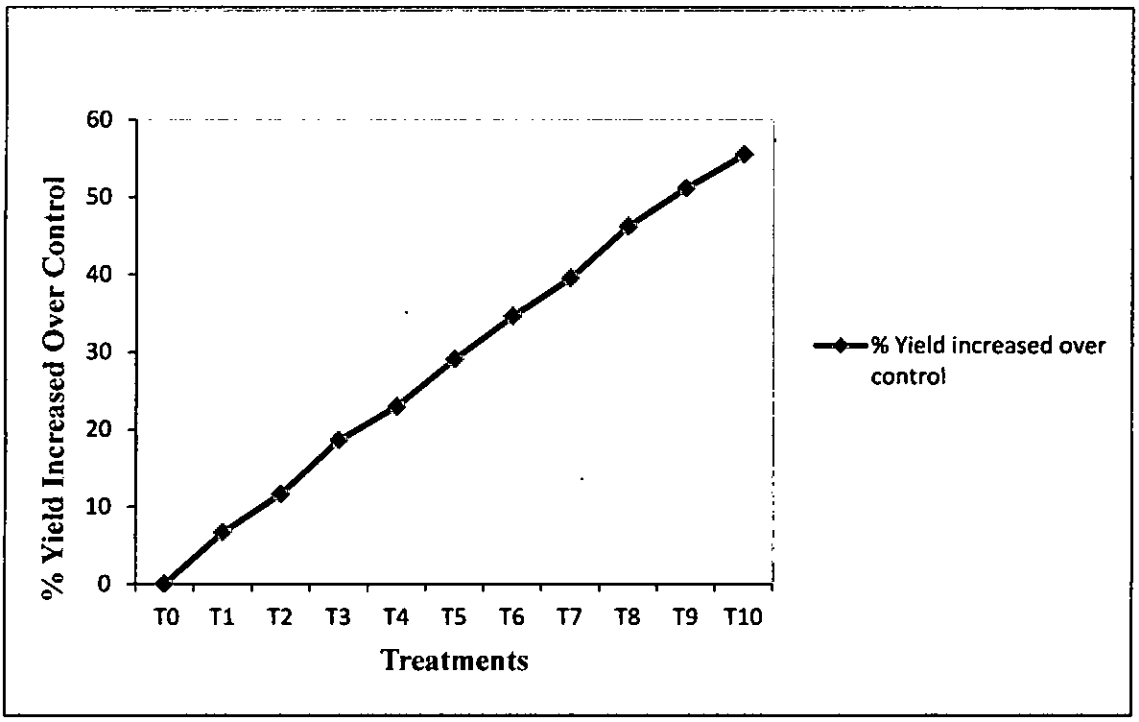


Fig 4. Effect of different treatments increasing percent yield over control

T_0 = Control
T_1 = 1 spray with Tilt 250 EC @ 0.1%
T_2 = 2 sprays with Tilt 250 EC @ 0.1%
T_3 = 3 sprays with Tilt 250 EC @ 0.1%
T_4 = 4 sprays with Tilt 250 EC @ 0.1%
T_5 = 5 sprays with Tilt 250 EC @ 0.1%
T_6 = 6 sprays with Tilt 250 EC @ 0.1%
T_7 = 7 sprays with Tilt 250 EC @ 0.1%
T_8 = 8 sprays with Tilt 250 EC @ 0.1%
T_9 = 9 sprays with Tilt 250 EC @ 0.1%
T_{10} = 10 sprays with Tilt 250 EC @ 0.1%

4.6 Percent Seed Germination

Percent germination of harvested seed was found to be varied significantly due to application of different treatments (Fig 5). Seed from T10 (10 field sprays with Tilt 250 EC) treated plot showed maximum seed germination (94.67%) which was statistically similar to T9 treated seed (92%) and minimum seed germination showed in control plot (66.67).

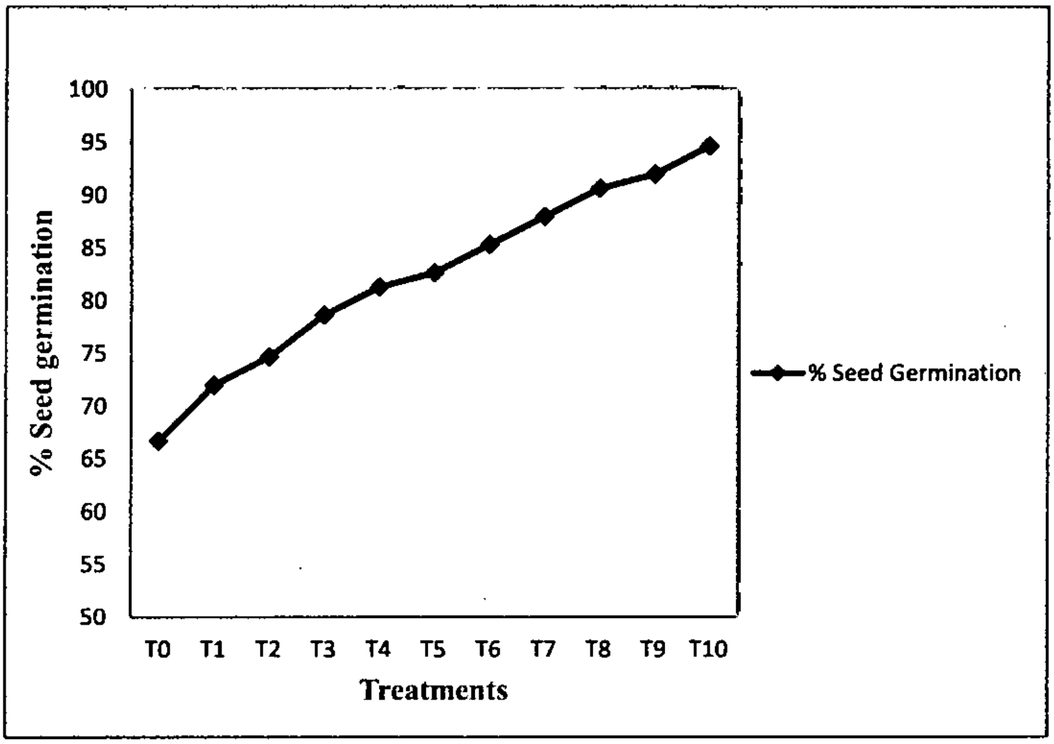


Fig 5. Effect of different treatments on percent seed germination of wheat

T_0 = Control
T_1 = 1 spray with Tilt 250 EC @ 0.1%
T_2 = 2 sprays with Tilt 250 EC @ 0.1%
T_3 = 3 sprays with Tilt 250 EC @ 0.1%
T_4 = 4 sprays with Tilt 250 EC @ 0.1%
T_5 = 5 sprays with Tilt 250 EC @ 0.1%
T_6 = 6 sprays with Tilt 250 EC @ 0.1%
T_7 = 7 sprays with Tilt 250 EC @ 0.1%
T_8 = 8 sprays with Tilt 250 EC @ 0.1%
T_9 = 9 sprays with Tilt 250 EC @ 0.1%
T_{10} = 10 sprays with Tilt 250 EC @ 0.1%

4.7 Percent Seed Infection

Percent seed infection by *Biporaris sorokiniana* of harvested seeds was varied as a result of different treatments. The lowest seed infection (0.00%) was found in the seed lot that collected from (T_{10}) which was statistically similar with the plot treated by T_9 (1.33%). This is followed by T_8, T_7, T_6 treated seed lot. Seed obtained from control showed the highest percent of seed infection (30.57%) which was statistically with similar the plot treated from T_1 (26.67%). This was followed by T_2, T_3, T_4, T_5 treated seed lot. (Fig 6)

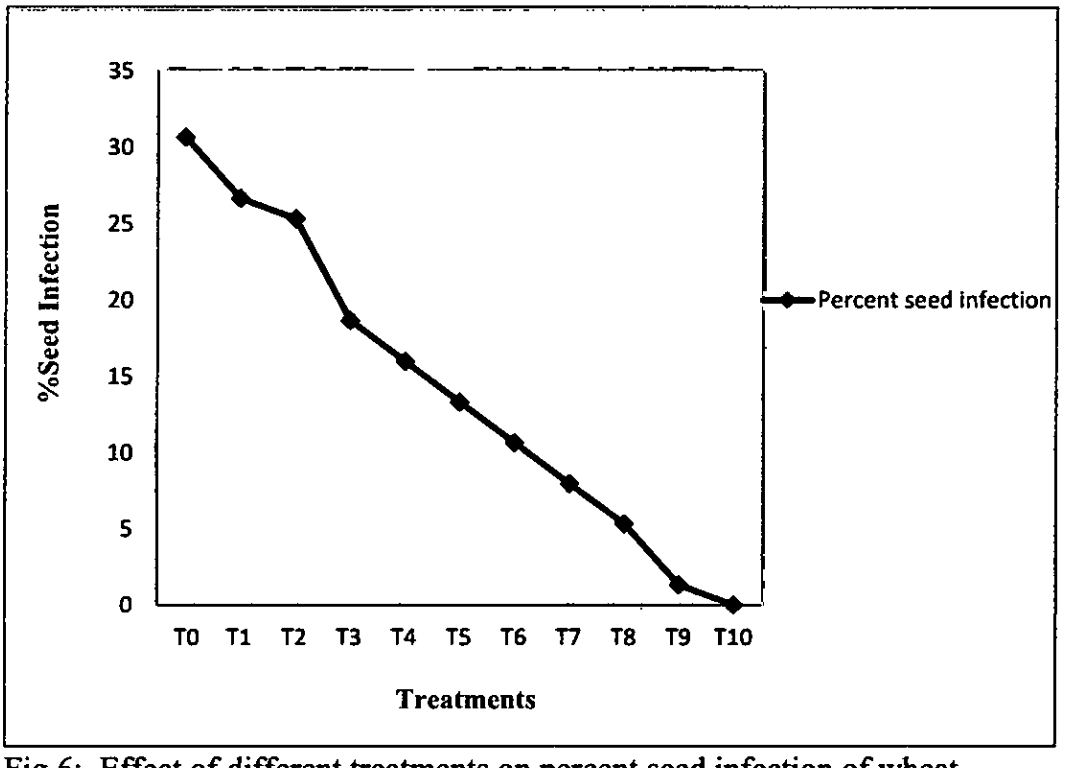


Fig 6: Effect of different treatments on percent seed infection of wheat

T_0 = Control
T_1 = 1 spray with Tilt 250 EC @ 0.1%
T_2 = 2 sprays with Tilt 250 EC @ 0.1%
T_3 = 3 sprays with Tilt 250 EC @ 0.1%
T_4 = 4 sprays with Tilt 250 EC @ 0.1%
T_5 = 5 sprays with Tilt 250 EC @ 0.1%
T_6 = 6 sprays with Tilt 250 EC @ 0.1%
T_7 = 7 sprays with Tilt 250 EC @ 0.1%
T_8 = 8 sprays with Tilt 250 EC @ 0.1%
T_9 = 9 sprays with Tilt 250 EC @ 0.1%
T_{10} = 10 sprays with Tilt 250 EC @ 0.1%

4.8 Construction of Regression equation for Yield Loss Assessment

Using the variation of disease severity (PDI) and corresponding yield loss from multiple treatment experiment, the predicted yield loss (Y) was calculated using the formula of regression equation and presented in Table 6. Using the variation of predicted yield loss and percent disease index (PDI) value the regression equation i.e. mathematical point model was constructed. By setting any PDI value in the formula, the yield loss of wheat due to leaf blight disease could be estimated.

Table 6. Estimation of regression value by percent disease index (PDI) and corresponding yield loss from multiple treatment experiment

Treatments	Percent Disease Index(PDI) X	Yield (t/ha)	Yield Loss (t/ha)	% Yield Loss Y	XY
T_0	81.1	3.44 h	1.91	35.7	2895.27
T_1	74.8	3.67 gh	1.68	31.4	2348.72
T_2	66.67	3.84 fgh	1.51	28.22	1881.4274
T_3	55.94	4.08 efg	1.27	23.74	1328.0156
T_4	43.44	4.23 def	1.12	20.93	909.1992
T_5	29.89	4.44 cde	0.91	17.01	508.4289
T_6	25.66	4.63 bcd	0.72	13.46	345.3836
T_7	18.8	4.80 abc	0.55	10.28	193.264
T_8	5.28	5.02 ab	0.32	5.98	31.5744
T_9	1.25	5.20 a	0.15	2.8	3.5
T_{10}	0	5.35 a	0	0	0
Total	402.83	48.71		189.52	$\sum XY =$ 10444.7831

Calculation:

Regression equation, $\hat{Y} = \bar{Y} + b\ (X_i - \bar{X})$

Here, $\hat{Y}$= Predicted yield loss (%)

$\bar{Y}$= Estimated yield loss (%)

X_i= Disease severity (PDI) (i=1, 2, 3,………)

b= Regression co- efficient

$$b = \frac{\sum XY - \frac{\Sigma X \Sigma Y}{n}}{\Sigma(X_i - \bar{X})^2}$$

$$= \frac{10444.78 - \frac{402.83 \times 189.52}{11}}{(81.1-36.62)2+(74.8-36.62)2+.........+(0-36.62)2}$$

$$= \frac{3504.39}{8816.18}$$

=0.40

Now putting the $\bar{Y}$, X and b value in the regression equation

$\hat{Y} = \bar{Y} + b\ (X_i - \bar{X})$
$=17.23+0.40\ (X_i - 36.62)$
$=17.23 + 0.40X_i - 14.65$
$=2.58 + 0.40X_i$

Therefore, $\hat{Y}$=2.58+40 X_i

Now setting X_i's value in the regression equation

When,

$X_i = 81.1$,	$\hat{Y}$=2.58 + 40 × 81.1	= 35.02
$X_{ii} = 74.8$,	$\hat{Y}$=2.58 + 40 × 74.8	= 32.5
$X_{iii} = 66.67$,	$\hat{Y}$=2.58 + 40 × 66.67	= 29.248
$X_{iv} = 55.94$,	$\hat{Y}$=2.58 + 40 × 55.94	= 24.956
$X_v = 43.44$,	$\hat{Y}$=2.58 + 40 × 43.44	= 19.956
$X_{vii} = 25.66$,	$\hat{Y}$=2.58 + 40 × 25.66	= 12.844
$X_{viii} = 18.8$,	$\hat{Y}$=2.58 + 40 × 18.8	= 10.1
$X_{ix} = 5.28$,	$\hat{Y}$=2.58 + 40 × 5.28	= 4.692
$X_x = 1.25$,	$\hat{Y}$=2.58 + 40 × 1.25	= 3.08

$X_{xi} = 0$, $\hat{Y}=2.58 + 40 \times 0 = 2.58$

Now, using the corresponding PDI value and predicted yield loss a graphical presentation of regression equation was presented below

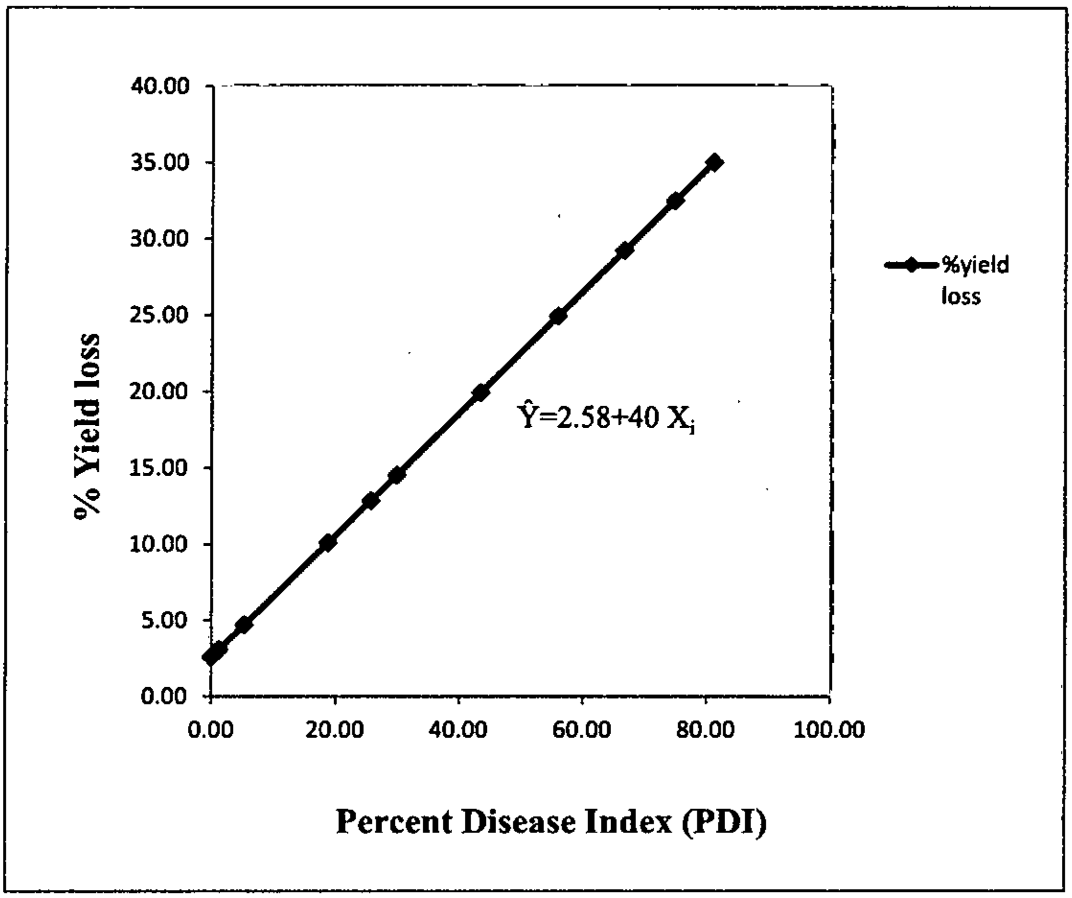


Fig 7. Mathematical point model for estimation of yield loss for leaf blight of wheat

Plate 1. Photograph showing the view of the experimental field conducted in the central farm of SAU

Plate 2. Photograph showing the healthy plant under T_{10} treated plot

Plate 3. Photograph showing the diseased plant under control plot

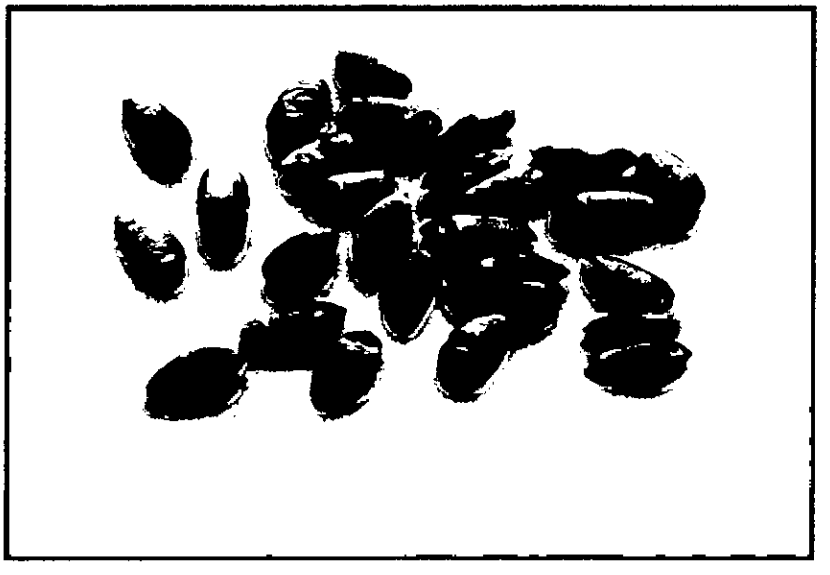


Plate 4. Photograph showing black pointed seed harvested from the diseased plot by leaf blight.

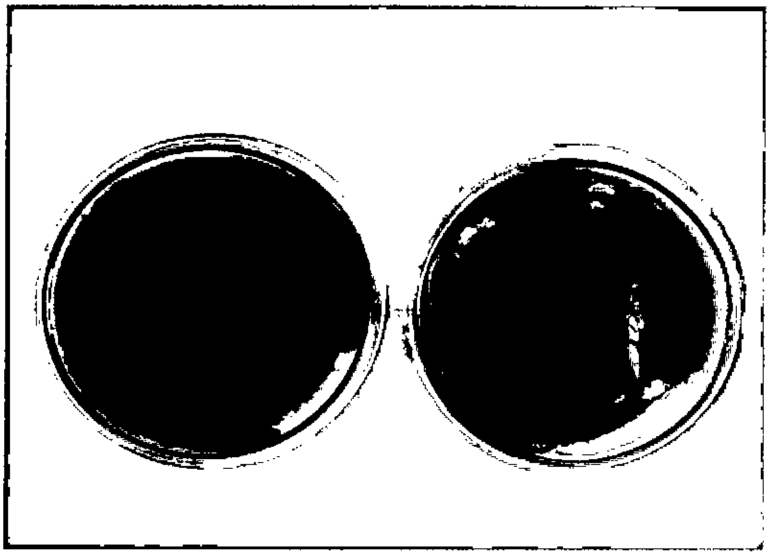


Plate 5. Pure culture of *Bipolaris sorokiniana* causing leaf blight of wheat

Plate 6. Conidia of *Bipolaris sorokiniana* causing leaf blight of wheat observed under compound microscope

Chapter 5

Discussion

CHAPTER 5

DISCUSSION

Wheat (*Triticum aestivum* L.) is one the of most important and staple cereal food crop in thê world. About 36% of the world populations consume wheat as staple food. Wheat is the second most important cereal crop in Bangladesh next to rice. Wheat production is expanding rapidly and its annual growth rate is 24% (BARI, 2010). Bangladesh is presently producing only about 15 percent of its wheat requirements due to lower yield (3.033 Mt/ha) compared to other wheat growing countries (NASS 2015, BBS 2015). Wheat suffers from as many as 26 seed borne pathogens causing 14 seed borne diseases. Among them leaf blight / spot and black point caused by *Bipolaris sorokiniana* has become a serious concern in the recent years in Bangladesh (Fakir, 1988). The Government has to face the market crisis by importing the deficit from abroad. Thus the government needs to have a picture about the national yield loss due to the disease prior to the crisis.

In the present study, a multiple treatment experiment with different spray schedule in controlling leaf blight of wheat caused by *Bipolaris sorokiniana* was done to construct the mathematical point model for yield loss assessment.

Ten sprays with Tilt 250 EC @ 0.1% at 7 day's interval completely controlled the disease which was statistically similar to nine spray. It was observed that percent disease incidence and severity increased gradually with the advancement of crop growth but disease incidence and severity found to be reduced with the increasing number of spraying of Tilt 250 EC @ 0.1%.

The effect of treatments on growth parameter viz. plant height, spike length and number of tillers per plant varied significantly. The treatment had great impact on yield and yield contributing characters. The highest yield (5.41 t/ha) was observed from the plot where ten field spray was applied against the disease that increased grain yield by 55.53% compared to control. The second highest yield was obtained from the plot where nine field sprays with Tilt 250 EC @ 0.1% was done that increased grain yield by 51.16% compared to control. It was noticed that grain yield increased gradually with the increased number of spraying with Tilt 250 EC @ 0.1%.

The finding of the experiment was well supported by the previous researcher. Rahman *et al.* (2013) while working with eight fungicides against leaf blight of wheat disease caused by *Bipolaris sorokiniana*, reported that the grain yield was increased by 61.96% compared to control applying Tilt 250 EC followed by Sunconazole 250 EC, Shadid 250 EC and Propicon 250 EC. Rashid *et al.* (2001) reported that the severity of *Bipolaris* leaf blight (BpLB) and black point of wheat were significantly reduced over control when 0.1% Tilt 250 EC was sprayed on wheat for 2 to 6 times and seed vigor in terms of 1000-seed weight were increased significantly over control.

Seed germination and seed infection were found to be differed significantly due to the application of different spray schedule. No seed infection by *Bipolaris sorokiniana* was noticed from the field treated ten times with Tilt 250 EC @ 0.1% where the highest seed germination (94.67%) was observed. Seeds obtained from control plot showed the lowest seed germination (66.67%) and maximum seed infection (30.67%). This finding was similar to previous researcher. Khanum *et al.* (1987) stated that black point is responsible for the germination failure of grain in the field. It was reported that natural infection of grains of the cultivars Lyp-73, Pai-73, and Pka-81 were 58%, 35% and 15%, respectively. The germination of healthy grains was 55-96.5% and that of diseased grains was 34-71%. Zhimin *et al.* (1998) observed that seed germination and seedling growth decreased with the increase of susceptibility of a variety to black point infection. Sinha and Thapliyal (1984) found maximum reduction (38%) in germination of wheat seed infested with black point pathogen.

The mathematical yield loss assessment model was made by using the regression equation $\hat{Y}=2.58+0.40X_i$ where Y stands for percent predicted yield loss and X_i stands for the disease severity (PDI - Percent disease index) of leaf blight of wheat in the standing crop. The equation indicates that increase of each percent of disease severity (PDI) increased about, 0.40% yield loss. The previous reports showed various yield losses of wheat for leaf blight but no constructive reports on the estimation of yield losses by mathematical point model are available in the literatures. Alam *et al.*, (1994) reported 29% yield losses due to leaf blight / spot disease of wheat. Hossain and Azad, (1994) reported 100% yield loss by leaf blight / spot disease of wheat in case of severe attack. Razzaque and Hossain (1991) reported that yield loss of wheat due to leaf blight to be 20% in Sonalika, 14% in Akbor and 8% in Kanchan. Rashid and Fakir (1998) estimated yield reduction of wheat due to *Bipolaris sorokiniana* as high as 57.6% and 64.5%, in Cvs. Kanchan and Sonalika, respectively, at maximum disease incidence.

On the basis of the present findings, it may be concluded that wheat growers may be suggested to apply Tilt 250 EC @ 0.1% for controlling leaf blight of wheat. By using the regression equation, the predicted yield losses could be estimated by putting the disease severity (PDI) values in the equation prior to the harvesting of the crops. Thus, in case of epidemic outbreak of the disease, the government will receive the information about natural yield loss from the Plant Protection Wing and would be able to take necessary initiatives to meet up the the crisis.

Chapter 6

Summary and Conclusion

CHAPTER 6

SUMMARY AND CONCLUSION

Leaf blight of wheat caused by *Bipolaris sorokiniana* occurs in almost all wheat growing areas in the world as well as in Bangladesh causing subsequent yield losses and deterioration of yield quality. A huge amount of yield losses incurred almost every year in Bangladesh due to this disease that creates national food crisis. The Government has to meet up the national deficit by importing wheat grains from Brazil and other neighboring countries. The present research work was carried out to simulate the yield loss assessment techniques of wheat due to leaf blight disease in the standing crop prior to harvest, so that the government could take necessary initiative to face the market crisis. The experiment was conducted in the Central farm of Sher-e-Bangla Agricultural University, Dhaka during the period from November, 2014 to April, 2015.

The experiment was laid out in a Randomized Block Design (one factor) with three replications. There were eleven treatment, viz. T_0 (Control); T_1 (1 spray with Tilt 250 EC @0.1%); T_2 (2 sprays with Tilt 250 EC @0.1%); T_3 (3 sprays with Tilt 250 EC@0.1%); T_4 (4 sprays with Tilt 250 EC @0.1%); T_5 (5 sprays with Tilt 250 EC @0.1%); T_6 (6 sprays with Tilt 250 EC @0.1%); T_7 (7 sprays with Tilt 250 EC @0.1%); T_8 (8 sprays with Tilt 250 EC @0.1%); T_9 (9 sprays with Tilt 250 EC @0.1%); T_{10} (10 sprays with Tilt 250 EC @ 0.1%). The unit plot size was 2m×1.5m with spacing 20cm × 10cm. The space between blocks and unit plot were 1m and 0.5 m, respectively. Data were collected on disease incidence, disease severity, yield and yield contributing characters. Data were analyzed by Computer Package Program MSTAT-C and the means were adjudged with Duncan's multiple range test (DMRT).

From the present study it is evident that application of fungicide (Tilt 250 EC @ 0.1%) significantly influenced almost all the yield contributing parameters and grain yield. The lowest percent of leaf infection (0.0 %), percent leaf area diseased (0.0%), and percent black pointed seeds (0.0%) were recorded from the plot where ten sprays were applied. The highest percent of leaf infection (91.84%), percent leaf area diseased (57.93%), and percent black pointed seeds were recorded from untreated control. Leaf infection, leaf area diseased and percent black pointed seed decreased with the increased number of sprays applied.

The influential effect on yield and yield contributing parameters were recorded from the plot where higher number of spraying with Tilt 250 EC @ 0.1% was routinely done. The lower yield and poor performances of yield contributing characters were recorded from the treatment where lower number of spraying was done. The lowest performances on yield and yield contributing characters were recorded from control where no spraying was done. Yield was gradually increased with the increasing number of spraying.

The highest percent seed germination (94.67%) and the lowest seed infection (0.0%) was found from the treatment while ten spraying were done. The lowest seed germination (66.67%) and the highest seed infection (30.67%) were recorded from untreated control.

From the constructed mathematical yield loss assessment point model made by using regression equation $Y = 2.58 + 0.40 X_i$ we can estimate the amount of yield losses. The regression equation indicates that each percent increase of disease severity (PDI) increased 0.4 % yield loss. Thus the wheat growers may be suggested to apply Tilt 250 EC @ 0.1% in controlling leaf blight disease of wheat for increasing production. The constructed regression equation $Y = 2.58 + 0.40 X_i$ may be used to estimate the yield losses of wheat for leaf blight caused by *Bipolaris sorokiniana*. However the multiple treatment experiments need to be reapted at different agro- ecological zones for at least 3 consecutive years to justify the finding of present experiment.

References

REFERENCES

Alam, K.B., Shaheed, M.A., Ahmed A.U. and P.K. Malaker, 1994. Bipolaris leaf blight (spot blotch) of wheat in Bangladesh. Mexico, DF (Mexico), CIMMYT, pp: 334-342.

Alam, K.B., Shaheed, M.U., Ahmed, F. and. Haque, M.S. 1995. Yield loss assessment of wheat due to Bipolaris leaf blight in Bangladesh. Bangladesh J. Plant Pathology. **11**(1-2): 35-38.

Ahmed, F., Khan, M. and Islam, R. 2007. Assessment of yield loss of wheat. Annual research report (2006-2007), BARI, BARS, Jessore, P. 57.

Ahmed, S.M. and Meisner, C.A. 1996. Wheat Research and Development in Bangladesh. Bangladesh Australia Wheat Improvement Project and CIMMYT-Bangladesh. 201 pp.

Annonymus 1989. Chemical control of Biolaris leaf blight of wheat. Annual report for the year 1988-89. Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. 28p.

Annonymus, 1992a. Assessment of yield loss due to foliar pathogen Ann. Rept. For the year 1991-92. BARI. Joydebpur, Gazipur. Pp.21.

Annonymus, 1992b. Assessment of yield loss due to leaf blight disease at farmer field. 1991-92. BARI. Joydebpur, Gazipur. Pp 45-46

Aulakh, K.S., Kaur, S., Chahal, S.S., and Randhawa, H.S., 1988. Seed borne Drechslera species in some important crops. Plant Disease Research.**3**:156-171.

Ashok, M., Patel, N.M., Patel, D.B., Patel J.R., Jadon, B.S. and Mishra, A 1989. Economical spray schedule for the management of leaf blight / bloch of wheat. Pestology. **13** (8): 22-25.

BARI, (Bangladesh Agricultural Research Institute). (2010). Annual Report (2008-2009). BARI, Gazipur.

BBS 2015. Year book of Agricultural Statistic-2013, Bangladesh Bureau of Statistics, Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh. www.bbs.gov.bd

Bockus, W.W., Devis, M.A. and shoroyer, J.P. 1992. Effect of foliar fungicides application on seed siz of winter wheat. *J. Appl. Seed Prod. (USA)*.10:1-6.

Breiman, A. Graur, D. 1995. Wheat Evaluation. *Israel J Plant Sci.* 43:58-95.

Canadian Grain Commission, Official Canadian Grain grading guide. 1983. Canadian Grain Commission, Winnipeg, Manitoba, 24 pp.

Conner, R. L., S. F Hwang and R. R. Stevens. 1996. *Fusarium proliferatum*: a new causal agent of black point in wheat. Can. J. Plant Path., (18): 419-423.

Chaudhary, R. C.; Aujla, S.S. and Sharma, I. 1984. Control of black point disease of wheat. *J. Res. Punjab. Agric. University*. **21**: 460-462.

Culshaw, F., Cook, R.J., Magan, N. and Evans, E.J. 1988. Black point of wheat. HGCA Research Review No. 7, Home-Grown Cereals Authority, London, UK, 43 pp.

Das, S.R. 1988. Control of leaf spot/leaf blight of wheat through fungicides. *Indian J. of plant protection*. **16**(2): 273-275.

Dubin, H.J., Duveiller, E. 2000. *Helminthosporium* leaf blights of wheat: integrated control and prospects for the future. In: proc. Int. conf. integrated Plant Disease Management for Sustainable Agriculture, New Delhi, vol. 1, pp 575-579.

Duveiller, E. 2004. Controlling foliar blights of wheat in the rice-wheat systems of Asia. Plant Dis. **88**:552-556.

Dubin H.J., van Ginkel, M. 1991. The status of wheat diseases and disease research in Warmer areas. In: Saunders DA (ed) Wheat for the Non-traditional Warm Areas. CIMMYT, Mexico, DF, pp. 125-145.

Duveiller, E. and Gilchrist, L. 1994. Production constraints due to Bipolaris sorokiniana in wheat: Current situation and future prospects. In D. A. Saunders and G.P. Hettle eds. 1994. Wheat in heat stressed environments: Irrigated, dry areas and rice wheat farming systems, Mexico, DF(Mexico). CIMMYT., pp.: 343-352.

Entz, M.H., Berg, C.G.J., Van Den, Lanfond, G.P., Stobbe, E.H., Rossanagel, B.G. and Austenson, H.M. 1990. Effect of late season fungicide application grain yield and seed size distribution in wheat and barley. *Canadian J. of Pl. Science*. **70**(3): 699-706.

Ellis, S., Gooding, M. and Thompson, A. 1996. Factors influencing the relative susceptibility of wheat cultivars (*T. aestivum* L.) to black point. Crop prot., **15**:69-76.

Fakir, G.A. 1988. Report on investigation into black point disease of wheat in Bangladesh. Seed Pathology Laboratory. Dept. of Plant Pathology, Bangladesh Agricultural University, Mymensingh.

Frank, J.A., 1985. Influence of root rot on winter survival and yield of winter barley and winter wheat. Phytopathology. **75:** 1039-1041.

Germán, S. *et al.,* 2011. Challenges in controlling leaf rust in the Southern Cone region of South America. 2011 BGRI Technical Workshop.

Gill, K.S. and Tyagi, P.D. 1970. Studies on more aspects of black point disease in wheat. *Journal of research, Ludhiana*. 7:610-617.

Giri, G.K., Gade, R.M., Patil, C.U. 2001 Seed borne *Bipolaris sorokiniana* in wheat and its chemical control. *J. Soils Crops* **11:**109–112.

Goulart, A.C.P., Paiva, A., de F. and Andrade, P.I.M. 1995. Effect of fungicides spraying on above ground parts of wheat and incidence of *Bipolaris sorokiniana* and *Pyricularia grisea* associated with seeds. Fitapathologia, Brasileria. **20**(4): 628-632.

Hobbs, P.R.; Giri, G.S. 1997. Reduced and zero-tillage options for establishment of wheat after rice in South Asia. In: Braun HJ, Altay F, Kronstad WE, Beniwal SPS, McNab A (eds) Wheat: Prospects for Global Improvement. Kluwer Academic Publishers, Dordrecht, the Netherlands, pp 455-465.

Hossain, I. and Azad, A.K. 1992. Reaction of wheat to *Helminthosporium sativum* in Bangladesh. Hereditas, **116**: 203-205.

Hossain, I. and Azad, A.K. 1994. *Bipolaris sorokiniana*, its reaction and effect on yield of wheat. Prog. Agric., **5(2)**: 63-69.

Hossain, I., Rashid, A.Q.M.B., Fakir, G.A. and Meah, M.B. 1998. Leaf blight of wheat: Its status and impact on grain formation. Proceedings of the 1st National Workshop on Seed Petrology Progress and Prospect of Seed Pathological Research in Bangladesh, June 9-12, 1998, Bangladesh Agriculture University Mymensingh, Pp.: 9-10.

Hossain, M.M., 2000. Effect of different level of black pointed seed on germination, seedling vigor, plant stand and seed quality of wheat. M.S. Thesis. Department of plant pathology. BAU, Mymensingh.

Hossain, M.Z., 2002. Comparative efficacy of bion, amistar and tilt in controlling sbrown spot and narrow brown spot of rice cv. BR 11 (Mukta). M.Sc. Thesis, Bangladesh Agricultural University Mymensingh, Bangladesh.

Hossein, M.E., 2002. Effect of seed treatment on the incidence of seed borne fungal diseases, yield and seed quality of rice. M S. Thesis, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh, pp: 1-126.

IFPRI (International Food Policy Research Institute). 1997. Researchreport-106. In: Morris ML, Chowdhury N, Meisner C, eds.Wheat pro-duction in Bangladesh: technological, economic, and policy issues. International Food Policy Research Institute (June 1997), ISBN-10:089629109X, ISBN-13: 978-0896291096, 95 pp.

Iqbal, M.F., Hussain, M, Ali, A.M., Nawaz, R. and Iqbal, Z. 2014. Efficacy of fungicides used for controlling black point disease in wheat crop. *Int.J.Adv. Res.Biol.Sci.2014*; **1**(6):59-64.

Islam, M.S., Sarker, M.N.I and Ali, M.A 2015. Effect of seed borne fungi on germinating wheat seed and their treatment with chemicals. International Journal of Natural and Social Sciences, **2**(1): 28-32.

Islam, M.A., Aminuzzaman, F.M., Islam, M.R. and Zamal, M.S. 2006. Seed treatment with plant extract and Vitavax-200 in controlling leaf spot (Bipolaris sorokiniana)with increasing grain yield of wheat. Int. J. of Sustain. Agril. Tech. **2**(8):15-20.

ISTA (International Seed Testing Association) (2001). International Rules for Seed Testing. Rules Amendments. Seed Science and Technology, 29 (2): 1-127.

Horsfall, J. G. and R. W. Barratt. 1945. An improved grading system for measuring plant diseases. Phytopathology 35:65 (abstract).

Jones, D.G., Clifford, B.C. 1983. Cereal diseases, their pathology and control. John Wiley and Sons Limited

Joshi, A.K., Chand, R. 2002. Variation and inheritance of leaf angle and its relationship with resistance to spot blotch inwheat (*Triticum aestivum*). Euphytica **123**: 221–228.

Joshi A.K., Mishra, B., Chatrath, R., Ferrara G. O., Singh, R.P. 2007a.Wheat improvement in India: present status, emerging chal-lenges and future prospects. Euphytica **157:** 431–446.

Joshi, A.K., Kumari, M., Singh, V.P., Reddy, C.M., Kumar, S., Rane, J.,Chand, R. 2007b. Stay green trait: variation, inheritance and itsassociation with spot blotch resistance in spring wheat (*Triticum aestivum* L.). Euphytica **153**: 59 –71.

Joshi, A.K., Ortiz-Ferrara, G., Crossa, J., Singh, G., Alvarado, G., Bhatta, M.R., Duveiller, E., Sharma, R.C., Pandit, D.B., Siddique, A.B., Das, S.Y., Sharma, R.N., Chand, R. 2007c. Associations of environ-ments in South Asia based on spot blotch disease of wheat caused by *Cochliobolus sativus*. *Crop Science* **47:** 1–11.

Kabir, (1997). Integrated control of leaf blotch of wheat by *Bipolaris sorokiniana*. M. S. Thesis. Department of plant pathology. BAU, Mymensingh 32p.

Kabir, M.S. and Hossain, I. (2000). Integrated management of bipolaris leaf blight of wheat. *Bangladesh J. of Pl. Path.* **16**(1-2): 9-12.

Kabir, M.H., Aminuzzaman, F.M., Islam, M.R. and Chowdhury, M.S.M. 2007. Effect of physical and chemical seed treatments on leaf spot (*Bipolaris sorokiniana*) and yield of wheat. World Journal of Agricultural Sciences, **3**(3): 306-315.

Khanum, M., Nigar, Y., and Khanzada, A.K., 1987. Effect of black point disease on the germination of wheat varieties. Pakistan J. Agric. Res. **8**(4): 467-473.

Khan, M.A. and Ityas, M.B. 1996. Effect of foliar applied on wheat varieties infected by *Puccinia recondite sp*. Tritici and *Drechslera sorokiniana*. Sultnia 1(1): 7-11.

Krishi Projocti Hatboi (Handbook on Agro-technology), 2005 3rd edition (reprint), Bangladesh Agricultural Research Institute, Gagipur, 1701, Bangladesh, pp: 10.

Kumar, A., Solanki, S. and Kumari, S. 2014. Management of Foliar Blight (Spot Blotch) of Wheat the Most Threatening Disease of North Eastern Plain Zone (NEPZ) through Chemicals. Journal of Agroecology and Natural Resource Management. 1(1): Pp. 4-6

Lapis, D.B. 1985. Insect pests and diseases in wheat in the Philippines. In: Wheat for More Tropical Environments. A Proceeding of the International Symposium, Mexico, D.F., CIMMYT, Pp. 152–157.

Lorenz, K. 1986. Effects of black point on grain composition and baking quality of New Zealand wheat. *N. Z. J. Agri. Res*., **29**: 711-718.

Mak, Y., Willowa, R.D., Roberts, T.H., Wrigley, C.V., Sharp, P.J. and Copeland. L. 2006. Black point is associated with reduced levels of stress, disease and defence-related proteins in wheat grain. Molec. Plant Path., **7**:177-189.

Mahto, B.N. 1999. Management of Helminthosporium leaf blight of wheat in Nepal. Indian Phytopathol **52**:408–413.

Malakar, P.K., Reza, M.M.A., Ahmed, F., Rahman, M.M, and Amin, M.F. 2008. Occurance and significance of black point disease of wheat seeds in Bangladesh: a review. *Bangladesh J. Pl. Patho.*, **23**(1-2): 43-50.

Malakar, P.K. 2003. Studies on black point (*Bipolaris sorokiniana*) of wheat and its management. Ph.D. Thesis. Department of plant pathology, BSMMU, Gazipur, Bangladesh. Pp:13-21.

Mehta, Y.R. (1997) Constraints on the Integrated Management of Spot Botch of wheat. Instituto Agronomico do arana- IAPAR, Londrina, PR, Brazil. In: Duveiller E, Dubin HJ, Reeves J, McNab A (eds) Proc. Int. Workshop Helminthosporium blights of wheat:spot blotch and tan spot, 9-14 February 1997, CIMMYT, El Batan, Mexico, DF, pp 18-27

Mironova, G.V. 1991. The effectiveness of spring wheat seed treatment Nauchno-Tekhnicheskii Bull. No. 5, 20-24.

Mondol, N.A., Assaduzzaman, S. M., Malakar, P. K., Rouf, M.A. and Haque, M. I. 1994. Evaluation of fungicides against *Bipolaris sorokiniana* leaf blight of wheat (*Triticum aestivum*). Ann. of Bangladesh Agric. **4**(1): 37-40.

Mondol, H. 2000. Effect of seed and soil borne inocula of *Bipolaris sorokiniana* on seedling mortality and spot bloch of wheat. M.S. Thesis. Department of plant pathology, BSMMU, Gazipur, 32p.

Murray, D.T., Parry, D.W., Cattlin, N.D. 1998. Disease of small grain cereal crops. Manson publishing. pp. 58-60.

Nagarajan, S.; Kumar, J. 1998. Foliar blights of wheat in India: germplasm improvement and future challenges for sustainable high yielding wheat production. In: Duveiller E, Dubin HJ, Reeves J and McNab A (eds) Proc. Int. Workshop Helminthosporium Diseases of Wheat: Spot Blotch and Tan Spot, 9-14 February 1997, CIMMYT, El Batan, Mexico, DF, pp. 52-58.

Nalli, R. 1986. Observations on the effects produced by *Bipolaris sorokiniana* on wheat. Seed Abs. **11**(3): 100.

NASS 2015. National Agricultural Statistics Service. Agricultural Statistics Board, United States Department of Agricultural (USDA). www.nue.okstate.edu

Nestrov, A. N., 1981. Black embryo grain as the source of root rot of spring wheat. Seed Abs. 5: 2053.

Orsi, C.; Chiusa, G. and Rossi, V. 1994. Further inverstigation on the relationship between the mycoflora of duram wheat kernels and the incidence of black point. Petria. 4(3): 225-235.

Özer, N. 2005. Determination of the fungi responsible for black point in bread wheat and effects of disease on emergence and seedling vigour. Trakya Univ. J. Sci., (6): 35-40.

Panna, R.,. Aminuzzaman, F.M., Islam, M.R. & Bhuyan, M.H.M.B. 2009. Evaluation of Some Physical Seed Treatment against (Bipolaris sorokiniana) associated with Wheat seeds. *Int. J. Sus. Crop Prod.*, 4(6):40-44.

Paradeshi, B. M., Mhaske, K.D., Bhoite, G., Bhangale, T. & Rasal, P.N. 2008. Effect of foliar fungicides on Black Point of Wheat. *Agri. Sci. Digest.*, 28(3):227-228.

Patil, V.S.; Kulkarni, S. and Kalappanavar, I.K. 2002. Field evaluation of fungicides/plant products against leaf blight of wheat. J. of Maharashtra Agril. Universities. 27(3): 313-314.

Peltonen, J. and Karjalanen, R. 1992. Effects of fungicides spray on foliar disease, yield and quality of spring wheat in Finland. Plant disease. 41(3): 477-478.

Poulton, P.L., Rawson, H.M. 2011. Physical constraints to cropping in Southern Bangladesh. In: Rawson HM, ed. Sustainable intensification of rabi cropping in southern Bangladesh using wheat and mungbean. ACIAR Technical Reports No. 78. Australian Centre for International Agricultural Research, Canberra, 256 pp.

Rahman, G.M.M. and Islam, M.R. 1998. Effect of black point of wheat on some qualitative character of its grains and seed vigour. Bangladesh J. Agril. Res. **23**(2): 283-287.

Rahman, M.M., Barma, N.C.D., Malaker, P. K., Karim, M. R. and Khan, A. A. 2009. Integrated Management for the Bipolaris Leaf Blight and Foot and Root Rot Diseases of Wheat. *Int. J. Sustain. Crop Prod.* **4**(1):1-4.

Rahman, M.M., Ali, M.S., Nahar, A., Karim, M.M., Begum, K. 2013. Efficacy of fungicides in controlling leaf blight of wheat. *Int. J. Expt. Agric.* **3**(1): 1-3.

Rashid, A.Q.M.B.; Sarker, K. and Khalequzzaman, K.M. 2001. Control of *Bipolaris* leaf blight of wheat with foliar spray of Tilt-250 EC. *Bangladesh J. of Pl. Path.* **17**(1-2): 45-47.

Rashid, A.Q.M.B. and Fakir, G.A. 1998. Seed-borne nature and transmission of *Bipolaris sorokiniana* in wheat. First national workshop on Seed Pathology. Progress and prospect of seed pathological research in Bangladesh. Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh.

Rashid A.Q.M.B.; 1997. Effect of *Bipolaris sorokiniana* on the germination of wheat seeds. Bangladesh Journal of Seed Sciences & Technonogy. **1**(1): 47-52.

Rashid A.Q.M.B., Lahiri, B.P., Islam, T. 1994. Effect of *Bipolaris sorokiniana* some yield components and seed quality of wheat. *Bangladesh Journal of Agriculture Sciences*. **21**: 185-192.

Rashid A.Q.M.B.; Meah, M.B. and Jalauddin, M. 1987. Effect of leaf blight caused by *Drechslera sorokiniana* on some yield components of wheat. Crop Protect. **6**(4): 256-260.

Razzaque, M.A. and Hossain, A.B.S. 1991. "Wheat for the non-traditional warm areas edited by D.A.Saunders. Proc. International Conf. Held in July 29 to August 3, 1990 in foz do Iguacu, Brazil. CIMMYT, pp: 44-54.

Regmi, A.P, Ladha, J.K., Pasuquin, E.M., Pathak, H., Hobbs, P.R., Shrestha, L.L., Gharti, D.B., Duveiller, E. 2002. The role of potassium in sustaining yields in a long-term rice-wheat experiment in the Indo-Genetic plains of Nepal. Biol Fertil Soils **36**: 240-247.

Reza, M.M.A., Khalequzzaman, K. M. and Rashid, A. Q. M. B. 2006. Effect of different levels of black pointed seed and plant infection by *Bipolaris sorokiniana* on wheat. *Bangladesh J. Agric. Res.* **31**(2): 241-248.

Saari, E.E. 1998. Leaf blight disease and associated soil borne fungal pathogens of wheat in South and Southeast Asia. In: Duveiller E, Dubin HJ, Reeves J, McNab A (eds) Helminthosporium blights of wheat: Spot blotch and tanspot. CIMMYT, Mexico, DF, pp 37-51.

Sadasivaiah, R.S.; Perkovic, S.M.; Pearson, D.C., Postman, B. and Beres, B.L. 2004. Registration of AC Andrew wheat. Crop Sci., **44**:696-697.

Schmidt, H.S. 1986. Investigation of influence of black point infested wheat seed at various infestation levels on the cultivated crop by using two seed treatments. Bangladesh-German Seed Development Project. Dhaka. Bangladesh. 23pp.

Shabeer, A. and Bochus, W.W. 1998. Leaf spot effects of yield and yield components relative to growth stage in winter wheat. Plant Disease **72(2)**: 599-602.

Shahidullah, M.S. 2006. Avoidable yield loss due to bipolaris leaf blight of wheat ant its management. M.S. Thesis. Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

Sharma, R.C., Duveiller, E. 2004. Effect of Helminthosporium leaf blight on performance of timely and late-seeded wheat under optimal and stressed levels of soil fertility and moisture. Field Crops Res **89**:205-218.

Sharma-Poudyal, D.; Duveiller, E., Sharma, R.C. 2005. Effects of seed treatment and foliar fungicides on Helminthosporium Leaf Blight and performance of wheat in warmer growing conditions. *J Phytopathol* 153:401-408.

Sharma, R.C., Duveiller, E. 2006. Spot blotch continues to cause substantial grain yield reductions under resource limited farming conditions. *J Phytopathol* **154**:482-488.

Sharma, R.C., Duveiller, E. 2007 Advancement toward new spot blotch resistant wheats in South Asia. Crop Sci **47**: 961-968.

Shrestha, K.K., Timila, R.D., Mahto, B.N. 1998. Disease incidence and yield loss due to foliar blight of wheat in Nepal. In: Duveiller E, Dubin HJ, Reeves J, McNab A (eds), Helminthosporium Blights of Wheat: Spot Blotch and Tan Spot, Mexico, D.F., CIMMYT, 1998, pp. 67–72.

Singh, V.A. and Chauhan, S.K.S. 1995. Efficacy of fungicide in- vivo and in-vivo against leaf blight of wheat. Indian J. Mycle. *Pl. Path.* **25** (1-2): 111.

Singh, R.V., Sinoh, A.K., Singh, D., Singh, S.P. and Choudhary, V.P. 1995. Management of foliar blight of wheat through chemicals. Indian Journal of Mycology and Plant Pathology, **25** (1 & 2): 113.

Singh, R.V., Singh, A.K., Ahmad, R. and Singh, S.P. 1998. Influence of agronomic practices on foliar blight and identification of alternate hosts in the rice-wheat cropping systems. In: Helmonthosporium blights of wheat spot blotch and tan spot (E Duveiller, E, HJ Dubin, J Reeves and A Mchab, eds). CIMMYT, Mexico, D.F.

Singh, D.P., Sinha, V.C., Goel, L.B., Ram, B., Singh, R.V., Singh, A.K., Singh, S.P., Jha, M.P., Khanna, B.M. 2005. Chemical control of leaf blight of wheat. *Indian J. Agric, Res.*, **39**(3), 229-231.

Singh, R., Sengar, R.M.S. and Singh, S. 2012. Incidence of Foliar Blight Pathogens of wheat (Triticum aestivum L.) In Agra Region. *Indian J.L.Sci.* **1**(2): 39-41.

Sinha, A.P. and Thapliyal, P.N. 1984. Seed disinfection in relation to black point disease of *Triticle*. *Indian phytopath.* **37**(1): 154-155.

Sisterna, M.N. and S.J. Sarandon. 2005. Preliminary studies on the natural incidence of wheat black point under different fertilization levels and tillage systems in Argentina. *Plant Patho.* J., (4):26-28.

Stack, R.W., McMullen, M.P. 1991. Effect of fungicidal seed treatments on common root rot of spring wheat and barley. North Dakota Farm Res **49**:13–16.

Viedma, L. Q., and Kohli, M. M. 1998. Spot blotch and tan spot of wheat in Paraguay. Helminthosporium Blights of Wheat: Spot Blotch and Tan Spot. CIMMYT.

Vir, D.; Adlakha, K. L., Joshi, L.M. and Pathik, K.D. 1968. Preliminary note on occurrence of black pointed disease of wheat in India. *Indian Phytopathology*. **21:** 334-335.

Wang, H.,. Fernandez, M. R., McCaig, T. N., Gan, Y. T., DePauw, R.M. and Clarke, J.M. 2003. Kernel discoloration and downgrading in spring wheat varieties in western Canada. *Can. J. Plant Patho.,* **25:**350-361.

Zamal, M.S., Aminuzzaman, F. M., Sultana, N. and Islam, M. A. 2007. Efficacy of fungicides in controlling leaf blight of wheat caused by *Bipolaris sorokiniana* of wheat. *Interl. J. Sustain. Agril. Tech.*, **3**(2): 1-6.

Zaman, R., Aminuzzaman, F.M., Islam, M.R. and Chowdhury, S.R. 2009. Eco-friendly management of leaf blight (*Bipolaris sorokiniana*) of wheat, *Am. Eurasian J. Sustain. Agric.*, **3**(3): 597-603.

Zaman, R., Aminuzzaman, F.M., Islam, M,R,, Chowdhury, S.R. 2010. Eco-friendly seed treatments in controlling black point (*Bipolaris sorokiniana*) of wheat. *Int. J. Sustain. Crop Prod.* **5**(3): 35-42.

Zhang, T. Y.; Wang, H. L. and Xu, F. L. 1990. Effects of grain black point disease of wheat and the pathogenic fungi. *Acta Phytophylacica Sinica.* **17**(4): 313-316.

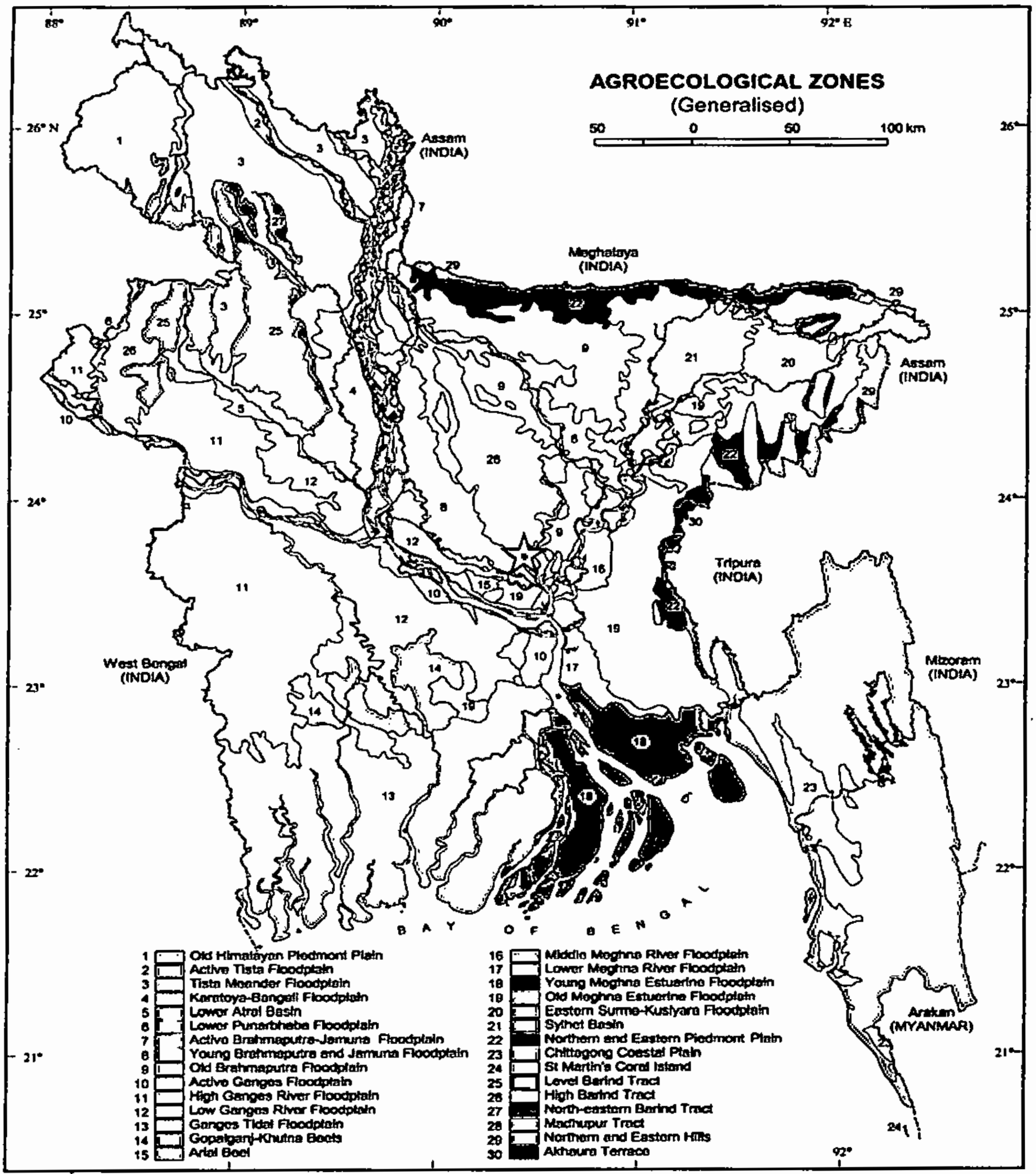
Zhimin, X.; Lianfa, S. and Wenli, X. 1998. Breeding for foliar blight resistance in Heilongjiang Province, China. In: *Helminthosporium* blight of wheat: spot bloch and tan bloch. E. Duveillier, H. J. Dubin, and MsNab (eds.). Maxico, D. F.: CIMMYT. Pp.: 114-118.

Zobaer, A.S.M., Aminuzzaman, F.M., Chowdhury, M.S.M. and Miah, M.S. 2007. Effect of seed sorting, solarization and treatment with vitavax-200 and hot water on leaf spot disease and yield of wheat. *Bangladesh j. Seed Sci. and Tech.*, **11**(1 & 2): 11-15.

Appendices

APPENDICES

Appendix I: Map showing the experimental sites under study.



☆ **The experimental site under study**

Appendix II: Particularities of the Agro-ecological zone of the experimental site.

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Farm, SAU, Dhaka
AEZ	Modhupur tract (28)
General soil type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	N/A

Source: Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

B. The physical and chemical characteristics of initial soil of the experimental plot.

Characteristics	Value
Sand (%)	16
Silt (%)	56
Clay (%)	28
Silt + Clay (%)	84
Textural class	Silty clay loam
pH	5.56
Organic matter (%)	0.25
Total N (%)	0.02
Available P (μgm/gm soil)	53.64
Available K (me/100g soil)	0.13
Available S (μgm/gm soil)	9.40
Available B (μgm/gm soil)	0.13
Available Zn (μgm/gm soil)	0.94
Available Cu (μgm/gm soil)	1.93
Available Fe (μgm/gm soil)	240.9
Available Mn (μgm/gm soil)	50.6

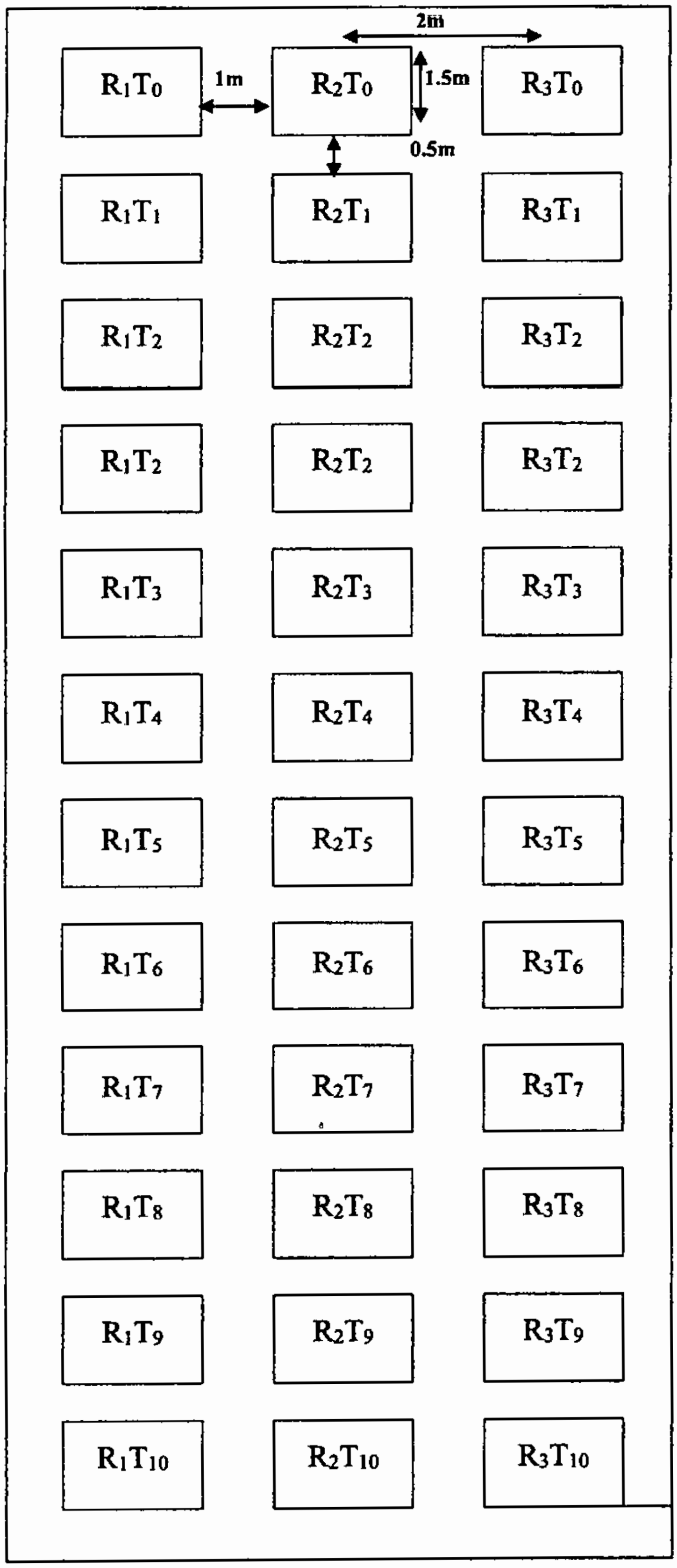
Source: Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

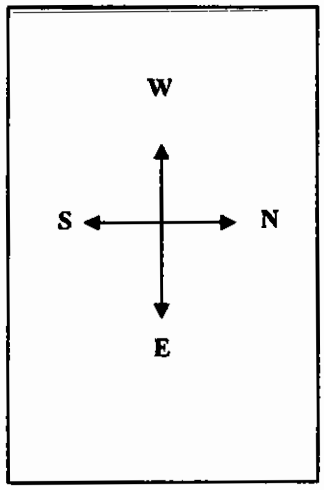
Appendix III. Monthly records of Temperature, Rainfall, and Relative humidity of the experiment site during the period from November 2014 to April 2015.

Year	Month	Air Temperature (^{0}c)			Relative humidity (%)	Rainfall (mm)	Sunshine (hr)
		Maximum	Minimum	Mean			
2014	November	34.8	18	26.4	77	227	5.8
2014	December	32.3	16.3	24.3	69	0	7.9
2015	January	29	13	21	79	0	3.9
2015	February	28.90	18.00	23.40	61.00	2.00	221.50
2015	March	33.60	29.50	31.60	72.70	3.00	227.00
2015	April	33.50	25.90	299.20	68.5	1.00	194.10

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1207.

Appendix IV: Layout of the experiment.





T_0 = Control
T_1 = 1 spray with Tilt 250 EC @ 0.1%
T_2 = 2 sprays with Tilt 250 EC @ 0.1%
T_3 = 3 sprays with Tilt 250 EC @ 0.1%
T_4 = 4 sprays with Tilt 250 EC @ 0.1%
T_5 = 5 sprays with Tilt 250 EC @ 0.1%
T_6 = 6 sprays with Tilt 250 EC @ 0.1%
T_7 = 7 sprays with Tilt 250 EC @ 0.1%
T_8 = 8 sprays with Tilt 250 EC @ 0.1%
T_9 = 9 sprays with Tilt 250 EC @ 0.1%
T_{10} = 10 sprays with Tilt 250 EC @

Plot size = $2 \times 1.5\ m^2$
Distances:
Block to Block = 0.5 m
Plot to Plot = 1 m

Appendix V: ANOVA table of the experiment.

01. Percent leaf infection at 75 days

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Probability
Replication	2	4.60	2.300	0.93	0.4109
Treatment	10	11685.81	1168.581	472.64	0.0000**
Error	20	49.45	2.472		
Total	32	11739.86			

Coefficient of Variation= 8.76%

** indicates 1% level of significance

02. Percent leaf area disease at 75 days

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Probability
Replication	2	0.29	0.145	0.54	0.5921
Treatment	10	1146.73	114.673	424.68	0.0000**
Error	20	5.40	0.270		
Total	32	1152.42			

Coefficient of Variation= 10.45%

** indicates 1% level of significance

03. Percent leaf infection at 90 days

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Probability
Replication	2	1.34	0.669	0.21	0.813
Treatment	10	19854.86	1985.486	617.55	0.000**
Error	20	64.30	3.215		
Total	32	19920.50			

Coefficient of Variation= 7.16%

** indicates 1% level of significance

04. Percent leaf area disease at 90 days

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Probability
Replication	2	0.62	0.310	0.57	0.5749
Treatment	10	3027.05	302.705	555.73	0.0000**
Error	20	10.89	0.545		
Total	32	3038.56			

Coefficient of Variation= 8.55%

** indicates 1% level of significance

05.Percent leaf infection at 105 days

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Probability
Replication	2	59.95	29.977	9.37	0.0013
Treatment	10	29659.99	2965.999	927.59	0.0000**
Error	20	63.95	3.198		
Total	32	29783.90			

Coefficient of Variation= 3.98%

** indicates 1% level of significance

06. Percent leaf area disease at 105 days

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Probability
Replication	2	29.42	14.711	4.68	0.0214
Treatment	10	23453.89	2345.389	746.89	0.0000**
Error	20	62.80	3.140		
Total	32	23546.11			

Coefficient of Variation= 5.51%

** indicates 1% level of significance

07. Percent black pointed seed

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Probability
Replication	2	1.01	0.506	0.57	0.5719
Treatment	10	2721.30	272.130	308.88	0.0000**
Error	20	17.62	0.881		
Total	32	2739.93			

Coefficient of Variation= 7.79%

** indicates 1% level of significance

08. No. of Tillers/Plant

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Probability
Replication	2	0.55	0.273	2.57	0.1014
Treatment	10	99.33	9.933	93.66	0.0000**
Error	20	2.12	0.106		
Total	32	102.00			

Coefficient of Variation= 4.65%

** indicates 1% level of significance

09. Plant height(cm)

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Probability
Replication	2	43.70	21.848	4.42	0.0257
Treatment	10	1408.14	140.814	28.50	0.0000**
Error	20	98.80	4.940		
Total	32	1550.64			

Coefficient of Variation= 2.37%

** indicates 1% level of significance

10. Spike length/plant(cm)

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Probability
Replication	2	34.20	17.099	197.16	0.0000
Treatment	10	110.96	11.096	127.94	0.0000**
Error	20	1.73	0.087		
Total	32	146.89			

Coefficient of Variation= 2.21%

** indicates 1% level of significance

11. Thousand Seed Weight (g)

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Probability
Replication	2	0.81	0.405	1.03	0.3761
Treatment	10	472.66	47.266	119.90	0.0000**
Error	20	7.88	0.394		
Total	32	481.36			

Coefficient of Variation= 1.51%

** indicates 1% level of significance

12. Yield (t/ha)

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Probability
Replication	2	0.00	0.000	0.01	0.9876
Treatment	10	10.63	1.063	36.18	0.0000**
Error	20	0.59	0.029		
Total	32	11.22			

Coefficient of Variation= 3.90%

** indicates 1% level of significance

13. Seed germination

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Probability
Replication	2	18.42	9.212	1.86	0.1812
Treatment	10	2344.73	234.473	47.41	0.0000**
Error	20	98.91	4.945		
Total	32	2462.06			

Coefficient of Variation= 2.70%

** indicates 1% level of significance

14. Seed Infection

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-value	Probability
Replication	2	2.91	1.455	0.35	0.7069
Treatment	10	3213.58	321.358	77.98	0.0000**
Error	20	82.42	4.121		
Total	32	3298.91			

Coefficient of Variation= 14.31%

** indicates 1% level of significance

Appendix VI: Calculation of regression value by percent disease index (PDI) and corresponding yield loss from multiple treatment experiment.

Regression equation, $\hat{Y}=\bar{Y}+b\,(X_i-X)$

Here, $\hat{Y}$= Predicted yield loss (%)

$\bar{Y}$= Estimated yield loss (%)

X_i= Disease severity (PDI) (i=1, 2, 3,.........)

b= Regression co- efficient

n = Number of observation

$$\bar{X}=\frac{\Sigma X}{n}$$

$$=36.62$$

$$\bar{Y}=\frac{\Sigma Y}{n}$$

$$=17.23$$

$$b=\frac{\sum XY-\frac{\Sigma X\Sigma Y}{n}}{\Sigma(Xi-X)2}$$

$$=\frac{10444.78-\frac{402.83\times189.52}{11}}{(81.1-36.62)2+(74.8-36.62)2+\cdots\ldots\ldots+(0-36.62)2}$$

$$=\frac{3504.39}{8816.18}$$

$$=0.40$$

Now putting the $\bar{Y}$, X and b value in the regression equation

$\hat{Y} = \bar{Y} + b\,(X_i - \bar{X})$

$= 17.23 + 0.40\,(X_i - 36.62)$

$= 17.23 + 0.40X_i - 14.65$

$= 2.58 + 0.40X_i$

Percent Disease Index (PDI) X	% Yield Loss Y	XY	Predicted yield loss % $\hat{Y}=2.58+0.40Xi$
$X_i = 81.1$,	35.7	2895.27	35.02
$X_{ii} = 74.8$,	31.4	2348.72	32.5
$X_{iii} = 66.67$,	28.22	1881.4274	29.248
$X_{iv} = 55.94$,	23.74	1328.0156	24.956
$X_v = 43.44$,	20.93	909.1992	19.956
$X_{vii} = 25.66$,	17.01	508.4289	14.536
$X_{viii} = 18.8$,	13.46	345.3836	12.844
$X_{ix} = 5.28$,	10.28	193.264	10.1
$X_x = 1.25$,	5.98	31.5744	4.692
$X_{xi} = 0$,	2.8	3.5	3.08
$X_i = 81.1$,	0	0	2.58
$\sum X = 402.83$	$\sum Y = 48.71$	$\sum XY$=10444.7831	