MANAGEMENT OF SHEATH BLIGHT *(RHIZOCTONIA SOLANI)* OF RICE THROUGH SELECTED CHEMICALS AND SOIL AMENDMENT

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MANAGEMENT OF SHEATH BLIGHT *(RHIZOCTONIA SOLANI)* OF RICE THROUGH SELECTED CHEMICALS AND SOIL AMENDMENT

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CERTIFICATE

This is to certify that the thesis entitled, **"MANAGEMENT OF SHEATH BLIGHT OF RICE (*RHIZOCTONIA SOLANI*) THROUGH SELECTED CHEMICALS AND SOIL AMENDMENT "** submitted to the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN PLANT PATHOLOGY**, embodies the result of a piece of *bona fide* research work carried out by **AFSANA HOSSAIN,** Registration No. **00950** under my supervision and guidance. No part of the 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 received during the course of this investigation have been duly acknowledged.

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DEDICATED
TO MY
BELOVED PARENTS

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ABSTRACT

Efficacy of fourteen treatments viz. T_1 (Bavistin 50 WP), T_2 (Tilt 250 EC), T_3 (Champion 77 WP), T_4 (Cupravit 50 WP), T_5 (Bleaching powder, BP), T_6 (Bavistin 50 WP + BP), T_7 (Tilt 250 EC + BP), T_8 (Champion 77 WP + BP), T_9 (Cupravit 50 WP + BP), T_{10} (Ash), T_{11} (Sawdust), T_{12} (Khudepana), T_{13} (Poultry manure) and T_{14} (Control) were assessed against *Rhizoctonia solani* for the management of sheath blight of rice (BR 3) during March to August, 2007 at the farm of Sher-e-Bangla Agricultural University (SAU), Dhaka. Effect of different treatments against sheath blight of rice differed significantly in terms of % Relative Lesion Height (RLH), number of infected tiller per hill, lesion size, length of panicle, number of filled and unfilled grain, grain yield (ton/ha), straw yield (ton/ha) and weight of 1000 grains weight. Among the treatments tested, T_6 (Bavistin 50 WP + BP) showed the best performance in reducing disease incidence and disease severity as well as increasing yield of rice followed by T_7 (Tilt 250 EC + BP) and T_8 (Champion 77 WP + BP). The treatment T_6 (Bavistin 50 WP + BP) reduced upto 54.09% RLH and increased grain yield by 37.34% over control which was followed by Tilt 250 EC + BP (52.12%, 32.62%) and Champion 50 WP + BP (49.10%, 31.94%), respectively. The fungicides alone also showed better performances but the soil amendment alone had no remarkable effect in controlling sheath blight of rice.

CHAPTER 1

INTRODUCTION

INTRODUCTION

Rice (*Oryza sativa*) belongs to the family Gramineae. It constitutes the staple food of 60 percent of the world population. It occupies second position next to wheat in respect of area and production. There are 111 rice growing countries in the world that occupies about 146.5 million hectares of land, more than 90 percent of which is in Asia (Anon., 1999). In terms of importance as a food crop, rice provides more calories per hectare than any other cereal crop. It is estimated that 40 percent of the world population use rice as a major source of calories.

Rice is grown in Bangladesh in three distinct seasons namely Aus, Aman and Boro. Rice is grown in 11.025 million hectares of land with a production of 26.796 million tons (BBS, 2005). Among the three seasons, Aman rice covers the large area of 5.678 million hectares with a production of 11.520 million tons (BBS, 2005)

Rice is a staple food for more than two billion people in Asia, Africa and Latin America. To feed the fast increasing global population, the world production must be increased to 760 million tons by the year 2020 (Kundu and Ladha, 1995). But production of rice decreases day by day due to scarcity of land and other factors which hamper rice cultivation.

Incidence of insect pests and diseases greatly hampers the production of rice. This crop suffers from various diseases; about 31 different diseases of rice are recorded in Bangladesh. Among those diseases, sheath blight caused by *Rhizoctonia solani* Kuhn. (*Thanatephorus cucumis* (A.B. Frank) Donk.) is documented as one of the major constrains for rice cultivation in the country. In Bangladesh, sheath blight is one of the major constraints for rice production (Dey *et al.* 1996, Ali 2002). Recent investigation on the occurrence and distribution of sheath blight indicated that 6.5 to 48.4% of the rice plants were infested with the disease with an average incidence of 20.8% (Anon., 2003). The disease recorded in all rice growing areas throughout the year in all three seasons (Anon, 2003). Yield loss estimated to the range 40.0-17800.0 kg/ha (Ali 2002) and 135.9 to 762.2 kg/ha (Anon, 2003).

Currently, the disease is most serious in intensive rice production system in Bangladesh.

The disease primarily affects leaf sheath and therefore the disease is commonly known as sheath blight. The disease was first reported in Bangladesh in 1973 (Miah *et al.* 1994). It has been found to be severe in the tropical, sub-tropical and temperate environments. It is found to be endemic in certain areas of Bangladesh (Ou, 1985; Shahjahan *et al.*, 1986). It is an increasing problem for rice cultivation in Bangladesh especially in Aus and Aman seasons (Miah *et. al.* 1985).

Sheath blight disease has emerged as a major economic concern since the introduction of modern rice varieties. The modern varieties are high yielding, semi-dwarf, high tillering, with a dense foliar canopy and nitrogen responsive which provides favourable environment for sheath blight development (Ou 1985, Shahjahan *et al.* 1990). Moreover, intensification with mono crop cultivation with rice provides a year round host plants for the pathogen and thus maintains a high level of potential inoculum in rice ecosystem (Cu *et al.* 1996).

Initial symptoms usually develop as lesions on sheaths of lower leaves near the water line when plants are in the late tillering or early internode elongation stage of growth (approximately 10 - 15 days after flooding). These lesions usually develop just below the leaf collar as oval-to-elliptical, green-gray, water-soaked spots about 1/4 inch wide and 1/2 to 1/4 inch long. With age, the lesions expand and the center of the lesions may become bleached with an irregular tan to brown border. When humidity exceeds 95 percent and temperatures are in the range of 85-90 °F, infection spreads rapidly by means of runner hyphae to upper plant parts, including leaf blades, causing extensive, tan, irregularly shaped lesions with brown borders (Plate 1). Disease development progresses very rapidly in the early heading and grain filling growth stages during periods of frequent rainfall and overcast skies. Plants heavily infected at these stages produce poorly filled grain, particularly in the lower portion of the panicle. Under field condition the disease can cause yield losses of as high as 32% especially in modern cultivars (Ou and Bandong, 1976; Shahjahan *et al.*, 1986) and the yield losses can reach 50% when the infection is well distributed (Rush and Lee, 1992). Additional losses result in increased lodging or reduced ratoon production due to infection of the culm and reduced carbohydrate reserves.

As plants senesce from maturity, lesions turn dry and become grayish white to tan with brownish borders. Sclerotia, initially white but turning dark brown at maturity, are produced superficially on or near the lesions. Sclerotia are loosely attached and easily dislodge from the plant. Sclerotia are the primary means for fungus survival between crops. They survive long periods in the soil and float to the surface of flooded rice fields in the subsequent rice crop, infect rice plants at the waterline and continue the disease cycle. Sclerotia can survive from one to several years in the soil. They can also attack several weed hosts and maintain infection chain to the following season.

Despite the widespread occurrence and the significant yield reductions throughout the rice growing countries of the world, its control attempts to had not been very successful. Control of sheath blight through use of resistant cultivars is not possible since any rice cultivars or genotypes have so far been found to possess acceptable resistance to sheath blight disease (Sharma, *et al.* 1985; Ou, 1985). Therefore emphasis should be paid on other management options. Use of chemicals to control the disease is a common option. However, to keep the environment pollution free, dependence on chemicals should be reduce as far as possible. As the pathogen is strictly soil borne, the ecofriendly approaches like soil amendment with natural organic wastes could be the nice alternative option of chemicals.

Considering the above facts the present investigations was under taken with the following objectives:

1. To determine the efficacy of different chemicals either alone or in combination against *Rhizoctonia solani* causing sheath blight of rice in the field condition.
2. To find out the effect of soil amendment for the management of sheath blight disease of rice in field condition.

CHAPTER 2

REVIEW OF LITERATURE

REVIEW OF LITERETARE

A large number of research works has been done in respect of chemical control for the management of sheath blight disease of rice under varying soil and climatic conditions. But few information has been obtained regarding soil amendment for controlling sheath blight of rice. The findings also have little relevance to the SAU farm conditions for rice cultivation. Information available in the literature pertaining to these aspects of rice cultivation has been reviewed in this chapter.

2.1. Occurrence of Sheath blight of rice

Sugiyama (1988) reported that the areas affected by sheath blight in Japans increased to 35% in 1960's, to 46% in 1970's and to 48% in 1980's.

Rice sheath blight disease caused by the fungus *Thanatephorus cucumeris* (Frank) Donk (*Rhizoctonia solani* Kuhn) was first reported in Bangladesh by Talukder 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.

Wei (1934) found the disease in China, and it has been seen in many countries in Asia. It was considered to be a disease of the Orient, but it has also been reported from Brazil, Surinam, Venezuela, Madagascar and the USA.

Miyake (1910) first described this disease in Japan and named the causal organism *Sclerotium irregulare*. Sawada (1912) later found the fungus to be idendical with *Hypochnus sasakii,* described earlier by Shirai (1906). Palo (1926) found a similar disease in the Philippines, which they considered to be due to a fungus of the *Rhizoctonia solani* group. Park and Bertus (1932) reported the disease in Sri Lanka and referred the organism to *Rhizoctonia solani* Kuhn.

2. 2. Symptoms of Sheath blight of rice

Rangaswami and Mahadevan (1999) reported that the pathogen causes spots or lesions mostly on the leaf sheath, extending to the leaf blades under favourable conditions. At first, the spots are greenish grey, ellipsoid or ovoid, and about 1 cm long. They enlarge and may reach 2 or 3 cm in length and become grayish white with 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 effected leaf can easily be pulled of from the plant. In severe cases all the leaves of a plant are blighted, resulted in death of the plant. Plants are usually, attached at the tillering stage, when the leaf sheaths become discolored at or above water level.

Sharama and Teng (1996) reported that two rice cultivars IR 42 and IR 72 were inoculated with *Rhizoctonia solani.* Disease development was found to be higher at late growth stages. Disease progress was faster at flowering and booting stages in both cultivars. The percent productive tillers, grain weight 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 stage and consequently the yield parameters also decline. The yield losses at different stages of inoculation ranged from 23.0% - 32.15% and 13.53% - 34.32% in IR 42 and IR 72, respectively. The yield losses were high in flowering stage in both the cultivars than the other three stages.

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 stages. Initial symptoms consists 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 favourable conditions i.e., low sunlight, humidity near 95% and high temperature (28-32° C), infection spreads rapidly by means of runner hyphae to upper plant parts including leaf blades, and to adjacent plants. Lesions on the upper plant portion may coalesce to encompass entire leaf sheaths and stems. Sclerotia are produced superficially on or near infected tissue after symptoms appear and are loosely attached and easily dislodged from the plant when they are mature. Heavily infected plants produce poorly filled grains, particularly in the lower portion of the panicle. Additional losses in yield result in increased lodging or reduced ratoon production as a result of death of culms.

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

Yu, C. M. (1975) reported that outer leaf sheaths are first affected, gradually extending towards the inner sheaths. Sheath blight lesion spread more rapidly on the leaf sheath blade than the sheath, and spread is hastened by loosening. Lesion length increases faster at heading than at booting and maximum at tillering stage. At booting the developments is more rapid on the lower leaf sheaths than the upper, but reverse at heading of the rice plants.

Roy (1978) said that the permeability of rice leaves increase as a result of infection with sheath blight. Decreases in electrolyte leachate after 2 days may be attributed to phenol leakage and conversion of phenol to high molecular weight compounds blocking the cell membrane pores.

2.3. Management of sheath blight

2.3.1. Management through Chemicals

Lore *et al.* (2005) conducted an experiment to evaluate different fungicides against sheath blight (*Rhizoctonia solani*) of rice under artificial epiphytotic conditions (Kapurthala, Punjab, India, during 2002 and 2003) and indicated that Monceren (pencycuron) 250 SC exhibited superior efficacy over other fungicides in controlling the disease as well as increasing the yield. Other fungicide such as RIL 010/F1 25 SC, RIL 010/F1 50 SC, Rhizolex 50 WP, Rhizocin 3L, Folicur the disease as well as increasing the yield. Other fungicide such as RIL 010/F1 25 SC, RIL 010/F1 50 SC, Rhizolex 50 WP, Rhizocin 3L, Folicur (tebuconazole) 250 EW, Contaf 5 EC and Tilt (propiconazole) 250 EC were also effective at higher concentration and was at par with Bavistin (carbendazim) 50 WP. Shield (clopyralid) 2.62 SC proved least effective.

Sudhakar *et al.* (2005) were conducted a study in Andhra Pradesh, India during the kharif seasons of 1991 and 1992 to investigate the chemical control of rice sheath blight (*R. solani*) on cultivars IR-50 (susceptible) and Kavya (moderately resistant) using different insecticides. The insecticide treatments included 0.2 and 0.3% concentrations of hexaconazole, propiconazole, cyproconazole, terbuconazole, mancozeb, chlorothalonil, pencycuron, iprodione and carbendazim. The most effective fungicides in *in vitro* tests were carbendazim, hexaconazole and propiconazole. Systemic fungicides were more effective than non-systemic ones. Mancozeb was the least effective among the treatments.

Ashrafuzzaman *et al.* (2005) conducted an experiment to assess the single and combined doses of ash (3 t ha^{-1}), bleaching powder (10 ppm), poultry manure (5 t ha^{-1}) and bavistin (0.05%) for the management of sheath blight caused by *Rhizoctonia solani* Kuhn and their effects on yield components and yield of cv. BRRI dhan 39. They found that highest weight of thousand grains, grain yield per hill, straw yield per hill and lowest percent of unfilled grains were obtained when ash, bleaching powder, poultry manure and bavistin used in combination.

Akter *et al.* (2001) conducted an experiment by using six fungicides, namely, Bavistin 50WP (carbendazim), Contaf 5EC (hexoconazole), Forastin 50WP (carbendazim), Anvil 5SC (hexoconazole), Tilt 250EC (propiconazole), and Thiovit 80WP (micronized sulfur), and a fertilizer, muriate of potash, in Gazipur, Bangladesh, in 1999 and 2000 against sheath blight of rice (cv. Swarna) caused by *Rhizoctonia solani*. They found that Contaf appeared to be the best in reducing the percent relative lesion height, percent disease index (PDI), and tiller infection. The reduction of PDI by Contaf in different seasons ranged from 80.37 to 88.58% over

Mian *et al.* (2004) conducted two field experiments in Bangladesh during T. Aus and T. Aman seasons in 2002 to find out the efficacy of eight fungicides viz. Forastin 50 WP (carbendazim), Genuine 50 WP (carbendazim), Cindazim 50 WP (carbendazim), Agben 50%F (carbendazim), Goldazim 50 WP (carbendazim), Akonazole 250 EC (propiconazole), Folicur EW 250 (tebuconazole) and Tilt 250 degrees EC (propiconazole)) in controlling the sheath blight of rice (*Rhizoctonia solani*). All the fungicides were sprayed twice at 5 and 20 days after inoculation at recommended doses. Akonazole and Folicur appeared to be the most effective in reducing percent tiller infection, percent relative lesion height and percent disease index (PDI). In terms of PDI reduction over the control, Akonazole and Folicur showed good performance in both seasons ranging from 59.96 to 80.29% and from 53.79 to 80.27%, respectively. The significant increase in grain yield was also recorded by applying Akonazole and Folicur over the untreated control.

Ali and Archer (2003) conducted an experiment with fungicides of diverse group and mode of action was evaluated *in vitro* and *in vivo* for their efficacy against sheath blight disease (*Rhijoctonia solani*) of rice. Ten fungicides viz. Azoxystrobin 250 SC (strobilurin), Carbendazim 500 Flo 2 (benzimidazole), Cyproconazole 240 EC (triazole), Fenpropimorph 750 EC (morpholine). Fludioxonil 2.5 SC (phenylpyrroles). Hexaconazole 250 SC (triazole), Iprodione 50 WP (dicarboximide), Pencycuron 250 Flo (phenylurea), Propiconazole 250 EC (triazole) and Tolclofos-methyl 500 Flo (aromatic hydrocarbon) were tested. Except Azoxystrobin, all fungicides were highly effective *in vitro*. The highest inhibition of mycelial growth was obtained with Pencycuron. In *in vivo* test, Azoxystrobin, Pencycuron and Hexaconazole were highly effective against sheath blight disease. Tolclofos-methyl and Carbendazim were effective only in high doses. Phytotoxicity was recorded in triazole and morpholine fungicides, which expressed as yellowing (chlorosis), inhibition of plant elongation and incomplete panicle emergence contributed to high sterility and yield loss.

Kandhari and Gupta (2003) conducted an experiment under greenhouse conditions to evaluated the efficacy of fungicides GFT-10 (S-methyls,s-diphenyl phosphorothioate) and Folicur (tebuconazole) against sheath blight (*Rhizoctonia solani*) of rice (cv. Pusa Basmati-1). Folicur was more effective than GFT-10, resulting in low disease incidence and greater lesion height reduction.

Saha (2003) conducted a field experiment to determined the efficacy of Emcop (2 ml), iprobenfos (2 or 2.5 ml) and flutolanil (1.5 or 2 g), along with the control fungicide validamycin, against *Rhizoctonia solani* (*Thanatephorus cucumeris*)causing sheath blight in rice in West Bengal, India during the kharif season of 2001. Disease severity was the lowest (20.3%) and grain yield was the highest (5026 kg/ha) with the application of 2 ml iprobenfos.

Kazempour *et al.* (2003) carried out an experiment with some fungicides (Benomyl, Carbendazim, Carboxin-Thiram, edifenphos and Zineb) to control sheath blight of rice incited by *R. solani in vitro* and under greenhouse conditions. Benomyl, Carbendazim, Carboxin-thiram, Edifenphos and Zineb reduced disease by 32.5, 21.5, 12.8, 9.5 and 0%, respectively.

Rodriguez *et al.* (2001) conducted an experiment with rice cultivars (Fonaiap 1 and Cimarron) infected with sheath blight (*Rhizoctonia solani*) and were treated with fenbuconazole (100 and 125 g/ha), citrex (563 and 750 ml/ha), propiconazole + difenoconazole (50 + 50, 63 + 63 and 75 + 75 g/ha) and flutolanil (300 ml/ha) in 1997-99. They reported that 125 g fenbuconazole/ha reduced sheath blight 72.33% to 82.81% and produced the highest yield (5050 kg/ha). Only two applications of 750 ml/ha Citrex controlled the disease, but gave less control than that of flutolanil. The best result was obtained with propiconazole + difenoconazole (both at 75 g/ha) as well as flutolanil, obtaining 59.02 and 58.51% reductions of disease incidence and severity, respectively.

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. He also suggested Homai or Topsin M at the rate of 2 kg/ha spraying at panicle initiation or boot stage.

Parveen (1998) observed that the chemical (Tilt 250EC) effect against sheath blight lesion development was found to be statistically significant but insignificant 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 250 EC.

Rajiv *et al.* (1997) conducted an experiment where rice seedlings were treated with fungicidal treatments. Epoxiconazole (as Opus) was the most effective in reducing sheath blight (*Rhizoctonia solani*) followed by thiophanate-methyl (as Baynate), cyproconazole (as Atemi) and thiophanate-methyl (as Tilt). Propineb (as Antracol) and prochloraz (as Octave) controlled the disease but had little effect on crop yield.

In an experiment Tiwari (1997) tested the efficacy Carbendazim (as Bavistin), benomyl, hexaconazole (as Contaf), mancozeb (as Dithane M-45), edifenphos (as Hinosan) and thiophanate-methyl (as Topsin-M) for control of *R. solani* on rice in the field, in Madhya Pradesh, India. Maximum disease control was obtained using hexaconazole, followed by edifenphos, and the least control was obtained using mancozeb. It is suggested that edifenphos sprays would be economical for control of *R. solani* on rice, as edifenphos also controls other rice diseases.

Acharya *et al.* (1997) conducted an experiment with four fungicides, ziram, tolclofos-methyl, carbendazim and edifenphos, for their *in vitro* efficacy against the rice sheath blight pathogen (*Rhizoctonia solani*). When studied by the poison food technique, tolclofos-methyl and edifenphos showed complete inhibition of fungal growth at concentrations of 0.2, 0.1 and 0.05%. When tested by dipping the mycelial and sclerotial inocula in the different concentrations of the test fungicides there was a significant reduction in growth with all the fungicides. Maximum inhibition occurred with tolclofos-methyl followed by carbendazim.

During the kharif season 1991-93, a field trial was conducted in a farmers plot at Mankundu, West Bengal, India. The rice cultivar Ratna was artificially inoculated with *R. solani* and the fungicides were sprayed at their recommended field doses 2 weeks after inoculation and 2 weeks later. All the fungicides significantly reduced sheath blight incidence. Maximum disease control was achieved with tolclofos-methyl followed by ziram. (Acharya *et al.*, 1997)

Miah *et al.* (1994) evaluated fourteen systemic and non systemic fungicides for the control of sheath blight of rice caused by *Rizoctonia solani* Kuhn as foliar spray on inoculated plants in the field. Among them Benlate or Fundazol (50% Benomyl l), Topsin-M (70% Thiophanate Methyl + 20% Thiram) were consistent in their effectiveness at 2.25 kg/ha sprayed either once at boot or twice at panicle initiation and boot stages. They were also effective under farmer's field condition. The results suggested that the disease can be managed by a single foliar spray with any one of the above mentioned fungicides at boot stage or after the symptom appearance.

Peng *et al.* (1993) reported that a single spray in the booting stage of rice (early to mid July) with a mixture of applaud (buprofezin) and bayleton (triadimefon), both of witch are highly effective and persistent and safe to humus, domestic animals and natural enemies and provided efficient reduction in yield loss.

Groth *et al.* (1993) evaluated a number of fungicides for control of rice diseases. Tilt (propiconazol) gave good control of sheath blight. Rovral (Iprodine) was effective against sheath blight and gave good yield stability.

Suryadi *et al.* (1991) evaluated the effectiveness of several fungicides against rice blast and sheath blight. Spraying of fungicides was done at full tillering stage before and after panicle initiation stage, respectively, using knapsack sprayer. The degree of efficacy was evaluated by using the percentage reduction of disease severity and the yield in each treatment. Mancozeb (1.6 kg/ha) was found good in controlling rice sheath blight. Treated plot yielded better than did the control plot.

Izadyar and Baradaran (1989) tested five fungicides for sheath blight control. IBP mepronil, validamycine and iprodine effectively controlled sheath blight. Yield was higher while spraying with IBP, validamycine and iprodin.

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

Suryadai and Kadir (1989) inoculated Pelita 1-2 rice plants with R. *solani* 55 day after transplanting (DAT). Eight fungicides were sprayed at 60, 67 and 74 DAT and disease incidence measured 25 days after flowering. Triazole was the most effective followed by Chlorothalonil, Mancozeb and Maneb + Zineb treatments. No, phytotoxicity occurred in any treatment.

Paromita and Mukerjee (1988) stated that seed treatment with Bavistin (Carbendazim) followed by dipping seedling in 0.05% solution for 10 min was better than seed treatment alone for controlling this disease caused by *Thanatephorus cucumis.*

Torabi and Binesh (1987) reported that in *in-vitro* condition Benomyl, Iprodine + Carbendazim and Mepronil at 50 ppm, Carboxin + Thiram and Carbendazim at 300 ppm, Edifenphos at 200 ppm and Zineb at 400 ppm inhibited mycelial growth of *Rhizoctonia solani.* In field trials, Iprodine + Carbendazim, Tilt and Validamycin effectively decreased disease incidence and increased yield but Mepronil, Zineb, Carboxin + Thiram and Edifenphos were less effective.

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

Arunyanart *et al.* (1986) tested 13 fungicides for sheath blight control where Pencycuron 25% WP, Validamycin 3% liquid, Carbendaziram 60% WP, and Propicanozonale 25% EC where most effective.

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

2.3.2. Management through soil amendment

Sarkar *et al.* (2002) found that soil amendment with oilcake not only reduce sheath blight incidence in rice, but also improve plant health. Amendment of soil with oilcakes (mustard and groundnut) resulted insignificant increase in the population of *R. solani* in the early stages of inoculum incubation (7-10 days). With increased in incubation period, however, the population of *R. solani* greatly reduced. The population of some saprophytic antagonistic fungi, such as *Aspergillus spp*. and *Penicillium spp*., increased greatly in amended soil. *Trichoderma harzianum*, a mycoparasite of *R. solani*, was isolated from amended soil only. Total bacterial population also substantially increased in amended soil. Soil amendment resulted in thickening, swelling and lysis of some cells of *R. solani* hyphae, particularly due to soil bacterial activity. In water and n-butanol extracts of oilcake-amended soils, the growth of *R. solani* was very much reduced. Volatile gaseous substances emitted by decomposing oilcakes in amended soil completely suppressed the growth of *R. solani.*

Meena *et al.* (2000) conducted an experiment to evaluate the efficacy of oils, oil cakes, bulb and seed extracts to suppress *Rhizoctonia solani in vitro* causing rice sheath blight. Palmarosa oil completely inhibited mycelial growth and gave good disease control.

Meena and Muthusamy (1999) stated that Neem (*Azadirachta indica*) cake (at 150 kg/ha) was the most effective treatment in reducing disease incidence and severity caused by *Rhizoctonia solani* on rice, compared with the control. This was followed by farmyard manure and decomposed coir pith (both at 12.5 t/ha).

Lee *et al.* (1998) stated that silicon soil amendments reduced disease severity in rice growing on several soils deficient in Si. Rice hull ash, a locally available rice processing by-product known to contain large amounts of Si, was evaluated as a preplant incorporated (PPI) soil amendment to reduce rice diseases. In 1996, rice plant Si content was increased from 2.30% (untreated plots) to 4.68% in plots treated with 8.9 tons/acre rice hull ash containing 61% Si. In 1997, rice hull ash with 91% Si applied at 4.5, 8.9 and 17.8 tons/acre increased rough rice yields, but rice blast was reduced only at the 17.8-ton rate with an accompanying 50% or greater reduction in rotten neck and panicle blast in La Grue cultivar under a moderately low, limited blast disease pressure. In summary, rice hull ash appeared to be limited as a means of reducing rice diseases in Arkansas.

Prasad *et al.* (1998) studied the effect of oil cakes (neem cake, groundnut cake, sesame cake) and 3 green leaf manures (*Calotropis* sp., *Crotalaria* sp. and *Phaseolus* sp.) on sclerotia survival of *R. solani* causing sheath blight of rice in 3 rice land soil. Neem cake and calotropis were the most effective in affecting the survival of sclerotia in the soil. The combined effect of calotropis with groundnut cake was the most effective combination in reducing sclerotial viability in soil.

Baby and Manibhushanrao (1996) studied the effect of various organic soil amendments on arbuscular mycorrhizal (AM) fungal activity on rice plants under greenhouse and field conditions with reference to sheath blight (Sh B) caused by *Rhizoctonia solani*. Organic amendments increased AM spore density, % infection and intensity of infection, whilst sheath blight was decreased. Green leaf manure stimulated arbuscule development in rice plants. Mycorrhizal formation and sporulation were higher in healthy rice plants than in infected rice plants. It is concluded that selective organic amendments could be used to enhance development of native AM fungi and reduce disease incidence.

Baby and Manibhushanrao (1993) conducted an experiment with two fungal antagonists (*Gliocladium virens* and *Trichoderma longibrachiatum*) and 2 organic soil amendments (gliricidia leaf and neem cake) to control rice sheath blight disease, caused by *Rhizoctonia solani*, under greenhouse and field conditions. Integration of these 2 systems enhanced the efficacy of their individual effects. In addition to disease suppression, the growth of rice plants and grain yield were increased to varying degrees by different treatments. The antagonists applied to the soil as wheat bran dust preparation survived well in the soil and reduced the pathogen population. When the antagonists were supplemented with organic substrates, an increase in the c.f.u. of the antagonists and a marked reduction in pathogen survival were noticed. The significance of integration of antagonists and amendments and the possible mechanisms involved are discussed.

Manibhushanrao and Baby (1991) evaluated the efficacy of two antagonistic fungi (*Trichoderma* sp. and *Gliocladium virens*) and two organic manures (*Gliricidia maculata* leaves and *Azadirachta indica*, cake) to control sheath blight caused by *Rhizoctonia solani*. Both antagonists and amendments alone and together significantly decreased sheath blight intensity and increased grain yield. Amendments protected plants better than antagonists; *Gliricidia* was the best, yielding 42% protection over the control. System integration helped both antagonists to more effectively control sheath blight.

Padmakumari and Balakrishna (1991) reported that paddy husk was very promising as an amendment for the biological control of *R. solani* while Gliricidia leaves, neem cake, punna cake, fish waste and groundnut shells were also effective.

Rajan and Reddy (1986a) evaluated the effect of bulky organic manure on sheath blight incidence. Incorporating neem cake, castor cake, rice straw, green leaf (*Gliricidia maculata*) or farmyard manure did not affect sheath blight incidence. Grain yield significantly differed among the treatments.

CHAPTER 3

MATERIALS AND METHODS

MATERIALS AND METHODS

The experiment was conducted (Plate 5) in the farm land alloted for the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka during the period from March to August, 2007.

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 Agro-ecological zone, Madhupur Tract (AEZ-28), which falls into Deep Red Brown Terrace Soils. The morphological description of the field is 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 Inundation	: Above flood level.
Drainage Condition	: Well drained.

3.2. Selection of the Variety

One high yielding rice variety, namely BR3 was used as test crops. This variety was developed by Bangladesh Rice Research Institute (BRRI) and was released by National Seed Board (NSB) for all season of Bangladesh. It is susceptible to sheath blight of rice (*Rhizoctonia solani*).

3.3. Chemicals Used

Five chemicals namely Bavistin 50 WP, Tilt 250 EC, Champion 77 WP, Cupravit 50 WP, Bleaching powder (BP) were used for the experiment. Details of fungicides are given below:

Name of fungicide	Active ingredients
Tilt 250 EC	25% Propiconazole
Bavistin 50 WP	50% Carbendazim
Champion 77 WP	77% Copper hydroxide
Cupravit 50 WP	50% Copper oxychloride

3.4. Soil amendment

Soil amendment was done adding with Ash, Sawdust, khudepana manure and Poultry manure. Amendment was done 15 days before transplanting of seedling.

3.5. Treatments of the experiment

Fourteen treatments including untreated control were explored in the experiment. The treatments comprise of five chemicals alone or in combination and four organic wastes for soil amendment and a control. The treatments were given below-

- **i.** T_1 = Bavistin 50 WP
- **ii.** T_2 = Tilt 250 EC
- **iii.** T_3 = Champion 77 WP
- **iv.** T_4 = Cupravit 50 WP
- **v.** T_5 = Bleaching powder (BP)
- **vi.** T_6 = Bavistin 50 WP + BP
- **vii.** T_7 = Tilt 250 EC + BP
- **viii.** T_8 = Champion 77 WP + BP
- **ix.** T_9 = Cupravit 50 WP + BP
- **x.** T_{10} = Ash
- **xi.** T_{11} = Sawdust
- **xii.** T_{12} = Khudepana
- **xiii.** T_{13} = Poultry manure
- **xiv.** T_{14} = Control untreated

3.6. Collection of Seed

3 kg seeds were collected from Bangladesh Rice Research Institute (BRRI) Joydebpur, Gajipur.

3.7. 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 seedbed.

3.8. 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 Laboratory, Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka. As the land was rich in organic matters, therefore no manuring was done. But 10 kg phosphate and 5 kg potash was applied to the seedbed. Sprouted seeds were sown in the wet seedbed on 21 March 2007. Seedlings were properly taken care of. Weeds were removed and irrigation was given in the seedbed as and when necessary.

3.9. Preparation of Experimental Land

The land for experiment was prepared with the help of power tiller and harrow. The land was first opened on 11 April 2007 and ploughed. After that, cowdung was incorporated to the puddle soil in the field. After 9 days, the final ploughing was performed with the help of power tiller followed by laddering in order 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.

3.10. Design of the Experiment

The experiment was carried out in a Randomized Complete Block Design (RCBD) with 3 replications. Each block comprised of 14 unit plots and total number of unit plots were 42 (14x3). The unit plot size was $4m^2$. The distance maintained between plots was 50 cm and between blocks was 1 m.

3.11. Fertilizer Application

Fertilizers were applied as per recommendation of BRRI (Adhunic Dhaner Chash, 2004). The following doses of fertilizers were applied to the plots:

Fertilizer	Dose/ha	Dose/plot
Urea	140 kg	56g
Triple super phosphate (TSP)	90 kg	36 g
Muriate of potash (MOP)	40 kg	16 g
Gypsum	60 kg	24 g
Zinc oxide	10 kg	4 g

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.

3.12. Application of organic waste for soil amendment

After preparation of unit plots of the experiment, the organic waste viz. ash, sawdust, khudepana manure and poultry manure, were separately mixed with the soil of the respective plot designed for. The prepared plots were kept 15 days for necessary amendment before transplanting of seedlings.

The dose of the application of organic wastes were as follows:

Name of waste	Dose/ha	Dose/Plot
Ash	3 ton	1.2 kg
Sawdust	3.5 ton	1.4 kg
Khudepana manure (Decomposed)	4 ton	1.6 kg
Poultry manure (Decomposed)	4 ton	1.6 kg

3.13. Transplanting of Seedling

Thirty days old seedlings were uprooted from the seedbed very carefully and then transplanted on 22 April 2007 in the main field. In the field experiment, row to row spacing was maintained as 25 cm and that of hill 20 cm and 2-3 seedlings were transplanted in an individual hill.

3.14. Intercultural Operation

3.12.1. Weeding : Weeding was done in the field as and when necessary.

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

3.15. Preparation and Application of Chemicals

Chemicals were sprayed as solution into the experimental plot as per treatment. Each spray solution was prepared by mixing desired amount of chemicals with tap water. The whole surface of the plant was sprayed by the solution of the chemicals. In case of control plot plain water was sprayed only. The chemical spraying was started from maximum tillering stage of rice plant and continued upto soft dough stage with 15 days intervals. Every time the chemicals were freshly prepared prior to application and the spray tank was thoroughly cleaned before filling with the individual spray material. While chemicals were used in combination with Bleaching powder in that case seedlings were dipped in chemical before transplanting. Paromita and Mukerjee (1988) stated that seed treatment with Bavistin (Carbendazim) followed by dipping seedling in 0.05% solution for 10 min was better than seed treatment alone. Special attention was given to complete coverage of the growing plants with the chemicals. Adequate precautions were taken to avoid drifting of spray materials from one plot to the neighboring ones. Concentration of spray chemicals are given bellow:

Common name	**Dose used (per 4 m ^{2} area)**
Bavistin 50 WP	0.1 %
Tilt 250 EC	0.1%
Champion 77 WP	0.1%
Cupravit 50 WP	0.1%
Bleaching powder	10 ppm

3.16. Assessment of the Disease Severity in the Field

Sixteen hills from each unit plot randomly considered for grading the severity of diseases on standing plants. Sixteen selected hills were tagged. 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 percent Relative Lesion Height (% RLH) which is given below:

0 = No incidence (Highly resistant)

1 = Less than 1% area affected (Resistant)

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

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

7 = 26-50% area affected (Susceptible)

9 = 51-100% 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 percent relative lesion height was calculated as per the formula given below (Ansari, 1995)

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

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

The crop was harvested on 09 August, 2007 at full ripening stage from field in plot wise. Moreover 16 tagged hills of each unit plot were harvested separately. The data on the following parameters were recorded:

i. Plant height (cm)
ii. Number of infected tillers/hill
iii. Lesion size
iv. Percent Relative Lesion Height (% RLH)
v. Length of panicle (cm)
vi. Number of filled grains/ panicle
vii. Number of unfilled grains / panicle
viii. Weight of thousand seeds (gm)
ix. Grain yield (ton/ha)
x. Straw yield (ton/ha)

3.18. Isolation and Identification of *Rhizoctonia solani* Pathogen

Collection of diseased leaf from the experimental site by using polythylene bag was taken to the laboratory of the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka. The diseased leaf was cut into small pieces (about 0.5-1 cm) from the infected portion of the leaf and surface sterilized by dipping in 10% sodium hypochlorite solution for 2-3 minutes or $HgCl_2$ solution (0.01%) for 30 second. The cut pieces were then washed in water in water at three times and were placed onto PDA media in sterilized petridish with help of sterile forceps and incubated were at 25 ± 1^0C for 7-10 days. Later the pathogen was purified using hyphal tip culture method and grown on PDA media at 25 ± 1^0C for 2 weeks and identified as *Rhizoctonia solani.* (Plate 2)

3.19. 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 II).

3.20. Analysis of data

The data recorded 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

RESULTS

The effect of different treatments against sheath blight (*Rhizoctonia solani*) was evaluated on the basis of plant height, number of infected tillers per hill, percent relative lesion height (%RLH), panicle length, number of filled and un filled grains per panicle, weight of 1000 grains, straw yield and seed yield that presented in this chapter.

4.1. Plant Height

The treatments had no remarkable differences on plant height. The plant height ranged from 100.51cm – 103.20 cm. The tallest plants (103.20 cm) were observed in treatment T_{11} (sawdust) which was closely followed by T_9 (Cupravit 50 WP + BP), T_6 (Bavistin 50 WP + BP) and T_8 (Champion 77 WP + BP). The shortest plants (100.51 cm) were obtained from the treatment T_5 (Table-1).

4.2. Percent Relative Lesion Height (% RLH)

The relative lesion height recorded before starting of spray was significantly indifferent with little extent. Comparatively, the lower % RLH was recorded in case of ash (T_{10}), sawdust (T_{11}), khudepana (T_{12}) and poultry manure (T_{13}) was applied for soil amendment (Table 1).

After starting the spray, marked differences on % RLH were notified at onward growth stage due to the application of treatments. At panicle initiation stage, the lowest % RLH (11.35) was recorded in T_6 (Bavistin 50 WP + BP) that reduced 23.25% RLH over control. The effect of T_7 (Tilt 250 EC + BP) and T_8 (Champion 77 WP + BP) on % RLH were significantly indifferent with that of T_6 (Bavistin 50 WP +BP). The highest % RLH was observed in control that was closely followed by T_{12} (Khudepana), T_{13} (Poultry manure), T_{11} (Sawdust) and T_{10} (Ash) where consecutive spraying was not applied after soil amendment (Table 1).

At flowering stage, the treatments showed similar trend of results on % RLH against sheath blight. The lowest % RLH (20.41) was obtained from the treatment T_7 (Tilt 250 EC + BP) that reduced 44.25% RLH over control and this effect was statistically identical with that of T_6 (Bavistin 50 WP + BP) which was closely followed by T_8 (Champion 77 WP +BP). The highest RLH was recorded in control (36.61 %) which was followed by T_{12} (28.87%), T_{11} (27.89%) and T_{13} (27.71%) where no spray were applied after soil amendment with agro wastes. (Table 1).

At soft dough stage, the trend of the effect of different treatments on % RLH were also similar as observed in panicle initiation stage and flowering stage. The % RLH reduced by 54.09% and 52.13%, respectively by the treatment T_6 (Bavistin 50 WP +BP) and T_7 (Tilt 250 EC +BP). The highest % RLH was recorded in control (46.25) at soft dough stage (Table 1).

4.3. Number of infected tillers per hill

The effect on number of infected tillers per hill due to the application of treatments were recorded at different growth stages and presented in Table 2.

The number of infected tillers per hill was found statistically similar among the treatments before starting of spray with the chemicals. But at advanced stages (flowering stage and soft dough stage) the number of infected tillers sharply differed among the treatments.

At panicle initiation stage, the lowest number of infected tillers (4.83) per hill was recorded in treatment T_6 (Bavistin 50 WP + BP) which did not differ statistically with T_7 (Tilt 250 EC + BP) that followed by T_1 (Bavistin 50 WP). The effect of T_1 (Bavistin 50 WP), T_2 (Tilt 250 EC) and T_3 (Champion 77 WP) was statistically identical in respect of number of infected tillers per hill. On the basis of the infected tillers per hill, the calculated result showed that the highest reduction (45.71%) of infected tillers per hill was scored by T_6 (Bavistin 50 WP + BP) which was closely followed by T_7 (Tilt 250 EC + BP) and T_8 (Champion

77 WP + BP). The treatments that applied for soil amendment alone unabled to contribute to reduced the number of infected tillers.

At flowering stage, the similar trend of results was maintained due to the application of the treatments. The lowest number of infected tillers per hill (5.51) was recorded in T_6 (Bavistin 50 WP + BP) that reduced 45.63% infected tiller followed by T_7 (Tilt 250 EC + BP) and T_8 (Champion 77 WP + BP). The control treatment yielded the highest number of infected tillers per hill while the treatments that comprised only agro wastes for soil amendment unabled to perform better result in reducing infected tiller (Table 2).

At soft dough stage, the effect of different treatments on reducing number of infected tillers seemed to be more distinct among the treatments. As like the previous trend, the lowest number of infected tillers (7.63) was noted in case of T_6 (Bavistin 50 WP + BP) that reduced 39.59% infected tillers per hill compared to control (Plate 3). The second lowest infected tillers per hill (8.51) was obtained in T_7 (Tilt 250 EC + BP) which was statistically indifferent with T_8 (Champion 50 WP + BP) and T_9 (Cupravit 50 WP + BP). The highest number of infected tillers was recorded in control (12.63) in soft dough stage (Table 2).

4.4. Lesion size

The effect of the treatments on lesion size recorded at different growth stages viz. panicle initiation stage, flowering stage and soft dough stage was presented in Table 3.

The lesion size recorded before starting of spray was significantly indifferent with some extent. Comparatively the lower lesion size was observed in those treatments where ash (T_{10}), saw dust (T_{11}), Khudepana (T_{12}) and poultry manure (T_{13}) were applied for soil amendment (Table 3).

After starting the spray, marked differences on lesion size were observed in advanced growth stages due to the application of treatments. At panicle initiation stage, the lowest lesion size (11.75 cm) was recorded in T_6 (Bavistin 50 WP +

BP) that reduced 22.75% lesion size over control. The effect of T_7 (Tilt 250 EC + BP) and T_8 (Champion 77 WP + BP) on lesion size were significantly indifferent with that of T_6 (Bavistin 50 WP + BP) and followed by T_9 (Cupravit 50 WP + BP), T_1 (Bavistin 50 WP) and T_2 (Tilt 250 EC). The effect of T_9, T_1 and T_2 was statistically identical in respect of lesion size. The highest lesion size was observed in control (5.785 cm) that was closely followed by T_{12} (khudepana), T_{13} (poultry manure), T_{11} (sawdust) and T_{10} (ash) where spraying were not done after soil amendment with agro wastes.

At flowering stage, the treatments showed similar trend of results on lesion size against sheath blight. The lowest lesion size (20.41 cm) was recorded in T_7 (Tilt 250 EC + BP) which did not differ significantly with T_6 (Bavistin 50 WP + BP). The effect of T_9 (Cupravit 50 WP + BP), T_1 (Bavistin 50 WP) and T_2 (Tilt 250 EC) was statistically identical in respect of lesion size. On the basis of the result made on reduction of lesion size it was observed that the highest reduction of lesion size over control (44.25%) was scored by T_7 (Tilt 250 EC + BP) which were closely followed by T_6 (Bavistin 50 WP + BP). The highest lesion size was recorded in control (36.61 cm) (Plate 4) which was followed by T_{12} (28.87), T_{11} (27.89) and T_{13} (27.71 cm) where no spray were applied after soil amendment with agro wastes (Table 3).

At soft dough stage, the trend of the effect of different treatments on lesion size was also similar as observed in panicle initiation stage and flowering stage. The lowest lesion size (21.86 cm) was noted incase of T_6 (Bavistin + BP) that reduced 54.04% lesion size compared to control. The second lowest lesion size (22.58 cm) was obtained in T_7 (Tilt 250 EC + BP). The highest lesion size (47.56 cm) was recorded in control in soft dough stage. (Table 3).

4.5. Length of panicle, number of filled grains per panicle and number of unfilled grains per panicle

The effect of length of panicle, number of filled grains per panicle and number of unfilled grains per panicle due to the application of treatments were recorded and presented in Table 4.

The treatment's effects were found to differ significantly in respect of length of panicle, number of filled grains per panicle and number of unfilled grains per panicle.

In case of length of panicle, the highest length of panicle (29.37 cm) was recorded from the treatment T_6 (Bavistin 50 WP + BP) which did not differ statistically with T_7 (Tilt 250 EC + BP) and that was closely followed by T_9 (Cupravit 50 WP +BP), T_{11} (sawdust) and T_2 (Tilt 250 EC). The lowest length of panicle was recorded in control (24.96 cm).

In case of filled grains per panicle, the highest number of filled grains (Plate 6) per panicle (99.73) was recorded in treatment T_6 (Bavistin 50 WP + BP). The second highest filled grains per panicle (87.07) was obtained from T_7 (Tilt 250 EC + BP) which was statistically identical with T_8 (Champion 77 WP + BP) and T_1 (Bavistin 50 WP). The lowest number of filled grains per panicle was recorded in control (36.50) preceded by T_{13} (54.63), T_{12} (58.37).

In case of unfilled grains per panicle, the performance of the treatments maintained the previous trend as observed in filled grains per panicle. The lowest number of unfilled grains (14.27) was obtained from T_6 (Bavistin 50 WP + BP) which was statistically indifferent with T_7 (Tilt 250 EC + BP) followed by T_8 (Champion 77 WP + BP) and T_9 (Cupravit 50 WP + BP). The number of unfilled grains per panicle observed in T_9 (Cupravit 50 WP + BP) which also statistically similar with T_8 (Champion 77 WP + BP). The highest number of unfilled grains (Plate 7) per panicle was obtained from control (61.70) preceded by T_{12} (38.43), T_{11} (36.77) and T_{13} (36.58). The number of unfilled grains recorded in T_1 (Bavistin 50 WP), T_3 (Champion 77 WP), T_4 (Cupravit 50 WP), T_{10} (ash), T_{11} (sawdust), T_{12} (khudepana) and T_{13} (poultry manure) were found statistically similar. (Table 4)

4.6. Grain Yield

The effect of treatments differ significantly in respect of grain yield (ton/ha). The highest grain yield (5.59 ton/ha) was recorded in T_6 (Bavistin 50 WP + BP) followed by T_7 (Tilt 250 EC + BP) which was statistically similar with that of T_8 (Champion 77 WP +BP). The lowest grain yield (4.06 ton/ ha) was recorded in control which was also statistically indifferent with T_{11} (sawdust). The effect of T_1 (Bavistin 50 WP), T_2 (Tilt 250 EC), T_3 (Champion 77 WP), T_4 (Cupravit 50 WP) and T_9 (Cupravit 50 WP + BP) were moderate in terms of grain yield (ton/ha) (Table 5).

On the basis of grain yield (ton/ha) performed by different treatments, the grain yield increased over control was calculated and it was observed that the highest increase (37.34%) of grain yield was found in T_6 (Bavistin 50 WP + BP) followed by T_7 (Tilt 250 EC + BP) and T_8 (Champion 77 WP + BP) where 32.62%, 31.94% grain yield were recorded respectively. The performance of T_{11} (Sawdust), T_{12} (Khudepana), T_{10} (Ash) and T_{13} (Poultry manure) were very poor in increasing the grain yield over control (Fig. 1). The effect of treatments T_1 (Bavistin 50 WP), T_2 (Tilt 250 EC), T_3 (Champion 77 WP), T_4 (Cupravit 50 WP) and T_9 (Cupravit 50 WP + BP) were moderate in terms of grain yield (ton/ha) (Table 5).

4.7. Weight of 1000 grain

In terms of 1000 grain weight the different treatments showed significant effect on sheath blight of rice. The highest weight of 1000 grains (26.50 gm) was measured in case of T_6 (Bavistin 50 WP + BP). The second highest weight of 1000 grains (25.60 gm) was obtained from T_7 (Tilt 250 EC + BP) which was statistically indifferent with T_2 (Tilt 250 EC), T_8 (Champion 77 WP +BP) and T_9

(Cupravit 50 WP + BP). The lowest 1000 grains weight was yielded by control (23.10 gm) preceded by T_{13} (Poultry manure), T_{11} (sawdust), T_{12} (khudepana) and T_3 (Champion 77 WP).

4.8. Straw Yield:

The effect of different treatments in terms of straw yield was determined and presented in table 5. The highest straw yield (6.25 ton/ha) was noted in case of T_6 (Bavistin 50 WP + BP) followed by T_7 (Tilt 250 EC + BP), T_2 (Tilt 250 EC) and T_9 (Cupravit 50 WP +BP). Effect of T_1 (Bavistin 50 WP), T_2 (Tilt 250 EC), T_3 (Champion 77 WP) and T_8 (Champion 50 WP + BP) in respect of straw yield (ton/ha) was significantly similar. The lowest performance was shown by control (4.39 ton/ha) which was statistically identical with T_{11} (sawdust), T_{12} (khudepana) and T_{13} (poultry manure) where soil amendment was done alone.

Table 1: Effect of different treatments on % Relative lesion height in different growth stages of rice cv. BR 3 (Biplob)

Treatments	Plant height (cm)	%Relative lesion height (RLH)						
		Before spray	After spray					
			Panicle initiation	%RLH reduced over control in panicle initiation	Flowering stage	%RLH reduced over control in flowering stage	Soft dough stage	%RLH reduced over control in soft dough stage
T_1	101.90	9.11 abc	12.10 gh	18.18	23.38 h	36.13	24.98 h	45.98
T_2	101.13	9.413 ab	12.23 fg	17.30	23.49 h	35.83	25.62 fg	44.65
T_3	101.56	8.98 bcd	12.72 de	13.99	24.29 g	33.65	25.93 f	43.94
T_4	102.90	9.52 a	12.84 de	13.18	25.22 f	31.11	26.02 f	43.74
T_5	100.51	8.96 bcd	12.51 ef	15.51	26.93 d	26.44	28.04 e	39.37
T_6	103.02	8.97 bcd	11.35 i	23.25	20.51 j	43.97	21.23 k	54.09
T_7	102.01	9.09 bcd	11.53 i	22.04	20.41 j	44.25	22.14 j	52.13
T_8	103.00	9.02 bcd	11.70 hi	20.89	21.95 i	40.04	23.54 i	49.10
T_9	103.09	9.03 bcd	12.02 gh	18.72	23.30 h	36.35	25.32 gh	45.25
T_{10}	102.00	8.85 cd	12.95 d	12.44	26.09 e	28.73	29.04 d	37.21
T_{11}	103.20	8.86 cd	13.56 c	08.31	27.89 c	23.81	31.82 c	31.20
T_{12}	102.59	8.75 cd	14.30 b	03.31	28.87 b	21.14	33.30 b	28.00
T_{13}	102.96	8.76 cd	13.92 bc	05.88	27.71 c	24.31	33.32 b	27.96
T_{14}	102.85	9.10 abc	14.79 a	-	36.61 a	-	46.25 a	-

T_1 = Bavistin 50 WP
T_2 = Tilt 250 EC
T_3 = Champion 77 WP
T_4 = Cupravit 50 WP
T_5 = Bleaching powder (BP)
T_6 = Bavistin 50 WP + BP
T_7 = Tilt 250 EC + BP
T_8 = Champion 77 WP + BP
T_9 = Cupravit 50 WP + BP
T_{10} = Ash
T_{11} = Sawdust
T_{12} = Khudepana
T_{13} = Poultry manure
T_{14} = Control

Table 2: Effect of different treatments on number of infected tillers per hill in different growth stages of rice cv. BR 3 (Biplob)

Treatments	No. of Infected Tillers Per Hill						
	Before spray	After spray					
		Panicle initiation	No. of infected tiller/hill reduced over control	Flowering stage	% No. of infected tiller/hill reduced over control	Soft dough stage	%No. of infected tiller/hill reduced over control
T_1	3.97 a	5.91 d	33.62	07.91 e	21.99	10.02 f	20.67
T_2	3.68 a	6.03 d	32.87	08.12 e	19.89	09.92 fg	21.43
T_3	4.00 a	5.93 d	33.31	08.25 de	18.64	09.55 g	24.39
T_4	3.84 a	6.24 d	29.88	08.57 cd	15.48	10.50 e	16.79
T_5	3.71 a	7.06 c	20.70	09.02 b	11.07	11.04 d	12.59
T_6	3.70 a	4.83 f	45.71	05.51 h	45.63	07.63 i	39.59
T_7	3.89 a	5.10 f	42.68	06.64 g	34.55	08.51 h	32.62
T_8	3.98 a	5.45 e	38.75	06.89 fg	32.05	08.83 h	30.11
T_9	4.04 a	5.86 d	34.18	07.03 f	30.70	08.93 h	29.32
T_{10}	4.02 a	7.22 c	18.82	09.81a	03.22	12.00 b	04.99
T_{11}	3.87 a	6.93 c	22.16	09.22 b	07.98	11.57 c	8.39
T_{12}	3.77 a	7.12 c	20.03	08.94 bc	11.86	11.15 cd	11.72
T_{13}	3.81 a	8.13 b	08.65	09.06 b	10.68	11.03 d	12.67
T_{14}	3.99 a	8.90 a	--	10.14 a	--	12.63 a	--

T_1 = Bavistin 50 WP
T_2 = Tilt 250 EC
T_3 = Champion 77 WP
T_4 = Cupravit 50 WP
T_5 = Bleaching powder (BP)
T_6 = Bavistin 50 WP + BP
T_7 = Tilt 250 EC + BP
T_8 = Champion 77 WP + BP
T_9 = Cupravit 50 WP + BP
T_{10} = Ash
T_{11} = Sawdust
T_{12} = Khudepana
T_{13} = Poultry manure
T_{14} = Control

Table 3: Effect of different treatments on Lesion size in different growth stages of rice cv. BR 3 (Biplob)

Treatments	Lesion size (cm)						
	Before spray	After spray					
		Panicle initiation	% Lesion size reduced over control	Flowering stage	% Lesion size reduced over control	Soft dough stage	% Lesion size reduced over control
T_1	9.28 abc	12.32 fg	19.00	23.38 h	36.14	25.12 h	47.30
T_2	9.51 ab	12.25 fg	19.46	23.49 h	35.84	25.90 g	45.54
T_3	9.05 bcd	12.91 de	15.12	24.29 g	33.65	26.33 fg	44.64
T_4	9.77 a	13.21 d	13.15	25.22 f	31.11	26.77 f	43.71
T_5	9.12 abcd	12.57 ef	17.36	26.93 d	26.44	28.16 e	40.79
T_6	9.14 abcd	11.75 h	22.75	20.51 j	43.98	21.86 k	54.04
T_7	9.15 abcd	11.76 h	22.68	20.41 j	44.25	22.58 j	52.52
T_8	9.28 abc	12.04 gh	20.84	21.95 i	40.04	24.24 i	49.03
T_9	9.56 ab	12.39 fg	18.54	23.30 h	36.36	26.09 g	45.14
T_{10}	8.78 cd	13.20 d	13.21	26.09 e	28.74	29.62 d	37.72
T_{11}	8.56 d	13.99 c	08.02	27.89 c	23.82	32.50 c	31.67
T_{12}	8.79 cd	14.66 b	03.62	28.87 b	21.14	34.16 b	28.17
T_{13}	8.58 cd	14.33 bc	05.79	27.71 c	24.31	34.30 b	27.88
T_{14}	9.27abc	15.21 a	--	36.61 a	--	47.56 a	--

T_1 = Bavistin 50 WP
T_2 = Tilt 250 EC
T_3 = Champion 77 WP
T_4 = Cupravit 50 WP
T_5 = Bleaching powder (BP)
T_6 = Bavistin 50 WP + BP
T_7 = Tilt 250 EC + BP
T_8 = Champion 77 WP + BP
T_9 = Cupravit 50 WP + BP
T_{10} = Ash
T_{11} = Sawdust
T_{12} = Khudepana
T_{13} = Poultry manure
T_{14} = Control

Table 4. Comparative effect of different treatments either alone or in combination on the length of panicle, number of filled grains and unfilled grains of rice cv. BR 3 (Biplob)

Treatments	Length of panicle	No. of filled grains/Panicle	No. of unfilled grains/Panicle
T_1 (Bavistin 50 WP)	26.40 d	83.10 b	33.60 c
T_2 (Tilt 250 EC)	28.00 abc	71.23 de	27.93 d
T_3 (Champion 77 WP)	27.36 bcd	81.23 bc	35.23 c
T_4 (Cupravit 50 WP)	27.13 bcd	74.67 d	35.33 c
T_5 (Bleaching powder, BP)	26.66 cd	64.87 f	27.50 d
T_6 (Bavistin 50 WP + BP)	29.37 a	99.73 a	14.27 f
T_7 (Tilt 250EC + BP)	28.37 ab	87.07 b	17.00 f
T_8 (Champion 77 WP + BP)	26.80 cd	86.43 b	21.83 e
T_9 (Cupravit 50 WP + BP)	28.16 abc	76.17 cd	25.27 de
T_{10} (Ash)	27.82 bcd	64.87 f	35.90 c
T_{11} (Sawdust)	28.00 abc	66.79 ef	36.77 c
T_{12} (Khudepana)	27.93 abcd	58.37 g	38.43 c
T_{13} (Poultry manure)	27.63 bcd	54.63 g	36.58 c
T_{14} (Control)	24.96 e	36.50 h	61.70 a

Table 5. Effect of different treatments on 1000 grain wt., grain and straw yield of rice cv. BR 3 (Biplob)

Treatments	Grain yield (ton/ha)	% increased (+) or decreased (-) of grain yield over control (ton/ ha)	wt. of 1000 grains (g)	Straw yield (ton/ha)
T_1 (Bavistin 50 WP)	4.91 c	20.92 (+)	24.63 c	5.40 cd
T_2 (Tilt 250 EC)	4.96 c	21.86 (+)	25.50 b	5.57 c
T_3 (Champion 77 WP)	4.58 d	12.53 (+)	24.35 c	5.17 d
T_4 (Cupravit 50 WP)	4.68 d	14.98 (+)	24.33 c	5.39 cd
T_5(Bleaching powder, BP)	4.28 e	05.15 (+)	24.00 cd	4.86 e
T_6 (Bavistin 50 WP + BP)	5.59 a	37.34 (+)	26.50 a	6.25 a
T_7 (Tilt 250 EC + BP)	5.39 b	32.62 (+)	25.60 b	5.91 b
T_8 (Champion 50 WP + BP)	5.37 b	31.94 (+)	25.35 b	5.43 cd
T_9 (Cupravit 50 WP + BP)	4.84 c	18.91 (+)	25.30 b	5.46 c
T_{10} (Ash)	4.31 e	05.65 (+)	24.53 c	4.79 ef
T_{11} (Sawdust)	4.11 fg	00.98 (+)	24.00 cd	4.60 efg
T_{12} (Khudepana)	4.24 ef	04.17 (+)	24.13 c	4.57 fg
T_{13} (Poultry manure)	4.31 e	05.97 (+)	23.47 de	4.56 fg
T_{14} (Control)	4.06 g	--	23.10 e	4.39 g

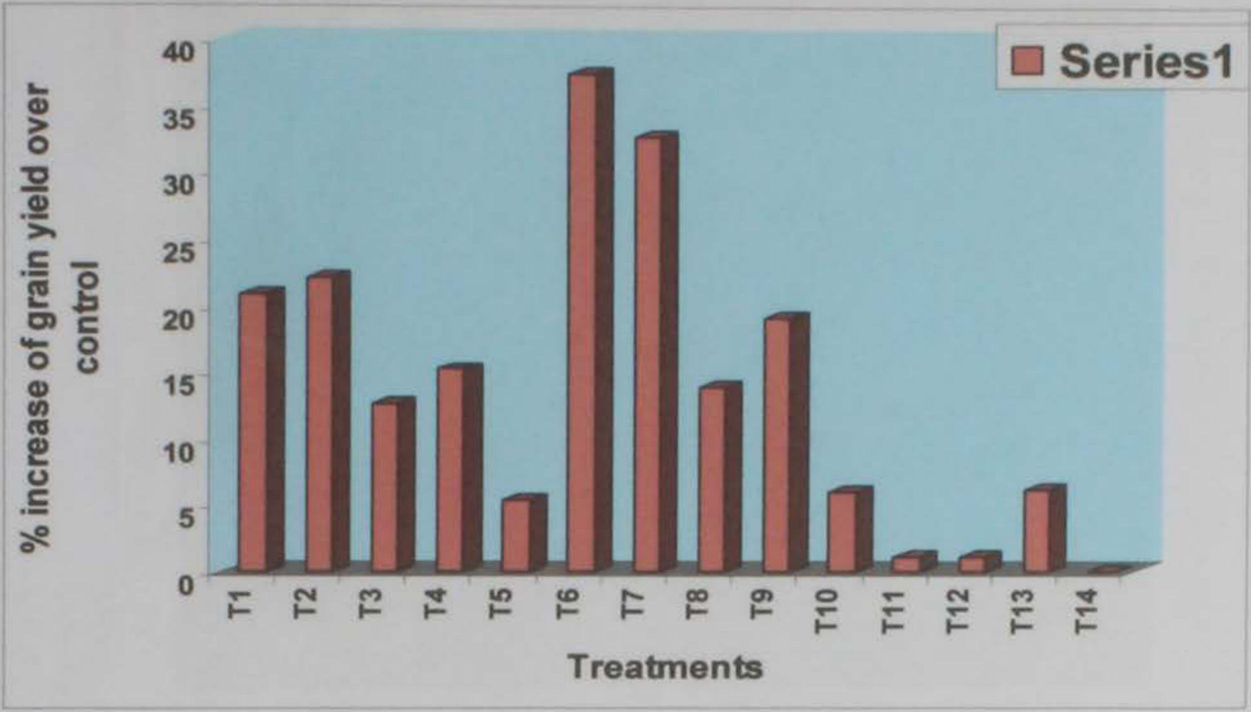

Figure 1. Effect of different treatments on % increased of grain yield over control.

Plate 1: Typical symptoms of sheath blight of rice caused by *Rhizoctonia solani*

Plate 2: Pure culture of *Rhizoctonia solani* showing huge number of sclerotium

Plate 3: Showing comparatively healthy plot of rice treated with T_6 (Bavistin 50 WP + BP)

Plate 4: Showing control plot affected by sheath blight of rice (*Rhizoctonia solani*)

Plate 5: A view of the field experimental field

Plate 6: Showing comparatively filled grains obtained from T_6 (Bavistin 50 WP + BP) treated plot

Plate 7: Showing unfilled grains obtained from control plot

CHAPTER 5

DISCUSSION

DISCUSSION

The sheath blight of rice caused by *Rizoctonia solani* is documented to be major and destructive disease occurring in Bangladesh especially of modern high input requiring cultivars (Miah *et al.*, 1985; Shahjahan *et al.*, 1987). The present study was carried out with fourteen treatments viz. T_1 (Bavistin 50 WP), T_2 (Tilt 250 EC), T_3 (Champion 77 WP), T_4 (Cupravit 50 WP), T_5 (Bleaching powder, BP), T_6 (Bavistin 50 WP + BP), T_7 (Tilt 250 EC + BP), T_8 (Champion 77 WP + BP), T_9 (Cupravit 50 WP + BP), T_{10} (Ash), T_{11} (Sawdust), T_{12} (Khudepana), T_{13} (Poultry manure) and T_{14} (Control untreated) for the management of sheath blight of rice (BR 3) caused by *Rhizoctonia solani* under field condition. The findings of the present study showed that the rice plant under different treatments were relatively healthy up to maximum tillering stage and the disease severity gradually increased during the later stages of crop growth. This finding is in accordance with the findings of Sharma and Teng (1996), who reported that disease development was also higher at later growth stages.

Regarding the effect of fourteen treatments on plant height no marked difference has been observed. Comparatively the tallest plant was recorded in case of T_{11} where agro waste as sawdust was used as soil amendment. Perhaps the organic matter added as sawdust slightly influenced the plant height.

From the present study it was evident that different treatments resulted in reduction of percent relative lesion height (% RLH) in comparison to control. Effect of different treatments on % RLH was studied before and after spray at different growth stages. The % RLH before starting spray, was found significantly indifferent with some extent. Comparatively, the lower % RLH were observed in case of ash, sawdust, khudepana and poultry manure applied for soil amendment. After spray, the highest % RLH was found in control and the lowest % RLH was found in T_6 (Bavistin 50 WP + BP) at all growth stages eg. panicle initiation stage, flowering stage and soft dough stage. 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. The performance of soil amendment with agro waste was not found remarkable like chemicals but was better than control. Lee *et al.* (1998) concluded that rice hull ash appeared to be effective in reducing rice disease.

The effect of different treatments in respect of number of infected tillers per hill at different stages indicated that the minimum number of infected tillers were found in T_6 (Bavistin 50 WP + BP) and maximum number in T_{14} (control) at panicle initiation stage, flowering stage and soft dough stage. The performances of soil amendment with agro wastes were not so remarkable like chemical but were better than control. The present findings also supported by Mian *et al.* (2004) who reported that Akonazole 250 EC (Propiconazole) appeared to be most effective in reducing tiller infection for sheath blight of rice.

The effect of different treatments in respect of lesion size, the minimum lesion size was obtained from T_6 (Bavistin 50 WP + BP) while the maximum lesion size was recorded from control. Parveen (1998) carried out a study on the chemical effect against sheath blight regarding lesion development and concluded that sheath blight disease of rice could be controlled by only one spray of Tilt 250 EC.

From the present study, it is evident that different treatments resulted in increasing length of panicle, number of filled grain per panicle and reducing number of unfilled grain per panicle in comparison to control. The highest length of panicle (29.37 cm), the highest number of filled grain per panicle (99.73) and the lowest number of unfilled grain per panicle (14.27) were recorded from T_6 (Bavistin 50 WP + BP) while the lowest length of panicle (24.96 cm), the lowest number of filled grain per panicle (36.50) and the highest number of unfilled grain per panicle (61.70) were recorded from control. Previous reports indicated that sheath blight disease of rice could successfully be control by using Tilt 250 EC, Bleaching powder and Bavistin 50 WP. (Akter *et al.*, 2001; Ashrafuzzaman *et al.*, 2005; Lore *et. al.*, 2005; Mian *et. al.*, 2004; Ali and Archer, 2003; Rodriguez *et. al.*, 2001; Mia, 1999); Rajiv *et. al.*, 1997; Tangasamy and Rangaswamy, 1989; Torabi and Binesh, 1987; Jones *et. al.*, 1987; Arunyanart *et. al.* 1986)

Considering the over all performances of treatments applied in management of sheath blight of rice, the best performance was shown by T_6 (Bavistin 50 WP + BP) followed by T_7 (Tilt 250 EC + BP) and T_8 (Champion 50 WP + BP) that reduced the disease incidence and severity, influenced the yield contributing characters and increased yield.

CHAPTER 6

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

A field experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka for the management of sheath blight of rice (BR 3) during the period of March 2007 to August 2007 in Aus season. Fourteen treatments viz. Bavistin 50 WP, Tilt 250 EC, Champion 77 WP, Cupravit 50 WP, Bleaching powder (BP), Bavistin 50 WP + BP, Tilt 250 EC + BP, Champion 77 WP + BP, Cupravit 50 WP + BP, Ash, Sawdust, Khudepana, Poultry manure and untreated Control were evaluated against *Rhizoctonia solani* causing sheath blight of rice. The experiment was laid out in Randomized Complete Block Design (RCBD) (one factor) with three replications. Data were collected on disease incidence and severity of the disease, yield and yield contributing characters at different stages.

The treatments had no remarkable different on plant height. The highest plant height (103.20 cm) was observed in case of sawdust which was closely followed by Cupravit 50 WP + BP, Bavistin 50 WP + BP and Champion 77 WP + BP. The shortest plant height (100.51 cm) was obtained from Bleaching powder (BP) treated plot.

The percent relative lesion highest (% RLH) before starting of spray were significantly indifferent with some extent. After starting the spray, the lowest % RLH (11.35 cm) was recorded in Bavistin 50 WP + BP that reduced 23.25% RLH over control in panicle initiation stage. The effect of Tilt 250 EC + BP (11.53) and Champion 77 WP + BP (11.70) on % RLH was significantly indifferent with that of Bavistin 50 WP + BP. The highest % RLH was observed in control (14.79) that was closely followed by khudepana (14.30), poultry manure (13.92), sawdust (13.56) and ash (12.95). At flowering stage, the lowest % RLH (20.41) was obtained from the treatment Tilt 250 EC + BP that reduced 44.25% RLH over control and this effect was statistically identical with that of Bavistin 50 WP + BP (20.51) which was closely followed by Champion 77 WP + BP (21.95). The highest % RLH was recorded in control (36.61 %) which was followed by khudepana (28.87%), sawdust (27.89%) and poultry manure (27.71%). At soft dough stage the lowest RLH (21.23 %) was recorded in Bavistin 50 WP + BP followed by Tilt 250 EC + BP (22.14 %) and highest RLH (46.25 %) was recorded in control.

Regarding number of infected tillers per hill, the lowest number of infected tillers (4.83) per hill at panicle initiation stage was recorded in treatment Bavistin 50 WP + BP which did not differ statistically with Tilt 250 EC + BP (5.10) and followed by Bavistin 50 WP (5.91). The highest reduction (45.71%) of infected tillers per hill was made by Bavistin 50 WP + BP which was closely followed by Tilt 250 EC + BP (42.68%) and Champion 77 WP + BP (38.75). At flowering stage, the lowest number of infected tillers per hill (5.51) was recorded in Bavistin 50 WP + BP followed by Tilt 250 EC + BP (6.64). The highest number of infected tillers per hill (10.14) was recorded in control. At soft dough stage, the lowest number of infected tillers (7.63) was noted in case of Bavistin 50 WP + BP that reduced 39.59% infected tillers per hill compared to control. The second lowest infected tillers per hill (8.51) were obtained in Tilt 250 EC + BP which was statistically indifferent with Champion 77 WP + BP (8.83) and Cupravit 50 WP + BP (8.93). The highest number of infected tillers was recorded in control (12.63).

At panicle initiation stage, the lowest lesion size (11.75 cm) was recorded in Bavistin 50 WP + BP that reduced 22.75% lesion size over control. The effect of Tilt 250 EC + BP (11.76 cm) and Champion 77 WP + BP (12.04 cm) on lesion size were significantly identical with that of Bavistin 50 WP + BP. The highest lesion size was observed in control (15.21 cm) that was closely followed by khudepana (14.66 cm), poultry manure (14.33 cm), saw dust (13.99 cm) and ash (13.20 cm). At flowering stage the lowest lesion size (20.41 cm) was recorded in Tilt 250 EC + BP which were significantly similar with Bavistin 50 WP + BP (20.51 cm). The highest reduction of lesion size over control (44.25%) was scored by Tilt 250 EC + BP closely followed by Bavistin 50 WP + BP (43.98%). The highest lesion size was recorded in control (36.61 cm) followed by khudepana (28.87 cm), sawdust (27.89 cm) and poultry manure (27.71 cm). At soft dough stage, the lowest lesion size (21.86 cm) was noted in Bavistin 50 WP + BP that reduced 54.04% lesion size compared to control. The second lowest lesion size (22.58 cm) was obtained from Tilt 250 EC + BP. The highest lesion size (47.56 cm) was recorded in control.

The highest length of panicle (29.37 cm) was recorded in Bavistin 50 WP + BP which did not differ statistically with Tilt 250 EC + BP (28.37 cm) and that was closely followed by Cupravit 50 WP + BP (28.16 cm), sawdust (28.0 cm) and Tilt 250 EC (28.00 cm). The lowest length of panicle was recorded in control (24.96 cm). The highest number of filled grain per panicle (99.73) was recorded in Bavistin 50 WP + BP followed by Tilt 250 EC + BP (87.07). The lowest number of filled grains per panicle was recorded in control (36.50) proceeded by poultry manure (54.63) and khudepana (58.37). The lowest number of unfilled grains (14.27) was obtained from Bavistin 50 WP + BP which was statistically indifferent with Tilt 250 EC + BP (17.00) followed by Champion 77 WP (21.83) and Cupravit 50 WP + BP (25.27). The highest number of unfilled grain per panicle was obtained from control.

The highest grain yield (5.59 ton/ha) was recorded in Bavistin 50 WP + BP followed by Tilt 250 EC + BP (5.39 ton/ha) which was statistically similar with Champion 77 WP + BP (5.37 ton/ha). The lowest grain yield (4.06 ton/ ha) was recorded in control. The highest grain yield (37.34%) increased over control was observed in Bavistin 50 WP + BP followed by Tilt 250 EC + BP (32.62%). The highest weight of 1000 grains (26.50 gm) was measured in case of Bavistin 50 WP + BP. The second highest weight of 1000 grains (25.60 gm) was obtained from Tilt 250 EC + BP which was statistically indifferent with Tilt 250 EC (25.50 gm), Champion 77 WP + BP (25.35 gm) and Cupravit 50 WP + BP

(25.30 gm). The lowest 1000 grain weight was yielded by control (23.10 gm). The highest straw yield (6.25 ton/ha) was noted in Bavistin 50 WP + BP followed by Tilt 250 EC + BP (5.913 ton/ha), Tilt 250 EC (5.57 ton/ha) and Cupravit 50 WP + BP (5.46 ton/ha). The lowest straw yield was shown by control (4.39 ton/ha).

From the present findings it may be concluded that Bavistin 50 WP + BP was found to be promising for lowering sheath blight incidence and severity and for the highest yield of rice (BR 3). However further investigation need to be carried out incorporating more treatments to authenticate the results against the disease.

CHAPTER 7

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CHAPTER 8

APPENDICES

APPENDICES

Appendix I. Results of mechanical and chemical analysis of soil of the experimental plot

A. Mechanical analysis:

Constituents	Percent
Sand	32.45
Silt	61.35
Clay	06.10
Textural class	Silty loam

B. Chemical analysis:

Soil properties	Amount
Soil pH	06.15
Organic carbon (%)	01.32
Total nitrogen (%)	00.08
Available phosphorous (ppm)	19.50
Exchangeable potassium (%)	00.20

Source: Agricultural University Humboldt Soil Testing Laboratory, Department of Soil Science, Bangladesh Agricultural University, Mymensingh.

Appendix II. Monthly average temperature, relative humidity and total rainfall, during the period from March to August 2007

Months of the year 2007	Air temperature (°C)			Relative humidity (%)	Total rainfall (mm)
	Maximum	Minimum	Average		
March	31.25	21.55	26.40	74.65	35
April	32.98	23.72	28.35	88.24	65
May	34.00	24.65	33.45	79.55	155
June	33.85	26.15	30.00	69.05	184
July	34.20	24.50	29.35	89.5	281
August	36.10	23.15	29.62	92.7	310

Source: Bangladesh Meteorological Department (Climate division) Agargoan, Sher-e - Bangla Nagar, Dhaka-1212.

Appendix III. ANOVA tables of the experiment

1. Percent relative height lesion (Before spray)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.222	0.111	1.6867	0.2048
Treatment	13	2.745	0.211	3.2047	0.0056
Error	26	1.713	0.066		
Total	41	4.681			
Coefficient of variation: 2.86%					

2. Percent relative height lesion (Panicle initiation stage)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.794	0.397	7.5097	0.0027
Treatment	13	43.488	3.345	63.3191	0.0000
Error	26	1.374	0.053		
Total	41	45.656			
Coefficient of variation: 1.80%					

3. Percent relative height lesion (Flowering stage)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.211	0.106	1.1570	0.3301
Treatment	13	678.559	52.197	572.3995	0.0000
Error	26	2.371	0.091		
Total	41	681.141			
Coefficient of variation: 1.19%					

4. Percent relative height lesion (Soft dough stage)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.032	0.016	0.2343	
Treatment	13	1601.404	123.185	1831.1390	0.0000
Error	26	1.749	0.067		
Total	41	1603.185			
Coefficient of variation: 0.92%					

5. Number of infected tiller per hill (Before spray)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.048	0.024	0.4086	
Treatment	13	0.631	0.049	0.8213	
Error	26	1.536	0.059		
Total	41	2.216			
Coefficient of variation: 6.27%					

6. Number of infected tiller per hill (Panicle initiation)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.149	0.075	1.7297	0.1971
Treatment	13	51.107	3.931	91.0832	0.0000
Error	26	1.122	0.043		
Total	41	52.379			
Coefficient of variation: 3.21%					

7. Number of infected tiller per hill (Flowering stage)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.084	0.042	0.8697	
Treatment	13	67.003	5.154	107.2336	0.000
Error	26	1.250	0.048		
Total	41	68.336			
Coefficient of variation: 2.67%					

8. Number of infected tiller per hill (Soft dough stage)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.051	0.025	0.3995	
Treatment	13	80.719	6.209	98.2096	0.0000
Error	26	1.644	0.063		
Total	41	82.413			
Coefficient of variation: 2.46%					

9. Lesion size (Before spray)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.333	0.166	1.3692	0.2720
Treatment	13	4.169	0.321	2.6406	0.0170
Error	26	3.158	0.121		
Total	41	7.659			
Coefficient of variation: 3.80%					

10. Lesion size (Panicle initiation)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.975	0.487	11.5566	0.0003
Treatment	13	48.186	3.707	87.8768	0.0000
Error	26	1.097	0.042		
Total	41	50.258			
Coefficient of variation: 1.57%					

11. Lesion size (Flowering stage)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.211	0.106	1.1570	0.3301
Treatment	13	678.559	52.197	572.3995	0.0000
Error	26	2.371	0.091		
Total	41	681.141			
Coefficient of variation: 1.19%					

12. Lesion size (Soft dough stage)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.334	0.167	2.1225	0.1400
Treatment	13	1717.538	132.118	1678.9573	0.0000
Error	26	2.046	0.079		
Total	41	1719.918			
Coefficient of variation: 0.97%					

13. Length of panicle

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	02.783	1.392	2.1749	0.1339
Treatment	13	43.499	3.346	5.2297	0.0002
Error	26	16.635	0.640		
Total	41	62.918			
Coefficient of variation: 2.91%					

14. Number of filled grains per panicle

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	3.654	1.827	0.1590	
Treatment	13	11693.807	899.524	78.2928	0.0000
Error	26	298.720	11.489		
Total	41	11996.181			
Coefficient of variation: 4.57%					

15. Number of unfilled grains per panicle

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0047.324	023.662	03.3811	0.0495
Treatment	13	6334.531	487.272	69.6272	0.0000
Error	26	0181.956	006.998		
Total	41	6563.811			
Coefficient of variation: 8.00%					

16. Grain yield (ton/ha)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.012	0.006	0.7813	
Treatment	13	8.428	0.648	81.5706	0.0000
Error	26	0.207	0.008		
Total	41	8.647			
Coefficient of variation: 1.92%					

17. Weight of 1000 grains

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.552	0.279	2.3694	0.1134
Treatment	13	33.036	2.541	21.8198	0.000
Error	26	3.028	0.116		
Total	41				
Coefficient of variation: 1.39%					

18. Straw yield (ton/ha)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.016	0.008	0.3653	
Treatment	13	11.672	0.898	41.3893	0.0000
Error	26	0.564	0.022		
Total	41	12.252			
Coefficient of variation: 2.84%					