EFFICACY OF SELECTED FUNGICIDES IN CONTROLLING SHEATH BLIGHT (*Rhizoctonia solani*) DISEASE OF RICE

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CERTIFICATE

This is to certify that the thesis entitled "**EFFICACY OF SELECTED FUNGICIDES IN CONTROLLING SHEATH BLIGHT (*Rhizoctonia solani*) DISEASE OF RICE**" 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 results of a piece of bona fide research work carried out by **MD. HOMAYON KABIR, REGISTRATION NO. 27563 / 00725,** under my supervision and guidance. No part of this thesis has been submitted for any other degree in any other institutions.

I further certify that any help or sources of information received during the course of this investigation have been duly acknowledged.

Dated: 30.12.2007

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Dedicated to

My

Heavenly Mother

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ABSTRACT

Effect of ten selected treatments viz. T_1 (Control), T_2 (Knowin 50 WP), T_3 (Score 250 EC), T_4 (Controll 5 EC), T_5 (Proud 25 EC), T_6 (Tilt 250 EC), T_7 (Folicur 250 EW), T_8 (Sunvit 50 WP), T_9 (Cupravit 50 WP) and T_{10} (Bordeaux mixture) were studied on sheath blight of rice BRRI 40 during Aman season in the Farm of Sher-e-Bangla Agricultural University, Dhaka. The lowest number of sheath blight infected tillers/hill was observed in T_6 (Tilt 250 EC) where the highest number was found in control (T_1). The highest percentage of relative lesion height (%RLH) was observed in Control (T_1) and lowest was found in T_6 (Tilt 250 EC) plot. All the chemicals significantly reduced percentage of sheath area diseased over control except Bordeaux mixture.The highest lesion height/sheath was obtained from the treatment T_1 (Control) under field condition and the lowest was found in T_6 (Tilt 250 EC) plot. All the treatments influenced yield contributing parameters of rice. The treatment T_6 (Tilt 250 EC) resulted 6.07 t/ha grain yield which was 61.86% increased over untreated control. Tilt 250 EC is the best fungicide.

Chapter 1
Introduction

1. INTRODUCTION

Rice (Oryza sativa L.) ranks to the top position among the cereal crops in Bangladesh. It is the staple food for about 125 million people of Bangladesh. It provides about 71% of the total calories and 51% of the total protein in a typical diet in Bangladesh (Anon. 1998). Total Agriculture in Bangladesh is characterized by intensive crop production with the rice based cropping system. Rice covers more than 10 million hectare of cropped area covering 80% arable land and accounts for 95% food grain production (BBS 1998).The average of rice yield is 3.45 tons ha-1(FAO, 2005), which is relatively lower than those of other rice producing countries of the world.

There are so many constraints responsible for lower yield of rice in Bangladesh. Among them, disease is considered to be the most important one. There are 36 fungal, 21 viral, 6 bacterial and 6 nemic diseases are recorded in rice (Ou 1985). Among fungal diseases, sheath blight (Rhizoctonia solani) is one of the most important disease of rice in most of the tropical and sub-tropical countries of the world (Ou 1985). It is an increasing problem for rice cultivation in Bangladesh especially in Aus and T. Aman seasons (Miah *et. al.* 1985).

Sheath blight affects filling of the grains and emergence of panicles. Under field condition the disease can cause yield losses of as high as 32% especially in the modern cultivars (Ou and Bandong, 1976; Shahjahan *et al.* 1986), where as Rush and Lee (1992) reported that yield losses can reach 50% when the infection is widely distributed.

No cultivars or genotypes have so far been found to posses resistance to sheath blight disease (Sharma et al. 1985; Ou. 1985). Therefore, emphasis should be paid on other management options. Control of sheath blight by fungicides has been attempted for many years in different countries of the world.

Present disease management practices concentrate on foliar fungicides, rotation and manipulation. However, cultural manipulations (Shahjahan et. al. 1990) crop rotation (Damicone et al. 1993) and biological control schemes (Sneh et al. 1996) appear to be limited effect. To date breeding for sheath blight disease resistance is not very successful due to lack of sources of immunity or of high level of resistance (Rao 1995, Hashiba and Kobayashi 1996).

Globally, chemical control represents the most significant practice to reduce yield loss caused by Sheath blight (Sarkar et. al. 1991, Acharya et. al. 1997, Tiwari 1997; Rajiv Kumar and Lakpale 1997). In Bangladesh , Propiconazole (Tilt 250 EC) and Bavistin are being used. However, their efficacy appeared to be poor and highly variable from one geographic location to another and profitability has always been questionable.

Thus, on the basis of above facts, thoughts and views the present study has been aimed to achieve the following objectives:

1. To evaluate the efficacy of selected fungicides against sheath blight of Rice.
2. To determine the efficacy of fungicides on yield of rice.

Chapter 2

Review of literature

2. REVIEW OF LITERATURE

Sheath blight (*Rhizoctionia solani*) is a world wide important disease of rice. Many workers and researchers have been trying to control sheath blight of rice with different tactics. For better and precise presentation only the related literatures are presented here.

2.1 Occurrence

The occurrence of sheath blight in rice caused by *Rhizoctonia solani* Kuhn was first reported by Miyake (1960) in Japan and subsequently it's occurrence in rice has been reported from almost all rice growing countries of the world in Asia, Africa and the Americas (Kozaka, 1975; Ou, 1985; Shahjahan *et al.* 1986).

Rice sheath blight disease caused by the fungus *Thanatephorus cucumeris* (Frank) Donk (=*Rhizoctonia solani* Kuhn) was first reported in Bangladesh by Talukdar in 1968. Later on, Miah (1973) confirmed its occurrence and reported that the incidence of the disease was increasing in Bangladesh. With the intensification of rice cultivation, it has now become a major disease of rice in the country.

2.2 Symptoms

Singh *et al.* (1988) reported that the pathogen normally attacked the leaf sheath and leaf blade but the symptoms were also found on emerging panicles which were chaffy, grayish brown and matted together by fungal mycelium, numerous white and brown sclerotia were found on diseased panicles.

Rush and Lee (1992) reported that the symptoms of sheath blight do not appear until plants are in the late tillering or early internodes elongation growth stages. Initial symptoms consist of circular, oblong or ellipsoid, green-gray water-soaked spots about 1 cm long that occur on the leaf sheaths near the waterline. The lesions enlarge to approximately 2-3 cm in length and 1 cm in width, and the centers of the lesions become pale green or white and are surrounded by an irregular purple-brown border. Under favorable conditions i.e., 1)low sunlight, 2)humidity near 95% and 3) high temperature (28-32^{0}C), infection spreads rapidly by means of runner hyphae to upper plant parts of the plant. Lesions on the upper portion of plants may coalesce to encompass entire leaf sheaths and stems. Sclerotia are produced superficially on or near infected tissue. Heavily infected plants produce poorly filled grains, particularly in the lower portion of the panicle. Additional losses in yield result from increased lodging or reduced ratoon production as result of death of Culm.

Ranaswami and Mahadevan (1999) reported that the pathogen causes spots or lesions mostly on the leaf sheath, extending to the leaf blades under favorable conditions. At first, the spots are greenish grey, ellipsoid or ovoid, and about 1 cm long. They enlarges and may reach 2 or 3 cm in length and become grayish white centre and brown margins and somewhat irregular in outline. In the advanced stages brown sclerotia are formed, which are easily detached from these spots. Under humid conditions, the fungal mycelium spreads to other leaf sheaths and blades. Eventually, the whole sheath rots and the affected leaf can easily be pulled of from the plant. In severe cases all the leaves of a plant are blight, the disease severity and yield losses were significantly higher when inoculated at booting stage than when inoculated at other stages reported by Miah *et al.* (1984).

Suparyono and Nuryanto (1991) observed the severity of sheath blight and its effect on rice yield depended on the rice variety and the host growth stage at which plants were inoculated. Disease development was greatest when plants at maximum tillering and primordial stages were inoculated with the fungus of *R. solani*. Disease severity of the early maturing varieties was less when plants were inoculated at the later stage, although disease severity was affected less by the later plant growth stage on the long duration rice varieties. Yields of both early and long duration varieties were significantly reduced by the disease when the plants were inoculated at the maximum tillering and primordial plant growth stages. Yield reduction decreased when plants of the early maturing varieties were inoculated at the later stage, although the reduction of the yield loss was smaller on the long duration varieties.

Sharma and Teng (1996) reported that two rice cultivars IR42 and IR72 were inoculated with *Rhizoctonia solani*. Disease development was found to be higher at later growth stages. Disease progress was faster at flowering and booting stages than at tillering and panicle initiation stages in both cultivars. The percent productive tillers, grain weight per plants, filled grain number per panicle, 1000-grain weight, filled grain percent and total biomass per plant were usually higher at early stages of inoculation and lower at booting and flowering stages of inoculation. The disease development was also higher at later growth stages and consequently the yield parameters also declined. The yield losses at different stages of inoculation ranged from 23.01%-32.15% and 13.53%-34.83% in IR42 and IR72 respectively. The yield losses were high in flowering stage in both the cultivars than the other three stages.

2.3 Control of sheath blight

2.3.1 Chemical control

Kannaiyan and Prased (1979) reported the systemic fungicide Benlate to be the best fungicide in inhibiting the fungal growth, which was followed by Hinosan and Brassicol. Behara *et. al*. (1982) evaluated eight fungicides in vitro against sheath blight pathogen of rice and concluded that only Bavistin (Carbendazim) and Benlate (Benomyl) were effective. Jones *et. al*. (1987) reported that 21 isolates of *R. solani* were sensitive to Benomyl and propicanazole (Tilt) in vitro.

Herman *et al*. (1984) conducted greenhouse and field tests against rice sheath blight caused by *Rhizoctonia solani* and showed that all three fungicides reduced the incidence of infection and subsequently increased the yield of rice. In most tests, Rovral (iprodione) and Folicur gave better control than Validamycin.

Arunyanart *et al*. (1986) tested 13 fungicides for sheath blight control. Where pencycuron 25% WP, validamycin 3% liquid, carbendazim (Bavistin) 60% WP, and propiconazole (Tilt) 25% EC were most effective.

Dev and Mary (1986) tested seven fungicides to control sheath blight of rice. All the fungicides checked sheath blight intensity. Validamycin and carbendazim performed similarly and significantly better than other fungicides.

The most effective fungicides against *Thanatephorus cucumeris* were Pencycuron 25% WP, Jingunmycin 5% liquid, Validamycin 3% liquid, Carbendazim 60% WP, and Mepronil 75% WP (Arunyanart *et al*., 1986).

Jones *et al*. (1987) reported that propiconazole (Tilt) applied twice or propiconazole (Tilt) followed by benomyl significantly reduced disease severity and increased yield. An economic return from propiconazole (Tilt) could be anticipated when >5% diseased tillers were observed at the panicle differentiation growth stage.

Torabi and Binesh (1987) reported that Iprodione+Carbendazim, Tilt and Validamycin effectively decreased disease incidence and increased yields but Mepronil, Zineb, Carboxin+Thiram and Edifenphos were less effective against sheath blight of rice.

Paromita and Mukerjee (1988) stated that seed treatment with Bavistin (Carbendazim) followed by dipping seedlings in 0.05% solution for 10 min was better than seed treatment alone for controlling rice sheath blight caused by *Thanatephorus cucumeris*.

Thangasamy and Rangaswamy (1989) tested control of sheath blight caused by *Thanatephorus cucumeris* by carbendazim (Bavistin) and mancozeb applied at different crop growth and disease development stages. Fungicides were applied when disease severity was 1, 3 and 5 and at panicle initiation (PI) or at heading stage. Carbendazim and mancozeb sprayed at PI and 15 day after PI controlled disease development.

Groth *et al.* (1993) evaluated a number of fungicides for control of rice diseases. Tilt (propiconazole) gave good sheath blight control but did not control blast. Rovral (Iprodione) was effective against sheath blight and gave good yield stability.

Parveen (1998) observed that Tilt 250 EC significantly controlled sheath blight development but no significant difference on lesion length was obtained between single and double sprays of Tilt 250 EC. She concluded that sheath blight disease of rice could be controlled by only one spray of Tilt.

Mia (1999) recommended Tilt 250 EC at the rate of 1 L/ha for spraying at panicle initiation to boot stage for successful control of sheath blight disease of rice from Bangladesh Rice Research Institute.

Hossain and Mia (2001) evaluated the effectiveness of four fungicides against sheath blight of rice where two foliar spays with Tilt 250 EC @ 0.1% caused significant reduction in sheath blight severity and improved grain yield.

Hossain and Mia (2001) carried out an experiment at Rajshahi in Bangladesh, during T.aman season (June to December) of 1998 to evaluate the effectiveness of four fungicides, i.e Amcozim 50 WP (carbendazim), Bavistin 50 WP (Carbendazim), Shincar 50 WP (carbendazim), and Tilt 250 EC (propiconazole), and two additional rates of muriate of potash (MP), i.e. 20 and 40 kg/ha, against sheath blight (*Rhizoctonia oryzae*) of rice. The application of two additional 40 kg MP/ha in two equal splits as top dress and two foliar sprays with Tilt 250 EC at 0.1% caused significant reduction in sheath blight severity and improved grain yield.

Chahal *et al.* (2003) reported that Propiconazole (0.1%), edifenphos (0.1%), iprodione (0.3%), carboxin (0.2%) and carbendazim (0.1%) effectively controlled sheath blight of rice.

Chapter 3
Materials and methods

3. MATERIALS AND METHODS

The experiment was conducted in the Farm land allotted for the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka during the period from June to November, 2006.

3.1. Experimental site and soil

The experimental site was located at $23^0 77'$ N latitude and $90\ ^0 3'$ E longitude with an elevation of 1.0 meter from sea level. The soil of the experiment site belongs to Tejgaon series under the Madhupur Tract (Agro-ecological zone-28), which falls into Deep Red Brown Terrace Soils. The common features of the field are given below:

Location: Sher-e-Bangla Agricultural University Farm, Dhaka.

Agro Ecological Region: Madhupur Tract (AEZ-28).

Land Type: High land.

General Type: Deep Red Brown Terrace Soil.

Soil Series: Tejgaon.

Topography: Fairly level.

Depth Height: Above flood level.

Drainage Condition: Well drained.

3.2. Selection of the variety

One high yielding rice variety, namely BRRI Dhan 40 was used as test crops. This variety was developed by Bangladesh Rice Research Institute (BRRI) and was released by National Seed Board (NSB) in 2003 for Aman season. BRRI Dhan 40 was developed from a cross between IRR 4595-4-1-15 and BR 10 (progoti) (BRRI, 2003).

3.3. Fungicides used

Nine chemicals namely 1) Knowin-50 WP, 2) Score-250 EC, 3) Controll-5 EC, 4) Proud-25 EC, 5) Tilt-250 EC, 6) Folicur-250 EW, 7) Sunvit-50 WP, 8) Cupravit-50 WP, and 9) Bordeaux Mixture were used for the experiments.

3.4. Treatments

Ten treatments were explored in this study as follows :

T_1 = Control (untreated)

T_2 = Knowin-50 WP

T_3 = Score-250 EC

T_4 = Controll-5 EC

T_5 = Proud-25 EC

T_6 = Tilt-250 EC

T_7 = Folicure-250 EW

T_8 = Sunvit-50 WP

T_9 = Cupravit-50 WP and

T_{10} = Bordeaux Mixture

3.5. Collection of seed

3 kg seeds were collected from the BADC office at Dhaka for 360 sq. m. of land to raise seedling.

3.6. Sprouting of seed

Seeds were soaked in water in a basket for 24 hours. The seeds were then taken out of water and kept in gunny bags at room temperature for 72 hours for sprouting before sowing in the seedbed.

3.7. Preparation of seedbed and sowing of seed

Seedbed was prepared by paddling the soil with the help of power tiller and harrow in the field allotted for the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka. As the land was rich in organic matters, no manuring was done. But 10 kg phosphate/20 m^2 and 5 kg potash/20 m^2 was applied to the seedbed. Sprouted seeds were sown in the wet seedbed on 18-June 2006. Seedlings were properly taken care of. Weeds were removed and irrigation was given in the seedbed as and when necessary.

3.8. Preparation of experimental land

The land for the experiment was prepared with the help of power tiller and harrow. The land was first opened on 11 July 2006 and ploughed. After that, cowdung was incorporated to the puddle soil in the plot. After 9 days, the final ploughing was performed with the help of power tiller followed by laddering to level the soil surface. Weeds and stubbles were removed from the land. Thus the land became ready for transplanting of rice seedlings. The layout of the experiment in the field was done according to the design adopted.

3.9. Design of the experiment

The experiment was carried out in a Randomized Completely Block Design (RCBD) with 3 replications. Each block comprised 10 unit plots and total number of unit plots were 30. The unit plot size was 6 m^2. The distance maintained between plots was 50 cm and between blocks was 1 m.

3.10. Fertilizer Application

Fertilizers were applied as per recommendation of BRRI, 2004. The following doses of fertilizers were applied to the plots:

Fertilizers	Dose/ 360 m^2	Dose/ha
Urea (N_2)	1908 g	53 kg
TSP (P_2O_5)	740 g	20.5 kg
MP (K_20)	860 g	23.8 kg
Gypsum (S)	490 g	13.6 kg
Zinc Sulphate (Zn)	72 g	2 kg

All fertilizers except 2/3 Urea were incorporated with soil during final land preparation. Rest of the Urea was applied in equal two installments at 30 and 45 days after transplanting.

3.11. Transplanting of seedling

Thirty days old seedlings were uprooted from the seedbed very carefully and then transplanted on 23 July 2006 in the main field. In the field experiment, row to row spacing was maintained as 25 cm and hill to hill 15 cm, 2-3 seedlings were transplanted together in individual hill.

3.12. Intercultural operation

3.12.1. Weeding : Weeding was done once on 12 August 2006.

3.12.2. Irrigation : Irrigation was given in the field as and when necessary.

3.13. Preparation and application of fungicides

Fungicides were sprayed as solution into the experimental plot except the control plot. Each spray solution was prepared by mixing definite amount of fungicides with tap water. The whole surface of the plant was sprayed by the solution of the fungicides. In case of control plot plain tap water was sprayed on the plants. The fungicides spraying was done in maximum tillering stage of rice plant. Every time the fungicides were freshly prepared prior to application and the spray tank was thoroughly cleaned before filling with the individual spray material. Special attention was given to complete coverage of the growing plants with the fungicides. Adequate precautions were taken to avoid drifting of spray materials from one plot to the neighboring ones. Concentration of fungicides are given bellow:

Common name	Dose used (per 18 m^2 area)
Knowin 50 WP	3.6 g
Score 250 EC	1.8 ml
Controll 5 EC	1.8 ml
Proude 25 EC	3.6 ml
Tilt 250 EC	0.9 ml
Folicur 250 EW	1.8 ml
Sunvit 50 WP	12.6 g
Cupravit 50 WP	12.6 g
Bordeaux mixture	3.6 g

3.14. Assessment of the disease severity in the field

Sixteen plants were selected randomly and tagged from each unit plot that were considered for grading the severity of diseases on standing plants. Sheath blight severity was recorded in four growth stages viz. flowering stage, milking stage, soft dough stage and maturity stage. The severity of sheath blight disease was recorded following the Standard Evaluation System of Rice (IRRI, 2001). The scale was formulated based on percentage of Relative Lesion Height (% RLH) which is given below:

0 = No incidence (Highly resistant)

1 = Less than 1% sheath area affected (Resistant)

3 = 1-5% sheath area affected (Moderately resistant)

5 = 6-25% sheath area affected (Moderately susceptible)

7 = 26-50% sheath area affected (Susceptible)

9 = 51-100% sheath area affected (Highly susceptible)

The RLH is the average vertical height of upper most lesion on sheath expressed as a percentage of the average plant height. The mean value of rating (% RLH) were determined to get rating score of the material under each treatment. The percentage of relative lesion height was calculated as per the formula given below (Ansari, 1995)

$$\text{Relative Lesion Height (\%)} = \frac{\text{Lesion height}}{\text{Plant height}} \times 100$$

3.15. Pathogen isolation and identification:

Sheath blight infected rice plants were collected from the field and brought to the laboratory of the Department of Plant Pathology, SAU, Dhaka. The diseased samples were washed in tap water to remove sand and soil. They were cut into small pieces which included healthy and diseased tissue. The pieces were surface sterilized with mercuric chloride solution (1: 1000) for 30 seconds. The pieces were washed out three times in sterile water. Two such inocula were placed on previously prepared Potato Dextrose Agar (PDA) plates. The petridishes were then incubated at room temperature for 7 days to grow the pathogen. The culture was then observed under microscope and were then transferred to another PDA plates by hyphal tip culture method to prepare pure culture (plate, 1, 2 and 3). All these operations were done aseptically in the lamina air flow chamber. About 40 plates were prepared and preserved in the refrigerator.

Plate 1. Typical symptom of sheath blight (*Rhizoctonia solani*) of rice BRRI 40 at flowering stage.

Plate 2. Severity of sheath blight (*Rhizoctonia solani*) of rice BRRI 40 at maturity stage.

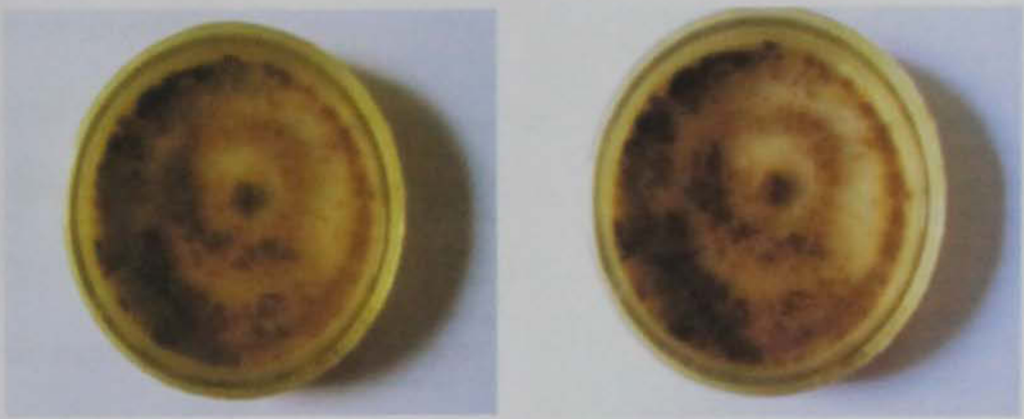

Plate 3. Pure culture of *Rhizoctonia solani* showing sclerotia on PDA

3.16. Harvesting and collection of data on yield and yield contributing parameters

The crop was harvested on 09 November, 2006 at full ripening stage from field in plot wise. Moreover 16 tagged plants of each unit plot were harvested separately. The data on the following yield contributing parameters were recorded:

Plant height (cm)

Number of tillers/hill

Number of infected tillers/hill

Lesion height/infected plant (cm)

% Relative lesion height (% RLH) (cm)

% Sheath area diseased/infected plant

Number of grains/hill

Number of grains/panicle

Weight of grains / hill (g)

Weight of grains / panicle (g)

Weight of thousand seeds (g)

Weight of straw/hill (g)

Weight of grain/plot (kg)

Weight of straw/plot (kg)

Grain yield (ton/ha)

Straw yield (ton/ha)

3.17. Weather report

The data of monthly average temperature, relative humidity, rainfall and sunshine hours were collected from weather yard, Bangladesh Meteorological Department, Agargaon, Dhaka-1207 (Appendix I).

3.18. Analysis of data

The data on different parameters were subjected to statistical analysis using analysis of variance to find out the variation resulting from experimental treatments. Treatment means were compared by DMRT (Duncan's Multiple Range Test).

Chapter 4
Results

4. RESULTS

4.1 Comparative effect of different treatments on plant height, number of tillers/hill and number of infected tillers/hill of rice BRRI-40

The effect of different treatments on plant height, number of tiller and number of infected tiller per hill of rice were determined and presented in Table 1. Plant height under different treatments ranged from 103.7 to 113.5 cm under field condition. The highest plant height was observed in T_6 (Tilt) and lowest in T_1 (Control). The number of tillers per hill did not differ significantly in respect of different treatment used. It was observed that the treatments showed significant effect on number of infected tiller per hill. Number of infected tiller per hill ranged from 1.20 to 2.85 under field condition. The highest number of infected tiller per hill was observed in T_1 (Control) and lowest in T_6 (Tilt) which is also statistically similar to T_3 (Score) and T_4 (Controll).

Table 1. Comparative effect of different fungicides on plant height, number of tillers/hill and number of infected tillers/hill of rice BRRI-40

Treatments	Plant height (cm)	Number of tillers/hill	Number of infected tillers/hill
T_1=Control (untreated)	103.7 c	14.95	2.85 a
T_2=Knowin 50 WP	107.1 abc	14.56	2.27 ab
T_3=Score 250 EC	110.3 ab	14.58	1.35 b
T_4=Controll 5 EC	110.9 ab	15.42	1.31 b
T_5=Proud 25 EC	111.0 ab	14.81	1.95 ab
T_6=Tilt 250 EC	113.5 a	14.32	1.20 b
T_7=Folicur 250 EW	105.5 bc	14.71	2.02 ab
T_8=Sunvit 50 WP	104.9 bc	15.23	2.14 ab
T_9=Cupravit 50 WP	104.4 bc	13.40	1.66 ab
T_{10}=Bordeaux mixture	104.8 bc	13.86	2.28 ab
$LSD_{0.05}$	5.831	NS	1.15

4.2 Comparative effect of different treatments on lesion height and percent sheath area diseased/infected plant and percentage of relative lesion height (% RLH) of rice BRRI-40

The treatments differed significantly in respect of percent sheath area diseased and lesion height per infected plant (Table 2). Percent sheath area diseased infected plant ranged from 10.20 to 16.29 where the highest percent sheath area diseased per infected plant was observed in T_1 (Control) and lowest in T_6 (Tilt). The treatment T_6 resulted statistically similar sheath area diseased as of T_3 (Score), T_4 (Controll), T_5 (Proud), T_7 (Folicur), T_8 (Sunvit), T_9 (Cupravit) andT_{10} (Bordeaux mixture). Lesion height per infected plant under different treatments ranged from 3.26 to 5.00 cm where the highest lesion height was observed in T_1 (Control) and lowest in T_6 (Tilt). Percent Relative Lesion Height (% RLH) on different treatments did not differ significantly though the highest (4.82 cm) and lowest (2.87 cm) % RLH was recorded under the treatments T_1 (Control) and T_6 (Tilt) respectively.

Table 2. Comparative effect of different fungicides on lesion height, percent sheath area diseased and percentage of relative lesion height (% RLH) of rice BRRI-40

Treatments	Lesion height/ infected sheath (cm)	% sheath area diseased	% RLH
T_1 =Control (untreated)	5.00 a	16.29 a	4.82
T_2 =Knowin 50 WP	4.10 ab	12.32 bc	3.82
T_3 =Score 250 EC	3.84 ab	10.47 c	3.47
T_4 =Controll 5 EC	3.72 ab	11.11 c	3.37
T_5 =Proud 25 EC	3.65 ab	10.99 c	3.29
T_6 =Tilt 250 EC	3.26 b	10.20 c	2.87
T_7 =Folicur 250 EW	3.83 ab	13.41 abc	3.63
T_8 =Sunvit 50 WP	4.03 ab	12.81 bc	3.84
T_9 =Cupravit 50 WP	3.91 ab	12.02 c	3.75
T_{10} =Bordeaux mixture	3.93 ab	15.24 ab	3.74
$LSD_{0.05}$	1.271	2.881	NS

4.3 Comparative effect of different treatments on number of grain and weight of grains/hill, weight of straw/hill (g), number of grain and weight of grains/panicle and weight of 1000-seeds

The treatments were found differ significantly in respect of number of grain per hill, weight of grain per hill, number of grain per panicle, weight of grain per panicle and weight of 1000 seeds (Table 3). Number of grain per hill ranged from 832.0 to 1195.0 where the highest number of grain per hill was recorded in T_6 (Tilt) and the lowest number of grain per hill was recorded in T_{10} (Bordeaux mixture). Weight of grain per hill ranged from 17.58 to 28.50 g where the lowest weight of grain per hill was recorded in T_1 (Control) and the highest weight of grain per hill was recorded in T_6 (Tilt). Number of grain per panicle ranged from 59.95 to 84.90 where the highest number of grain per panicle was recorded in T_6 (Tilt) and the lowest number was recorded in T_{10} (Bordeaux mixture) which was also statistically similar to T_1 (Control). Weight of grain per panicle ranged from 1.18 to 2.03 g where the highest weight of grain per panicle was recorded in T_6 (Tilt) and the lowest weight of grain per panicle was recorded in T_1 (Control). Weight of 1000-seeds ranged from 19.50 to 23.87 g where the highest and lowest weight of 1000-seeds was recorded in T_6 (Tilt) and T_1 (Control) respectively. Weight of straw/hill (g) did not differ significantly in respect of different fungicides used.

Table 3. Comparative effect of different fungicides on number of grain and weight of grains/hill, weight of straw/hill(g), number of grain and weight of grains/panicle and weight of 1000 seeds

Treatments	No. of grains/ hill	Wt. of grains/ hill(g)	Straw yield/ hill(g)	No. of grains/ panicle	Wt. of grains/ panicle (g)	Wt. of 1000 seeds (g)
T_1 =Control(untreated)	901.9 b	17.58 c	63.02	60.26 c	1.18 d	19.50 b
T_2 =Knowin 50 WP	948.0 ab	21.90 abc	73.23	65.29 bc	1.52 bcd	23.05 a
T_3 =Score 250 EC	1160 ab	26.27 ab	80.42	79.81 ab	1.81 ab	22.68 a
T_4 =Controll 5 EC	1058 ab	23.96 abc	89.97	68.43 bc	1.55 bcd	22.68 a
T_5 =Proud 25 EC	1099 ab	25.81 ab	84.79	74.34 abc	1.75 abc	23.35 a
T_6 =Tilt 250 EC	1195 a	28.50 a	82.50	84.90 a	2.03 a	23.87 a
T_7 =Folicur 250 EW	1033 ab	24.23 abc	81.67	70.23 abc	1.65 abc	23.47 a
T_8 =Sunvit 50 WP	1013 ab	22.83 abc	92.72	66.59 bc	1.50 bcd	22.56 a
T_9 =Cupravit 50 WP	956.4 ab	21.77 abc	77.71	72.17 abc	1.64 abc	22.65 a
T_{10}=Bordeaux mixture	832.0 b	18.60 bc	70.81	59.95 c	1.34 cd	22.31 a
$LSD_{0.05}$	288.4	7.217	NS	14.20	0.4138	2.095

4.4 Comparative effect of different treatments on grain yield and straw yield of rice BRRI 40

The grain yield/plot (kg) differed significantly from one treatment to another (Table 4). The grain yield/plot ranged from 2.25 to 3.64 g where the highest and lowest yield were made in T_6 (Tilt) and T_1 (Control) respectively. Straw yield of rice profoundly varied from one treatment to another, ranging 8.06 to 11.87 kg/plot and 13.47 to 19.77 ton/ha (Table 4).

The highest grain yield (ton/ha) was obtained in T_6 (Tilt) which significantly differed with any other treatments. The second highest grain yield (ton/ha) was observed in plot of T_3 (Score). No significant variation was found among T_2 (Knowin), T_4 (Controll), T_5 (Proude), T_7 (Folicur), T_8 (Sunvit) and T_9 (Cupravit). The lowest grain yield (ton/ha) was observed in plot of T_1 (Control). The treatment T_6 (Tilt) resulted 61.86 % increased grain yield over untreated control (T_1).

Table 4. Comparative effect of different fungicides on grain yield and straw yield of rice BRRI 40

Treatments	Grain yield/plot (kg)	Straw yield/ plot (kg)	Grain yield (t/ha)	Straw yield (t/ha)	% Grain yield increased over control
T_1 =Control (untreated)	2.253 c	8.067 a	3.757 c	13.47 a	00.00
T_2 =Knowin 50 WP	2.800 abc	9.370 a	4.667 abc	15.60 a	24.26
T_3=Score 250 EC	3.360 ab	10.30 a	5.593 ab	17.17a	49.72
T_4 =Controll 5 EC	3.067 abc	11.52 a	5.110 abc	19.20 a	36.26
T_5 =Proud 25 EC	3.303 ab	10.85 a	5.507 abc	18.10 a	46.66
T_6 =Tilt 250 EC	3.647 a	10.56 a	6.077 a	17.60 a	61.86
T_7 =Folicur 250 EW	3.100 abc	10.46 a	5.163 abc	17.47 a	37.60
T_8 =Sunvit 50 WP	2.920 abc	11.87 a	4.867 abc	19.77 a	29.60
T_9 =Cupravit 50 WP	2.790 abc	9.947 a	4.643 abc	16.57 a	23.73
T_{10} =Bordeaux mixture	2.380 bc	9.067 a	3.967 bc	15.10 a	5.60
$LSD_{0.05}$	0.9206	NS	1.538	NS	

Chapter 5
Discussion

5. DISCUSSION

Effect of different treatments viz. T_1 (Control), T_2 (Knowin), T_3 (Score), T_4 (Controll), T_5 (Proude), T_6 (Tilt), T_7 (Folicur), T_8 (Sunvit), T_9 (Cupravit) and T_{10} (Bordeaux mixture) on sheath blight of rice cv. BRRI 40 were studied in the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka. Significant variation on number of infected tillers/hill was recorded among the treatments. From the present study it is evident that different treatments resulted reduction of number of infected tiller of rice in comparison with untreated control. One sprays of Tilt 250 EC @ 0.2% resulted significant reduction in number of infected tiller under field condition. Jones *et al.* (1987) reported that Tilt (Propiconazole) applied twice significantly reduced sheath blight disease severity and increased yield. Groth *et al.* (1993) also reported that Tilt (Propiconazole) gave good control of sheath blight control. Mia (1999) also recommended Tilt 250 EC at the rate of 1L/ha for spraying at PI to boot stage for successful control of sheath blight disease of rice from Bangladesh Rice Research Institute. Parveen (1998) concluded that sheath blight disease could be controlled by only one spray of Tilt 250 EC (0.2%).

The average plant height of the plants was 98 to 105 cm, but by applying the Tilt 250 EC, it was reached up to 113.5 cm. The normal luxuriant leafy growth of the high yielding short varieties seems to produce a dense canopy more favourable disease encouraging micro climate and also for the successful growth of the fungus on the leaf sheaths. In the taller plants with comparatively early leaf senescence, the lower leaf dry up, some of which fall off as the plant grows and new leaves emerge on the upper nodes far above the plant base. So, the lower part of the culm remains clear partly covered with dead and dry leaf sheaths. This condition in taller plants allows more sun rays and better ventilation than the case of shorter plants. Thus the micro climate as well as the lack of living green leaf sheaths at the infection site remain unfavorable for the successful disease development. The sheath blight development in short/semi-dwarf lines is more because of shorter distance between the sheath position at water line, the usual infection court, and the flag leaf or the panicles. These are may be main reasons why relatively taller plants produced with the help of Tilt to reduce the growth of pathogen which remain erect show more resistance to this disease. Chlorophyllous leaves are helpful only up to the grain filling stage. After that, if the lower leaves dry up, the yield is not much affected. So, the senescence of lower leaves may start at grain filling stage or later without affecting the yield.

Lesion height and percent sheath area diseased of infected plant increased systemitically. The sclerotia of *R. solani* destroyed the chlorophyllous tissue. Tilt 250 EC as a systemic fungicides it also help to reduce the sclerotial population in the soil. This reduction directly help to reduce disease severity on the next crop of that field. According to Shahjahan *et al.* (1990) the sclerotia production in the fungicides sprayed plots was less coinciding with the reduced disease development in those plots. Belmar *et al.* (1987) observed a linear correlation between the number of *R. solani* sclerotia from soil and sheath blight incidence at the panicle initiation growth stage. Cropping systems for 34 fields had a significant effect on the preplant inoculum density of *R. solani* and percentage of sheath blight incidence. Thus, the treatments have a significant role in reducing the inoculum density of the respective plot and thereby minimize the chance of becoming severe havoc of sheath blight during next crop.

In the present experiment under field condition it has been found that all the treatments resulted significant effect on grain weight/panicle of rice. The highest grain weight/panicle was obtained in the sprayed plot with T_6 (Tilt) and the lowest in T_1 (Control). The same trend was also found in case of total number of grains/panicle and grain weight/ hill. The total number of grains/panicle under field condition was the highest in the plot of T_6 (Tilt). On the contrary, the lowest grain was observed in T_1 (Control). It indicates that heavily infected plants produce poorly filled grains, particularly in the lower portion of the panicle (Rush and Lee, 1992).

The pathogen became more severe at flowering than the earlier stages of the plant growth and exhaust the nutrients and inhibit the translocations of the nutrients in the severely infected plants during the grain filling stages of the plant growth which result in the production of less number of filled grains with increased number of unfilled grains/panicle and finally the yield was drastically reduced (Rush and Lee, 1992).

The effect of different treatments on yield performance differed significantly. 1000-seeds weight of all the treatments ranged from 19.50 to 23.87 g, where the highest weight was obtained by T_6 (Tilt), which was statistically similar to T_2 (Knowin), T_3 (Score), T_4 (Controll), T_5 (Proude), T_7 (Folicur), T_8 (Sunvit) T_9 (Cupravit) and T_{10} (Bordeaux mixture). The lowest weight was recorded in T_1 (Control) plot. Arunyanart and Surin (1984) also observed significant difference among the 1000 grain weight, where highest weight was found from disease free plant.

Grain yield of rice profoundly varied from one treatment to another ranging from 3.75 to 6.07 ton/ha. The highest yield was recorded by T_6 (Tilt) and the lowest was T_1 (Control). The second highest yield (5.59 ton/ha) was observed in plot of T_3 (Score). It was oserved that T_2 (Knowin), T_4 (Controll), T_5 (Proude), T_7 (Folicur), T_8 (Sunvit) and T_9 (Cupravit) produce lower yield than T_6 (Tilt). Sharma *et al.* (1995) reported that 30.34 and 22.88% yield loss occurred in cv. BR1 and BR6, respectively due to sheath blight. Jones *et al.* (1987) reported that Tilt applied twice significantly reduced disease severity and increased yield. Groth *et al.* (1993) recorded that Tilt gave good control of sheath blight and good yield stability. The highest straw yield was recorded in T_8 (Sunvit) and the lowest in T_1 (Control), though the straw yield did not differ significantly among the different treatments used.

Chapter 6
Summary and Conclusion

6. SUMMARY AND CONCLUSION

The present piece of research work was conducted in the farm field allotted for the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka during the period from June, 2006 to November 2006. The experiments were carried out following RCBD with ten treatments viz. T_1 (Control), T_2 (Knowin), T_3 (Score), T_4 (Controll), T_5 (Proude), T_6 (Tilt), T_7 (Folicur), T_8 (Sunvit), T_9 (Cupravit) and T_{10} (Bordeaux mixture) with three replications to investigate the effect of these treatments on sheath blight and yield of rice variety BRRI 40 in the field.

Lesion height varied from 3.26 to 5.00 cm under different treatments. The lowest lesion height was observed in plot of T_6 (Tilt 250 EC) whereas the highest lesion height was observed in control plot (T_1). The rest of the treatments viz. T_2 (Knowin), T_3 (Score), T_4 (Controll), T_5 (Proud), T_7 (Folicur), T_8 (Sunvit), T_9 (Cupravit) and T_{10} (Bordeaux mixture) was statistically similar to T6 (Tilt) regarding lesion height. Percent Sheath Area Diseased per infected plant varied from 10.20 to 16.29 under field condition. The highest sheath area diseased per infected plant was observed in plot T_1 (Control) and the lowest in T_6 (Tilt). But percent Relative Lesion Height (% RLH) among different treatments was statistically insignificant. Number of infected tiller per hill varied from 1.20 to 2.85 whereas the highest and the lowest counts were made under the treatments T_1 (Control) and T_6 (Tilt), respectively. Plant height, number of grains per panicle, number of grains per hill, weight of grains per panicle, weight of grains per hill, grain yield, straw yield and 1000 seed weight of rice were significantly the highest in the treatment T_6 (Tilt). The highest grain yield (6.07 ton/ha) was obtained from the treatment T_6 (Tilt) and the lowest was in control (3.75 ton/ha).The Second highest grain yield (5.59 ton/ha) was observed in the Score 250 EC treated plot (T_3). The treatment T_6 (Tilt) showed 61.86 % increased grain yield over untreated control.

From the findings of the present study it has been found that the treatment T_6 (Tilt 250 EC) may be advised to the farmers to combat the sheath blight disease of rice under field conditions. But similar research works needs to be carried out in other agro-ecological zones of the country to find out its overall fitness.

Chapter 7
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7. REFERENCES

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Chapter 8
Appendix

8. APPENDIX

Appendix I. Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from June to November 2006

Month	Air temperature (° C)		RH (%)	Total rainfall (mm)
	Maximum	Minimum		
June 06	33.40	26.80	91	279
July 06	31.52	25.35	88	233
August 06	28.25	24.55	82	165
September 06	26.20	24.15	73	117
October 06	26.70	21.13	89	41
November 06	22.00	20.15	87	00

Source : Dhaka metrological center