MANAGEMENT OF LEAF BLIGHT OF WHEAT CAUSED BY *Bipolaris sorokiniana*

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DHAKA-1207, BANGLADESH

DECMBER- 2007

MANAGEMENT OF LEAF BLIGHT OF WHEAT CAUSED BY *Bipolaris sorokiniana*

A thesis

By

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REGISTRATION NO.: 00805

Submitted to the Faculty of Agriculture
Sher-e-Bangla Agricultural University, Dhaka,
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE
IN
PLANT PATHOLOGY
SEMESTER: JULY-DECEMBER, 2007

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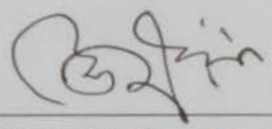

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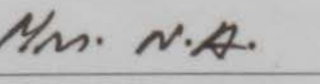

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CERTIFICATE

This is to certify that the thesis entitled, "*MANAGEMENT OF LEAF BLIGHT OF WHEAT" CAUSED BY Bipolaris sorokiniana* submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of *MASTER OF SCIENCE IN PLANT PATHOLOGY*, embodies the result of a piece of bona fide research work carried out by ***Saila Yesmin, Registration No. 00805,*** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

I further certify that any help or sources of information, as has been availed of during the course of this investigation has been duly acknowledged.

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TO

MY BELOVED

PARENTS

ACKNOWLEDGEMENT

The author wishes to acknowledge the immeasurable grace and profound kindness of Almighty Allah the supreme Ruler of the Universe, Who has enabled him to carry out this research work and prepare the thesis.

The author feels proud to expresses her hear-felt gratitude, immense indebtedness and sincere appreciation to her respected teacher and supervisor Dr. F. M. Aminuzzaman, Assistant Professor, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for his scholastic guidance, valuable suggestions, constant encouragement, affectionate feelings, patience and advices throughout the research period and for completion of the thesis.

It is a great pleasure for the author to extend her deep sense of gratitude and indebtedness to her honorable teacher and co-supervisor Dr. Md. Rafiqul Islam, Professor, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for his creative suggestions, constructive criticism and sincere co-operation in completing the thesis.

Cordial thanks and honors to Mrs. Nasim Akhtar, Professor, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, for her helpful comments and providing necessary facilities during the period of the research work.

The author desires to express her respect and deepest sense of gratitude to all the respectable teachers of the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for their valuable suggestion and kind co-operation during the period of the study.

The author pleased to convey cordial thanks to Md. Tohidul Islam, Lecturer, Department of Plant Pathology, Abu Noman Faruk Ahmmed, Lecturer, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for their kind help and valuable advices during the research period and for preparation of the thesis.

The author desires to express her heartiest gratitude to Md Mosiur Rahman, MS student, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for his inspiration and best co-operation during the research period.

Cordial appreciation and thanks are extended to all the staff of Plant Pathology Laboratory and the farm workers of Sher-e-Bangla Agricultural University, Dhaka for their assistance and co-operation for conducting the research work.

Lastly the author expresses her indebtedness to her beloved parents, brothers, uncle and relatives for their blessings, love, and affection and well wishes.

The author

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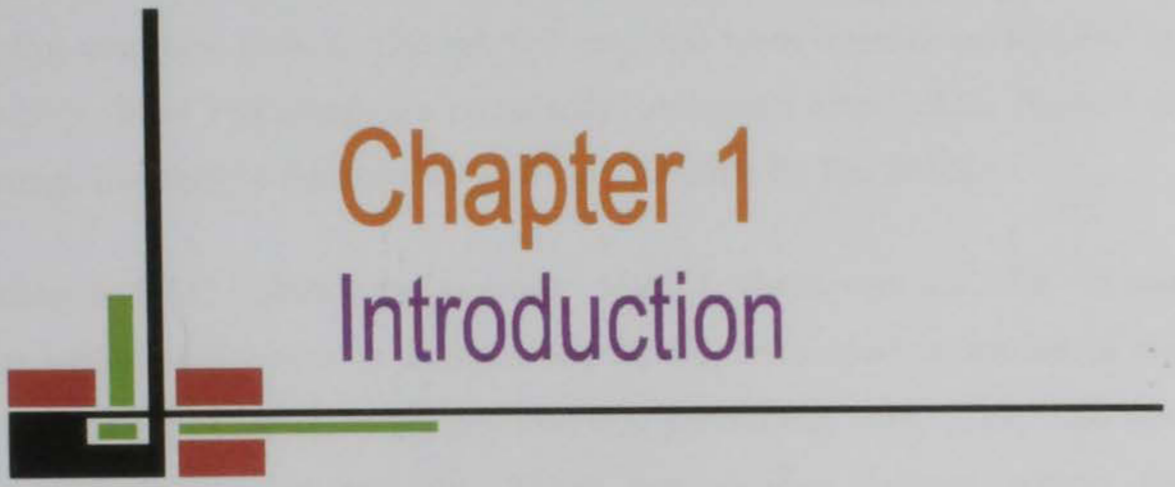
MANAGEMENT OF LEAF BLIGHT OF WHEAT CAUSED BY *Bipolaris sorokiniana*

ABSTRACT

An experiment was carried out to determine the efficacy of some eco-friendly seed treatments and fungicidal treatments against leaf blight (*Bipolaris sorokiniana*) and grain yield of wheat. Among the different eco-friendly treatments, the highest reduction of incidence of seed borne *Bipolaris sorokiniana* and increasing seed germination and seed yield (3.85 t/ha) was obtained by manually sorted healthy looking seed treated with hot water (T_8) followed by farmer's saved seed treated with hot water (T_7). Significant reduction of incidence of same fungus was achieved by treating seeds with solar heat and polythene solarization. The rest of the treatments have some remarkable effect in controlling the disease and increasing seed yield of wheat. Among the fungicidal treatments, apparently healthy seed+ foliar spraying of Tilt-250 EC (T_4) was found best in reducing the leaf infection and increasing the seed yield (4.02 t/ha) which was followed by farmer's saved seed+ foliar spraying of Tilt (T_3) and apparently healthy seed+ foliar spraying of Proud -250 EC(T_8). Another two fungicides Proven-250 EC and Propicon also gave the better performance in reducing the leaf infection and increasing seed yield in comparison to control.



Chapter 1
Introduction

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most popular staple foods in the world. It is the second most important cereal crop next to rice in Bangladesh. About 706.86 thousand hectares of land in Bangladesh is covered by wheat cultivation with the annual production of 1570 thousand tons (BBS, 2005). Wheat is well adapted crop in our native climate and can play a vital role in recovering our food deficit. Though the crop has been introduced in 1967 in the country (East Pakistan), its popularity increased after 1975. Now it is cultivating throughout the country and well adapted by the farmer.

According to FAO (2005), the average yield of wheat was 1.7 t ha^{-1} in our country which was lower in comparison to the developed countries of the world like Japan, France, Germany and UK producing 3.76, 7.12, 7.28 and 8.00 t ha^{-1} yield, respectively. There are various factors which are responsible for lower yield of wheat. Among them, diseases play a vital role. The production of wheat has undergone a historic revolution in many developing nations of Asia and Africa where the crop is grown under different environmental conditions ranging from humid to arid, subtropical to temperate and sea level to an altitude of 3000 meters (Sarri and Wilcoxon, 1974). Wheat suffers as many as 26 seed-borne pathogens causing 14 seed-borne diseases (Fakir, 1999). Among the diseases, leaf blight is the major constraint that limiting wheat production in the tropical and sub tropical regions of the world (Duveiller and Gilchrist, 1994; Mehta, 1997). Leaf blight caused by *Bipolaris sorokiniana* (Sacc. in Sork.) Shoemaker, teleomorph *Cochliobolus sativus* (Ito & Kuribayashi) Dreshs. Ex Dastur,

(Syn. *Helminthosporium sativum* Pamm. King and Blakke) is now a common disease of wheat in Bangladesh (Hossain *et al.*, 1993; Alam and Shah, 1991 and Alam *et al.*, 1995).

In the farmer's field, the yield loss in wheat due to leaf blight/spot disease in the 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). The 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 blotch disease in the country has been reported to be 20% in var. Sonalika, where 14% and 8% in Akbar and Kanchan, respectively (Razzaque and Hossain, 1991).

There are several approaches that have been practiced for controlling leaf blight disease, such as use of resistant variety, cultural control, chemical control, biological control and use of plant extract etc. The most acceptable method for controlling of this disease is cultivation of resistant variety. But none of the wheat varieties in the country is found resistant against this disease (Hossain and Azad, 1992).

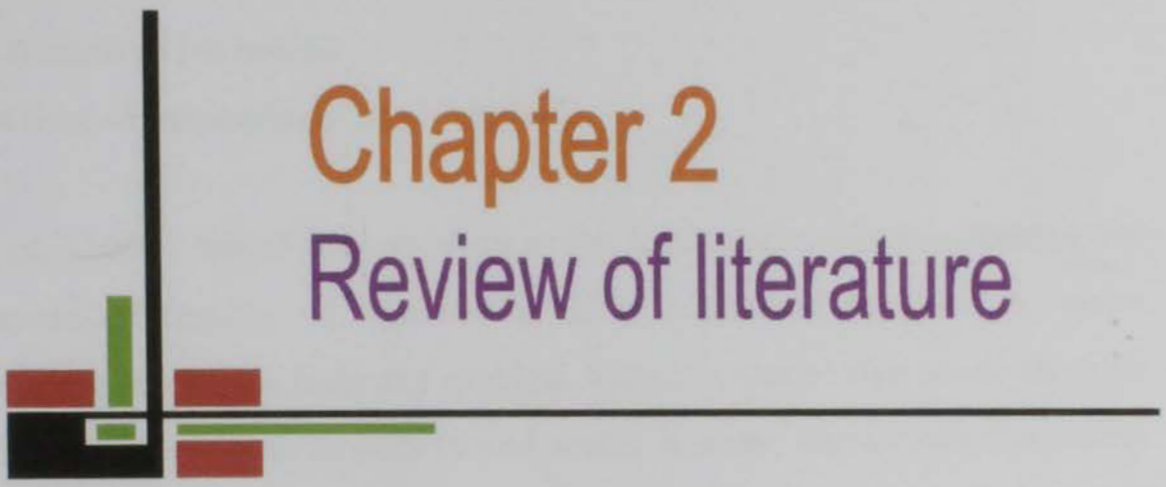
The acceptable method for controlling this disease is sowing of pathogen free seeds. Therefore along with routine seed health testing, seed treatment before sowing is necessary. Treatment of seed with seed-dressing fungicides was found to improve germination and decrease infection of seedling growth from the black pointed seeds. Indiscriminate using of chemicals are creating health hazards and environmental pollution. Use of alternate methods instead of seed treating with chemicals is of great concern now a days to

save our environment. Therefore, it is judicious to explore less expensive, less risky non-chemical components to treat seeds to free them from seed-borne pathogens. In this respect, use of solar heat, seed treatment with hot water and brine solution are used to control seed borne fungal pathogens.

Leaf blight of wheat can also be controlled by the application of fungicides as a last option. Many workers used of different chemicals against the disease and Tilt-250 EC has been proved effective (Anonymous, 1989). Foliar spray with Tilt-250 EC has been practiced in controlling the disease under field condition. (Meyer, 1990; Bockus *et al.*, 1992; Anonymous, 1993 and Malaker *et al.*, 1994). Efficacy of 0.1% Tilt-250 EC have been found much better than the 0.025 % Mancozeb (pencozeb) and 0.1% carbendazim (Bavistin) 50 WP in controlling leaf blight of wheat. (Patil *et al.* 2002, Shahidullah, 2006). Among the fungicides maximum yield, grain weight and minimum disease were found with four spraying of Tilt starting at disease initiation following by 3 spraying of Tilt (Singh *et al.*, 1995 and Zamal, 2006). Foliar spray of Tilt-250 EC (0.1%) was found more effective than seed treatment with Vitavax-200 in controlling leaf spot of wheat. (Rahman,1998; Rahman *et al.* 1999 and 2001).

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

- To evaluate the effect of some selected eco-friendly seed treatments on seed germination and incidence of *Bipolaris sorokiniana* in the laboratory.
- To determine the effect of some selected seed eco-friendly treatments on leaf blight (*Bipolaris sorokiniana*) and yield of wheat.
- To evaluate the efficacy of some selected fungicides on leaf blight (*Bipolaris sorokiniana*) and yield of wheat.



Chapter 2
Review of literature

2. REVIEW OF LITERATURE

Leaf blight of wheat caused by *Bipolaris sorokiniana* is a very common and destructive disease in Bangladesh. To control the disease, several management programme has been practiced. Literature on chemical control and some eco-friendly approaches like seed treatment with hot water, brine solution, sun drying and polythene solarization for the management of leaf blight of wheat is presented in this chapter.

2.1. Eco-friendly treatment

2.1.1. Sorting of apparently healthy seed

Fakir *et al.* (2000) found that seed cleaning had paramount importance for improvement of quality of rice seeds. They separated the best or clean apparently healthy seeds from the original farmer's stored rice seeds through elimination of seed contaminants (weed seeds, insects, varital mixture, seeds of other crops, germinated seeds, smutted seeds and matter) and abnormal seeds (spotted, discolored, deformed, shriveled, unfilled and half-seeds) by physical seed sorting. The least percentage of seed-borne pathogenic fungi was recorded on seed health analysis. Also lesser number of dead/abnormal seedling and higher percentage of normal seedlings and higher percentage of normal seedling were obtained from best seeds in the germination tests.

Hasan (2000) found that seed cleaning and washing with water increased of germination and vigor index by 8.33 and 31.1. %, respectively in farmer's rice seed (cv.BR11). Seed health test revealed that farmer's seeds yielded *Bipolaris oryzae, Fusarium monoliformae, Alternaria padwickii, Aspergillus niger, Aspergillus flavus* and *penicillium spp.* by 1.5%, 13.5%, 1.3%, 0.5%

and 0.5%, respectively, over the best seeds. Seed cleaning followed by washing with water also increased 24.63% grain yield over farmer's seeds. He emphasized the importance of seed cleaning and washing for controlling seed borne pathogens of rice. Seed cleaning and washing reduced incidence of foliar diseases in the field and increased seed yield by 35.13% over the use of normal farmer's seed of rice.

Mia *et al.* (2000) reported that rice seed treated with Vitavax-200 showed the best performance followed by manual seed sorting against *Bipolaris oryzae.* Significant reduction of brown spot and seedlings with lesion in coleoptile was noted in Vitavax treated and manually sorted seed. Seed cleaning also increased the number of tiller and effective tiller/hill significantly.

Rahman *et al.* (2000) carried out an experiment to improve seed quality by seed cleaning (manual sorting and flotation in water) in four seed samples of rice cv. BR11. The seed borne fungi associated with the treated and untreated seeds were *Bipolaris oryzae*, *Trichoconis padwickii*, *Curvularia lunanta*, *Nigrospora oryzae*, *Alternaria tenuis*, *Aspergillus* spp. and *Penicillium* spp. All the seed treatment methods reduced all seed borne fungal infections. The best method was treatment with Vitavax-200, followed by manual sorting and flotation method. Vitavax-200 treated seeds and manually sorted seed produced the highest number of tillers/hill, percentage of healthy seeds and 1000-seed weight. Grain yield was increased in manually sorted, flotation and Viatavax-200 treated seed/plots by 30.5, 13.5 and 27.3, respectively.

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

2.1.2 Seed treatment with brine solution

Gworgwor *et al.* (2002) conducted field trials in Nigeria during 1997 and 1998 in wet seasons to determine the effect of seed treatment of different sorghum cultivars with brine solution (NaCl) on *Striga hermonthicam* in sorghum. Different concentration of brine at 0.5, 1.0, 1.5 and 2.0 M. were used. They reported that the effect of brine solution on establishment, growth and yield of sorghum under striga infestation shows that there was a decrease in crop stands with increase in brine concentration, with the least value at 2.0 M brine treatment, which was damaging at this rate. Plant height and LAI of sorghum increased with increasing concentration of brine to a maximum at 1.5 M. and declined at 2.0 M brine treatment. The 1.5 M brine treatment produced the highest grain yield.

Uddin (2005) reported that seed borne pathogens significantly reduced by treating seeds with chemical (Vitavax-200) followed by garlic extract, brine solution, hot water and physically sorted seeds in Lentil. The highest reduction of seed borne fungal flora were observed in case of chemical treatment followed by garlic extract, brine solution, hot water and physically sorted seeds. In the field condition, germination percentage was higher in physically sorted seeds.

Kabir (2006) carried out an experiment to control leaf blight of wheat where chemical & different physical seed treatments were used and the treatments were differed significantly. Among the different seed treatments, apparently healthy seed treated with Vitavax-200 @ 0.4% followed by apparently healthy seed treated with brine solution @ 2%, washed apparently healthy seed treated with brine solution @ 2% was found to be best in reducing leaf infection, increased seed germination and seed yield.

2.1.3 Seed treatment by solar heat

Mohinder *et al.* (1994) conducted a field experiment at Hisar, India, they studied the efficacy of solar heat treatment for controlling loose smut of wheat, caused by *Ustilago tritici* (*U. segatum* var *tritici*) and observed that The disease was completely controlled by solar heat.

Jahan (1996) demonstrated that solar heat treatment on jute seed effectively inhibited seed-borne fungi.

Haque (1997) conducted an experiment to evaluate the solar heat treatment for 3 hours to control major seed-borne fungal pathogens of chilli. He found that solar heat treatment significantly inhibited the growth of all the major seed-borne fungi, in chilli seeds as compared to the control. Treated seed yielded 3.75%, 4.25%, 6.25% and 8.50% *Alternaria tenuis, Colletotrichum capsici, Curvularia lunata* and *Fusarium* spp. respectively. In the control treatment infection percentage were 14.0%, 12.75%, 12.00%, 20.25% for *A. tenuis*, *C. capsici*, *C. lunata* and *Fusarium* spp., respectively.

Mahfuzul (1997) reported solar heat treatment as an effective method in reducing seed-borne infection of chilli compared to control.

Fakir and Jahan (1998) carried out an experiment to control seed-borne, fungal pathogens of jute by seed treatment with solar heat. Solar heat treatment effectively reduced 91.3% seed-borne infections and increased 9.0% seed germination.

Zobaer (2006) carried out an experiment to control leaf blight of wheat where different physical seed treatments were used and the treatments were differed significantly. Among the different seed treatments, solar heat treatment of apparently healthy seeds was found to be best in reducing leaf infection, increased seed germination and seed yield. Apparently healthy seed treated with hot water increased seed germination, seed yield and also reduced the leaf infection.

2.1.4. Seed treatment with hot water

Karunaratne (1999) stuided the effect of hot water treatments (different temperature, time combination) of tomatoes, cucumbers and *Momordica charantia* (55°C for 1min), *Capsicum annum* (Chillis), carrots (50°C for 1min), *Phaseolus vulgaris* (50°C for 30S) and okras (52°C for 30S) on shelf life of each commodity at room temperature, (27±3°C) and relative humidity (65±5%) and found that no disease symptom was developed on the seedling raised from the treated seeds.

Nega *et al.* (2000) investigated the effect of hot water treatment against seed borne pathogens on five important vegetable crops (carrot, cabbage, celery, parsley lamb's lettuce). They found that most important seed-borne pathogens were *Alternaria* spp., *Phoma* spp., *Septoria* spp., *Xanthomona* spp., *Peronospora valerianellae*. Hot water treatments at 40°C & 50°C for 10 to 30 min, in some cases to 60 min and found no infected seeds from those vegetables. Seed borne pathogens could be reduced without significant losses of germination by hot water treatments at 50°C for 20 to 30 min up to 53°C for 10 to 30 min.

Satvinder and Kahur (2000) reviewed some physical techniques such by dry heat, hot water, solar heat, washing, radiation, microwave treatment, ultrasonic waves and forced air circulation for the management of plant disease including post harvest disease.

Sadek *et al.* (2001) stated that hot water treatment at 10°C for 10 minutes with potassium permanganate (1%) or copper sulphate (1%) application effectively controlled the pathogen in infected seeds of tomato, tobacco, cowpea, bean and pepper. By this treatment irregular spots were overcome finely.

Winter *et al.* (2001) reported that the incidence of common bunt (*Tilletia caries*) in winter wheat was strongly reduced by a seed treatment with skim milk powder and warm water. The combined seed treatment with warm water at 45°C for 2 hours and skim milk powder (160g/litre water) controlled the seed borne infection of *Tilletia caries* (Common bunt),

Garlachia nivalis, (Snowmould), *Fusarium graminearum* and *Septoria nodorum* (Damping off) in winter wheat.

Muniz (2001) reported that the dry heat treatment of tomato seeds treated at 70° C for 12 days eradicated fungi associated with the seeds. But in hot water treatment at 50° C for 30 minutes under laboratory research the associated fungi in tomato seeds were eradicated.

Jiskani (2002) found that the brown spot or blight of rice caused by *Helminthosporium oryzae* effectively controlled by hot water seed treatment at 54°C for 10 minutes.

William Nesmith (2003) at Ohio State University found hot water treatment effective against the major seed borne diseases of vegetables. He found effective temperature of 122°F (49.95°C) for 25 min for brussels sprouts, cabbage, eggplant. tomato and spinach; 122°F (49.95°C) for 20 min for broccoli, cauliflower, Chinese cabbage, carrot, kale, kohlrabi and turnips; I22°F (49.95°C) for 1-5 min for mustard and radish; 125°F (51.6°C) for 30 min for peppers and 118°F (47.73°C) for 30 min for lettuce and celery.

2.1.5 Foliar spraying with Boron

Katyal and Friensen (1987) reported that when the major and minor elements are not present optimally in plants and soils, plants show different types of hunger signs and in some cases the plants become more vulnerable to disease.

Jahiruddin (1991) used boron, copper and molybdenum to find out their effect on grain formation in wheat. He reported that boron at the rate of 3 kg/ha. in case of soil application and 400 ppm B as foliar spray had the dominant effect on the number of grain per spike and yield.

Yahiya (1995) was conducted an experiment to evaluate the effect of Cu, Bo and Mo on leaf spot of wheat and he reported that boron as soil application found to be best in reducing leaf infection, yield and yield contributing characters followed by boron as foliar spray at 400 ppm concentration.

2.2 Foliar spraying with Fungicides

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

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

Mondal *et al.* (1994) evaluated four commercial fungicides to evaluate their efficacy in controlling *Bipolaris* leaf blight of wheat under natural epiphytotic condition during 1991-1992 and 1992-1993. Among them, Tilt-250 EC (0.05%) was the most effective and profitable one, which controlled the disease significantly, producing the highest grain yields with maximum

gross margin. The disease severity was also reduced by Dithane M-45 (0.02%) and Pencozeb (0.15%) and gave profitable yield while application of Rovral (0.2%) was round uneconomic offering the lowest gross margin.

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

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

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

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

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

Rashid *et al.* (2001) reported that Tilt-250 EC (Propiconazole) is a good fungicide in controlling *Bipolaris* leaf blight of wheat

Patil *et al.* (2002) investigated the efficiency of 0.1% Propiconazole (Tilt) 250 EC & 25% EC, 0.1% Haxaconazole 25% EC, 0.05% Tridemorph 200 WC, 0.1% Carbendazim 50 WP (Bavistin), 0.1% Triadimefon, 0.0025% Mancozeb (Pencozeb), 0.020% Chlorothalonil, 0.3% Copper oxychloride 50 WP and 0.03% Nimbicidin in controlling leaf blight of wheat. The incidence of the disease was not observed in plant sprayed with 0.1% Propiconazole (Tilt) and increased the yield and biomass.

Sharma-Poudyal *et al.* (2005) was conducted an experiment to determine the effect of seed treatment and foliar fungicides on disease and performance of wheat. Seed was treated with Vitavax® 200, Bavistin® and Simonis carbendazim in 2002, and Areestin® instead of Simonis carbendazim in 2003. One and two foliar sprays with Opus®, Allegro®, Horizon® and Tilt® were tested, along with a control treatment. *Cochliobolus sativus* was isolated from 8 and 34% presown seeds in 2002 and 2003, respectively, and no *P. tritici-repentis* was found. Seed treatments were not equally effective: Vitavax® 200B increased germination by up to 43% in both years and reduced seedling infection by *C. sativus* in 2003. The foliar fungicides

reduced HLB severity and increased grain yield. Compared with the control, the highest reduction in area under disease progress curve (AUDPC) was 53% in 2002 and 63% in 2003. 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, thanks to the application of foliar fungicides.

Shahidullah (2006) conduced 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.

Zamal (2006) conducted an experiment to determine 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 *Bipolaris sorokiniana* under field condition. He reported that the effect of seed treatment withVitavax-200 followed by subsequent three times foliar spray with Tilt-250 EC has been found significantly more effective than the other single and combined effects in reducing leaf spot severity and increasing yield of wheat.

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. Sonalika.

Chapter 3
Materials and Methods

3. MATERIALS AND METHODS

3.1. Laboratory experiment

The experiment was conducted in the Seed Pathology Laboratory, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka.

3.1.1. Treatments

There were ten treatments namely:

T_1= Farmer's saved seed

T_2= Apparently healthy seed

T_3= Farmer's saved seed treated with brine solution

T_4= Apparently healthy seed treated with brine solution

T_5= Sun drying of farmer's saved seed

T_6= Sun drying of apparently healthy seed

T_7= Farmer's saved seed treated with hot water

T_8= Apparently healthy seed treated with hot water

T_9= Polythene solarization of farmer's saved seed

T_{10}= Polythene solarization of apparently healthy seed

3.1.2. Collection of seeds

Wheat seeds of Kanchan variety were collected from a farmer named Abdul Malek Sarder of Village West Rahamotpur, Thana Babugonj, District Barisal.

3.1.3 Preparation of the seed sample for different treatments

Seed samples for different treatments were prepared following the methods of Kabir, 2006.

3.1.3.1. Sorting of apparently healthy seeds

Apparently healthy seeds were obtained by manual separation of seeds from the contaminants and abnormal seeds of the lot of original farmer stored seeds.

3.1.3.2. Seed treatment with brine solution

At first 2% brine solution was prepared by mixing 100 ml tap water with 2g edible salt (NaCl) and seeds were soaked in the solution for 15 minutes. After treating seeds the excess water was removed and the seeds were air dried in the laboratory prior to sowing.

3.1.3.3. Seed treatment by sun drying

Apparently healthy and farmer's saved seeds were sun dried for 14 hours before sowing.

3.1.3.4. Seed treatment by polythene solarization

Apparently healthy and farmer's saved seeds were covered by transparent polyethylene paper and sun dried for 14 hours before sowing.

3.1.3.5. Seed treatment with hot water

Apparently healthy and farmer's saved seeds were treated with hot water at 50°C for 5 minutes

3.1.4. Seed health study

Health status of the treated and untreated seeds was done following ISTA rules (ISTA, 1999). In this method 3 layers of blotter were soaked in sterilized water and placed at the bottom of the glass petridish. Then 25 seeds were plated on the blotting paper in a petridish maintaining equal distance and covered with lid. Seeds thus plated were incubated in an air

cooled room at about 20°C temperature for 7 days in Seed Pathology Laboratory, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka. After 7 days of incubation the seeds were observed for the presence of seed-borne *Bipolaris sorokiniana* under stereo binocular microscope following the key of Mathur and Kongsdal (2003). Germination percentage of the seeds were also recorded.

3.2. Field experiment

3.2.1. Experimental site and experimental period

The experiment was conducted at Sher-e-Bangla Agricultural University Farm, Dhaka-1207 during the period December, 2006 to April 2007.

3.2.2. Soil

The soil of the experimental field belongs to the Tejgaon series under the Agro Ecological Zone, Madhupur Tract (AEZ-28) and the general soil type is Shallow, Red Brown, and Terrace Soils.

3.2.3 Climate of experimental site

The experimental area belongs to the subtropical climate was characterized by the high rainfall, high humidity, high temperature, relatively long day during April to September and scanty rainfall, low humidity, low temperature and short day period during October to March. The later period is favorable for wheat cultivation.

3.2.4. Soil properties

The description of the Agro-ecological Zone (UNDP and FAO, 1988) and soil properties of the experimental soil properties of the experimental site was as follows:-

Agro-ecological region: Madhupur Tract (AEZ-28)

Land Type : Medium high land.

General soil type : Non-Calcareous Darkgray floodplain soil

Soil series : Tejgaon

Topography : Up land

Elevation : 8.45

Location : SAU Farm, Dhaka.

Field level : Above flood level

Drainage : Fairly good

Firmness (Consistency) : Compact to friable when dry.

3.2.5. Fertility status of the soil

The soil of experimental site was analyzed in Soil Resource Development Institute (SRDI), Dhaka and found as silty clay with pH 6.0 and the soil contains-

1. Total N (%)	0.078
2. Organic matter (%)	0.88
3. Phosphorus (%)	0.0015
4. Potassium (%)	0.0053
5. Sulphur (%)	0.0017

3.2.6. Treatments

3.2.6.1 Eco-friendly treatments

In this experiment, there were twelve eco-friendly treatments which were as follows:-

T_1= Farmer's saved seed

T_2= Apparently healthy seed

T_3= Farmer's saved seed treated with brine solution

T_4= Apparently healthy seed treated with brine solution

T_5= Sun drying of farmer's saved seed

T_6= Sun drying of apparently healthy seed

T_7= Farmer's saved seed treated with hot water

T_8= Apparently healthy seed treated with hot water

T_9= Polythene solarization of farmer's saved seed

T_{10}= Polythene solarization of apparently healthy seed

T_{11}= Farmer's saved seed + Foliar spraying with boron

T_{12}= Apparently healthy seed + Foliar spraying with boron

3.2.6.2. Fungicidal treatments

In this experiment, there were ten fungicidal treatments which are as follows:-

T_1= Farmer's saved seed

T_2= Apparently healthy seed

T_3= Farmer's saved seed + Foliar spraying of Tilt-250 EC

T_4= Apparently healthy seed + Foliar spraying of Tilt-250 EC

T_5= Farmer's saved seed + Foliar spraying of Proven 250-EC

T_6= Apparently healthy seed + Foliar spraying of Proven 250-EC

T_7= Farmer's saved seed + Foliar spraying of proud 250-EC

T_8= Apparently healthy seed + Foliar spraying of proud 250-EC

T_9= Farmer's saved seed + Foliar spraying of propicon

T_{10}= Apparently healthy seed + Foliar spraying of propicon

3.2.7. Preparation of seed sample for different treatments

For eco-friendly treatments, seed samples were prepared following the methods of Kabir, 2006 as described in laboratory experiments (3.1.3).

Foliar spraying of boron was done @ 500 ppm at tillering stage of the crop. For fungicidal treatments Tilt 250-EC (0.1%), Proud (0.1%), Proven (0.1%), and Propicon (0.1%) was used in this experiment as spraying solution. All sprays solution was sprayed with compressed sprayer. Spraying was done at tillering stage.

3.2.8. Design of experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) comprising three replications for each treatment. The unit plot size was (1m× 1m). Distance between block and between the plots will be 1m and 0.5m, respectively. Thus, there were altogether 36 plots for first experiment (Eco-friendly treatment) and 30 plots for second experiment (fungicidal treatments).

3.2.9. 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.

3.2.10. Application of fertilizers

The field was fertilized at the rate of 220 Kg urea, 180 Kg TSP, 50 Kg MP, 120 Kg Gypsum and 10 tons cow dung per hectare (BARI, Krishi Projucti Handbook, 2000). 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 was applied at 21 days after seed sowing.

3.2.11. Sowing of seeds

Wheat seeds were sown in the field on 6th December 2006 at the rate of 120 kg/ha. The seeds were sown in lines at a depth of 5 cm and covered by soil with the help of hand. The distances between lines were 20 cm in every plot.

3.2.12. Intercultural operation

Irrigation was done once after 25 days and another after 45 days of sowing. Irrigation was generally followed by each weeding of the crops. Weeding was performed twice during the growing period of the crop for better soil aeration and conservation of soil moisture.

3.2.13. Tagging and data collection

Randomly three plants were selected from each row of the plot and tagged. So, 15 plants/plot were tagged for rating and mean valued were determined to get rating score of the material of each treatment.

3.2.14 Evaluation of leaf blight severity

Leaf blight severity of flag leaf and penultimate leaf was recorded in three growth stages of plant viz. flowering stage, milking stage and hard dough stage. The severity of leaf blight was recorded following 0-5 scale (Plate-1) of Hossain and Azad (1992). The grades are given below:-

0= No infection (Highly resistant)
1= Few minute lesions on leaves (Resistant)
2= Black lesion with no distinct chlorotic halos covering ≤10% of the leaf area (Moderately resistant).
3= Typical lesions surrounded by distinct chlorotic halos covering 10-50 % of the leaf area (Moderately susceptible)

4= Severe lesions on leaves with ample necrotic zones drying over part of the leaf, covering ≥50 % of the leaf area (Susceptible).

5= Severe infection, drying of the leaf, spike infected to some extend (Highly susceptible)

0 1 2 3 4 5

Plate 1. Disease severity grades (0-5 scale) of wheat leaves showing leaf spot symptom.

3.2.15. Harvesting

The crop was harvested at full ripening stage on 5th April, 2007.

3.2.16. Isolation and identification of pathogen

The causal organism of leaf blight of wheat was isolated and identified following tissue planting method.

The diseased leaves were collected and were taken to the laboratory. The leaves were then cut into small pieces (about 0.5cm) with healthy and diseased portion and surface sterilized with $HgCl_2$ solution (0.01%) for 30 second. The cut pieces were then washed in sterile water at three times and were placed onto PDA medium in petridish. The plates were then incubated at 25±1°C for 7 days. Later the pathogen was purified using hyphal tip culture method and grown on PDA medium for 2 week and identified as *Bipolaris sorokiniana* (Plate-2 and Plate-3) with the help of relevant literature (CMI Description).

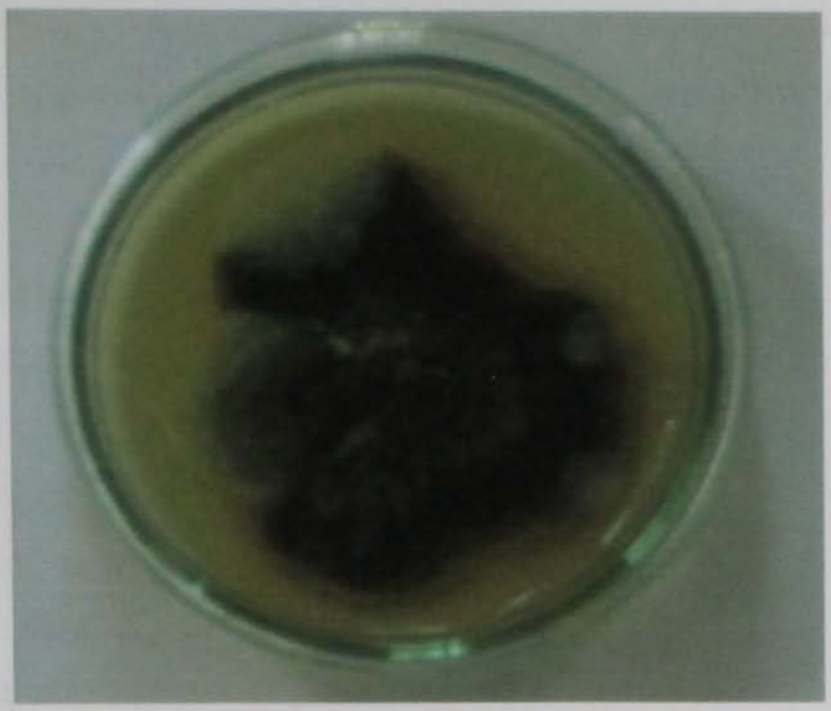


Plate 2: Pure culture of *Bipolaris sorokiniana*

Plate 3. Mycelia and conidia of *Bipolaris sorokiniana* as observed under compound microscope (×100)

3.2.17. Collection of data on yield and yield contributing characters:

Data of plant growth and yield contributing characters was recorded from the randomly selected 15 tagged plants of each unit plot on the following parameters.

i) Plant height (cm)
ii) Length of ear (cm)
iii) Length between the point of flag leaf initiation and base of ear (cm)
iv) Number of spikelets /ear
v) Number of grains/ ear
vi) Number of healthy grains/ ear
vii) Number of diseased grains/ ear
viii) Weight of grains/ ear (g)
ix) Weight of healthy grains/ ear (g)
x) Weight of diseased grains/ ear (g)
xi) 1000 grain weight (g)
xii) Grading of seeds /ear (0-5)
xiii) Grain yield /plot
xiv) Straw yield /plot
xv) Grain yield (t/ha)
xvi) Straw yield (t/ha)

3.2.18. Grading of seeds

The grading of seeds (Plate 4) were done following the 0-5 rating scale of CIMMYT (Gilchrist, 1985). The rating scale is as follows:

0= free from infection

1= only embryo blackish

2= embryo and its adjacent area slightly infected

3= embryo and less then ¼ of grains are discolored

4= embryo and ½ of grain are infected

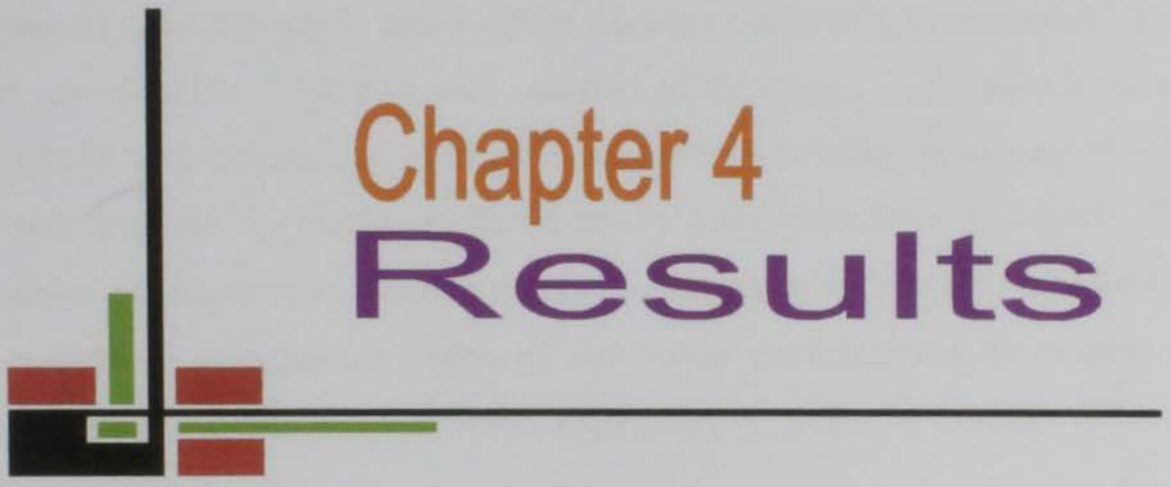
5= grains are shriveled, almost completely discolored or more than ½ of grains were discolored.

3.2.19. Analysis of data

The data on various parameters were analyzed using analysis of variance to find out variation obtained from different treatments. Treatments means were compared by DMRT (Duncan's Multiple Range Test).

0 1 2 3 4 5

Plate 4: Wheat seeds of different grade (0-5)



Chapter 4
Results

4. RESULTS

4.1. Laboratory experiment

4.1.1. Effect of eco-friendly seed treatments on germination of seeds

Significant variations were observed in percentage of seed germination (Table 1). The highest germination (97.33%) was counted in the treatment T_8 (apparently healthy seed treated with hot water) which was statistically similar with T_7 (farmer's saved seed treated with hot water), T_6 (Sun drying of apparently healthy seed) and T_5 (Sun drying of farmer's saved seed). The lowest germination (77.00%) was counted in treatment T_1 (farmer's saved seed) which was statistically similar T_3 (apparently healthy seed treated with brine solution) and T_4 (farmer's saved seed treated with brine solution). The treatments T_2 (apparently healthy seed), T_{10} (apparently healthy seed treated with polythene solarization) showed the better performance in respect of seed germination and they differed significantly from T_1 (farmer's saved seed).

4.1.2. Effect of eco-friendly seed treatments on incidence of *Bipolaris sorokiniana*

Incidence of seed borne *Bipolaris sorokiniana* differed significantly in respect of different eco-friendly seed treatments (Table 1). The highest incidence (27.32%) of *Bipolaris sorokiniana* was recorded under the treatment T_1 (farmer's saved seed) and the lowest incidence (4.82%) was recorded under the treatment T_8 (apparently healthy seed treated with hot water) which was statistically similar with T_7 (farmer's saved seed treated with hot water), T_6 (Sun drying of apparently healthy seed). The treatment T_8 reduced 82.24% incidence of *Bipolaris sorokiniana* over control (T_1).

Table 1. Effect of seed treatments on germination and incidence of *Bipolaris sorokiniana* on wheat seeds by blotter method

Treatments	Germination (%)	*Bipolaris sorokiniana* on seed surface (%)	Decrease (%) of *Bipolaris sorokiniana* over control
T_1	77.00 e	27.32 a	--
T_2	89.00 bc	11.23 c	58.90
T_3	79.33 de	15.07 b	44.84
T_4	80.66 de	10.42 c	61.86
T_5	93.33 ab	6.59 e	75.88
T_6	94.00 ab	5.92 ef	78.33
T_7	96.66 a	5.72 ef	79.06
T_8	97.33 a	4.82 f	82.24
T_9	83.00 c-e	8.72 d	68.09
T_{10}	84.22 cd	7.08 e	74.08
LSD (P=0.05)	6.15	1.55	--

T_1= Farmer's saved seed
T_2= Apparently healthy seed
T_3= Farmer's saved seed treated with brine solution
T_4= Apparently healthy seed treated with brine solution
T_5= Sun drying of farmer's saved seed
T_6= Sun drying of apparently healthy seed
T_7= Farmer's saved seed treated with hot water
T_8= Apparently healthy seed treated with hot water
T_9= Polythene solarization of farmer's saved seed treated
T_{10}= Polythene solarization of apparently healthy seed treated

4.2. Field experiment

4.2.1 Effect of eco-friendly seed treatments on germination, plant growth, leaf blight severity and yield of wheat

4.2.1.1. Effect of eco-friendly seed treatments on germination of wheat

The germination of wheat was recorded at 10 and 15 days after sowing (DAS) in the field. Significant variation was found in percentage of seed germination at 10 DAS and 15 DAS among the treatments (Table 2). The germination percentage varied from 48.00% to 82.67% at 10 DAS and 54.33% to 88.33% at 15 DAS. The highest germination was counted 82.67% and 88.33% at 10 and 15 DAS respectively, under the treatment T_8 (apparently healthy seed treated with hot water) and this was statistically similar to the treatment T_7 (Farmer's saved seed treated with hot water) where germination was counted 79.33% and 85.00% at 10 DAS and 15 DAS, respectively. On the other hand the lowest germination (48.00% and 54.33% at 10 and 15 DAS, respectively) was recorded in the treatment T_1 (farmer's saved seed).

Table 2. Effect of eco-friendly seed treatments on germination of wheat in the field

Treatments	Germination (%)	
	10 DAS	15 DAS
T_1	48.00 f	54.33 e
T_2	66.33 de	76.00 c
T_3	62.33 e	70.67 d
T_4	68.00 cd	77.00 bc
T_5	72.00 bc	76.33 c
T_6	74.00 b	80.67 b
T_7	79.33 a	85.00 a
T_8	82.67a	88.33 a
T_9	67.67 cd	76.33 c
T_{10}	71.67 bc	78.33 bc
LSD (P=0.05)	4.03	3.6

T_1= Farmer's saved seed
T_2= Apparently healthy seed
T_3= Farmer's saved seed treated with brine solution
T_4= Apparently healthy seed treated with brine solution
T_5= Sun drying of farmer's saved seed
T_6= Sun drying of apparently healthy seed
T_7= Farmer's saved seed treated with hot water
T_8= Apparently healthy seed treated with hot water
T_9= Polythene solarization of farmer's saved seed treated
T_{10}= Polythene solarization of apparently healthy seed treated

4.2.1.2. Effect of eco-friendly seed treatments on leaf blight severity of wheat at flowering stage and milking stage

Leaf blight severity at flowering stage and milking stage was recorded on flag leaf and penultimate leaf infection of wheat and was found statistically significant among different treatments (Table 3). In the flowering stage, the lowest disease severities were recorded in the treatment T_8 (apparently healthy seed treated with hot water), which was 0.11 and 0.21 on flag leaf and penultimate leaf, respectively. On the other hand the highest disease severities 0.67 and 1.43 were recorded under the treatment T_1 (farmer's saved seed) on flag leaf and penultimate leaf of wheat, respectively. The average disease severity of flag leaf and penultimate leaf under different treatments at flowering stage ranged from 0.16 to 1.05 where the lowest and highest disease severity was recorded under the treatment T_8 and T_1, respectively. In milking stage, the lowest disease severities on flag leaf (0.12) and penultimate leaf (0.22) were recorded in the treatment T_8 which was statistically similar with T_7. On the other hand the highest disease severities and on flag leaf (0.78) and penultimate leaf (1.77) were obtained under the treatment T_1. The average disease severity at milking stage under different treatments at flowering stage ranged from 0.17 to 1.28 where the lowest and highest disease severity was recorded under the treatment T_8 and T_1, respectively.

Table 3. Effect of eco-friendly seed treatment on leaf blight severity of wheat at flowering and milking stage

Treatments	Disease severity at flowering stage			Disease severity at milking stage		
	Flag leaf	Penultimate leaf	Average	Flag leaf	Penultimate leaf	Average
T_1	0.67 a	1.43 a	1.05 a	0.78 a	1.77 a	1.28 a
T_2	0.18 d-f	0.89 e	0.53 f	0.37 d	0.91 b	0.64 c
T_3	0.42 b	1.19 b	0.80 b	0.51 c	0.74 d	0.63 c
T_4	0.23 cd	1.07 c	0.65 cd	0.21 fg	0.43 g	0.32 g
T_5	0.14 fg	0.27 fg	0.20 g	0.57 c	0.62 e	0.75 b
T_6	0.12 g	0.24 gh	0.18 gh	0.24 f	0.52 f	0.38 f
T_7	0.15 e-g	0.29 fg	0.22 g	0.15 gh	0.24 i	0.20 h
T_8	0.11 g	0.21 h	0.16 h	0.12 h	0.22 i	0.17 h
T_9	0.20 de	1.00 d	0.60 de	0.69 b	0.82 c	0.76 b
T_{10}	0.14 fg	0.30 f	0.22 g	0.28 ef	0.32 h	0.30 g
T_{11}	0.26 c	1.12 c	0.69 c	0.42 d	0.93 b	0.68 c
T_{12}	0.19 d-f	0.97 d	0.58 ef	0.35 de	0.56 f	0.46 e
LSD (P=0.05)	0.05	0.05	0.05	0.075	0.053	0.053

T_1= Farmer's saved seed
T_2= Apparently healthy seed
T_3= Farmer's saved seed treated with brine solution
T_4= Apparently healthy seed treated with brine solution
T_5= Sun drying of farmer's saved seed
T_6= Sun drying of apparently healthy seed
T_7= Farmer's saved seed treated with hot water
T_8= Apparently healthy seed treated with hot water
T_9= Polythene solarization of farmer's saved seed treated
T_{10}= Polythene solarization of apparently healthy seed treated
T_{11}= Farmer's saved seed + Foliar spraying with boron
T_{12}= Apparently healthy seed + Foliar spraying with boron

4.2.1.3. Effect of eco-friendly seed treatments on leaf blight severity of wheat at hard dough stage

Leaf blight severity at hard dough stage was recorded on flag leaf and penultimate leaf of wheat and was found statistically significant effect among different treatments (Table 4). The lowest disease severities were recorded in the treatment T_8 (apparently healthy seed treated with hot water), which was 0.23 and 0.69 on flag leaf and penultimate leaf, respectively and this was statistically similar with T_7 (farmer's saved seed treated with hot water) where disease severities were 0.29 and 0.74 on flag leaf and penultimate leaf respectively. On the other hand the highest disease severities 1.61 and 2.48 were recorded under the treatment T_1 (farmer's saved seed) that was on flag leaf and penultimate of wheat, respectively. The average disease severity at hard dough stage under different treatments ranged from 0.46 to 1.94 where the lowest and highest disease severity were recorded under the treatment T_8 that was statistically similar with T_7 and T_1, respectively.

Table 4. Effect of eco-friendly treatments on leaf blight severity of wheat at hard dough stage

Treatments	Disease severity at hard dough stage		
	Flag leaf	Penultimate leaf	Average
T_1	1.61 a	2.48 a	2.05 a
T_2	0.68 d	1.65 c	1.16 bc
T_3	0.93 c	1.81 b	1.37 b
T_4	0.44 e	0.87 g	0.66 de
T_5	1.21 b	1.01 f	1.11 bc
T_6	0.66 d	1.20 e	0.93 cd
T_7	0.29 fg	0.74 h	0.51 e
T_8	0.23 g	0.69 h	0.46 e
T_9	0.85 c	1.45 d	1.15 cd
T_{10}	0.38 ef	0.95 fg	0.66 ef
T_{11}	0.71 d	1.52 d	1.11 cd
T_{12}	0.62 d	1.28 e	0.95 cd
LSD (P=0.05)	0.092	0.107	0.302

T_1= Farmer's saved seed
T_2= Apparently healthy seed
T_3= Farmer's saved seed treated with brine solution
T_4= Apparently healthy seed treated with brine solution
T_5= Sun drying of farmer's saved seed
T_6= Sun drying of apparently healthy seed
T_7= Farmer's saved seed treated with hot water
T_8= Apparently healthy seed treated with hot water
T_9= Polythene solarization of farmer's saved seed treated
T_{10}= Polythene solarization of apparently healthy seed treated
T_{11}= Farmer's saved seed + Foliar spraying with boron
T_{12}= Apparently healthy seed + Foliar spraying with boron

4.2.1.4 Effect of eco-friendly seed treatment on plant height, ear length, distance between the point of flag leaf initiation and base of ear and no of spikelets/ear of wheat

The effect of eco-friendly seed treatments on plant height, ear length, distance between the point of flag leaf initiation and base of ear and number of spikelets/ear, differed significantly (Table 5). Plant height varied from 78.85 to 89.09 cm where the highest and lowest plant height were recorded under the treatment T_8 and T_1, respectively. The treatments T_6, T_7 and T_8 resulted statistically similar effect regarding plant height. The treatments T_1, T_3, T_9, T_{11}, and T_{12} resulted statistically similar effect regarding plant height.

The ear length under different treatments ranged from 13.63 to 15.98 cm. The highest (15.98 cm) ear length was observed in T_8 which was statistically similar with T_7. The lowest (13.63 cm) ear length was recorded in control plot (T_1) which was statistically similar with T_{11}. Statistically no significant variation was found in T_2, T_3, T_4 and T_{10} regarding ear length. While considering distance between the point of flag leaf initiation and base of ear of wheat, no significant variation was found among the treatments (Table 5). The highest distance between the point of flag leaf initiation and base of ear (14.98 cm) was recorded in the treatment T_8 and the lowest (13.28 cm) was recorded in the treatment T_1 (farmer's saved seed).

The number of spikelets per ear varied from 20.92 to 27.14. The highest numbers of spikelets were observed in T_8 which was statistically similar with T_6, T_7 and T_{10}. The lowest number spikelets was recorded in control plot which was statistically similar with T_3.

Table 5. Effect of eco-friendly seed treatments on plant height, length of ear, distance between the point of flag leaf initiation and base of ear and no of spikelets of ear of wheat

Treatments	Plant height (cm)	Length of ear (cm)	Distance between the point of flag leaf initiation and base of ear (cm)	No. of spikelets/ear
T_1	78.85 c	13.63 f	13.28	20.92 e
T_2	83.25 b	14.74 de	13.45	24.04 c
T_3	80.25 c	14.74 de	13.45	21.21e
T_4	83.78 b	14.76 de	13.67	25.02 bc
T_5	83.36 b	14.99 cd	14.12	21.57 e
T_6	85.03 ab	15.30 bc	14.27	25.92 ab
T_7	84.80 ab	15.62 ab	14.54	26.12 ab
T_8	89.09 a	15.98 a	14.98	27.14 a
T_9	80.64 c	14.74 de	13.78	22.32 de
T_{10}	83.35 b	14.88 c-e	14.13	25.71 ab
T_{11}	79.82 c	13.87 f	13.35	23.41 cd
T_{12}	80.25 c	14.38 e	13.47	24.01 c
LSD (P=0.05)	1.70	0.49	NS	1.51

NS= Non significant

T_1= Farmer's saved seed
T_2= Apparently healthy seed
T_3= Farmer's saved seed treated with brine solution
T_4= Apparently healthy seed treated with brine solution
T_5= Sun drying of farmer's saved seed
T_6= Sun drying of apparently healthy seed
T_7= Farmer's saved seed treated with hot water
T_8= Apparently healthy seed treated with hot water
T_9= Polythene solarization of farmer's saved seed treated
T_{10}= Polythene solarization of apparently healthy seed treated
T_{11}= Farmer's saved seed + Foliar spraying with boron
T_{12}= Apparently healthy seed + Foliar spraying with boron

4.2.1.5. Effect of eco-friendly seed treatments on grain formation and grain weight of wheat

Number of grains/ear, number of healthy grains/ear and number of diseased grains/ear varied significantly in respect of different eco-friendly treatments. (Table 6). Number of grains/ear ranged from 34.04 to 42.60 where the highest and lowest counts were made under the treatments T_8 (42.60) and T_1 (34.04), respectively. The treatments T_2, T_4, T_9 and T_{12} resulted statistically similar effect in producing grains/ear. All the treatments differed significantly from the treatment T_1 (farmer's saved seed) in producing number of grains/ear. The lowest number of healthy grains/ear (31.10) was recorded in the treatment T_1. On the other hand, the highest healthy grains/ear (42.36) was recorded in the treatment T_8 which was statistically similar with T_7 (farmer's saved seed treated with hot water). The highest number diseased grains/ear (3.03) was recorded in the treatment T_1 (farmer's saved seed) and the lowest diseased grains/ear (0.26) was recorded in the treatment T_8. No significant variation among the different treatments was recorded in case of weight of grains/ear. But the lowest weight of grain/ear (1.47 g) was recorded in the treatment T_1. On the other hand the highest weight of grains/ear (1.71 g) was recorded in the treatment T_8. Considering the weight of healthy grains/ear significant variations was recorded among the treatments (Table 6). The lowest weight of healthy grain/ear (1.30 g) was recorded in the treatment T_1 (farmer's saved seed). On the other hand the highest weight of healthy grains/ear (1.70 g) was recorded in the treatment T_8.The highest weight of diseased grains/ear (0.17 g) was recorded in the treatment T_1 which was statistically similar with T_{11} and T_9. On the other hand the lowest weight of diseased grains/ear (0.01 g) was recorded in the

treatment T_8 followed by T_7, T_6, T_5 and T_{10}. From the results it was observed that farmer's saved seed gave the highest weight of diseased grains/ear.

Table 6. Effect of eco-friendly seed treatments on grain formation and grain weight of wheat

Treatments	Number of grains / ear	Number of healthy grains / ear	Number of diseased grains/ ear	Weight of grains/ ear (g)	Weight of healthy grains/ ear (g)	Weight of diseased grains / ear (g)
T_1	34.04 e	31.10 i	3.03 a	1.47	1.30 e	0.17 a
T_2	39.24 bc	38.04 de	1.20 d	1.61	1.56 a-d	0.08 b-d
T_3	35.03 d	33.6 4 h	1.39 c	1.51	1.36 de	0.12 a-c
T_4	38.82 bc	37.64 e	1.18 d	1.63	1.56 a-d	0.08 b-d
T_5	39.92 a-c	38.85 cd	1.07 de	1.66	1.60 a-c	0.06 de
T_6	41.58 ab	40.82 b	0.76 f	1.67	1.64 ab	0.03 de
T_7	42.04 a	41.56 ab	0.47 g	1.68	1.66 ab	0.02de
T_8	42.60 a	42.36 a	0.26 h	1.71	1.70 a	0.01 e
T_9	39.84 bc	38.68 cd	1.14 d	1.53	1.40 c-e	0.13 ab
T_{10}	40.01 a-c	39.00 c	0.98 e	1.65	1.60a-c	0.05 de
T_{11}	36.82 cd	34.80 g	2.02 b	1.59	1.45 b-e	0.14 a
T_{12}	37.84 c	36.63 f	1.19 d	1.64	1.57 a-d	0.07 c-e
LSD(P=0.05)	3.18	0.85	0.13	NS	0.20	0.053

T_1= Farmer's saved seed, T_2= Apparently healthy seed
T_3= Farmer's saved seed treated with brine solution
T_4= Apparently healthy seed treated with brine solution
T_5= Sun drying of farmer's saved seed
T_6= Sun drying of apparently healthy seed
T_7= Farmer's saved seed treated with hot water
T_8= Apparently healthy seed treated with hot water
T_9= Polythene solarization of farmer's saved seed treated
T_{10}= Polythene solarization of apparently healthy seed treated
T_{11}= Farmer's saved seed + Foliar spraying with boron
T_{12}= Apparently healthy seed + Foliar spraying with boron

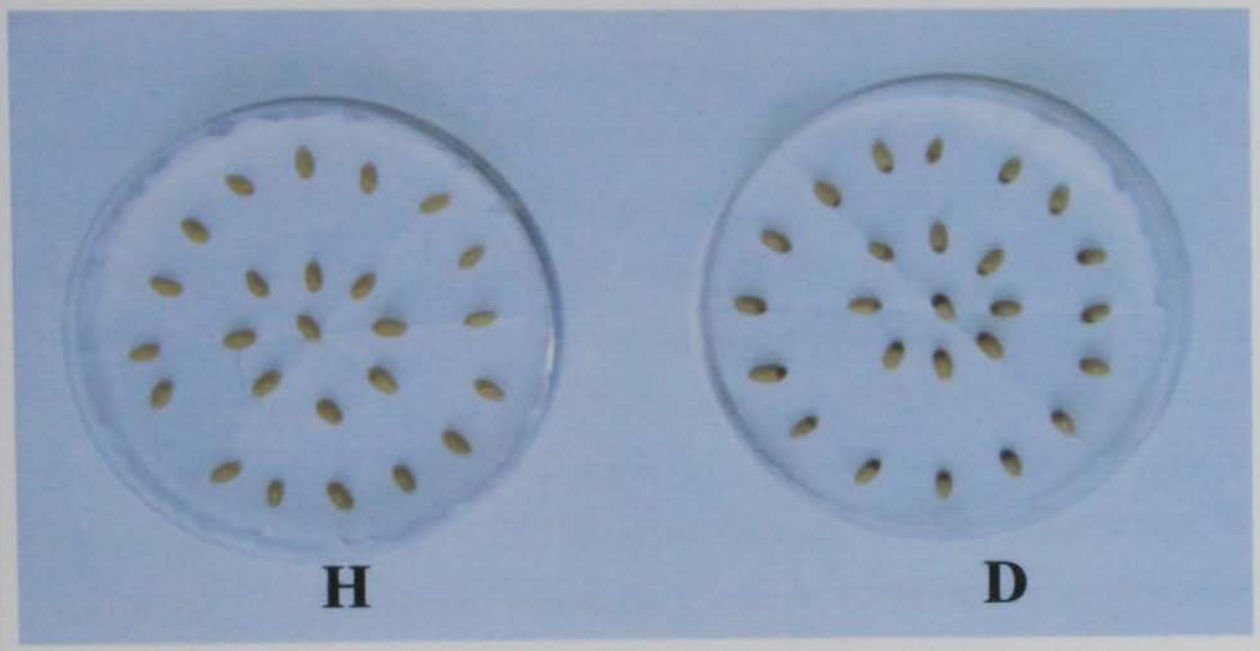


Plate 5. Healthy (H) and diseased seeds (D) of wheat

4.2.1.6. Effect of eco-friendly seed treatment on number of grains/ear of different grades of wheat

The number of grains/ear of different grades varied significantly in respect of eco-friendly seed treatments (Table 7). In case of grade-0 (No infection) the highest counts (42.36) were recorded in the treatment T_8 which was statistically similar with T_7 while the lowest (31.10) were recorded in the treatment T_1. In case of grade-1(Only embryo blackish) the highest (0.82) counts was recorded in the treatment T_1 and the lowest (0.36) was recorded in the treatment T_8 which was followed by T_7. In case of grade-2 grains/ear the highest counts (0.62) were recorded in the treatment T_1 and the lowest (0.08) in T_8 which was statistically similar with T_6, T_7, T_5, T_2, T_4, and T_{10}. Considering grade-3 grains/ear it was found that the highest infected seed (0.39) was recorded in the treatment T_1 and the lowest infected seed (0.01) was recorded in the treatment T_8 which was statistically similar with T_6 and T_7. In grade-4 grains/ear the highest counts (0.27) were recorded in the treatment T_1 which was statistically similar with T_{11} and the lowest (0.00) was recorded in the treatment T_8 which was statistically similar with T_7. In case of grade-5 grains/ear the highest infected seed (0.73) was recorded in the treatment T_1 and the lowest infected seed (0.00) was recorded in the treatment T_8 which was statistically similar with T_7 (Table 7).

4.2.1.7. Effect of eco-friendly seed treatment on 1000- seed weight and yield of wheat

Effect of eco-friendly treatments on 1000-seed weight and yield of wheat cv. Kanchan is presented in Table 8. 1000-seed weight, straw yield and grain yield differed significantly among the treatments. The 1000-seed weight of wheat varied from 32.07 g to 38.07 g. where the highest weight of 1000-

seed (38.07 g) was recorded in the treatment T_8 which was statistically similar with T_7 and T_6. The lowest (32.07 g) weight of 1000- seed was recorded in the treatment T_1 (farmer's stored seed) which was statistically similar with T_3. Straw yield under the treatment varied from 4.65 to 6.40 t/ha. The highest straw yield (6.40 t/ha) was recorded in the treatment T_8 (apparently healthy seed treated with hot water) followed by T_7. On the other hand the lowest straw yield (4.65 t/ha) was recorded in the treatment T_1 followed by T_3.

Grain yield of wheat was varied from 2.21 to 3.85 t/ha. The highest grain yield (3.85 t/ha) was obtained from treatment T_8 followed by T_7. The lowest grain yield (2.21 t/ha) was recorded in the treatment T_1 which was followed by T_{11} (farmer's saved seed + Foliar spraying with boron). Significantly no variation was found regarding yield (t/ha) among the treatments T_3, T_4, T_5 and T_9. All the treatments differed significantly from T_1 (farmer's saved seed) except T_{11} in respect of grain yield (t/ha). The treatment T_8 (apparently healthy seed treated with hot water) resulted 74.21% increased yield over control.

Table 7. Effect of eco-friendly seed treatments on number of grains/ear of different grades of wheat

Treatments	Grading of seeds (0-5 scale)					
	0	1	2	3	4	5
T_1	31.10 i	0.82 a	0.62 a	0.39 a	0.27 a	0.73 a
T_2	38.04 de	0.56 e	0.19 ef	0.16 e	0.14 de	0.32 d
T_3	33.6 4 h	0.72 c	0.52 b	0.30 b	0.18 cd	0.27 d
T_4	37.64 e	0.70 d	0.18 ef	0.24 cd	0.17 cd	0.21 e
T_5	38.85 cd	0.45 f	0.57 ab	0.09 fg	0.07 fg	0.12 fg
T_6	40.82 b	0.42 fg	0.12 f	0.04 gh	0.05 f-h	0.07 gh
T_7	41.56 ab	0.39 gh	0.10 f	0.06 gh	0.03 gh	0.02 hi
T_8	42.36 a	0.36 h	0.08 f	0.01 h	0.00 h	0.00 i
T_9	38.68 cd	0.56 e	0.42 c	0.19 de	0.13 de	0.27 d
T_{10}	39.00 c	0.40 f-h	0.15 ef	0.14 ef	0.09 ef	0.17 ef
T_{11}	34.80 g	0.76 b	0.33 cd	0.26 bc	0.26 ab	0.64 b
T_{12}	36.63 f	0.62 d	0.25 de	0.22 cd	0.21 bc	0.52 c
LSD(P=0.05)	0.85	0.053	0.09	0.053	0.053	0.053

0 = free from infection
1 = only embryo blackish
2 = embryo and its adjacent area slightly infected
3 = embryo and less than ¼ of grains are discolored
4 = embryo and ½ of grains are infected and
5 = grains are shriveled, almost completely discolored or more than ½ of grains discolored.

T_1= Farmer's saved seed
T_2= Apparently healthy seed
T_3= Farmer's saved seed treated with brine solution
T_4= Apparently healthy seed treated with brine solution
T_5= Sun drying of farmer's saved seed
T_6= Sun drying of apparently healthy seed
T_7= Farmer's saved seed treated with hot water
T_8= Apparently healthy seed treated with hot water
T_9= Polythene solarization of farmer's saved seed treated
T_{10}= Polythene solarization of apparently healthy seed treated
T_{11}= Farmer's saved seed + Foliar spraying with boron
T_{12}= Apparently healthy seed + Foliar spraying with boron

Table 8. Effect of eco-friendly treatments on 1000 seed weight and yield of wheat

Treatments	1000-seed weight (g)	Straw yield (g/plot)	Straw yield (t/ha)	Grain yield (g/plot)	Grain yield (t/ha)	% Grain yield increased over control
T_1	32.07 f	465.0 k	4.65 k	221.0 f	2.21 f	--
T_2	35.01 c-e	552.0 h	5.52 h	289.0 e	2.89 e	30.77
T_3	33.52 ef	482.0 j	4.82 j	285.0 e	2.85 e	28.96
T_4	35.27 cd	585.0 e	5.85 e	290.0 e	2.90 e	31.22
T_5	35.81 bc	591.0 de	5.91 de	317.0 d	3.17 d	43.43
T_6	36.91 ab	609.0 c	6.09 c	343.0 c	3.43 c	55.20
T_7	37.12 ab	621.0 b	6.21 b	362.0 b	3.62 b	63.80
T_8	38.07 a	640.0 a	6.40 a	385.0 a	3.85 a	74.21
T_9	34.12 de	562.0 g	5.62 g	300.0 de	3.00 de	35.74
T_{10}	36.13 bc	599.0 d	5.99 d	309.0 d	3.09 d	39.82
T_{11}	34.66 c-e	592.0 i	4.92 i	233.0 f	2.33 f	5.43
T_{12}	35.23 cd	572.0 f	5.72 f	317.0 d	3.17 d	43.43
LSD (P=0.05)	1.49	9.53	0.09	17.01	0.169	-

T_1= Farmer's saved seed, T_2= Apparently healthy seed
T_3= Farmer's saved seed treated with brine solution
T_4= Apparently healthy seed treated with brine solution
T_5= Sun drying of farmer's saved seed
T_6= Sun drying of apparently healthy seed
T_7= Farmer's saved seed treated with hot water
T_8= Apparently healthy seed treated with hot water
T_9= Polythene solarization of farmer's saved seed treated
T_{10}= Polythene solarization of apparently healthy seed treated
T_{11}= Farmer's saved seed + Foliar spraying with boron
T_{12}= Apparently healthy seed + Foliar spraying with boron

4.2.2. Effect of foliar spraying with fungicides on leaf blight severity and yield of wheat.

4.2.2.1 Effect of foliar spraying with fungicides on leaf blight severity of wheat at flowering stage and milking stage

Leaf blight severity at flowering stage and milking stage recorded on flag leaf and penultimate leaf of wheat and significant variation was found under different treatments (Table 9). In case of flowering stage, the lowest disease severity (0.05) on flag leaf was recorded in the treatment T_4 (apparently healthy seed + Foliar spraying of Tilt-250 EC) which was statistically similar with T_3 (Farmer's saved seed + Foliar spraying of Tilt-250 EC) and T_8 (Apparently healthy seed + Foliar spraying of proud 250-EC). The lowest disease severity (0.12) on penultimate leaf was recorded in the treatment T_4. On the other hand the highest disease severities (0.67 and 1.43) were obtained under the treatment T_1 (farmer's stored seed) that was on flag leaf and penultimate leaf of wheat, respectively. In case of milking stage, the lowest disease severity on flag leaf (0.09) was recorded in the treatment T_4 which was statistically similar with T_3 and T_8 and the lowest disease severity (0.14) on penultimate was recorded in the treatment T_4 which was statistically similar with T_3. On the other hand the highest disease severities (0.78 and 1.77) were obtained under the treatment T_1 on flag leaf and penultimate leaf of wheat, respectively. The average disease severity at flowering stage under different treatments ranged from 0.08 to 1.05 where the lowest and highest disease severity was recorded under the treatment T_4 and T_1, respectively. The average disease severity at milking stage under different treatments ranged from 0.11 to 1.28 where the lowest and highest disease severity was recorded under the treatment T_4 and T_1, respectively.

Table 9. Effect of foliar spraying with fungicides on leaf blight severity of wheat at flowering and milking stage

Treatments	Disease severity at flowering stage			Disease severity at milking stage		
	Flag leaf	Penultimate leaf	Average	Flag leaf	Penultimate leaf	Average
T_1	0.67a	1.43 a	1.05 a	0.78 a	1.77 a	1.28 a
T_2	0.18 bc	0.89 e	0.54 c	0.37 b	0.91 b	0.64 b
T_3	0.07 ef	0.14 g	0.10 f	0.10 ef	0.17de	0.13 g
T_4	0.05 f	0.12 h	0.08 g	0.09 f	0.14 e	0.11 h
T_5	0.14 b-d	0.90 de	0.52 cd	0.21 c	0.27 c	0.24 cd
T_6	0.12 de	0.91 cd	0.51 d	0.19 cd	0.26 c	0.22 d
T_7	0.13 cd	0.92 c	0.52 cd	0.20 cd	0.26 c	0.22 d
T_8	0.07 ef	0.17 f	0.12 ef	0.13 ef	0.20 d	0.16 f
T_9	0.19 b	0.95 b	0.57 b	0.22 c	0.27 c	0.24 c
T_{10}	0.09 d-f	0.18 f	0.13e	0.15 de	0.22cd	0.18 e
LSD (P=0.05)	0.05	0.017	0.017	0.05	0.05	0.017

T_1= Farmer's saved seed

T_2= Apparently healthy seed

T_3= Farmer's saved seed + Foliar spraying of Tilt-250 EC

T_4= Apparently healthy seed + Foliar spraying of Tilt-250 EC

T_5= Farmer's saved seed + Foliar spraying of Proven 250-EC

T_6= Apparently healthy seed + Foliar spraying of Proven 250-EC

T_7= Farmer's saved seed + Foliar spraying of Proud 250-EC

T_8= Apparently healthy seed + Foliar spraying of Proud 250-EC

T_9= Farmer's saved seed + Foliar spraying of Propicon

T_{10}= Apparently healthy seed + Foliar spraying of Propicon

4.2.2.2. Effect of foliar spraying with fungicides on leaf blight severity at hard dough stage

Effect of foliar spraying with different fungicides on leaf blight severity at hard dough stage recorded on flag leaf and penultimate leaf of wheat and was found to differ significantly (Table 10). The lowest disease severity (0.21) on flag leaf was recorded in the treatment T_4. The lowest disease severity on penultimate leaf was also recorded in the treatment T_4 which was statistically similar with T_3, T_8, T_7, T_5, T_6 and T_{10}. On the other hand the highest disease severities (1.61 and 2.49) were obtained under the treatment T_1 that was on flag leaf and penultimate leaf of wheat, respectively. The average disease severity at hard dough stage under different treatments ranged from 0.44 to 2.05 where the lowest disease severity was recorded under the treatment T_4 that was statistically similar with T_3, T_7, and T_8. On the other hand, the highest average disease severity was recorded under the treatment T_1.

Table 10. Effect of foliar spraying with fungicides on leaf blight severity of wheat at hard dough stage

Treatments	Disease severity at hard dough stage		
	Flag leaf	Penultimate leaf	Average
T_1	1.61 a	2.49 a	2.05 a
T_2	0.68 b	1.65 b	1.16 b
T_3	0.24 h	0.69 d	0.46 f
T_4	0.21 i	0.67 d	0.44 f
T_5	0.37 e	0.82 cd	0.59 de
T_6	0.34 f	0.79 cd	0.56 e
T_7	0.26 g	0.73 cd	0.49 f
T_8	0.25 gh	0.72 cd	0.48 f
T_9	0.42 c	0.90 c	0.66 c
T_{10}	0.39 d	0.86 cd	0.62 cd
LSD(P=0.05)	0.017	0.17	0.05

T_1= Farmer's saved seed

T_2= Apparently healthy seed

T_3= Farmer's saved seed + Foliar spraying of Tilt-250 EC

T_4= Apparently healthy seed + Foliar spraying of Tilt-250 EC

T_5= Farmer's saved seed + Foliar spraying of Proven 250-EC

T_6= Apparently healthy seed + Foliar spraying of Proven 250-EC

T_7= Farmer's saved seed + Foliar spraying of Proud 250-EC

T_8= Apparently healthy seed + Foliar spraying of Proud 250-EC

T_9= Farmer's saved seed + Foliar spraying of Propicon

T_{10}= Apparently healthy seed + Foliar spraying of Propicon

4.2.2.3. Effect of foliar spraying with fungicides on plant growth and spikelet formation of wheat

Plant height, ear length and number of spikelets/ear were found to differ significantly under different treatments. (Table 11). Plant height varied from 78.85 to 88.27 cm. The highest plant height (88.27cm) was recorded under the treatment T_4 treatment which was statistically similar to the treatment T_3 and T_8. On the other hand the lowest plant height (78.85 cm) was recorded in the treatment T_1 which was statistically similar to the treatment T_9 (farmer's saved seed + Foliar spraying of propicon).

The ear length under different treatments ranged from 13.63 to 15.78 cm. The highest ear length was observed in T_4 which was statistically similar with T_3. The lowest ear length was recorded in control plot (T_1) which was statistically similar with T_9.

Considering distance between the point of flag leaf initiation and base of ear of wheat, the different treatments did not differ significantly (Table 11). The highest distance between the point of flag leaf initiation and base of ear (14.75 cm) was recorded in the treatment T_4 and lowest distance between the point of flag leaf initiation and base of ear (13.29 cm) was recorded in the treatment T_1 (farmer's saved seed).

The number of spikelets per ear varied from 20.93 to 27.92. The highest numbers of spikelets per ear were observed in T_4 which was statistically similar with T_3 and T_8. The lowest number spikelets recorded in control plot (T_1) which was statistically similar with T_7 (Farmer's saved seed + Foliar spraying of proud 250-EC) and T_9 (Farmer's saved seed + Foliar spraying of propicon).

Table 11. Effect of foliar spraying with fungicides on plant height, length of ear, distance between the point of flag leaf initiation and base of ear and no of spikelets per ear of wheat

Treatments	Plant height (cm)	Length of ear (cm)	Distance between the point of flag leaf initiation and base of ear (cm)	No. of spikelets/ear
T_1	78.85 f	13.63 e	13.29	20.93 e
T_2	83.25 c-e	14.74 b-d	13.45	24.04 b-d
T_3	87.95 a	15.64 ab	14.27	26.31ab
T_4	88.27 a	15.78 a	14.75	27.92 a
T_5	83.72 b-d	14.93 a-d	13.99	23.57 cd
T_6	84.35 b-d	14.96 a-c	14.13	25.12 bc
T_7	85.45 bc	14.81 a-d	13.68	22.02 de
T_8	85.92 ab	14.88 a-d	13.52	25.85 a-c
T_9	81.10 ef	13.97 de	13.37	21.62 de
T_{10}	82.02 de	14.57 cd	13.78	24.92 bc
LSD (P=0.05)	1.49	0.87	NS	2.28

NS= Non Significant

T_1= Farmer's saved seed
T_2= Apparently healthy seed
T_3= Farmer's saved seed + Foliar spraying of Tilt-250 EC
T_4= Apparently healthy seed + Foliar spraying of Tilt-250 EC
T_5= Farmer's saved seed + Foliar spraying of Proven 250-EC
T_6= Apparently healthy seed + Foliar spraying of Proven 250-EC
T_7= Farmer's saved seed + Foliar spraying of Proud 250-EC
T_8= Apparently healthy seed + Foliar spraying of Proud 250-EC
T_9= Farmer's saved seed + Foliar spraying of Propicon
T_{10}= Apparently healthy seed + Foliar spraying of Propicon

4.2.2.4. Effect of foliar spraying with fungicides on grain formation and grain weight of wheat

Number of grains/ear, number of healthy grains/ear and number of diseased grains/ear varied significantly in respect of different fungicidal treatment. (Table 12). Number of grains/ear ranged from 34.04 to 41.60 where the highest and lowest counts were made under the treatments T_8 (41.60) and T_1 (34.04) respectively. The treatments T_3, T_6, and T_8 resulted statistically similar effect in producing grains/ear. All the treatments differed significantly from the treatment T_1 in producing number of grains/ear. The lowest number of healthy grains/ear (31.10) was recorded in the treatment T_1 On the other hand, the highest numbers of healthy grains/ear (41.32) was recorded in the treatment T_4 which was statistically similar with T_2, T_3, T_6, T_8, T_9 and T_{10}. The highest number of diseased grains/ear (3.03) was recorded in the treatment T_1 and the lowest number of diseased grains/ear (0.28) was recorded in the treatment T_4. No significant variation among the different treatments was recorded in case of weight of grains/ear. But the lowest weight of grain/ear (1.47 g) was recorded in the treatment T_1 and the highest weight of grains/ear (1.72 g) was recorded in the treatment T_4. Considering the weight of healthy grains/ear significant variations was recorded among the treatments (Table 12). The lowest weight of healthy grains/ear (1.30 g) was recorded in the treatment T_1 and the highest weight of healthy grains/ear (1.70 g) was recorded in the treatment T_4 which was statistically similar with T_3, T_5, T_6, T_7, T_8 and T_{10}. The highest weight of diseased grains/ear (0.17 g) was recorded in the treatment T_1. On the other hand the lowest weight of diseased grains/ear (0.02 g) was recorded in the treatment T_8 that was closely followed by T_8 and T_6

Table 12. Effect of foliar spraying with fungicides on grain formation and grain weight of wheat

Treatments	Number of grains / ear	Number of healthy grains / ear	Number of diseased grains/ ear	Weight of grains/ ear (g)	Weight of healthy grains/ ear (g)	Weight of diseased grains / ear (g)
T_1	34.04 e	31.1 c	3.03 a	1.47	1.30 d	0.17 a
T_2	39.24 bc	38.04 ab	1.20 c	1.64	1.56 b	0.08 b
T_3	40.75 ab	40.25 ab	0.51 f	1.69	1.65 a-c	0.04 cd
T_4	41.60 a	41.32 a	0.28 g	1.72	1.70 a	0.02 e
T_5	37.83 d	36.22 b	1.61 b	1.67	1.62 a-c	0.05 c
T_6	40.31ab	40.34 ab	0.97 de	1.71	1.68 ab	0.03 de
T_7	36.77 d	35.68 bc	1.09 cd	1.66	1.59 a-c	0.07 b
T_8	40.34ab	39.52 ab	0.82 e	1.68	1.65 a-c	0.03 de
T_9	37.87 bc	36.63 ab	1.24 c	1.60	1.52 c	0.08 b
T_{10}	38.62 c	37.82ab	0.80 ef	1.68	1.63 a-c	0.05 c
LSD(P=0.05)	1.52	5.08	0.18	NS	0.12	0.017

NS= Non Significant

T_1= Farmer's saved seed

T_2= Apparently healthy seed

T_3= Farmer's saved seed + Foliar spraying of Tilt-250 EC

T_4= Apparently healthy seed + Foliar spraying of Tilt-250 EC

T_5= Farmer's saved seed + Foliar spraying of Proven 250-EC

T_6= Apparently healthy seed + Foliar spraying of Proven 250-EC

T_7= Farmer's saved seed + Foliar spraying of Proud 250-EC

T_8= Apparently healthy seed + Foliar spraying of Proud 250-EC

T_9= Farmer's saved seed + Foliar spraying of Propicon

T_{10}= Apparently healthy seed + Foliar spraying of Propicon

4.2.2.5. Effect of foliar spraying with fungicides on number of grains/ear of different grades of wheat

The effect of foliar spraying with fungicides on number of grains/ear under different grades (0-5 grade) of wheat was found to differ significantly and is shown in Table 13. In case of grade-0 the highest no. of seeds (41.32) were recorded in the treatment T_4 which was statistically similar with T_2, T_3, T_6, T_8, T_9 and T_{10}.The lowest no. of grade-0 seeds (31.10) were recorded in the treatment T_1 which was statistically similar with T_7. In case of grade-1 the highest no. seeds (0.83) were recorded in the treatment T_1 and the lowest (0.22) was recorded in the treatment T_4 which was closely followed by T_3. In case of grade-2 grains/ear the highest counts (0.62) were recorded in the treatment T_1 and the lowest (0.02) in T_4. Considering grade-3 grains/ear it was found that the highest infected seed (0.40) was recorded in the treatment T_1 and the lowest (0.01) in T_4. In grade-4 grains/ear the highest counts (0.28) were made in the treatment T_1 and the lowest (0.03) in T_4 which was statistically similar with T_3. In case of grade-5 grains/ear the highest infected seed (0.73) was recorded in the treatment T_1. The lowest infected seed (0.00) was recorded in the treatment T_4.

Table 13. Effect of foliar spraying with fungicides on number of grains/ear of different grades of wheat

Treatments	Grading of seeds (0-5 scale)					
	0	1	2	3	4	5
T_1	31.10 c	0.83 a	0.62 a	0.40 a	0.28 a	0.73 a
T_2	38.04 ab	0.56 b	0.19 cd	0.16 c	014 d	0.32 b
T_3	40.25 ab	0.26 gh	0.08 f	0.03 f	0.04 fg	0.03 g
T_4	41.32 a	0.22 h	0.02 g	0.01 g	0.03 g	0.00 h
T_5	36.22 b	0.45 de	0.27 b	0.13 d	0.013 d	0.16 d
T_6	40.34 ab	0.43 e	0.14 de	0.06 e	0.10 e	0.09 e
T_7	35.68 bc	0.34 f	0.13 ef	0.06 e	0.06 f	0.06 f
T_8	39.52 ab	0.29 fg	0.11 ef	0.05 e	0.05 f	0.04 g
T_9	36.63 ab	0.52 bc	0.23 bc	0.19 b	0.18 b	0.32 b
T_{10}	37.82ab	0.49 cd	0.19 cd	0.15 c	0.16 c	0.23 c
LSD(P=0.05)	5.08	0.05	0.05	0.017	0.017	0.017

0 = free from infection
1 = only embryo blackish
2 = embryo and its adjacent area slightly infected
3 = embryo and less than ¼ of grains are discolored
4 = embryo and ½ of grains are infected and
5 = grains are shriveled, almost completely discolored or more than ½ of grains discolored.

T_1= Farmer's saved seed
T_2= Apparently healthy seed
T_3= Farmer's saved seed + Foliar spraying of Tilt-250 EC
T_4= Apparently healthy seed + Foliar spraying of Tilt-250 EC
T_5= Farmer's saved seed + Foliar spraying of Proven 250-EC
T_6= Apparently healthy seed + Foliar spraying of Proven 250-EC
T_7= Farmer's saved seed + Foliar spraying of Proud 250-EC
T_8= Apparently healthy seed + Foliar spraying of Proud 250-EC
T_9= Farmer's saved seed + Foliar spraying of Propicon
T_{10}= Apparently healthy seed + Foliar spraying of Propicon

4.2.2.6. Effect of foliar spraying with fungicides on 1000- seed weight and yield of wheat

Effect of foliar spraying with fungicides on 1000-seed weight and yield of wheat cv. Kanchan is presented in Table 14. 1000-seed weight differed significantly among the treatments. The 1000-seed weight of wheat varied from 32.08 g to 38.12 g. where the highest weight of 1000- seed (38.12 g) was recorded in the treatment T_4 which was statistically similar with T_3 and T_8.The lowest weight of 1000- seed (32.08 g) was recorded in the treatment T_1.

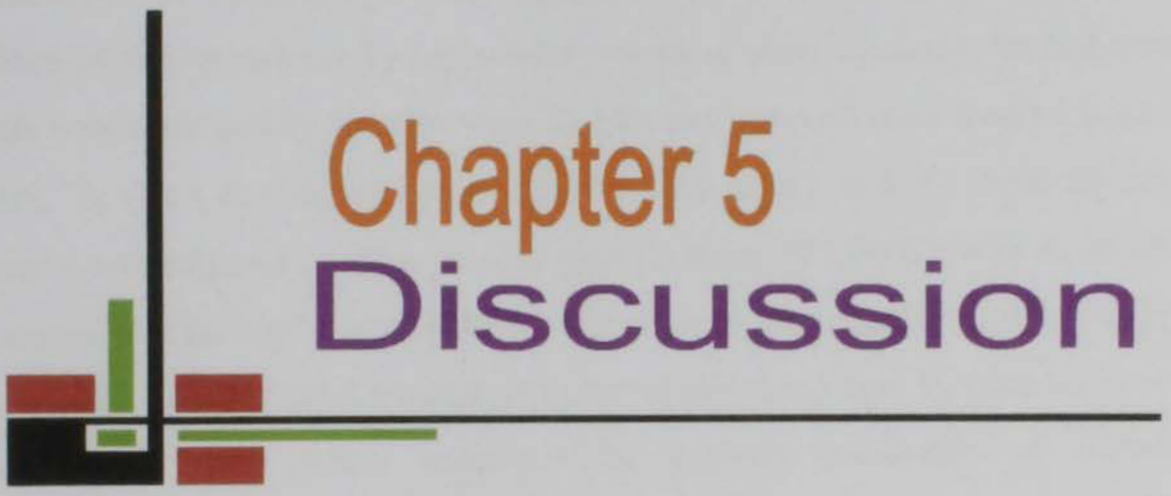
Considering the straw yield of wheat a significant variation was recorded among the treatments (Table 14). Straw yield under the treatments varied from 4.65 to 6.42 t/ha where the highest straw yield (6.42 t/ha) was recorded in the treatment T_4 which was statistically similar with T_3 and the lowest straw yield (4.65 t/ha) was recorded in the treatment T_1 (farmer's saved seed).

A significant variation was recorded in grain yield of wheat under the different treatments (Table 14). Grain yield of wheat varied from 2.21 to 4.02 t/ha. The highest grain yield (4.02 t/ha) was found in treatment the T_4 followed by T_3 (3.27 t/ha). The lowest grain yield (2.21 t/ha) was recorded in the treatment T_1 (farmer's saved seed). All the treatments differed significantly from T_1 in respect of grain yield (t/ha). The treatment T_4 (apparently healthy seed + Foliar spraying of Tilt-250 EC) resulted 81.90% increased grain yield over control.

Table 14. Effect of foliar spraying with fungicides on 1000 seed weight and yield of wheat

Treatments	1000- seed weight (g)	Straw yield (g/plot)	Straw yield (t/ha)	Grain yield (g/plot)	Grain yield (t/ha)	% Grain yield increased over control
T_1	32.08 e	465.0 f	4.65 f	221.0 i	2.21 i	-
T_2	35.01 cd	552.0 e	5.52 e	289.0 e	2.89 e	30.77
T_3	37.13 ab	623.0 ab	6.23 ab	372.0 b	3.72 b	68.32
T_4	38.12 a	642.0 a	6.42 a	402.0 a	4.02 a	81.90
T_5	33.96 d	598.0 cd	5.98 cd	273.0 f	2.73 f	23.52
T_6	34.05 d	607.0 b-d	6.07 b-d	292.0 e	2.92 e	32.12
T_7	36.07 bc	601.0cd	6.01 cd	301.0 d	3.01 d	36.19
T_8	37.07 ab	611.0 bc	6.11 bc	337.0 c	3.37 c	52.49
T_9	35.41 cd	587.0 d	5.87 d	232.0 h	2.32 h	4.98
T_{10}	35.90 bc	593.0 cd	5.93 cd	252.0 g	2.52 g	14.02
LSD (P=0.05)	1.49	19.23	0.19	7.63	0.076	-

T_1= Farmer's saved seed
T_2= Apparently healthy seed
T_3= Farmer's saved seed + Foliar spraying of Tilt-250 EC
T_4= Apparently healthy seed + Foliar spraying of Tilt-250 EC
T_5= Farmer's saved seed + Foliar spraying of Proven 250-EC
T_6= Apparently healthy seed + Foliar spraying of Proven 250-EC
T_7= Farmer's saved seed + Foliar spraying of Proud 250-EC
T_8= Apparently healthy seed + Foliar spraying of Proud 250-EC
T_9= Farmer's saved seed + Foliar spraying of Propicon
T_{10}= Apparently healthy seed + Foliar spraying of Propicon



Chapter 5
Discussion

5. DISCUSSION

5.1 Effect of eco-friendly seed treatment on germination, leaf blight severity and yield of wheat

Different methods of eco-friendly seed treatment differed significantly in respect of seed germination and incidence of seed borne *Bipolaris sorokiniana* in laboratory. The highest seed germination (97.33%) was counted in the treatment T_8 (apparently healthy seed treated with hot water) which was statistically similar with T_7 (farmer's saved seed treated with hot water), T_6 (Sun drying of apparently healthy seed) and T_5 (Sun drying of farmer's saved seed). The lowest germination (77.00%) was counted in treatment T_1 (farmer's saved seed) which was statistically similar with T_3 (apparently healthy seed treated with brine solution) and T_4 (farmer's saved seed treated with brine solution).The highest incidence of *Bipolaris sorokiniana* was recorded under the treatment T_1 and the lowest incidence (4.82%) was recorded under the treatment T_8 which was statistically similar with T_7 and T_6. The treatment T_8 reduced 82.24% incidence of *Bipolaris sorokiniana* over control (T_1). The findings of the present study corroborates with the findings of Hasan (2000). In a similar type of experiment with rice, he found the highest incidence (3.5%) of *Bipolaris oryzae* was found in discolored and diseased seeds. These findings are also supported by Zobaer (2006). He recorded highest seed germination and lowest incidence of *Bipolaris sorokiniana* in apparently healthy seed treated with vitvax-200 followed by sun drying of apparently healthy seed and apparently healthy seed treated with hot water.

The highest germination in the field of 82.67% and 88.33% at 10 and 15 DAS, respectively was counted in the treatment T_8 which was statistically similar to the treatment T_7 (Farmer's saved seed treated with hot water) where germination was counted 79.33% and 85.00% at 10 DAS and 15 DAS, respectively. On the other hand the lowest germination (48.00% and 54.33% at 10 and 15 DAS, respectively) was recorded in the treatment T_1 (farmer's saved seed). From this result it was observed that farmer's saved seed have the lowest germination ability, this might be happened due to lack of proper storage facilities, germination inhibitory fungi or other microorganisms. On the other hand physically treated seeds gave the highest germination percentage, which was the result of destroying germination inhibitory fungus or other microorganisms. Sun drying of apparently healthy seed (T_6) and apparently healthy seed treated with polythene solarization (T_{10}) also gave the higher germination percentage at 10 DAS and 15 DAS. The findings of the present study corroborates with the study of Fakir and Jahan (1998), Nega *et al.* (2000) and Uddin (2005). Fakir and Jahan (1998) reported solar heat treatment increased 9.0% seed germination. Hot water treatment of wheat seeds at 50°C for 5 minutes resulted 72.22% and 62.59% seed germination at 10 and 15 DAS, respectively that was statistically similar with T_7 (Farmer's saved seed treated with hot water). These findings is similar with Nega *et al.* (2000) who stated that seed borne pathogens could be reduced without significant losses of germination by hot water treatments at 50°C for 20 to 30 min up to 53°C for 10 to 30 min.

Regarding the leaf blight severity of wheat it was found that at the onset of infection and preliminary disease development was more or less similar for all the treatments but in different growth stages the disease severity appeared

to be distinct in comparison to control. It has been found that the farmer's saved seed always resulted highest disease severity at flowering (1.05%), milking (1.28%) and hard dough (1.94%) stage, whereas the treatment T_8 (apparently healthy seed treated with hot water) resulted minimum disease severity at all growth stages and it was closely followed by T_7 (farmer's saved seed treated with hot water). The findings of the present study corroborates with the study of William Nesmith (2003) who found that hot water treatment was effective against the major seed borne diseases of vegetables. He found effective temperature of 122°F (49.95°C) for 25 min for brussels sprouts, cabbage, eggplant. tomato and spinach. The findings of the present study also corroborates with the study of Khaleduzzaman (1996) who studied hot water treatment of wheat seeds at 49°C, 52°C, 55°C and 61° C for 5 and 10 min in controlling seed borne infection and observed that 52°C-55°C for 10 min gave highest control of *Alternaria tenuis*, *Aspergillus flavus*, *Bipolaris sorokiniana, Curvularia lunata*, *Fusarium* spp. and *Penicillium* spp. and increased seed germination.

It was found that sun dried of physically sorted seeds also reduced the leaf blight severity at all growth stages of wheat. The possible explanation of decrease of this *Bipolaris sorokiniana* may be due to the seeds dried for long time, firstly the temperature acted upon primarily on the fungal propagules lying on the surface of the seeds as contaminants and with the increasing of temperature it penetrated within the seed and killed the fungal parts embedded deeper and dipper in the seeds. So the present findings showed that growth of seed borne fungus *Bipolaris sorokiniana* significantly inhibited by solar heat treatment. These results closely agreed with the report of Fakir and Jahan (1998), Mohinder *et al.* (1994) and Guldhe *et al.* (1985).

According to Fakir and Jahan (1998), solar heat was most effective against major seed-borne pathogens of jute and reduced 91.3% seed infection. It has been reported that solar heats completely eradicate the loose smut pathogens of wheat (Guldhe *et al.*, 1985; Mohinder *et al.*, 1994).

It also found that apparently healthy seeds also reduced the leaf blight severity in flowering (0.53), milking (0.64) and hard dough (1.16) stage in comparison to control. The findings are in agreement with Hossain and Asad-ud-Doullah (1998), who found cleaning and seed washing of farmer's saved seed reduced the seedling disease and increased yield up to 53.87% and 14.77%, respectively over the unclean farmer's saved seed.

The result showed that the minimum plant height was found in the treatment T_1 (78.85cm) and the highest plant height was found in the treatment T_8 (89.09 cm) and it was closely followed by treatment T_6, and T_7. In case of ear length, the minimum value was found in the treatment T_1 (13.63 cm) and the highest ear length was found in the treatment T_8 which was closely followed by T_7. It also observed that the treatment T_8 (apparently healthy seed treated with hot water) resulted the highest number of grains/ear (42.60) and healthy grains/ear (42.36) and the lowest diseased grains/ear (0.26) which was closely followed by T_7 (farmer's saved seed treated with hot water), T_6 (Sun drying of apparently healthy) and T_5 (Sun drying of farmer's saved seed). Farmer's saved seed always resulted significantly lowest number of grains/ear (34.04), healthy grains/ear (31.10) and the highest diseased grains/ear (3.03). Zobaer (2006) reported that seed treated with hot water produced the highest number of healthy grain and lowest number of diseased grain.

Regarding wheat seed yield, significant increase in grain yield was obtained in all the treatments over control. The highest grain yield (3.85 t/ha) was recorded in the treatment T_8 followed by T_7. The lowest yield (2.21 t/ha) was recorded in the treatment T_1 (farmer's saved seed). It was observed that grain yield was increased at 5.43%, 28.96%, 30.77%, 31.22%, 35.74%, 39.82%, 43.43%, and 55.20% for the treatments T_{11}, T_3, T_2, T_4, T_9, T_{10}, T_5, and T_6, respectively. Zobaer (2006) reported that apparently healthy seed treated with hot water and sun drying increased seed yield by 28.70%, 31.01%, respectively over farmer's saved seed of wheat. Kabir (2006) reported that apparently healthy seed and apparently healthy seed treated with brine solution increased seed yield 50.00% over control (farmer's saved seed).

5.2. Effect of foliar spraying with fungicides on leaf blight severity and yield of wheat

The effect of different foliar fungicides differed significantly in case of leaf blight severity and yield of wheat. The disease severity was recorded in three different growth stages viz. flowering stage, milking and hard dough stage. Significantly the highest disease severities (1.05% at flowering stage, 1.28% at milking stage and 2.04% at hard dough stage) were recorded in the control plot (T_1). The lowest disease severities 0.08% at flowering stage, 0.11% at milking stage and 0.44% at hard dough stage) were recorded in treatment T_4 (Apparently healthy seed + Foliar spraying of Tilt-250 EC) which was closely followed by T_3(Farmer's saved seed + Foliar spraying of Tilt-250 EC) and T_8 (Apparently healthy seed + Foliar spraying of Proud 250-EC). The findings of the present study supported by a good number of researcher(

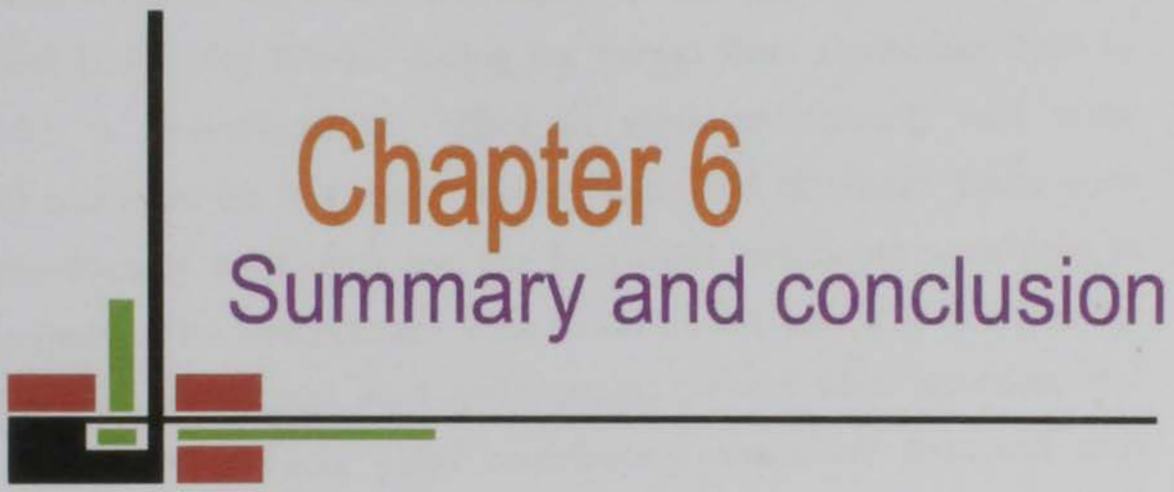
Peltonen and Karjslsinen, 1992; Mondal *et al.* (1994) and Alam *et al.*, 1995). Tilt-250 EC (0.1%) was used by the researchers of Bangladesh Agricultural Institute (BARI) for controlling leaf blight of wheat (Anonymous, 1989). They reported that Tilt-250 EC was highly effective to reduce the disease incidence. The disease severity was also reduced significantly by Tilt-250 EC, when sprayed @ 0.04% (Alam *et al.* 1995). In the field experiment by many researchers, it was found that application of Tilt-250 EC to wheat significantly decreased the pathogen population and percent blighted area, compared to unsprayed plot. (Alikeeva *et al.*1990; Patil *et al.* 2002; Sharma-Poudyal *et al.* 2005; Zamal, 2006 and Shahidullah, 2006).

The highest plant height (88.27 cm), ear length (15.78 cm), distance between the point of flag leaf initiation and base of ear (14.75 cm) and number of spikelets of ear (27.92) were recorded in treatment T_4 (Apparently healthy seed + Foliar spraying of Tilt-250 EC) which was closely followed by T_3(Farmer's saved seed + Foliar spraying of Tilt-250 EC) and T_8 (Apparently healthy seed + Foliar spraying of Proud 250-EC). Many workers found that Tilt-250 EC was effective in decreasing disease severity and increasing N_2 uptake efficiency as well as protein quality resulting in positive effect in vegetative growth such as stem elongation increases the tiller number per plant (Barshehak *et al.* 1991; Peltonen and Karjslsinen, 1992 and Wildermuth *et al.* 1992). The effect of fungicides on yield performance has been found that treatments different significantly from one after another. Number of grains/ear ranged from 34.04 to 41.60 where the highest and lowest counts were made under the treatments T_8 (41.60) and T_1 (34.04) respectively. The lowest number of healthy grains/ear (31.10) was recorded in the treatment T_1 and the highest numbers of healthy grains/ear

(41.32) was recorded in the treatment T_4 which was statistically similar with T_2, T_3, T_6, T_8, T_9 and T_{10}. The highest number of diseased grains/ear (3.03) was recorded in the treatment T_1 and the lowest diseased grains/ear (0.28) was recorded in the treatment T_4. No significant variation among the different treatments was recorded in case of weight of grains/ear. The lowest weight of grain/ear (1.47 g), healthy grain/ear (1.30 g) and the highest weight of diseased grains/ear (0.17 g) were recorded in the treatment T_1. On the other hand the highest weight of grains/ear (1.72 g), weight of healthy grains/ear (1.70 g) and the lowest weight of diseased grains/ear (0.02 g) were recorded in the treatment T_4 which was closely followed by T_3 and T_8. The findings of the present study corroborates with the study of Zamal (2006) who reported that spray of Tilt-250 EC on wheat increased the grain formation and grain weight of wheat. Shahidullah (2006) reported that foliar spraying with Tilt-250 EC resulted the highest spike length, number of seed/spike and the lowest number of black pointed seed.

The foliar spraying with Tilt-250 EC revealed profound effect on the straw yield and grain yield of wheat. The yield of wheat profoundly varied from one treatment to another, ranging from 2.21 to 4.02 t/ha where the highest grain yield (4.02 t/ha) was observed in T_4 and the lowest yield (2.21 t/ha) was recorded under T_1. The T_4 treatment resulted 81.90% increased grain yield over control. The second highest yield (3.72 t/ha) was observed in T_3, which was 68.32% higher over control. The findings of the present study corroborates with the study of Patil *et al.* (2002) who reported that he incidence of leaf blight disease of wheat was not observed in plant sprayed with 0.1% Propiconazole (Tilt) and increased the yield and biomass. Sharma-Poudyal *et al.* (2005) reported that the highest increase in grain

yield over the control due to Tilt-250 EC 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. Shahidullah (2006) reported that Tilt-250 EC appeared most effective against the leaf blight disease of wheat reduced PDI value of 72% and increased more than 108% grain yield over control. Zamal (2006) reported that Tilt-250 EC reduced leaf blight severity of wheat and increased seed yield 32.14% over control (farmer's saved seed).



Chapter 6
Summary and conclusion

6. SUMMARY AND CONCLUSION

Wheat (*Triticum aestivum* L.) is the second most important cereal crop in Bangladesh. Wheat plant suffers from many diseases of which leaf blight disease is a common and devastating disease of wheat considering grain quality and grain yield.

The present research work was conducted in the farm of Sher-e-Bangla Agricultural University Dhaka, during the period from December 2006 to April 2007, to investigate the effect of some eco-friendly and some fungicidal treatment on leaf blight severity and yield of wheat. There were twelve eco-friendly treatments and ten fungicidal treatments were used in this experiment. The observations were made on the effect of eco-friendly seed treatments on percent seed germination, percent seed infection, leaf blight severity, seed yield, yield contributing characters thousand seed weight and fungicidal treatment on percent seed infection, leaf blight severity, seed yield, yield contributing characters and thousand seed weight.

Under *in vitro* test the highest germination (97.33%) and lowest seed infection (4.82%) by *Bipolaris sorokiniana* were recorded in T_8 (apparently healthy seed treated with hot water) which was statistically similar with T_7 (farmer's saved seed treated with hot water), T_6 (Sun drying of apparently healthy seed) and T_5 (Sun drying of farmer's saved seed). The lowest germination and highest seed infection (4.82%) by *Bipolaris sorokiniana* were recorded in T_1.

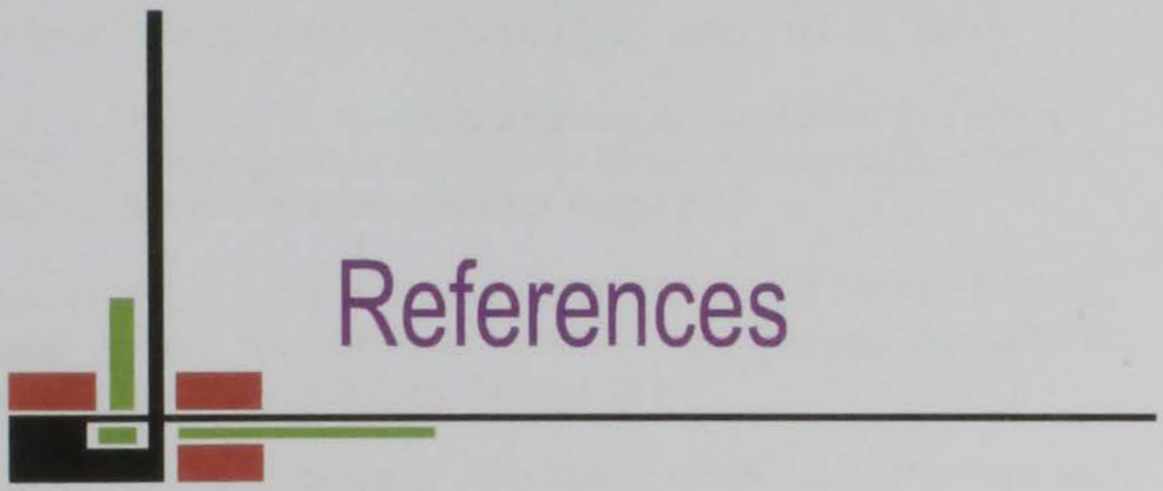
In case of eco-friendly management, the lowest leaf infection was observed in hot water treated seed (T_8) which was followed by sun drying (T_6), polythene solarized seeds (T_{10}) and apparently healthy seed (T_2). The highest percent leaf infection was recorded in control treatment. All the eco-friendly treatments under this experiment were also differed significantly on seed yield in comparison to control. The seed yield was recorded highest in hot water treated seed (T_8) which was followed by sun drying (T_6), polythene solarized seed (T_{10}) and apparently healthy seed (T_2). The lowest seed yield was recorded in control treatment (T_2).

In case of fungicidal management, maximum plant height, distance between flag leaf tip and base of ear, number of spikelets/ear were recorded under the treatment T_4 (Apparently healthy seed + Foliar spraying of Tilt-250 EC) followed by T_3 (Farmer's saved seed + Foliar spraying of Tilt-250 EC) and T_8 (apparently healthy seed + Foliar spraying of Proud 250-EC). All the fungicidal treatment varied significantly in terms of grain yield and straw yield. Maximum grain yield (4.02 t/ha), which was 81.90% increased over control was recorded under the treatment T_4. The treatment T_8 (apparently healthy seed + Foliar spraying of Proud 250-EC) also gave the better performance in terms of grain yield (3.37 t/ha) which was 52.49 % increased over control.

Considering the overall performances of eco-friendly treatments in controlling leaf blight of wheat, hot water treatment at 50°C for 5 minutes was found best followed by other treatments. Hot water treatment not only reduced the seed borne infections and increased germination of seeds, it also decreased leaf blight severity and increased seed yield. From the results it

also observed that solar heat treatment of apparently healthy seed for 14 hours gave control of leaf blight disease and increase seed yield. Uses of apparently healthy seed performed better than farmer's saved seed (untreated control). The rest of the treatments have some remarkable effect in controlling the disease. Among the fungicidal treatments, apparently healthy seed+ foliar spraying of Tilt-250 EC was found best followed by other treatments. From the results it also observed that farmer's saved seed +foliar spraying of Tilt-250 EC, apparently healthy seed + foliar spraying of proud-250 gave control of leaf blight disease and increase seed yield. Uses of apparently healthy seed performed better than untreated control.

On the basis of the present findings, it may be concluded that hot water treated seeds (50°C for 5 minutes) revealed to be effective for controlling leaf blight of wheat among the eco-friendly treatment employed in the experiment. It also observed that uses of sun dried seed (for 14 hours), polythene solarized seed (for 14 hours) and apparently seed reduced leaf blight severity and increase seed yield. Among the fungicidal treatment foliar spraying with Tilt 250 EC revealed to be effective for controlling leaf blight of wheat followed by Proud-250 EC. So, further study is needed in different AEZ with more eco-friendly options and fungicides to find out their fitness.



References

7. REFERENCES

Ahmed, F., Khan, M. and Islam,R. (2007). Assesment of yield loss of wheat. Annual Research Report (2006-2007), BARI, RARS, Jessore. P. 57

Alam, K.B. and Shah, N. K. (1991). *Helminthosporium* leaf blight of wheat-a new problem in Bangladesh. CIMMYT Regional Workshop on *Helminthosporium* Leaf Blight. Dec. 2-3, Kathmandu, Nepal.12 p.

Alam, K.B., Malakar, R.K., Shasheed, M.A., ahmed, M.U., Ahmed, F. and Haque, M.S. (1995). Yield loss assessment of wheat due to *Bipolaris* leaf blight in Bangladesh. Bangladesh J. Pl. path. 11(1-2): 35-37.

Alekeeva, T. P., Pavlova, T. V. and Izmalkova, A. G. (1990). The effect of Tilt-250 EC on population structure of brown rust pathogen of wheat. Zashchita-Restenii-Moskva.1990.No. 9.pp.18-19.

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

Annonymus. (1993). Assessment of yield loss of wheat due to Bipolaris leaf blight at farmer's field. Annual Report, 1992-93, BARI, Gazipur. 46p.

BARI, (1992). Assessment of yield loss of wheat due to foliar pathogen. Ann. Rept. 1992-1993, BARI, Gazipur.p.16.

BARI, (Bangladesh Agricultural Research Institute). (2000). Krishi Projucti Handbook, 10p.

Barshehak, T., Korts, M., Barszezak, T. and Kore, M. (1991). Yield of spring wheat treated with Tilt-250 EC fungicide depending on rates, dates and methods of urea application: Izvestiya Timcryazevskoi-scl.Skokhozyais tyennoi-Akademii (Poland) No.4.186, 11 ref.

BBS (Bangladesh Bureau of Statistics). (2005). Monthly statistical bulletin, Bangladesh. Statistics Division. Ministry of Planning. Government of the Peoples republic of Bangladesh. Dhaka. pp.57.

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

Duveiller, E. and Gilchirst, L. (1994). Production constraints due to *Bipolaris sorokiniana* in wheat: Current situation and prospects. Wheat in heat stressed environments: Irrigated, dry areas and rice wheat farming systems, Mexico, DF(Mexico). CIMMYT p.343-352.

Fakir, G.A. and Jahan, R. (1998). Control of major seed borne fungal pathogens of Jute. First National Workshop on Seed Pathology, Progress and Prospect of Seed Pathological Research in Bangladesh. Organized by Danish Govt. Institute of seed Pathology, Denmark and SPL, Dept. of Plant Pathology, BAU, Mymensingh. Held on 6-9 June, 1998. 18p.

Fakir, G.A. (1999). An Annotated list of seed borne disease in Bangladesh. Seed Pathology Laboratory, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh. 52p.

Fakir, G.A., Hossain, I. and Ahmad, M.U. (2000). Quality of farmer's saved rice seed in Bogra, Rajshahi and Rangpur sites of Bangladesh. Paper presented in the review and planning workshop on rice seed health improvement for increasing yield and reducing pest pressure in Bangladesh, held on 25-26 Nov.2000. Dhaka.

FAO. (2005). Production Yearbook. Food and Agriculture Organization of the United Nations, Italy, Rome, 73p.

Gilchrist, L. I. (1985). CIMMYT Methods for screening wheat for *Helminthosporium sativum* Resistance. In: wheat for more tropical environment-A proceedings of the international symposium Sept. 24-28. 1984. Mexico, D. F. Sponsored by: The united Nations Development Programme and CIMMYT. 149-151pp.

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.

Guldhe, S.M., Raut, J.G. and Qangikar, P.D. (1985). Control of loose smut prevalence in wheat by physical and chemical methods of seed treatment. PVK Res. J. 9(1):56-58.

Gworgwor-NA, Huda-AI and Joshua-SD. (2002). Seed treatment of sorghum varieties with brine (NaCl) solution for control of *Striga hermonthica* in sorghum. Crop-Protection. 21: 10, 1005-1021.

Haque, M. (1997). Control of major seed-borne fungi of chilli. M.S. Thesis, Dept. of Plant Pathology. Bangladesh Agricultural University, Mymensingh, Bangladesh. P.53.

Hasan, M. M. (2000). Effect of seed cleaning and washing on germination, disease incidence and yield of rice BR-11 (Mukta) M. S. Thesis, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh.

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

Hossain, I., Ashrafuzzaman, H. and Khan, M. H. H. (1993). Bio-control of *Rhizoctonia solani.* Bangladesh Agricultural University Research. Progress. 7:264-269.

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. and Asad-ud-Doullah, M. (1998). Pilot projects Research. Paper presented at the DGISP Workshop ii "Future Strategies for research, Training and Development of Seed Pathology in Bangladesh" held on 10 December 1998 at BARC, Dhaka, 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. Bangladesh, 1p.

ISTA. (1999). International rules for Seed Testing. Seed Science and Technology, 27, Supplement, 333p.

Jahiruddin, M. (1991). Status of leaf blight of wheat in Bangladesh. Proc. BAU, Res. Prog.5:209-213.

Jahan, R. 1996. Fungi associated with seeds and their control. M.S. Thesis. Dept. of Plant Pathology. Bangladesh Agricultural University, Mymensingh, Bangladesh. P. 106.

Jiskani, M.M. 2002. Effect of hot water treatment on brown spot of rice caused by *Bipolaris oryzae*. Indian Journal of Plant Pathology. 3(1): 56-58.

Khaleduzzaman, M. 1996. Control of seed borne infection by seed treatment in wheat. MS thesis, Department of Plant Pathology. Bangladesh Agricultural University. Mymensingh, Bangladesh, p45.

Kabir, M. S. (1997). Integrated control of leaf blight of wheat caused by *Bipolaris sorokiniana*. MS thesis, Department of Plant Pathology. Bangladesh Agricultural University, Mymensingh, Bangladesh. P 52.

Kabir, M.H. (2006). Effect of physical and chemical seed treatments on leaf spot (*Bipolaris sorokiniana*) and grain yield of wheat. M.S. thesis. Department of plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. P. 45

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.

Karunaratne, A.M. (1999). A Preliminary investigation on the response of some locally popular vegetables to post harvest hot water treatment. Ceylon Journal of science. 27(1): 62-67.

Katyal, J.C. and D.K. Friensen, (1987). Deficiency of micronutrients and sulphur in wheat production constraints in tropical environment. Preoc. 11th Conf. held chiang Mai, Thailand, January 19-23, 1987. Sponsered by UNDP and CIMMYT, edited by A.R. Klatt.

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

Mahfuzul, H. (1997). Control of major Seed-borne fungi of chilli (*Capsicum annum* L.). M.S. Thesis. Department of Plant Pathology. Bangladesh Agricultural University, Mymensingh, Bangladesh. 12p.

Malaker, P.K. , N.K. Saha, M.M. Rahman, A.B.S., Hossain, M.I. Haq. And K.H. Kabir. (1994). Yield loss assessment of wheat due to *Helminthosporium* leaf blight of farmer's field. Bangladesh J. Scientific and Industrial research. 29(4): 49-57.

Mathur, S.B. and Kongsdal O. (2003). Common laboratory seed health testing methods for detecting fungi. International seed testing association, Denmark. 3rd edition, 47p.

Mehta, Y. R. (1997). Integrated management of spot blotch of wheat-the state of art. Paper presented in the Golden Jubilee International Conference on Integrated Plant Disease Management for Sustainable Agriculture. Nov. 10-15, 1997. New Delhi, India. 94 p.

Meyer, L. (1990). On the occurrence of *Bipolaris sorokiniana* (sacc.) subram. Et. Jain as a foot rot pathogen in winter wheat. Archiv-fur-phytopathologic and pflanzenschutz. 26(2):125-130.

Mia, M.A.T., Rahman, A.J.M.M. and Islam, M.K. (2000). Evaluation of cleaning methods to improve the quality of farmer's saved rice seed. Bangladesh J. Plant Pathol. 16 (1&2): 39-42.

Mohinder, S., Hooda, K.S. and Singh, M. (1994). Physio-chemical treatment of loose smut of wheat caused by *Ustilago tritici* (Pers.). Rostrup. Annals of Biology Ludhina. 19(1): 66-68.

Mondal, N. A., Assaduzzaman, S. M., Malaker, 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.

Muniz, M.F.B (2001). Control of microorganisms associated with tomato seed using thermotherapy. Phytopathology.23(1): 123-125.

Nega, E., Ulrich, R., Werner, S. And Jalin, M. (2000). Effect of hot water treatment against seed-borne pathogens on vegetables seeds. Indian Phytopathology. 53(6): 177-184.

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 diseases, yield and quality of spring wheat in Finland. Plant disease. 41(3): 477-478.

Rahman, M. A. (1998). Study on the effect of seed treatments and foliar spray in controlling Bipolaris leaf blight of wheat. MS Thesis. Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Rahman, M. A., Rashid, A. Q. M. B. and Islam, M. A. (1999). Effect of seed treatment and foliar spray on the yield of wheat as affected by *Bipolaris* leaf blight. *Bangladesh J. of Pl. Path.***15** (1-2):17-19.

Rahman, A. J. Islam, M. M., Mia, T. (2000). Evaluation of cleaning methods to improve the quality of farmers' saved rice seed. Bangladesh J. Plant Pathology. 16 (1-2): 39-42.

Rahman, M. A., Rashid, A. Q. M. R. and Islam, M. A. (2001). Control of *Bipolaris* leaf blight of wheat through seed dressing chemical. Seed Res. **29**(1):121-123.

Rashid, A. Q. M. B.; Kakoli-Sarker 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.

Razzaque, M.A. and Hossain, A.B.S. (1991). The wheat development Programme in Bangladesh. "Wheat for the nontraditional warm areas" edited by D.A. Saunders. Proc. Intl. Conf. held in July 29 to Aug. 3, 1990 in Foz dolguacu Brazil CIMMYT. Pp.44-54.

Sadek, E.L. Addel, G.T. and Abdel, A.H.A. (2001). Occurrence of bacterial leaf spot disease on greenhouse grown paper in EL-Minie, Egpt. Assint. J. of Agril. Sci.,35(5)57-69.

Sarri, E. E. and Wilcoxon, R. D. (1974). Plant disease situation of high yielding dwarf wheat in Asia and Africa. Annual Rev. Phytopathol. 12: 49-68.

Satvinder and Kahur, S. (2000). Use of physical methods to manage plant disease. Plant disease Research. 15(2): 191-195.

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

Sharma-Poudyal, D., Duveiller, E. Sharma, R. C. (2005). Effects of seed treatment and foliar fungicides on *Helminthosporium* leaf blight and on performance of wheat in warmer growing conditions. Journal of Phytopathology 153. (7-8), 401–408.

Singh, R. V., Singh, A. K., Singh, D., Singh, S. P. and Chowudhary, V. P. (1995). Management of foliar blight of wheat through chemicals. Indian J. Mycol. Pl. Path. 25: (1 and 2):113.

Uddin, M. J. (2005). Effect of seed treatment on disease incidence of lentil. M. S. Thesis, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh. 45-54pp.

Wildermuth, G. B., Mcnamara, R. B. and Tinline, R. D. (1992). Assessment of yield loss caused by common rot in wheat cultivar in Queensland (*B. sorokiniana*). *Australian J. of Agril. Res.* (Australia) **43** (1): 43-58.

William Nesmith. (2003). Seed Treatments for Commercial Vegetablse in Kentucky State University. Actaphytophylacica Sinica. 22 (1): 67-69.

Winter, W., Banziger, I., Krebs, H., Ruegger, A., Frel, P. And Giandrat, D. (2001). Warm water treatment of wheat seeds. Warmwanerbehandlung von weizensaal-gut, Agrar-forschung. 1 (11-12).492-495.

Yahiya, G. (1995). Effect of copper, boron and molybdenum on leaf spot disease of wheat and its yield. M.S. Thesis. Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh. P34.

Zamal, M.S. (2006). Efficacy of some selected fungicides in controlling leaf spot (*Bipolaris sorokininana*) of wheat. M.S. Thesis. Department of plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. P 46.

Zobaer, A.S.M. (2006). Effect of manual seed sorting, seed solarization and seed treatment with vitavax-200 and hot water on leaf spot (*Bipolaris sorokininana*) and grain yield of wheat. M.S. Thesis. Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. P. 53.

8. APPENDICES

Appendix I. Monthly average of Temperature, Relative humidity, Total Rainfall and Sunshine hour of the experimental site during the period from November 2006 to April 2007

Year	Month	Air temperature (^{0}c)			Relative humidity (%)	Rain fall (mm)	Sun shine (hr)
		Maximum	Minimum	Mean			
2006	November	29.0	19.1	24.05	68.5	0.0	230.7
	December	26.5	16.5	21.5	70.5	0.0	213.5
2007	January	24.9	13.2	19.05	67.5	3.0	192.5
	February	28.1	17.8	22.95	61.5	4.0	220.3
	March	32.5	22.6	27.55	66.6	0155	214.5
	April	34.5	24.8	29.65	67.5	0091	251.8

Source: Bangladesh Meteorological Department (Climate division), Agargoan, Dhaka-1212.