EFFECT OF SOME SELECTED SEED TREATMENTS ON MAJOR DISEASES AND YIELD ATTRIBUTES OF HYBRID RICE (Var. Taj-1) IN AMAN SEASON

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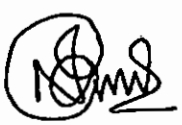

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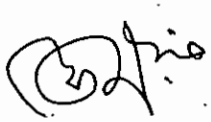

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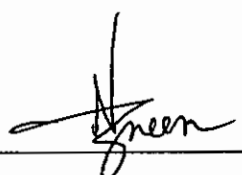

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This is to certify that the thesis entitled "***EFFECT OF SOME SELECTED SEED TREATMENTS ON MAJOR DISEASES AND YIELD ATTRIBUTES OF HYBRID RICE (Var. Taj-1) IN AMAN SEASON***" submitted to the Department of Plant Pathology, Faculty of Agriculture, Sher-e-Bangla 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 bonafide research work carried out by ***MD. RUHUL AMIN, REGISTRATION NO. 08-03255,*** 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.

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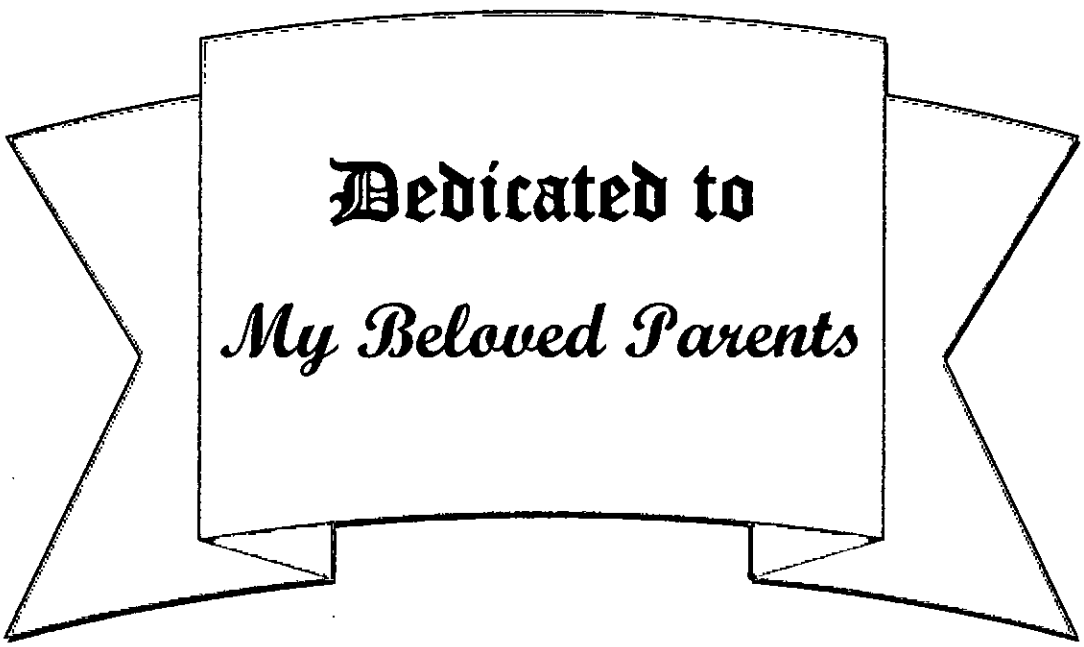

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ABSTRACT

An investigation was carried out to evaluate the efficacy of some selected seed treatments on seed germination, seed borne pathogens, incidence and severity of major field diseases and yield contributing characters of imported hybrid aman rice (Taj-1) in the laboratory of Plant Pathology department and field of Sher-e-Bangla Agricultural University farm during the period from November 2009 to December 2010. Eleven seed treating agents viz. untreated control, sun drying, polythene solarization, brine solution, neem leaf extract, allamanda leaf extract, hot water treatment, Provax 200, Bavistin 50 WP, Dithane M 45 and *Trichoderma harzianum* were evaluated for their effect on seed germination and incidence of seed borne pathogens *in vitro* as well as disease incidence and severity at 3 stages and on yield contributing characters *in vivo*. Nine seed borne pathogens namely bacteria (unidentified), *Rhizopus stolonifer, Aspergillus* spp., *Fusarium moniliforme, Phoma* sp., *Bipolaris oryzae, Curvularia lunata, Penicillium* sp. and *Alternaria tenuissima* were recorded and identified in blotter and agar plate method of seed health study. In blotter and agar plate method the highest seed germination (94.60%) and (91.45%), respectively were recorded under Dithane M 45 and the lowest (77.31%) and (78.32%) were recorded under untreated control. The highest pathogen incidence was observed under untreated control and all the treatments significantly reduced the pathogen incidence except polythene solarization and sun drying treated seed. Dithane M 45, Bavistin 50 WP, Provax 200 and hot water treatment showed the best performance in reducing seed borne pathogen incidence in both the methods of seed health testing. Five field diseases viz. brown spot (*Bipolaris oryzae*), narrow brown spot (*Cercospora oryzae*), leaf blast (*Pyricularia grisea)*, BLB (*Xanthomonas campestris* pv. *oryzae)*, and sheath blight (*Rhizoctonia solani)* were recorded and identified. The disease incidence and severity of brown spot at maturity stage were recorded from 5.48% to 13.89% and 0.91 to 1.67 (0-9 scale), respectively where Dithane M 45, Bavistin 50 WP and Provax 200 showed good performance against the disease. In case of leaf blast, the disease incidence and severity ranged from 5.96% to 16.11% and 2.63 to 5.86 (0-9 scale), respectively at maturity stage where hot water treatment showed the lowest incidence (5.96%) and severity (2.63). Disease incidence and severity of sheath blight varied from 15.87% to 20.30% and 6.47 to 7.80 (0-9 scale), respectively at maturity stage where hot water treatment showed the best result against the disease. Provax 200 was also effective followed by hot water treatment. In case of BLB, the disease incidence and severity ranged from 13.62% to 23.20% and 5.64 to 8.29 (0-9 scale), respectively at maturity stage where none but hot water treatment was effective against the disease. In case of narrow brown leaf spot, the disease incidence and severity ranged from 1.49% to 7.79% and 0.63 to 3.44 (0-9 scale), respectively at maturity stage where three fungicides and hot water treatment effectively managed the disease.The highest growth and yield contributing characters were recorded under the fungicidal seed treatment followed by hot water treatment considering plant height, panicle length, effective panicle and filled grain. Grain yield ranged from 7.27 t/ha to 10.40 t/ha. Under different treatments, the highest grain yield (10.40 t/ha) was recorded under Dithane M 45 followed by Bavistin 50 WP and Provax 200. The lowest grain yield (7.27 t/ha) was found under polythene solarization which was statistically identical with untreated control. It was observed that disease incidence and severity was gradually increased from flowering stage to maturity stage with the age of the plant and minimum incidence and severity gave the maximum yield.

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CHAPTER 1

INTRODUCTION

Rice (*Oryza sativa*) is the staple food of Bangladesh and it constituted about 90% of the total food grain production (Huda, 2001). It covers about 75% of the total cultivable land in Bangladesh (BBS, 2008). The average world yield of rice is 3.84 tons/ha but the average yield of rice in Bangladesh is 2.52 ton/ha (BBS, 2007; FAO, 2007). So, the average per hectare production of rice in Bangladesh is extremely low as compared to other rice growing countries of the world. So there is no alternative to increase the yield of rice to fulfill the national future demand. One of the best options available to the plant breeder is the hybrid rice. For its yield potential, hybrid rice has brought a great hope and aspiration to meet the challenging demand of food deficits of the 21st century (Fakir, 1998). To overcome the present yield ceiling of existing high yielding varieties (HYVs) of rice, hybrid rice seems to be highly attractive and available alternative.

In Bangladesh, hybrid rice has taken up significant land coverage due to active government attention, promotion of private seed companies and publication of mass media. In 2006-07, among the total 4.5 million hectares of Boro cultivation, hybrid rice was promoted in 1.2 million hectares (BBS, 2008). Among the hybrid varieties Taj-1 is the most promising one due to its higher yield potentiality. There are several constraints of hybrid rice production in Bangladesh, Major constraints in hybrids rice adoption were identified; these were high cost of seed, requirement of more crop care and management, high pest and disease infestation (AAS, 1999). Recently bacterial leaf blight, bacterial leaf streak and blast disease appeared seriously in the aman rice. Objections were made from some corner that those diseases extremely appear in the hybrid rice varieties.

Seed is the most important input for crop production. Pathogen free healthy seed is urgently needed for desired plant population and good harvest. Many plant pathogens are seed-borne, which can cause enormous crop losses. In Bangladesh, out of 16% annual crop losses due to plant diseases, at least 10% loss is incurred due to seed-borne diseases (Fakir, 1983). Coincidentally important or devastating crop diseases are seed-borne and caused by fungi.

Seed is a common carrier of plant pathogens. It acts as the primary source many diseases. Most of the major diseases of rice are seed-borne (Fakir, 2002). Rice suffers from more than 60 different diseases. In Bangladesh, 43 diseases are known to occur on the rice crop. Among these diseases 27 are seed-borne of which 14 are of major importance. Fungi are the principal organisms associated with seed in storage. Of all the seed-borne diseases of rice, 22 are caused by fungi (Fakir, 2000). The most destructive seed-borne fungal diseases of rice are Brown spot (*Bipolaris oryzae*), Blast (*Pyricularia grisea*), Sheath rot (*Sarocladium oryzae*), Sheath blight (*Rhizoctonia solani*), Leaf scald (*Michrodochium oryzae*), Seed rot and Seedling blight (*Bipolaris oryzae, Sclerotium rolfsii and Fusarium* spp.), Grain spot (*Curvularia lunata, Nigrospora oryzae, Phoma glumarum, Cladosporium* sp.).

There are many constraints responsible for low yield of rice in Bangladesh. Seed-borne pathogens are one of the major causes for low yield of rice and most of the diseases are seed-borne. In Bangladesh, approximately 2.5 million tons of rice worth more than Tk. 12000 million is lost annually due to diseases caused by seed-borne pathogens (Fakir *et al.*, 2003). Various methods have been practiced to control these pathogens. Use of chemical can give quick result. Farmers are therefore, interested to use chemical for controlling plant diseases. Use of chemicals is an established effective standard seed treatment practice. An appreciable amount of work has been done on the control of seed-borne pathogens of rice by fungicidal seed treatment at home and abroad

(Toledo *et al.* 1972; Kauraw, 1986; Misra and Vir, 1990; Suratuzzaman *et al.* 1994; Parisi *et al.* 2001). But, most of the chemicals are costly, so the farmers have to spend a large amount of money to buy these chemicals. Now-a-days use of chemical for management of crop disease is being discouraged due to health hazards and environmental pollution. So, control of the pathogens through botanical pesticides or plant extracts and natural bioagents might be a good alternative. Moreover many physical techniques like hot water, solar heat etc. are also found to be effective against seed borne pathogens.

Botanical extracts are biodegradable and their use in crop protection is a practical sustainable alternative (Devlin and Zettel, 1999). It reduces environmental contamination and health hazards (Grange and Ahmed, 1988). Research on the active ingredients, fungicide preparation, application rates and environmental impact of botanical fungicides is a prerequisite for sustainable agriculture (Buss and Park, 2002). Botanical fungicides are unique because they can be produced easily by the farmers and small industries (Roy *et al.,* 2005). Few works have been done by using tobacco, neem, garlic and some other plant extracts to control some other fungi. Antifungal activities of garlic, neem, allamanda have been reported by many researchers (Islam, 2005; Rahman *et al.,* 1999; Arun *et al.,* 1995 and Mohanty *et al.,* 1995). Antagonistic effect of many natural bioagents like *Trichoderma*, *Bacillus* etc have also been reported by many researchers (Shin *et al.* 1987; Moon *et al.* 1988 and Parveen *et al.* 1993).

It is thus necessary to work extensively to examine the effect of different indigenous plant extract and natural bioagents in controlling disease which are easily available. These botanical pesticides are affordable by low income farmers and they have the potentiality to use in agriculture, especially with the dramatic increase towards the consumption of organically produced plants and ensure the sound ecology and friendly environment without any pollution. It is

also need to examine the efficacy of different physical seed treating methods eg. Hot water treatment, sun drying and polythene solarization for managing the seed borne pathogens of rice.

Considering the above facts the present study has been conducted

- ✓ To evaluate the efficacy of fungicides, botanicals, bio agents and physical seed treatment against seed-borne pathogens of imported hybrid rice.
- ✓ To evaluate the efficacy of different seed treatment against major seed-borne diseases and on yield contributing characters of imported hybrid rice.
- ✓ To find out some eco-friendly seed treating agent for management of seed borne pathogens of imported hybrid rice.

CHAPTER 2

REVIEW OF LITERATURE

In this chapter an attempt has been made to review available information related to different seed treating agents on disease incidence and severity of major diseases and their effect on yield and yield contributing characters of rice.

2.1. Seed treatment with fungicides

Dharma *et al.* (1970) reported the complete control of seed-borne *Drechslera oryzae*, *D. sativa* and *D. avenae* on rice, barley and oats respectively through seed tratmemt with Dithane M-45 at 0.3g/kg seed. Such treatment was also found to increase seed germination.

Toledo *et al.* (1971) found in laboratory tests that Vitavax and Brassicol were effective against seed-borne pathogens like *D.oryzae*, *Pyricularia oryzae*, *Cercospora oryzae*, *Alternaria* sp., *Fusarium* spp. and *N. oryzae*.

Park and Cho (1972) reported that Dithane M-45 was effective against *H. oryzae* and *P. oryzae*, though this was not suitable against *Fusarium spp.* Seven fungicides namely Arasan, Bavistin, Brassicol, CGA 49104, Dithane M-45, Homai and Vitavax 200 were tried at recommended doses for treatment of BR10, Nizersail and Purbachi seeds.

Anon. (1984) stated that Dithane M-45 and Vitavax-200 were more effective against *Curvularia lunata*. Complete elimination of *Trichoconis padwickii* was obtained with Bavistin which however was found to be least effective against *C. lunata* and *Alternaria tenuis*. Dithane M-45 appeared to be the best among the seven tested fungicides in controlling the fungi associated with seeds.

Srinivasaiah *et al.* (1986) found that *Trichoconis padwickii* was eliminated by seed treatment with Bavistin, Panoctin, RH-2161, Ceresan wet.

Anon. (1988) Seeds of BR10 and BR11 with natural infection of seed borne pathogens were treated with Bavistin, Benlet, Dithane M-45, Homai, Rovral-50, Tecto-60, Topsin-M and Vitavex-200 at the rate of 3g/kg. Among the nine fungicides tested, Dithane M-45 gave a very good control of all the fungal pathogens associated with seeds of BR10 and BR11. The best control of *D. oryzae* was obtained with Rovral-50 WP and Dithane M-45, followed by Vitavex-200. Seed germination increased in all the cases over control.

Suratuzzaman *et al.* (1994) observed that Vitavax-200 effectively eradicated seed-borne fungal pathogens of rice seeds.

Khan *et al.* (1995) reported that seed treatments of rice with Benomyl (as Benlate), Carbendazim (as Derosal), Kasugamycin (as Kasuram), Healthied, Thiophanate-methyl (AS Topsin-M), Mancozeb (as Dithane M-45), Triadimefon (as Bayleton) and Metalaxyl (as Ridomil) increased seed germination and reduced bakanae disease (caused by *F. moniliforme*) in green house experiments. Thiophanate-methyl, followed by Benomyl, Carbendazim and Kasugamycin were most effective for disease control and yield increase.

Rahman *et al.* (2000) tested 4 seed samples of rice cv. BR11. The seed-borne fungi associated with the treated and untreated seeds were *Bipolaris oryzae, Trichoconis padwickii, Curvularia lunata, Nigrospora oryzae, Alternaria tenuis, Aspergillus* spp. and *Penicillium* spp. All the 3 seed treatment methods reduced all seed-borne fungal infections wherein the best method was treatment with Vitavax-200. Germination test following paper towel method showed that chemical treatment was the best. Seed treatment with vitavax showed

highest shoot and root length followed by manually cleaned seed and flotation method. Seedling height was highest in vitavax treated seeds and had low number of infected seedlings. Vitavax treated seed and manually sorted seed produced the highest number of tillers/hill, percentage of healthy seeds and 1000-seed weight. Grain yield increased in manually sorted, flotation and vitavax treated seed plots.

Rahman *et al.* (2000) tested an experiment to evaluate the efficacy of 2 fungicides (0.45% thiovit and 0.1% bavistin). The lowest disease incidence followed by thiovit + diazinon at 15 or 30 days interval and bavistin+thiovit at 30 days interval where in disease incidence was 4.66, 8.86 and 10.06, respectively. Diazinon applied at 15 days interval completely eradicated SFB shoot infestation while diazinon applied alone or in combinations with thiovit and bavistin at 15 days interval significantly reduced SFB fruit and seed infestation. The number of fruits/plant, number of seeds/fruits, and seed yield/plot increased with application of bavistin+thiovit+diazinon at 15 days interval.

Parisi *et al.* (2001) treated seeds of rice cv. IAC 165 with the fungicides. All treatments significantly reduced the incidence of pathogens in rice seeds. *Pyricularia grisea, Bipolaris oryzae* and *Microdochium oryzae* were eradicated by carbendazirn + thiram and carboxin + thiram. The emergence rate in sterile soil was higher in the treatment with carbendazim + thiram compared with pyroquilon and the control. The number of dead or infected seedlings in all treatments was significantly lower than that in the control and pyroquilon treatments. Field emergence was higher in seeds treated with carbendazim + thiram compared with that obtained with carboxim+thiram and pyroquilon. Carbendazim + thiram were the most efficient treatment for rice seeds.

Russo (2001) treated seeds of rice cv. Dorella (very susceptible to *Fusarium* sp.) with iprodione (600 ml/quintal) and carboxim + thiram (Vitavax Flo, at 350 g/quintal) during 1999 and 2000. In both years, the iprodione treatment produced fewer stems than the Vitavax Flo treatment and significantly lower healthy stems. There were even indications that the iprodione treatment actually increased the incidence of the disease, possible because it adversely affected some antagonists. Iprodione did control *Bipolaris oryzae.* Seed treatment with carboxim + thiram drastically reduced the incidence of *Fusarium* sp. and also controlled *Helminthosporium* sp.

Rashid (2003) detected seed borne fungi from two soybean germplasms (PB^{-1} and SB_3) and an attempt was made to control them by fungicides and different plant extracts. Vitavax-200 was found best as seed treating agent for reducing fungal population.

Kabir *et al.* (2006) carried out an experiment in Bangladesh during 2002-03 to evaluate the effects of physical and chemical seed treatments on the prevalence of seed-borne fungi and seedling development of Boro rice. The untreated farmer's seeds yielded seed-borne infection of *Bipolaris oryzae, Alternaria padwickii, Aspergillus flavus, A. niger, Fusarium moniliforme, F. oxysporum, Curvularia lunata* and *Penicillium* spp., respectively, in blotter method. The lowest prevalence of those fungi was found in the farmer's seeds treated with Vitavax-200.The farmer's seeds treated with Vitavax-200 showed the highest percentage of germination (91.25%). Number of diseased seedlings/m^2 was significantly decreased in the seedbed when the farmer's seeds treated with Vitavax 200.

Kabir *et al.* (2006) carried out another experiment treating rice seed with Vitavax 200 [carboxin + thiram] on the incidence and severity of diseases of

Boro rice cv. BR 28. The incidence of six diseases, i.e. brown spot, blast, bakanae, foot rot and seedling blight was recorded at 15 and 30 after sowing in the seedbed. The maximum reduction of diseases were recorded in Vitavax 200-treated seeds. The highest number of seeds per panicle (17.5 g) as well as the highest number of healthy seeds per panicle (158.6) was obtained in the Vitavax 200-treated seeds. The highest seed yield was also found in the Vitavax 200-treated seeds.

Jambhulkar and Janki Kandhary, 2007 was conducted an experiment by using four rice cultivars, namely Pusa 44, PRH 10, Jaya and Pusa Sugandh 2 and seeds were treated with three plant extracts *(Piper betle, Allium sativum, Cahtropis procerd)* at 0.5 and 1% concentrations, one phytochemical (geraniol), two antagonists (Kalisena SD, *Trichoderma harzianum*) and two fungicides (vitavax 200 [carboxin + thiram] and carbendazim 50 WP). Seed treatment with leaf extract of *Piper betle* (0.5%) increased seed germination and seedling vigour and decreased mycoflora even after six months of storage. *P. betle* 0.5% extract was found as a potent biopesticide against most of the storage and field fungi associated with rice seeds.

2.2. Seed treatment with plant extracts

Plant extract have been reported to be anti-fungal by many researchers (Kishori *et al.*, 1982, Naidu, 1988, Ashrafuzzaman and Hossain, 1992, Hossain *et al.*, 1993, Suratuzzaman *et al.*, 1994).

Lapis and Dumancas (1978) screened crude extracts of 93 plants against *Helminthosporum oryzae* on rice seed and found that 42 inhibited its growth. The extracts were active at 1:10 aq. Solutions except *Euphorbia pulcherrima* which was only active in its concentrated form. The precipitate was generally more active than the supernatant and activity decreased with time. *Impatiens*

balsamina, *Pseudocalyma alliaceum*, garlic and *Tagetis erecta* were further evaluated in vitro. *Impatiens balsamina* extracts were active as a therapeutant and protectant against the pathogen on rice while the other 3 were effective as therapeutants only.

Alice and Rao (1987) evaluated 31 plant extracts in vitro on *D. oryzae* in rice using paper disc technique (inhibition zone technique) and found the maximum inhibition of *D. oryzae* obtained with *Mentha piperita* followed by *piper nigrum* seed extract and *Allium sativum* extract.

Assad and Behroozin (1987) performed an experiment with bulb extracts of onion and garlic and observed the effect of these extracts on mycelial growth of *Fusarium spp.* and *Sclerotium cepivorum*. Garlic extracts were found more active than that of onion in inhibiting growth of *F. solani*, *F. acumiatum*.

Natarajan and Lalithakumari (1987) reported that the activity of leaf extract (*L. inermis*) against *D. oryzae* was tested at 1:40 dilution (E_{50}Conc.) by measuring the growth, protein, DNA, RNA synthesis and O_2 uptake. O_2 uptake was inhibited most. The antifungal factor contained in the leaf was identified as 2-hydroxy-1, 4 napthoquinone. *In vitro*, spraying rice leaves with extract gave better control than seed treatment.

Naidu (1988) used extract of deshi patabahar (*Codiaenum variegatum*) assayed for antifungal activity and was found effective against *Alternaria alternata* and *F. oxysporum in vitro*.

Miah *et al.* (1990) observed that extracts of garlic and neem were effective in controlling *D. oryzae* in rice. Other workers also showed the presence of antifungal properties in garlic (Misra and Dixit, 1976). Other plant extracts viz

biskatali, gagra, vatpata and bitter gourd were also found effective. The antifungal activity of these plant species was also reported by several workers (Singh and Dwivedi, 1987; Ashrafuzzaman and khan, 1992; Ashrafuzzaman and hossain, 1992).

Miah *et al.* (1990) assayed gada (*Tagetes erecta*) for antifungal activity and found effective against *Monographella alboscens*, *P. oryzae* and *R. solani*.

Dubey and Dwivedi (1991) tested for fungitoxic properties of extracts of leaves and bulbs of onion and garlic, fruit and bark of *Allium cearabica* against vegetative growth and sclerotial viability of *Macrophomina phaseolina*. They found that all the extracts inhibited growth to various degrees but garlic bulb extract was more effective than other extracts employed in the tests.

Tewari and Mandakini (1991) reported that Piper betel, *Ocimum sanctum*, *Nyctanthes arbortristis* and *Cityrus limon* were effective in reducing the radial growth of *P. oryzae*, *C. miyabeanus* and *R. solani in vitro*, with extracts of *P. betel* followed by *O. sanctum* the best effective.

Ashrafuzzaman and Hossain (1992) evaluated pudina (*Mentha viridis*) extract against *Bipolaris sorokiniana* and observe that can inhibited mycelial growth and spore germination. In the same work they have found the extract of castor (*Ricinus communis*) and Dantha kalash (*Leucas aspera*) were also inhibitory against mycelia growth and spore germination of *B. sorokiniana*.

Khan and Kumar (1992) reported that seed treatment with the garlic extract, neem, gagra, vatpata, Biskatali leaf extract reduced seed borne prevalence and increased germination percentage of wheat seeds. Among them garlic and neem bark gave better results.

Hossain *et al.* (1997) reported that extract of *Lawsonia alba*, *Ipomoea fistulosa*, *Allium sativum* and *Leucas aspera* when screened for their antifungal property against *B. sorokiniana*, only *A. sativum* completely inhibited the mycelia growth at dilution ratio of 1:4 (wt/v). They also found the extract of mehedi (*Lawsonia alba*) was inhibitory against *B. sorokiniana*.

Khan and Hossain (1993) observed that extracts of *Allium cepa*, *Allium sativum*, *Datura stramonium*, *Datura pulmeiri*, *Lawsonia alba*, *Ricinus communis*, *Leonurus sibiricus* amd *Mentha viridis* completely inhibited spore germination of *B. sorokiniana* at 1:3 dilution ratio.

Ganguly (1994) reported that leaf extracts of *Vicina rosea*, *Lantana camada*, *Ocimum tenuiflorum*, *Solanum melongena*, *Azadirachta indica*, *Polyatthia longifolia*, *Aegle marmelos* and *Datura metel* showed antifugal activity against *P. oryzae* and *H. oryzae in vitro*. Extracts of *V. rosea* showed inhibition of mycelilal growth and germination.

Arun *et al.* (1995) observed that extract of garlic , marsh peppers, mart weed and vitavax-200 effectively suppressed seed-borne fungal pathogen of rice seeds. They found highest reduction of fungal population with vitavax-200 followed by garlic extract.

Bisht and Khulbi (1995) evaluated the leaf extract of 10 plants against *D. oryzae in vitro*. All extractcts exhibited fungitoxic properties and significantly reduced mycelia growth. Maximum inhibition was recorded by plant extract from *Junlans regia*, *Allium sativum*, *Origanum vulgare* and *A. wallichii*.

Mohanti *et al.* (1995) investigated the allelopathic control of *Phomopsis vexans*, causal agent of Phomopsis fruit rot of brinjal by aqueous leaf extracts

of 5 plants. Fungal growth was inhibited to maximum by leaf extracts of *Allamanda cathertia* (93.75%) followed by *Aegle marmelos* (85.38%). Leaf extracts of *Catherathus roseus*, *Polyalthia longifolia* and *Azadirachta indica* were equally effective. But that of *Ocimum sanctum* was the least effective causing 52.23% growth inhibition.

Mohanti *et al.* (1995) reported that garlic bulb extract (1:1) and allamanda leaf extract sprays in the field reduced phomopsis blight and fruit rot by 66 and 75%, respectively.

Panda *et al.* (1996) tested the efficacy of leaf extracts from *Polyalthia longifolia*, *Aegle marmelos*, *Azadirachta indica*, *Carthemus roseus*, *Ocimum sanctum* and *Allamanda cathertica* for the control of phomopsis blight (caused by *P. vexans*). Leaf extract of *Allamanda cathertica* had excellent potential as fungicide.

Hossain *et al.* (1997) reported that the extract of *Allium sativum* and *Lawsonia alba* was effective in reducing the spore germination and mycelia growth of *B. sorokiniana*, *Nigella sativa* showed positive antifungal activity in reducing the pathogenicity of *B. sorokiniana* on wheat leaves.

Parveen (1998) studied the effect of lemon grass oil for controlling sheath blight (*R. solani*) of rice in laboratory net house and field. She assessed the effect of lemon grass oil at 1:80 dilution and found that grass oil was very effective in controlling sheath blight disease of rice in Binasail and TN1 variety.

Khan (1999) studied the effect of plant extracts (Allamanda, Bael and Neem) for the management of phomopsis blight/ fruit rot of egg plant in field

condition by spraying and observed that among the 3 plant extracts, Allamanda was most effective than Bael and Neem extracts.

Rahman *et al.* (1999) found that biskatali (*Polygonum hydropiper*), garlic (*Allium sativum*), ginger (*Zingiber officinale*) and neem (*Azadirachta indica*) extracts were effective against seed borne infections of *Alternaria tenuis*, *A. alternate*, *B. sorokiniana*, *Curvularia lunata*, *Fusarium spp.* of wheat. However, garlic was found superior to the other extracts followed by ginger and neem.

Ahmed (2000) tested tweleve seed samples of rice were tested and all were found infected by *B. oryzae* the cause of brown spot disease. Four fungicides viz. Bavistin, Homai, Tilt 250 EC and Dithane M-45 and four plant extracts viz. Biskatali, Onion, Garlic and Neem were evaluated against *B. oryzae*. Dithane M-45 was the best with 100% inhibition of the mycelial growth at 0.3%. Neem and Garlic were effective against *B. oryzae* at 1:1 dilution. All test fungicides and plant extracts were effective against *B. oryzae* at higher concentration.

Howlader (2003) reported that seed treatment with Allamanda leaf extract (1:1) effectively increased germination of egg plant seeds and also decreased nursery diseases.

Rashid (2003) observed that seed borne fungi were detected on two soybean germplasm (PB^{-1} and BS_3) and attempt has been made to control them by different plant extracts. Although vitavex-200 was found best as seed treating agent for reducing fungal population, among seven plant extracts the extracts of gada and neem were found better.

Mostafa (2004) studied efficacy of some plant extracts (rhizome of ginger, turmeric and bon ada, leaf of neem, allamanda pitraj and marigold, plant of biskatali and fruits of pepper) on the incidence and severity of the viral diseases of tomato through a field experiment. Among the plant extracts Allamanda was most effective. The lowest percent plant infection (3.75) observed in Allamanda extract treated plots.

2.3. Seed treatment with brine solution

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

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

Kabir (2006) carried out an experiment to control leaf blight of wheat where chemical & different physical seed treatments were used and the

treatments differed significantly. Among the different seed treatments, apparently healthy seed treated with Vitavax-200 @ 0.4% followed by apparently healthy seed treated with brine solution @ 2%, washed apparently healthy seed treated with brine solution @ 2% was found to be best in reducing leaf infection, increased seed germination and seed yield.

2.4. Seed treatment by solar heat

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

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

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

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

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

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

2.5. Seed treatment with hot water

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

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

significant losses of germination by hot water treatments at 50°C for 20 to 30 min up to 53°C for 10 to 30 min.

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

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

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

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

Jiskani (2002) found that the brown spot or blight of rice caused by *Helminthosporium oryzae* effectively controlled by hot water seed treatment at 5 4 ° C for 10 minutes.

William Nesmith (2003) at Ohio State University found hot water treatment effective against the major seed borne diseases of vegetables. He found effective temperature of 122°F (49.95 °C) for 25 min for brussels sprouts, cabbage, eggplant, tomato and spinach; 122°F (49.95 °C) for 20 min for broccoli, cauliflower, Chinese cabbage, carrot, kale, kohlrabi and turnips; I22°F (49.9 5 °C) for 1-5 min for mustard and radish; 125°F (51.6°C) for 30 min for peppers and 118°F (47.73°C) for 30 min for lettuce and celery.

2.6. Seed treatment with *Trichoderma harzianum*

Shin *et al.* (1987) reported that among the treatments *Trichoderma* spp. isolates, 60% were antagonistic to *Fusarium oxysporum.* They observed that normal sesame seedlings on beds treated with antagonist grew better than seedlings in untreated soil.

Moon *et al.* (1988) reported that in dual culture, *T. harzianum* parasitized *F. oxysporum* f. sp. *fragarie* and inhibited mycelial growth. The process of mycoparasitism included coiling round and attachment to host hyphae, penetration into the hypae or breaking the septa of hyphae and conidia.

Sivan and Chet (1989) investigated the possible role of competition between *Trichoderma harzianum* and *Fusarium oxysporum* on rizosphere colonization. They found that addition of *Trichoderma harzianum* conidia in soil or seed significantly reduced the chlamydospore germination rate of both *F. oxysporum* f. sp. *vasinfectum* and *F. oxysorum* f. sp. *melonis*.

Calvet *et al.* (1990) found that non-volatile compounds released by *Trichoderma harzianum* isolates growing on cellophane discs over malt agar significantly inhibited growth of *Fusarium oxysporum.*

Parveen *et al.* (1993) recored that seed treatment with *Trichoderma harzianum* gave complete control of *Fusarium oxysporum* on 30 and 120 days old tomato plants.

CHAPTER 3

MATERIALS AND METHODS

In this chapter the details of different materials used and methodology followed during the experimental period are described.

3.1. Experimental Site

The laboratory experiment was conducted at the Seed Pathology Laboratory and Plant Disease Diagnostic Laboratory, Department of Plant Pathology, Sher-e-Bangla Agricultural University (SAU), Dhaka and the field experiment was conducted in the Field of SAU (Sher-e-Bangla Agricultural University) farm allotted for the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka-1207 and shown in Appendix- I.

3.2. Experimental period

The laboratory experiment was conducted during the period from November 2009 to February 2010 and the field experiment was carried out during the period form July 2010 to December 2010.

3.3. Hybrid rice variety used in the experiment

Hybrid rice variety Taj-1 of the line GRA-2/06 was used in this experiment. Seeds of the hybrid variety Taj-1 of the origin China (imported) was collected from National Seed Co. Ltd.

3.4. Laboratory experiment

3.4.1. Treatments

There were 11 treatments used in the experiment including untreated control. These were as follows:

T_1= Untreated control

T_2= Seed treatment by sun drying

T_3= Seed treatment by polythene solarization

T_4= Seed treatment with brine solution

T_5= Seed treatment by neem leaf extract

T_6= Seed treatment by allamanda leaf extract

T_7= Seed treatment by hot water

T_8= Seed treatment with Provax 200

T_9= Seed treatment with Bavistin 50 WP

T_{10}= Seed treatment with Dithane M 45

T_{11}= Seed treatment by *Trichoderma harzianum*

3.4.2. Seed treatment by sun drying

Collected hybrid rice seeds were sun dried for 14 hours before sowing using the sun light in two days.

3.4.3. Seed treatment by polythene solarization

Collected hybrid rice seeds were covered by transparent polythene paper and sun dried for 14 hours before sowing using the sun light in two days.

3.4.4. Seed treatment with brine solution

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

3.4.5. Seed treatment by neem and allamanda leaf extracts

Collected rice seeds were treated with each of the two botanical extracts namely, neem leaf extract and allamanda leaf extract by dipping rice seeds in 1:2 (w/v) ratio preparations. The leaf extract of neem and allamanda were

prepared by using the method of Ashrafuzzaman and Hossain, 1992. For preparation of extracts, collected leaves were weighted in an electric balance and then washed in water. After washing big leaves were cut into small pieces. For getting extracts, weighted leaves were blended in an electric blender and then distilled water was added into the jug of blender. The pulverized mass was squeezed through folds of fine cloth. For getting 1:2 (w/v) ratio, 200 ml of distilled water was added with 100 g leaves.

3.4.6. Seed treatment by hot water

Hybrid rice (Taj-1) seeds were treated with hot water by hot water plant following the procedure of IPM Laboratory, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh.

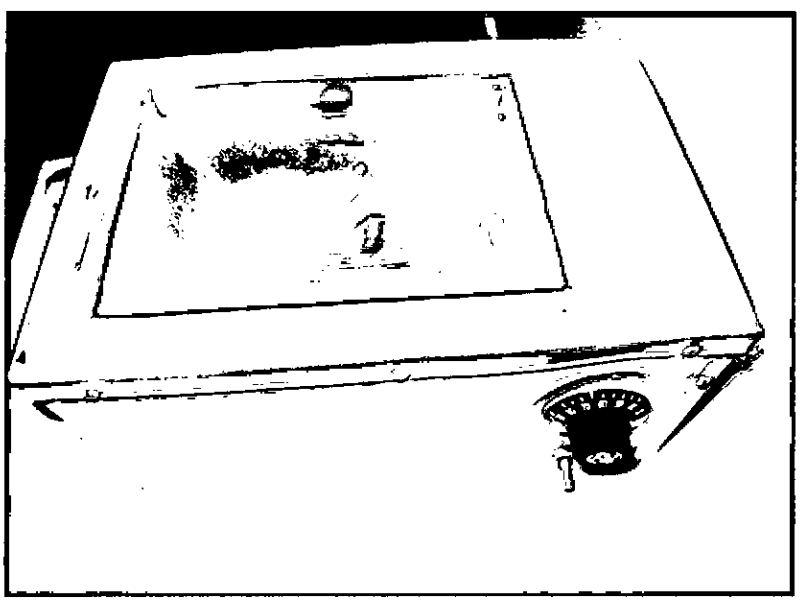

Figure 1: Seed treatment with hot water by hot water plant

For treatment of seed by hot water at first, the seeds were soaked in normal water for 3-4 hour in a cotton fabric bag. Then 2 liter water was poured in the plant (below the red marking). Then the plant was connected with electricity and waited for 10 minutes to get the temperature 50^0 C. The water inside the plant was stirred frequently for even distribution of heat. Then the seeds (in

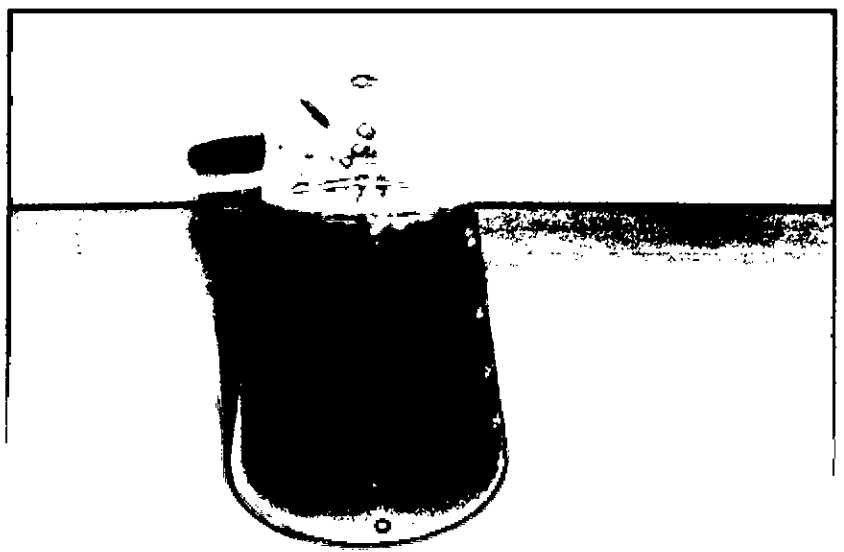

Figure 3: Spore suspension of *T. harzianum*

3.4.9. Detection of seed borne pathogens

To identify the different pathogens on the hybrid (Taj-1) rice under different treatments, the following two methods were used in this experiment:

3.4.10. Blotter Method

The treated seed samples of rice were analyzed for the presence of major seed borne fungal pathogens by blotter method following the International rules for Seed Testing (ISTA, 1996). Two hundred seeds were tested for each treatment maintaining three replications. Twenty-five seeds were placed on three layers of moist blotting paper (Whatman No.1) in each glass petridish. The petridishes were incubated at 25±1°C under 12/12 hrs light and darkness cycle for 7 days. Each seed was observed under strereomicroscope in order to record the presence of fungal colony and bacterial ooze 7 days after incubation based on growth habit. In doubtful cases temporary slides were prepared from the fungal colony and observed under compound microscope. Appropriate keys (Booth, 1971; Chidambaram *et al.*, 1973; Misra *et al.*, 1994 and Malone and

Muskette1964.) were consulted for identification of the fungi. The results were presented as percent incidence for individual pathogen. Germination percentage of the seeds was also recorded.

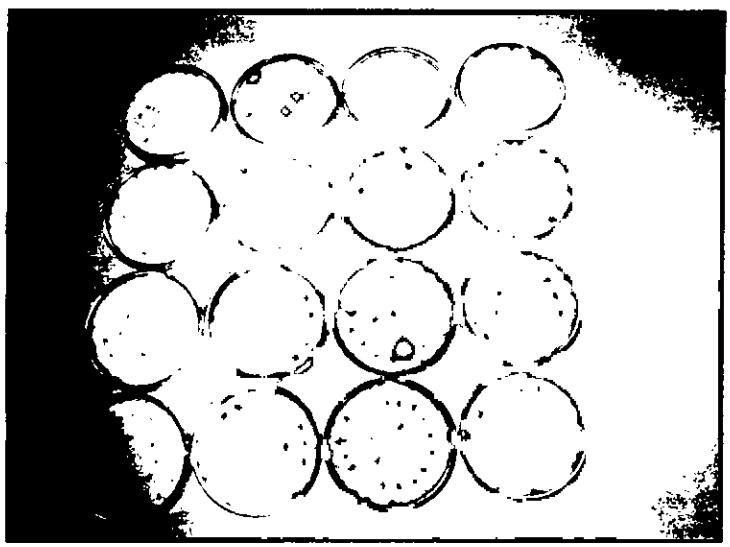

Figure 4: Seed health study by blotter method

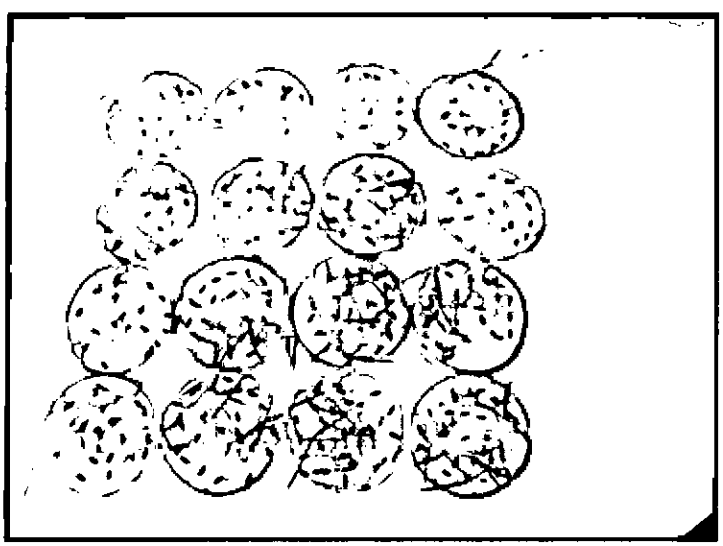

Figure 5: Germinated seedlings on the blotter paper

3.4.11. Agar Plate Method

In the agar plate method, one hundred seeds were tested for each maintaining three replications. Generally surface disinfected seeds (0.1% mercuric chloride) were plated on the PDA medium and the plated seeds were incubated for 5-7 days at 22-25°C under 12h altering cycles of light and darkness. At the end of the incubation period, fungi growing out from the seeds on the agar

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medium were examined and identified. Identification was done based on colony characters and morphology of sporulation structures under a compound microscope. In case of occurrence more than one type of fungal colonies, identification was done on the most frequently occurring colony present in all the petridishes, and then the second most frequent, the third most frequent and so on. Thereafter, the identification of the different colonies were done visually and then under a stereomicroscope and followed by an examination of the fruiting structures under a compound microscope. Once the identification was done, the colonies were assigned names and their acronyms written on the reverse.

Figure 6: Seed health study by agar plate method

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Figure 6: Seed health study by agar plate method

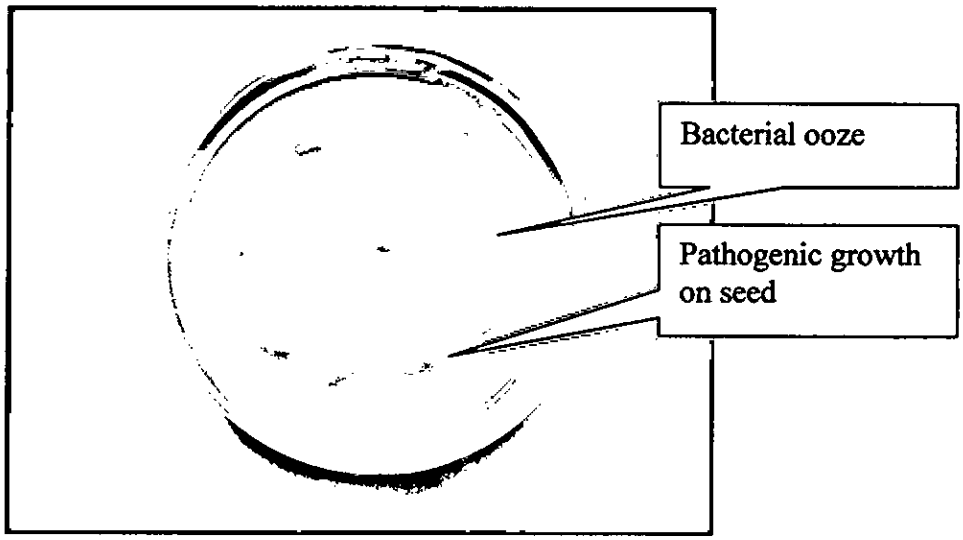

Figure 7: Bacterial ooze and pathogenic growth on seed in agar plate

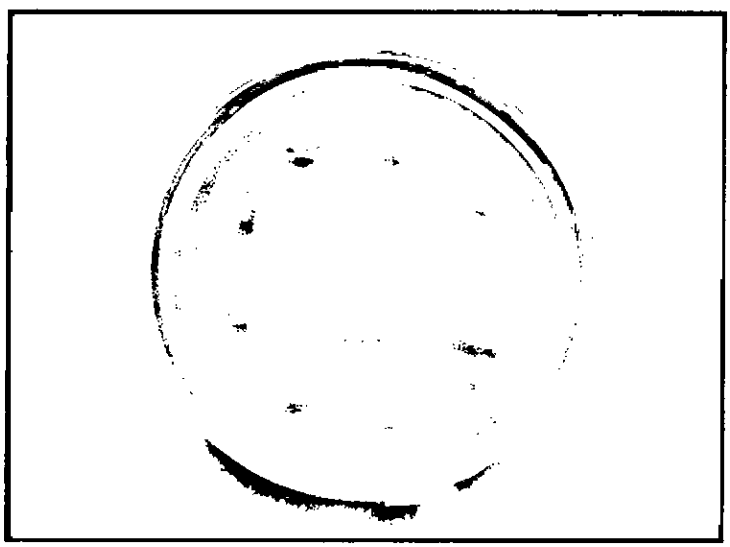

Figure 8: Pathogenic growth on seed in agar plate

3.4.12. Preparation of culture media

3.4.13. Potato dextrose agar medium (PDA)

200g clean and healthy potato slice were taken in saucepan in 500ml water and boiled. The extract was filtered throw a fine cloth and potato extract was then transferred in a clean beaker. 17g agar was melted in 500 ml of water in another beaker and the extract of potato was added to melt agar and was stirred with a glass rod. 20g of dextrose was dissolved and the volume was raised to 1000ml with distilled water. The mixture was agitated and heated with frequent stirring with a glass rod to dissolve and melted agar. The medium was

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poured to flask or tubes and was plugged with cotton and autoclaved for 15 minutes at 121°c under 15 PSI in an autoclave. After autoclaving, the liquid medium was poured in the petridishes and solidified.

3.4.14. Nutrient agar medium (NA)

Bacto agar (15g) was taken in the Erlenmeyer flask containing 1000 ml distilled water. Peptone (5g) and beef extract (3g) were added to flask. For mixing properly the nutrient agar was shacked thoroughly for few minutes. Flask was then plugged with cotton and wrapped with a piece of brown paper and tied with thread. It was then autoclaved at 121°c under 15 lbs pressure for 15 minutes. After autoclaving, the liquid medium was poured in the sterile petridishes and solidified.

3.4.15. Isolation and identification of different pathogenic fungi

Diseased rice plant parts were collected from the field and brought to the laboratory. Diseased leaves and sheath were cut into small pieces along with healthy portion. Cut pieces were sterilized by the surface disinfectants e.g. 0.1% mercuric chloride for 30 seconds. After sterilization the cut pieces were washed three times with sterile water. The cut pieces were than placed on sterile blotter paper to remove excess water. The cut pieces were than placed on the PDA plate. The plates were labeled and placed in the incubation chamber for 7 days at 25^{0}c. After 7 days of incubation, the fungi grown on culture media. A portion of culture was taken on slide and observed under microscope and identified the pathogenic fungi i.e. *Bipolaris oryzae, Cercospora oryzae, Pyricularia grisea, Alternaria tenuissima, Rhizoctonia solani* with the help of "Common Laboratory Seed Health Testing Methods for Detecting Fungi" (Mathur and Kongsdal, 2003) and " A Handbook of Rice Seedborne Fungi" (Mew and Gonzales, 2002). A portion of culture was taken by inoculating needle on another PDA plate. A small portion from the

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subculture was inoculated to another PDA plate for pure culture. The fungus, thus purified, was kept in refrigerator for future use. All these operations were done aseptically in the laminar air flow chamber.

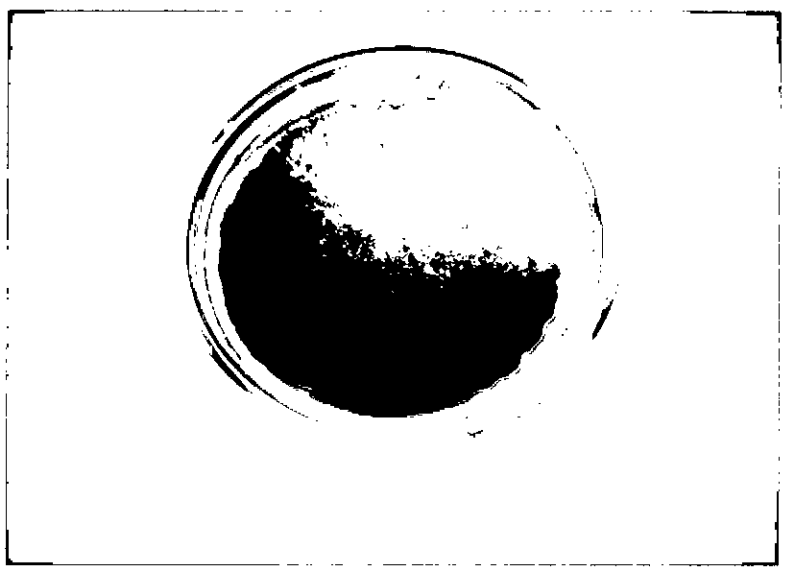

Figure 9. Pure culture of *Bipolaris oryzae*

Figure 10: Conidium of *Bipolaris oryzae* observed under compound Microscope (×400)

Figure 11: Pure culture of *Alternaria tenuissima*

Figure 12: *Alternaria tenuissima* under compound microscope (×100)

Figure 13: Pure culture of *Aspergillus flavus*

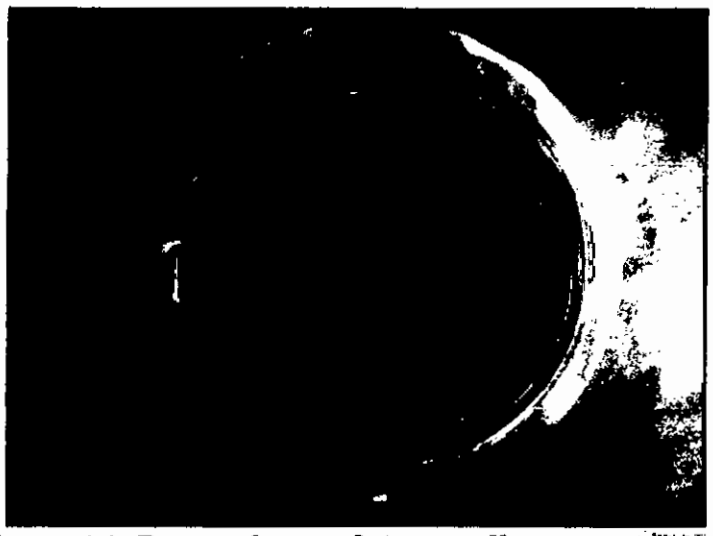

Figure 14: Pure culture of *Aspergillus niger*

Figure 15: *Aspergillus flavous* under compound microscope

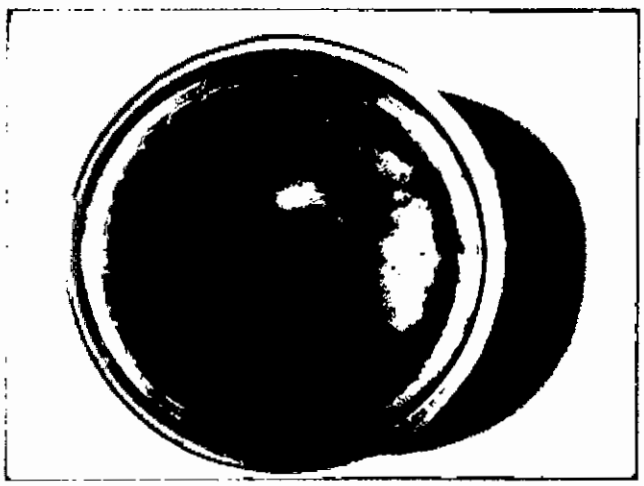

Figure 16: Pure culture of *Rhizoctonia solani*

Figure 17: Pure culture of *Curvularia lunata*

Figure 18: Conidia of *Curvularia lunata* under compound microscope (×400)

Figure 19: Pure culture of *Fusarium moniliforme*

Figure 20: Conidia of *Fusarium moniliforme* under compound microscope (×400)

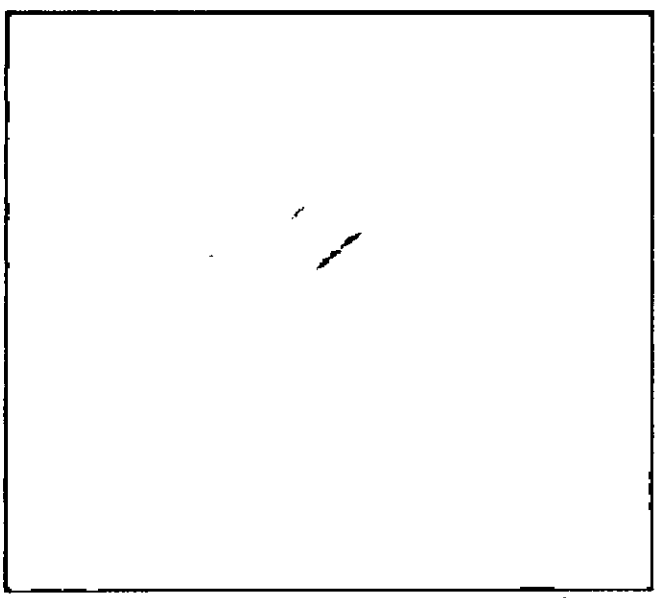

Figure 21: *Penicillium sp.* under compound microscope (×400)

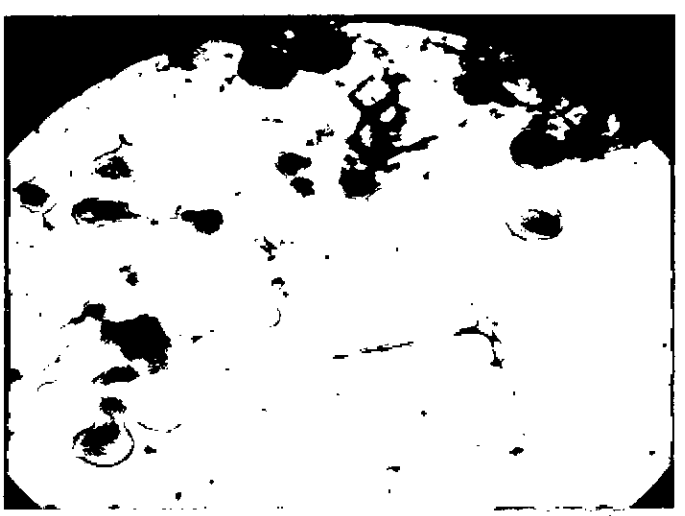

Figure 22: *Rhizopus stolonifer* under compound microscope (×100)

Figure 23: Pycnidium of *Phoma* sp. under compound microscope (×100)

3.4.16. Isolation and identification of bacteria

Blighted leaves were collected from the experimental plots. The leaves were washed by water and cut into small pieces and surface sterilized by 75% ethyl alcohol. The cut pieces then washed in sterile water three times. Then the cut pieces were kept into a sterilized petridish. The sterilized inocula were placed into the culture plates. Three or four inocula were used in each petridish. Then the inoculated plates were allowed to incubate into an incubator of a temperature (37^0C). The inoculated plates were kept under daily observation to note bacterial growth around the pieces of inocula. After some days, bacterial ooze was found. Bacterial colony, light yellow colour was seen in media and *Xanthomonas campestris pv. oryzae* was identified by physiological study .Then a drop of bacterial ooze was taken in a test-tube containing 9ml of sterile water .From this test-tube again 1ml of inocula was added to another test-tube containing 9ml of sterile and the same process was repeated for several times (3-4).

The procedure of Gram staining (Hucker's modification) -A drop of diluted inocula suspension taken by sterilized needle was placed on the slide and was

fixed with the least amount of heat. Then the slide was immersed in iodine solution for one minute and washed in tap water. The water was shaken off from the slide but was not allowed to dry. The slide was decolorized for 25 seconds with 95% ethyl alcohol and then washed thoroughly in tap water and shake off excess water. Finally the slide was counterstained with safranine for 15-20 seconds and washed in tap water. The slide was dried by blotting paper or air dry and observed under the compound microscope.

Gram negative bacteria appear red colour after decolourization with 95% ethyl alcohol and gram positive ones violet colour.

3.5. Field experiment

3.5.1. Soil type

The soil of the experimental plot was loam to clay loam in texture belonging to the Madhupur Tract (AEZ-28). The description of the Agro-Ecological Zone (UNDP and FAO, 1988) of the experimental site is sited below:-

Agro Ecological Region	: Madhupur Tract (AEZ-28).
Land type	: Medium high land.
General soil type	: Non-Calcareous Dark gray floodplain soil
Soil series	: Tejgaon
Topography	: Up land
Elevation	: 8.45 meter
Location	: SAU Farm, Dhaka.
Field level	: Above flood level.
Drainage	: Fairly good.
Firmness (consistency)	: Compact to friable when dry.

The physical and chemical characteristics of the soil collected from Soil Resource Development Institute (SRDI), Farmgate, Dhaka and are presented below (For 0-14 cm depth): -

Particle size distribution:

Sand : 34%

Silt : 46%

Clay : 20%

Soil texture : Loam to clay loam.

3.5.2. Climate

The climate of the experimental area was of sub-tropical in nature characterized by high temperature associated with heavy rainfall during Kharif-2 season (June to December).

3.5.3. Weather

The data of monthly average temperature, relative humidity, rainfall and sunshine hours received at the experimental site during the period of the study have been collected from the surface synoptic Data card, Bangladesh Meteorological Department, Sher-e-Bangla Nagar, Dhaka and shown in Appendix- II.

3.5.4. Sprouting of seed

100g seeds of each treatment were soaked in water in a basket for 16 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.

3.5.5. 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 of Sher-e-Bangla Agricultural University Farm. Sprouted seeds treated earlier with the same treatments and same procedures mentioned above were sown in the wet seedbed on 11 July 2010. Proper care of seedlings

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were taken. Weeds were removed and irrigation was given in the seedbed as and when necessary.

3.5.6. Fertilizer application to the seedbed

Fertilizers were applied as per recommendation of Bangladesh Rice Research Institute (BRRI), 2007. As the land was rich in organic matters, therefore no manuring was done. The following doses of fertilizers were applied to the seedbed at 12 days after sowing (DAS) of seeds:

Fertilizers	Dose/m^2(g)	Dose/17m^2(g)
Urea (N_2)	7	119
TSP (P_2O_5)	4	68
MP(K_2O)	7	119

3.5.7. Land preparation

The land was prepared with the help of power tiller and harrow. The land was first opened on 10 August 2010 and ploughed. 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.

3.5.8. Fertilizer application to the main field

Fertilizers were applied as per recommendation of BRRI, 2007. The following doses of fertilizers were applied to the plots:

Fertilizers	Dose/ha (kg)	Dose/415 m^2 (kg)
Urea (N_2)	270	11.21
TSP (P_2O_5)	150	6.23
MP(K_2O)	120	4.98
Gypsum (S)	70	2.91
Zinc Sulphate (Zn)	12	0.50
Cowdung	12000	498

All fertilizers except two-thirds of 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.

Figure 24. Experimental plots

3.5.9. Transplanting of seedling

Thirty days old seedlings were uprooted from the seedbed very carefully and then transplanted on 12 August 2010 in the main field. In the field experiment, row to row spacing was maintained as 20 cm and that of hill was 15 cm. One seedling was transplanted in individual hill.

3.5.10. Intercultural operation

Weeding, Irrigation and other intercultural operation were given in the field as and when necessary.

3.5.11. Assessment of the disease incidence in the field

Each plot was visited for recording the incidence. The disease incidence was recorded in the three growth stage of the plant namely flowering stage, milking

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Weeding, Irrigation and other intercultural operation were given in the field as and when necessary.

3.5.11. Assessment of the disease incidence in the field

Each plot was visited for recording the incidence. The disease incidence was recorded in the three growth stage of the plant namely flowering stage, milking

stage and maturity stage. Data was recorded visually by observing the symptoms. Sixteen hills were randomly selected from each unit plot and the following parameters were considered for data collection-

(1) Number of tillers /hill

(2) Number of diseased tillers /hill

(3) Percent leaf area diseased (LAD)

Disease incidence was calculated by the following formula (Rajput and Bartaria, 1995).

$$\text{Disease Incidence (\%)} = \frac{\text{Number of diseased tillers}}{\text{Total number of inspected tillers}} \times 100$$

3.5.12. Assessment of the disease severity in the field

Sixteen plants from each unit plot were randomly selected and tagged for grading the severity of diseases. The severity of five diseases viz. brown spot, narrow brown leaf spot, leaf blast , bacterial leaf blight (BLB), sheath blight were recorded following IRRI recommended grading scale (Standard Evaluation System for Rice, 1980). The disease severity was recorded in the three growth stage of the plant namely flowering stage, milking stage and maturity stage. The grade of different diseases is given below:

Brown spot: Disease severity of brown spot (*Bipolaris oryzae*) of rice was measured on a 0-9 scale of Standard Evaluation System for Rice (Annon. 1996). The scale is

0 = no incidence

1 = less than 1% leaf area affected

2 = 1-3% leaf area affected

3 = 4-5% leaf area affected

4 = 6-10% leaf area affected

5 = 11-15% leaf area affected

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0 = no incidence

1 = less than 1% leaf area affected

2 = 1-3% leaf area affected

3 = 4-5% leaf area affected

4 = 6-10% leaf area affected

5 = 11-15% leaf area affected

6 = 16-25% leaf area affected

7 = 26-50 leaf area affected

8 = 51-75 % leaf area affected

9 = 76-100% leaf areas affected

Figure 25. Symptoms of brown spot in the control field

Narrow brown leaf spot: Disease severity of narrow brown spot (*Cercospora oryzae*) of rice was measured on a 0-9 scale of Standard Evaluation System for Rice (Annon. 1996).

0 = no incidence

1 = less than 1% leaf area affected

3 = 1-5% leaf area affected

5 = 6-25% leaf area affected

7 = 26-50 leaf area affected

9 = 51-100% leaf area affected

Figure 26. Symptoms of narrow brown leaf spot observed in the field

Leaf Blast: Disease severity of leaf blast (*Pyricularia grisea*) of rice was recorded by Singh (2000) used a 0-9 scale.

0 = no lesion observed

1 = 1% leaf area covered

3 = 10% leaf area covered

5 = 25% leaf area covered

7 = 50% leaf area covered

9 = more than 50% leaf area covered

Figure 27. Symptom of leaf blast observed in the field

Sheath blight: The assessment of rice sheath blight (*Rhizoctonia solani*) was done using the Standard Evaluation System for Rice on a 0-9 scale (Annon. 1996) The scale is

0 = no infection observed,

1= lesion limited to lower 20%

3 = 20-30%

5 = 31-45%

7 = 46-65%

9 = more than 65% (based on the lesion height).

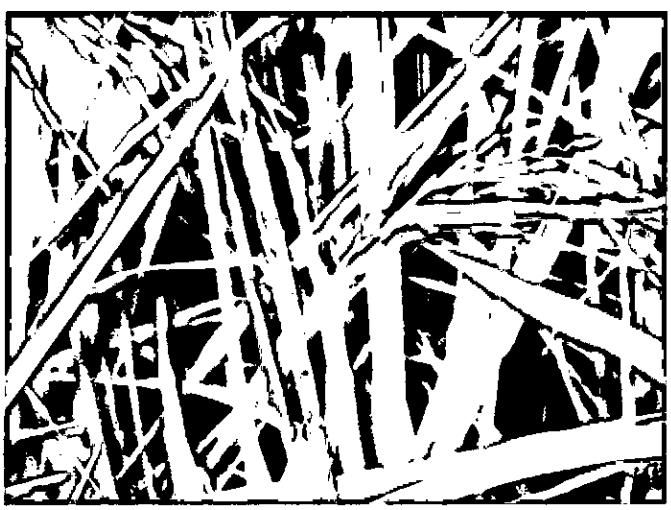

Figure 28: Typical sheath blight symptom observed in the field

Bacterial leaf blight (BLB): Bacterial leaf blight of rice (*Xanthomonas campestris* pv. *oryzae*) was measured for field test on a 0-9 scale by Standard Evaluation System for Rice (Annon. 1996).

0 = no lesion

1 = 1-5% lesion area

3 = 6-12% lesion area

5 = 13-25% lesion area

7 = 26-50% lesion area

9 = 51-100% lesion area

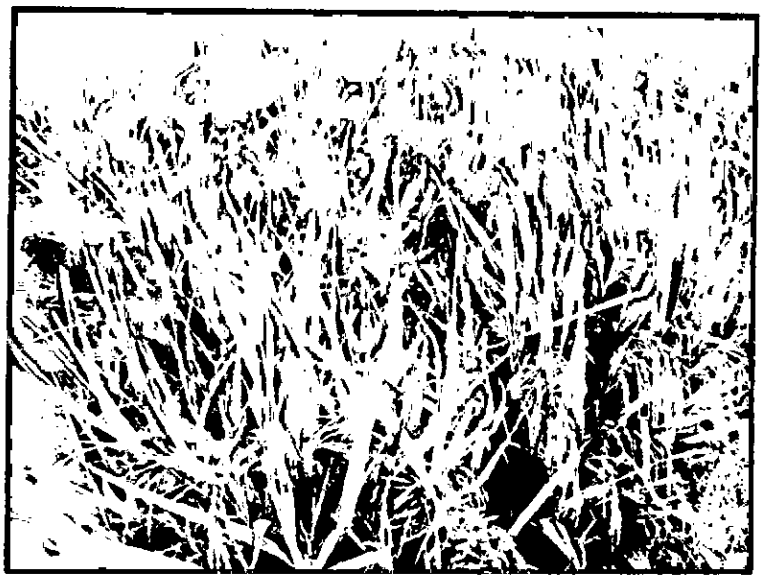

Figure 29. Symptoms of Bacterial leaf blight observed in the field

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

The crop was harvested on 8 November 2010 at full ripening stage. Moreover 16 tagged plants of each plot were harvested separately. The data on the following yield contributing parameters were recorded:

- ♦ Plant height (cm)
- ♦ Panicle length (cm)
- ♦ No. of effective panicles/hill
- ♦ No. of ineffective panicles/hill
- ♦ No. of filled grains/ panicle
- ♦ No. of unfilled grains /panicle
- ♦ No. of rachis /panicle
- ♦ Weight of grains /panicle (g)
- ♦ Weight of grains /hill (g)
- ♦ Weight of straw/hill (g)
- ♦ Grain yield /plot (kg)
- ♦ Straw yield /plot (kg)
- ♦ Weight of thousand seeds (g)
- ♦ Grain yield (t/ha)

3.6. Data analysis and design of experiment

The data on different characters were subjected to statistical analysis using analysis of variance to find out the variation resulting from experimental treatments. The laboratory experiment was conducted following Completely Randomized Design (CRD) with three replications.

The field experiment was carried out in a Randomized Complete Block Design (RCBD) with three replications. Each block comprised 11 unit plots and total number of unit plots were 33 (11 X 3). The size of the unit plot was 2.5m X 1.5m and the distance between plot to plot and block to block was 1.0 m and 1.5 m, respectively. The layout of this experiment was shown in Appendix- III. The recorded data on various parameters under the present study were statistically analyzed using MSTAT-C statistical package. Mean differences among the treatments were compared by Duncan's Multiple Range Test (DMRT).

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CHAPTER 4

RESULTS

4.1. Laboratory experiment

4.1.1. Determination of seed health status by blotter method under different treatments

4.1.2. Percent seed germination by blotter method

Germination records of hybrid (Taj-1) rice under different treatments were investigated through Blotter methods and are shown in Table-1. The highest (94.60%) seed germination was found in Dithane M 45 treated seed followed by Bavistin 50 WP (92.85%), Provax 200 (94.60%), and hot water treatment (89.91%), respectively. The lowest germination (77.31%) was recorded under untreated control preceded by sun drying (79.17%), polythene solarization (79.87%), and brine solution (83.19%). Seed germination under neem leaf extract treated seed (87.66%) and allamanda leaf extract treated showed statistically identical. *Trichoderma harzianum* (83.46%) showed moderate result in respect of seed germination.

4.1.3. Identified Pathogens by blotter method

The identified pathogens were *a gram negative bacterium* (unidentified), *Rhizopus stolonifer, Aspergillus* spp., *Fusarium moniliforme, Phoma sp., Bipolaris oryzae, Curvularia lunata, Penicillium* sp., *Alternaria tennuissima.*

4.1.4. Incidence of seed borne pathogens by blotter method

Results regarding the incidence of bacteria (unidentified) under different treatments are shown in Table-1. The incidence of bacteria (unidentified) under different treatments were significantly different from one to another that

ranged from 0.96% to 11.19%. The highest incidence of bacterial strain was observed under polythene solarization (11.19%) followed by untreated control (10.51%), sun drying (10.40%) and brine solution (8.79%). The lowest incidence was found under Dithane M 45 (0.96%) preceeded by Bavistin 50 WP (1.19%), Provax 200 (2.47%) and hot water treatment (3.21%). The rest of the treatments showed the medium incidence

The incidence of *Rhizopus stolonifer* ranged from 1.38% to 8.30% where highest incidence was observed under control followed by polythene solarization (8.10%), sun drying (7.58%) and brine solution (6.74%). The lowest incidence was found under Dithane M 45 (1.38%) preceeded by Bavistin 50 WP (1.86%), Provax 200 (2.98%) and hot water treatment (3.12%). The rest of the treatments showed the medium incidence (Table-1).

The incidence of *Aspergillus* spp. ranged from 0 .to 2.07% .The highest incidence was observed under control (2.07%) followed by sun drying (1.94%) polythene solarization (1.79%), and brine solution (1.67%) which was statistically identical with neem leaf extract (1.61%). No incidence was found under Dithane M 45 and Bavistin 50 WP treated seeds. The rest of the treatments showed the medium incidence (Table-1).

The incidence of *Fusarium moniliforme* ranged from 0 to 3.20%. The highest incidence was under untreated control (3.20%) followed by polythene solarization (3.05%) which was statustically identical with sun drying (3.01%). No incidence (0) was found under Dithane M 45, Bavistin 50 WP, Provax 200 and hot water treatment respectively. The rest of the treatments showed medium incidence (Table-1).

Table 1: Effect of different seed treatments on percent seed germination and incidence of seed borne pathogens of imported hybrid rice seed (Taj-1) by blotter method (2009-10)

Treatments	% Seed germination	%Pathogen incidence								
		Bacteria (unidetified)	*Rhizopus stolonifer*	*Aspergillus* spp.	*Fusarium moniliforme*	*Phoma* sp.	*Bipolaris oryzae*	*Curvularia lunata*	*Penicillium* spp.	*Alternaria tennuissima*
Control	**77.31 j**	10.51 b	**8.30 a**	**2.07 a**	**3.20 a**	**0.95 a**	**3.24 a**	**2.03 a**	**1.75 a**	**0.61 a**
Sun drying	79.15 i	10.40 c	7.58 c	1.94 b	3.01 b	0.30 c	1.94c	1.60 c	0.49 b	**0.00 c**
Polythene solarization	79.87 h	**11.19 a**	8.10 b	1.79 c	3.05 b	0.51 b	2.53 b	1.87 b	**1.75 a**	0.25 b
Brine solution	83.19 g	8.79 d	6.74 d	1.67 d	1.42 c	**0.00 d**	1.12d	0.83 d	0.54 b	**0.00 c**
Neem leaf extract	87.66 e	6.34 e	5.18 e	1.61 d	1.17 d	**0.00 d**	0.93 e	0.47 e	**0.00 d**	**0.00 c**
Allamanda leaf extract	87.60 e	4.30 g	5.04 f	1.37 e	1.06 e	**0.00 d**	0.71 f	0.51 e	0.35 c	**0.00 c**
Hot water treatment	89.91 d	3.21 h	3.12 g	1.13 g	**0.00 g**	**0.00 d**	**0.00 g**	**0.00 f**	**0.00 d**	**0.00 c**
Provax 200	90.51 c	2.47 i	2.98 h	0.97 h	**0.00 g**	**0.00 d**	**0.00 g**	**0.00 f**	**0.00 d**	**0.00 c**
Bavistin 50 WP	92.85 b	1.19 j	1.86 i	**0.00 i**	**0.00 g**	**0.00 d**	**0.00 g**	**0.00 f**	**0.00 d**	**0.00 c**
Dithane M 45	**94.60 a**	**0.96 k**	**1.38 j**	**0.00 i**	**0.00 g**	**0.00 d**	**0.00 g**	**0.00 f**	**0.00 d**	0.25b
Trichoderma harzianum	83.46 f	5.25 f	5.26 e	1.28 f	0.16 f	**0.00 d**	1.18d	0.50 e	**0.00 d**	**0.00 c**
LSD ($p \leq 0.005$)	0.1204	0.005386	0.1077	0.007617	0.007617	0.005386	0.007617	0.009329	0.007617.	0.007617

Values within the same column having a common letter(s) do not differ significantly ($P \leq 0.005$)

The incidence of *Phoma Spp.* ranged from 0 to 0.95%. The highest incidence was found under untreated control (0.95%) followed by polythene solarization (0.51%) and sun drying (0.30%). The rest of the treatments showed no incidence (Table-1).

The incidence of *Bipolaris oryzae* differed significantly from each other that ranged from 0 to 3.24%. The highest incidence was observed under untreated control (3.24%) followed by polythene solarization (2.53%) and sun drying (1.94%). No incidence were found under Dithane M 45, Bavistin 50 WP, Provax 200 and hot water treated seeds. The rest of the treatments showed medium incidence (Table-1).

The incidence of *Curvularia lunata* ranged from 0 to 2.03%. The highest incidence was observed under control (2.03%) followed by polythene solarization (1.87%) and sun drying (1.60%). No incidence was found under Dithane M 45, Bavistin 50 WP, Provax 200 and hot water treatment respectively. The lower incidence was observed under neem leaf extract (0.47%) which was statistically identical with *T. harzianum* (0.50%) and allamanda leaf extract (0.51). Brine solution (0.83%) showed medium incidence. (Table-1)

The incidence of *Penicillium* spp. ranged from 0 to 1.75%. The highest incidence was observed under control (1.75%) which was statistically similar with polythene solarization (1.75%). No incidence was found under Dithane M 45, Bavistin 50 WP, Provax 200, hot water treatment neem leaf extract treated seeds respectively. The rest of the treatments showed medium incidence (Table-1).

The incidence of *Alternaria tennuissima* ranged from 0 to 0.61%.The highest incidence was observed under untreated control (0.61%) followed by polythene solarization (0.25%), and *T. harzianum* (0.25%). The rest of the treatment showed no incidence. (Table 1)

4.1.5. Determination of seed health status by agar plate method under different treatments

4.1.6. Percent seed germination by agar plate method

Germination records of hybrid (Taj-1) rice under different treatments were investigated through agar plate method and are shown in Table-2. The highest seed germination was found under Dithane M 45 (91.45%) followed by Bavistin 50 WP (90.007%), Provax 200 (88.07%), and hot water treatment (86.94%) respectively. The lowest (78.32%) germination was recorded under untreated control preceded by polythene solarization (78.52%), sun drying (80.25%), and brine solution (81.10%). The rest of the treatments showed medium seed germination.

4.1.7. Identified pathogens by agar plate mehod

The identified pathogens were *a gram negative bacterium* (unidentified), *Rhizopus stolonifer, Aspergillus flavus, Fusarium moniliforme, Bipolaris oryzae, Curvularia lunata, Penicillium* sp., and *Alternaria tennuissima.*

4.1.8. Incidence of seed borne pathogens by agar plate mehod

Results regarding the incidence of bacteria (unidentified) under different treatments are shown in Table 2. The highest incidence of gram negative bacteria was observed under control (12.75%) followed by polythene

solarization (11.53%), sun drying (6.64%) which was statistically similar with *T. harzianum* (6.75%). The lowest incidence was observed under Dithane M 45 (0.98%) which was statistically identical with Bavistin 50 WP (1.15%) preceeded by Provax 200 (1.58%). The rest of the treatments showed the medium incidence.

The incidence of *Bipolaris oryzae* ranged from 0 to 9.63% under different treatment. The highest incidence was noticed under untreated control (9.63%) followed by polythene solarization (6.22%) and sun drying (5.0%). No incidence was found under Dithane M 45, Bavistin 50 WP, Provax 200 and hot water treatment respectively. Seed treated with brine solution, neem leaf extract and *T. harzianum* showed statistically similar results.

The incidence of *Fusarium moniliforme* ranged from 0 to 3.85% (Table 2). The highest incidence was recorded under control (3.85%) followed by polythene solarization (3.61%) and sun drying (2.23%). No incidence was found under Dithane M 45, Bavistin 50 WP, Provax 200 and hot water treatment respectively. The rest of the treatments showed medium incidence.

The incidence of *Rhizopus stolonifer* ranged from 0 to 2.53% (Table 2). The highest incidence of *Rhizopus stolonifer* was observed under control (2.53%) followed by *T. harzianum* (2.20%). No incidence was found under Dithane M 45, Bavistin 50 WP, Provax 200, hot water treatment and allamanda leaf extract, respectively. The rest of the treatments showed medium incidence.

Table 2: Effect of different seed treatments on percent seed germination and incidence of seed borne pathogens of imported hybrid rice seed (Taj-1) by agar plate method (2009-10)

Treatments	% Seed germination	%Pathogen incidence							
		Bacteria (unidetified)	*Bipolaris oryzae*	*Fusarium moniliforme*	*Rhizopus stolonifer*	*Alternaria tennuissima*	*Curvularia lunata*	*Penicillium* sp.	*Aspergillus flavus*
Control	**78.32 k**	**12.75 a**	**9.63 a**	**3.85 a**	**2.53 a**	**1.63 a**	**2.25 a**	**1.56 a**	**3.20 a**
Sun drying	80.25 i	6.75 c	5.00 c	2.23 c	1.64 c	**0.00 c**	1.87 c	**0.00 c**	2.63 c
Polythene solarization	78.52 j	11.53 b	6.22 b	3.61 b	1.75 c	1.56 a	2.05 b	1.50 a	2.75 b
Brine solution	81.10 h	4.50 e	3.07 d	1.08 d	0.85 d	1.25 b	**0.00 f**	**0.00 c**	2.12 d
Neem leaf extract	83.19 g	5.40 d	2.88 d	0.92 e	0.93 d	**0.00 c**	**0.00 f**	**0.00 c**	1.55 f
Allamanda leaf extract	85.61 e	3.40 f	2.55 e	0.87 e	**0.00 e**	**0.00 c**	0.25 e	**0.00 c**	1.13 g
Hot water treatment	86.94 d	3.28 f	**0.00 f**	**0.00 f**	**0.00 e**	**0.00 c**	**0.00 f**	**0.00 c**	**0.00 i**
Provax 200	88.07c	1.58 g	**0.00 f**	**0.00 f**	**0.00 e**	**0.00 c**	**0.00 f**	**0.00 c**	0.62 h
Bavistin 50 WP	90.007 b	1.15 h	**0.00 f**	**0.00 f**	**0.00 e**	**0.00 c**	**0.00 f**	**0.00 c**	**0.00 i**
Dithane M 45	**91.45 a**	**0.98 h**	**0.00 f**	**0.00 f**	**0.00 e**	**0.00 c**	**0.00 f**	**0.00 c**	**0.00 i**
Trichoderma harzianum	83.45 f	6.64 c	2.91 d	1.84 d	2.20 b	1.57 a	0.76 d	1.07 b	1.88 e
LSD (P≤ 0.005)	0.1866	0.2468	0.1786	0.007617	0.1425	0.1523	0.009329	0.1616	0.1077

Values within the same column having a common letter(s) do not differ significantly (P≤ 0.005)

The incidence of *Alternaria tennuissima* ranged from 0 to 1.63% (Table 2). The highest incidence was observed under control (1.63%) which was statistically identical with *T. harzianum* (1.57%) and polythene solarization (1.56%) followed by brine solution (1.25%). The rest of the treatments showed no incidence.

The incidence of *Curvularia lunata* ranged from 0 to 2.25% (Table 2). The highest incidence was found under untreated control (2.25%) followed by polythene solarization (2.05%) and sun drying (1.87%). No incidence was found under Dithane M 45, Bavistin 50 WP, Provax 200 and hot water treatment, neem leaf extract and brine solution, respectively. The rest of the treatments showed medium incidence.

The incidence of *Penicillium* sp. ranged from 0 to 1.56% (Table 2). The highest incidence was observed under control (1.56%) which was statistically identical with polythene solarization (1.50%) followed by *T. harzianum* (1.07%). The rest of the treatments showed no incidence.

The incidence of *Aspergillus flavus* ranged from 0 to 3.20% (Table 2). The highest incidence was observed under control (3.20%) followed by polythene solarization (2.75%) and sun drying (2.63%). No incidence was found under Dithane M 45, Bavistin 50 WP and hot water treatment respectively. The rest of the treatments showed medium incidence.

4.2. Field experiment

4.2.1. Effect of different seed treatments on the incidence and severity of brown spot disease caused by *Bipolaris oryzae*

Results regarding the incidence and severity of brown spot caused by *Bipolaris oryzae* at different treatments are shown in Table 3. The incidence and severity of brown spot at different treatments were significantly different from one to another. The incidence of brown spot at flowering stage ranged from 0 to 3.27%. The highest incidence (3.27%) of brown spot was observed on control closely followed by polythene solarization (3.05%) and sundrying (2.95%). These were also statistically similar with the treatment *T. harzianum* (2.27%) and brine solution (1.89%). No incidence was observed on Dithane M 45 which was statistically identical with Bavistin 50 WP (0.008%), Provax 200 (0.61%), hot water treatment (0.72%), allamanda leaf extract (0.96%) and neem leaf extract (1.13%) treated plants.

The incidence of brown spot at milking stage ranged from 1.06% to 9.12%. The highest incidence (9.12%) was observed on control. Seed treatment with polythene solarization (8.62%), sun drying (7.98%), *T. harzianum* (6.95%) and brine solution (5.69%) showed no significant difference with control. The lowest incidence (1.06%) was observed on Dithane M 45 which was statistically similar with Bavistin 50 WP (1.26%), Provax 200 (2.66%), and hot water treatment (2.72%). Seed treatment with allamanda leaf extract and neem leaf extract showed moderate incidence which was also statistically identical with Dithane M 45.

The incidence of brown spot at maturity stage ranged from 5.48% to 13.89%. The highest incidence (13.89%) of brown spot was observed on control which was statistically identical with polythene solarization (13.34 %), sun drying (12.06%), *T. harzianum* (11.23%), brine solution (10.53%) and neem leaf

extract (9.55%). The lowest incidence of brown spot was observed on Dithane M45 (5.48%). Bavistin 50 WP (5.83%), Provax 200 (7.01%), hot water treatment (7.68%) and seed treatment with allamanda leaf extract (8.22%) showed statistically similar results with Dithane M 45.

The severity of brown spot at flowering stage ranged from 0 to 0.28 (0-9 scales). The highest (0.28 grade) severity of brown spot was observed on untreated control which was statistically similar with polythene solarization (0.24), *T. harzianum* (0.23) and sun drying (0.21). No disease severity observed on Dithane M 45 and Bavistin 50 WP which was statistically identical with Provax 200 (0.005) and hot water treatment (0.006). Brine solution (0.12), neem leaf extract (0.11) and allamanda leaf extract (0.10) showed medium severity and statistically identical with both the highest and the lowest severity.

The severity of brown spot at milking stage ranged from 0 to 0.48 (0-9 scales). The highest severity of brown spot was observed on the untreated control plot (0.48) and polythene solarization (0.48) which were statistically identical with *T. harzianum* (0.47) and sun drying (0.39). No severity of brown spot was observed on Dithane M 45 and Bavistin 50 WP seed treated plot which were statistically identical with Provax 200 (0.007). The plot treated with brine solution (0.35), neem leaf extract (0.29), allamanda leaf extract (0.28) and hot water (0.14) showed statistically identical result.

The severity of brown spot at maturity stage ranged from 0.91 to 1.67 (0-9 scales). Untreated control (1.67) showed highest severity which was statistically similar with the plot where seed treated with polythene solarization (1.63) and sun drying (1.57). The lowest severity of brown spot was observed on the plot treated with Dithane M 45 (0.91) which was statistically similar with the plot treated with Bavistin 50 WP (1.08). The rest of the treatment showed medium severity.

Table 3. Effect of different seed treatments on disease incidence and severity of brown spot caused by *Bipolaris oryzae* (2010-2011)

Treatments	Disease Incidence (%)			Disease severity grade (0-9 scales)		
	Flowering stage	Milking stage	Maturity stage	Flowering stage	Milking stage	Maturity stage
Control	**3.27 a**	**9.12 a**	**13.89 a**	**0.28 a**	**0.48 a**	**1.67 a**
Sun drying	2.95 a	7.98 ab	12.06 ab	0.21 ab	0.39 ab	1.57 ab
Polythene solarization	3.05 a	8.62 a	13.34 a	0.24 ab	**0.48 a**	1.63 a
Brine solution	1.89 ab	5.69 abc	10.53 a-d	0.12 abc	0.35 abc	1.29 abc
Neem leaf extract	1.13 bc	4.86 a-d	9.55 a-e	0.11 abc	0.29 abc	1.27 abc
Allamanda leaf extract	0.96 bc	3.86 bcd	8.22 b-e	0.10 abc	0.28 abc	1.20 abc
Hot water treatment	0.72 bc	2.72 cd	7.68 b-e	0.006 bc	0.14 abc	1.19 abc
Provax 200	0.61 bc	2.66 cd	7.01 cde	0.005 bc	0.007 bc	1.18 abc
Bavistin 50 WP	0.008c	1.26 d	5.83 de	**0.00 c**	**0.00 c**	1.08 bc
Dithane M 45	**0.00 c**	**1.06 d**	**5.48 e**	**0.00 c**	**0.00 c**	**0.91 c**
Trichoderma harzianum	2.27 ab	6.95 abc	11.23 abc	0.23 ab	0.47 a	1.61 a
LSD (P≤ 0.005)	1.519	3.941	4.316	0.1616	0.3049	0.4506

Values within the same column having a common letter(s) do not differ significantly (P≤ 0.005)

4.2.2. Effect of different seed treatments on the incidence and severity of narrow brown spot disease caused by *Cercospora oryzae*

Results regarding the incidence and severity of narrow brown spot by *Cercospora oryzae* under different treatments are shown in Table 4. The incidence of narrow brown spot at flowering stage ranged from 0 to 1.40%. The highest incidence of narrow brown spot was observed on the plots planted with untreated control (1.40%) and no incidence was recorded with the plots treated with Dithane M 45 which was statistically similar with Bavistin 50 WP (0.008%). All other treatments did not show statistically different results with control.

The incidence of narrow brown spot at milking stage ranged from 0 to 3.16%. The highest incidence of narrow brown spot was observed on untreated control (3.16%) which was statistically similar with polythene solarization (3.14%), *T. harzianum* (3.12%), sun drying (3.00%), and brine solution (2.94), neem leaf extract (2.63) and allamanda leaf extract (2.26) which was preceeded by hot water treatment (1.73), Provax 200 (1.61) and Bavistin 50 WP (1.41%). No incidence was recorded under the treatment Dithane M 45 which was statistically different from all other treatments.

The incidence of narrow brown spot at maturity stage ranged from 1.49% to 7.79%. The highest incidence was recorded under untreated control (7.79) which was statistically similar with polythene solarization (7.60%), *T. harzianum* (7.11%), sun drying (6.82%), brine solution (5.71), neem leaf extract (5.35) and allamanda leaf extract (4.73%).The lowest incidence was recorded under Dithane M 45 (1.49%) which was not statistically different from Bavistin 50 WP (1.98%), Provax 200 (3.51%), hot water (3.59%) and allamanda leaf extract (4.73%)

The severity of narrow brown spot at flowering stage ranged from 0 to 0.32 (0-9 scales).The highest severity of narrow brown spot was recorded under control (0.32) which was statistically similar with polythene solarization (0.27), sun drying (0.20), *T. harzianum* (0.20), brine solution (0.15) and neem leaf extract (0.11). No disease severity was observed under the treatment Dithane M 45 and Bavistin 50 WP which was statistically similar with all the treatments used except polythene solarization (0.27) and control (0.32).

The severity of narrow brown spot at milking stage ranged from 0 to 1.59 (0-9 scales). The highest severity of narrow brown spot was recorded on untreated control (1.59) and seeds treated with polythene solarization (1.59) which was statistically identical with *T. harzianum* (1.52), sun drying (1.42), brine solution (0.99), neem leaf extract (0.96) and allamanda leaf extract (0.87). No severity was observed under Dithane M 45 which was statistically similar with Provax 200 (0.62) and Bavistin 50 WP (0.26).

The severity of narrow brown spot at maturity stage ranged from 0.63 to 3.44 (0-9 scales). The highest severity of narrow brown spot was observed on untreated control (3.44) which was statistically identical with polythene solarization (3.23), *T. harzianum* (3.11), sun drying (2.76), brine solution (2.12) and neem leaf extract (2.09). The lowest severity was recorded under Dithane M 45 (0.63) which was statistically identical with Bavistin 50 WP (0.64), Provax 200 (1.25), hot water treatment (1.50), allamanda leaf extract (1.80), neem leaf extract (2.09) and brine solution (2.12).

Table 4. Effect of different seed treatments on disease incidence and severity of narrow brown spot caused by *Cercospora oryzae* (2010-2011)

Treatments	Disease Incidence (%)			Disease severity grade (0-9 scales)		
	Flowering stage	**Milking stage**	**Maturity stage**	**Flowering stage**	**Milking stage**	**Maturity stage**
Control	**1.40 a**	**3.16 a**	**7.79 a**	**0.32 a**	**1.59 a**	**3.44 a**
Sun drying	1.28 a	3.00 abc	6.82 ab	0.20 abc	1.42 a	2.76 abc
Polythene solarization	1.34 a	3.14 a	7.60 a	0.27 ab	**1.59 a**	3.23 ab
Brine solution	1.07 a	2.94 ab	5.71 ab	0.15 abc	1.16 ab	2.12 a-d
Neem leaf extract	0.86 a	2.63 abc	5.35 abc	0.11 abc	0.99 abc	2.09 a-d
Allamanda leaf extract	0.84 a	2.26 abc	4.73 a-d	0.009 bc	0.96 abc	1.80 bcd
Hot water treatment	0.77 a	1.73 bc	3.59 bcd	0.008 bc	0.87 abc	1.50 cd
Provax 200	0.72 ab	1.61 c	3.51 bcd	0.004 c	0.62 bcd	1.25 cd
Bavistin 50 WP	0.008 bc	1.41 c	1.98 cd	**0.00 c**	0.26 cd	0.64 d
Dithan M 45	**0.00 c**	**0.00 d**	**1.49 d**	**0.00 c**	**0.00 d**	**0.63 d**
Trichoderma harzianum	1.33 a	3.12 a	7.11 a	0.20 abc	1.52 a	3.11 ab
LSD (P≤ 0.005)	0.6418	1.134	3.070	0.1942	0.7002	1.370

Values within the same column having a common letter(s) do not differ significantly (P≤ 0.005)

4.2.3. Effect of different seed treatments on the incidence and severity of leaf blast disease caused by *Pyricularia grisea*

Results regarding the incidence and severity of leaf blast caused by *Pyricularia grisea* under different treatments are shown in Table 5. The incidence and severity of leaf blast under different treatments were significantly different from one to another. The incidence of leaf blast at flowering stage ranged from 0.50% to 4.49%. The highest incidence of leaf blast was observed on control (4.49%) which was statistically identical with polythene solarization (4.18%), *T. harzianum* (4.03%), sundrying (3.75%), brine solution (2.81%), neem leaf extract (2.67%), and allamanda leaf extract (2.54%). The lowest incidence of leaf blast was observed on hot water treatment (0.50%) which was statistically similar with Dithane M 45 (0.83%) Bavistin 50 WP (1.75%), Provax 200 (2.13%), and allamanda leaf extract (2.54%).

The incidence of leaf blast at milking stage ranged from 3.11% to 9.37%. The highest incidence of leaf blast was observed on untreated control (9.37%) which was statistically identical with polythene solarization (9.06%), *T. harzianum* (8.67%) and sun drying (8.24%). The lowest incidence of leaf blast was observed on hot water treatment (3.11%) which was statistically identical with Dithane M 45 (3.69%), Bavistin 50 WP (4.51%), and Provax 200 (5.33%). The rest of the treatments showed medium incidence and statistically similar with both the highest and lowest incidence.

The incidence of leaf blast at maturity stage ranged from 5.96% to 16.11%. The highest incidence of leaf blast was observed on untreated control (16.11%) which was statistically identical with polythene solarization (16.10%), *T. harzianum* (15.05), sun drying (14.24%), (12.96%) and brine solution (12.47%). The lowest incidence of leaf blast was observed on hot water

treatment (5.96%) which was statistically identical with Dithane M 45 (7.34%), Bavistin 50 WP (8.47%), and Provax 200 (9.84%). Seed treated with allamanda leaf extract (11.59%) showed medium disease incidence and also statistically identical with both the highest and the lowest incidence.

The severity of leaf blast at flowering stage ranged from 0.006 to 0.79 (0-9 scales). The highest severity (0.79) of leaf blast was observed on control which was statistically identical and closely followed by polythene solarization (0.75), *T. harzianum* (0.73), sun drying (0.68) and brine solution (0.50). The lowest severity (0.006) of leaf blast was observed on hot water treatment and Dithane M 45 (0.006) which was statistically identical with Bavistin 50 WP (0.24), Provax 200 (0.29) and allamanda leaf extract (0.35).

The severity of leaf blast at milking stage ranged from 1.53 to 3.87 (0-9 scales). The highest severity (3.87) of leaf blast was observed unde control which was statistically similar with polythene solarization (3.81), sun drying (3.62), brine solution (3.55), neem leaf extract (3.30), allamanda leaf extract (3.13) and Provax 200 (2.99). The lowest severity (1.53) of leaf blast was observed on hot water treatment which was statistically similar with Dithane M 45 (2.00) and Bavistin 50 WP (2.15). *T. harzianum* showed medium severity and statistically identical with both the highest and the lowest severity.

The severity of leaf blast at maturity stage ranged from 2.63 to 5.86 (0-9 scales). The highest severity (5.86) of leaf blast was observed on untreated control which was statistically identical and closely followed by polythene solarization (5.61), *T. harzianum* (5.56), sun drying (5.23), brine solution (4.61) and neem leaf extract (4.44). The lowest severity (2.63) of leaf blast was observed on hot water which was statistically similar with Dithane M 45 (2.80), Bavistin 50 WP (3.39), Provax 200 (3.60) and allamanda leaf extract (4.15).

Table 5. Effect of different seed treatments on disease incidence and severity of leaf blast caused by *Pyricularia grisea* (2010-2011)

Treatments	Disease Incidence (%)			Disease severity grade (0-9 scales)		
	Flowering stage	Milking stage	Maturity stage	Flowering stage	Milking stage	Maturity stage
Control	**4.49 a**	**9.37 a**	**16.11 a**	**0.79 a**	**3.87 a**	**5.86 a**
Sun drying	3.75 abc	8.24 abc	14.24 abc	0.68 abc	3.62 ab	5.23 abc
Polythene solarization	4.18 ab	9.06 ab	16.10 a	0.75 ab	3.81 a	5.61 ab
Brine solution	2.81 a-d	6.82 a-d	12.96 a-d	0.50 a-d	3.55 ab	4.61 a-d
Neem leaf extract	2.67 a-d	6.55 a-d	12.47 a-d	0.47 a-e	3.30 abc	4.44 a-e
Allamanda leaf extract	2.54 a-e	6.40 a-d	11.59 a-e	0.35 b-e	3.13 abc	4.15 b-f
Hot water treatment	**0.50 e**	**3.11 d**	**5.96 e**	**0.006 e**	**1.53 d**	**2.63 f**
Provax 200	2.13 b-e	5.33 bcd	9.84 b-e	0.29 cde	2.99 abc	3.60 c-f
Bavistin 50 WP	1.75 cde	4.51 cd	8.47 cde	0.24 de	2.15 bcd	3.39 def
Dithane M 45	0.83 de	3.69 d	7.34 de	**0.006 e**	2.00 cd	2.80 ef
Trichoderma harzianum	4.03 ab	8.67 ab	15.05 ab	0.73 ab	3.66 a-d	5.56 ab
LSD (P≤ 0.005)	1.853	3.351	5.242	0.3731	1.307	1.500

Values within the same column having a common letter(s) do not differ significantly (P≤ 0.005)

4.2.4. Effect of different seed treatments on the incidence and severity of bacterial leaf blight (BLB) disease caused by *Xanthomonas campestris* pv. *oryzae*

Results regarding the incidence and severity of BLB caused by *Xanthomonas campestris* pv. *oryzae* under different treatments are shown in Table 6. The incidence and severity of BLB under different treatments were significantly different from one to another. The incidence of BLB at flowering stage ranged from 4.15% to 8.01%. The highest incidence (8.01%) of BLB was observed on untreated control which was statistically identical with Provax 200 (7.80%) and closely followed by neem leaf extract (7.35%), Bavistin 50 WP (6.99%), brine solution (6.31%) and sun drying (5.88%). The lowest incidence (4.15%) of BLB was observed on hot water treatment which was statistically identical with allamanda leaf extract (4.47%) and preceded by *T. harzianum* (4.87%), Dithane M 45(5.15%), polythene solarization (5.42%) and sun drying (5.88%).

The incidence of BLB at milking stage ranged from 8.50% to 13.75%. The highest incidence of BLB was observed on untreated control (13.75%) which was statistically similar with Provax 200 (13.67%) and neem leaf extract (13.45%) and closely followed by Bavistin 50 WP (13.25%), sun drying (12.52%) and polythene solarization (12.11%).The lowest incidence of BLB was observed on hot water treatment (8.50%) which was statistically identical with allamanda leaf extract (9.65%) and *T. harzianum* (9.83%). Medium incidence were recorded under Dithane M 45 (11.23%) and brine solution (11.11%) treated plots.

The incidence of BLB at maturity stage ranged from 13.62% to 23.20%. The highest incidence of BLB was observed on untreated control (23.20%) which was statistically similar with Provax 200 (22.96%) and closely

Table 6. Effect of different seed treatments on disease incidence and severity of bacterial leaf blight caused by *Xanthomonas campestris* pv. *oryzae* (2010-2011)

Treatments	Disease Incidence (%)			Disease severity grade (0-9 scales)		
	Flowering stage	Milking stage	Maturity stage	Flowering stage	Milking stage	Maturity stage
Control	**8.01 a**	**13.75 a**	**23.20 a**	**2.33 a**	**4.05 a**	**8.29 a**
Sun drying	5.88 a-d	12.52 abc	19.11 a-e	1.96 ab	3.51 ab	7.63 ab
Polythene solarization	5.42 bcd	12.11 abc	17.37 b-e	1.89 ab	3.27 abc	7.00 abc
Brine solution	6.31 a-d	11.11 a-d	19.33 a-d	2.02 ab	3.48 ab	7.29 ab
Neem leaf extract	7.35 ab	13.45 a	22.11 ab	2.25 a	3.87 a	**8.11 a**
Allamanda leaf extract	4.47 d	9.65 cd	14.55 de	1.58 b	2.63 c	**5.71 c**
Hot water treatment	**4.15 d**	**8.50 d**	**13.62 e**	**1.57 b**	**2.59 c**	**5.64 c**
Provax 200	7.80 a	13.67 a	22.96 a	2.31 a	3.94 a	**8.24 a**
Bavistin 50 WP	6.99 abc	13.25 ab	21.11 abc	2.25 a	3.84 ab	**8.00 a**
Dithane M 45	5.15 bcd	11.23 a-d	16.16 cde	1.76 b	3.02 bc	6.41 bc
Trichoderma harzianum	4.87 cd	9.83 bcd	15.80 cde	1.78 b	3.03 bc	6.40 bc
LSD (P≤ 0.005)	2.059	3.131	4.976	0.4066	0.7345	1.386

Values within the same column having a common letter(s) do not differ significantly (P≤ 0.005)

followed by neem leaf extract (22.11%), Bavistin 50 WP (21.11%) and brine solution (19.33%). The lowest incidence (13.62%) of BLB was observed under hot water treatment which was statistically similar with allamanda leaf extract (14.55%), *T. harzianum* (15.80%), Dithane M 45 (16.16%) and polythene solarization (17.37%). Sun drying (19.11%) showed medium incidence.

The severity of BLB at flowering stage ranged from 1.58 to 2.33 grade (0-9 scales). The highest severity of BLB was observed on the plots planted with untreated control (2.33) which was statistically identical with Provax 200 (2.31), Bavistin 50 WP (2.25) and neem leaf exract (2.25). The lowest severity of BLB was observed under hot water treatment (1.57) which was statistically similar with allamanda leaf extract (1.57), Dithane M 45 (1.76) and *T. harzianum* (1.78). Brine solution, sun drying and polythene solarization showed medium severity.

The severity of BLB at milking stage ranged from 2.59 to 4.05 (0-9 scales). The highest severity of BLB was observed under control (4.05) which was statistically identical and closely followed by Provax 200 (3.94), neem leaf extract (3.87), Bavistin 50 WP (3.84), and sun drying (3.51). The lowest severity of BLB was observed on hot water treatment (2.59) which was closely preceeded by and statistically similar with allamanda leaf extract (2.63), *T. harzianum* (3.03), and Dithane M 45 (3.02). polythene solarization (3.27) showed medium severity.

The severity of BLB at maturity stage ranged from 5.64 to 8.29 (0-9 scales). The highest severity of BLB was observed on control (8.29) closely followed by Provax 200 (8.24), neem leaf extract (8.11) and Bavistin 50 WP (8.00) which was statistically identical with sun drying (7.63) and brine solution (7.29). The lowest severity of BLB was observed on hot water treatment (5.64)

closely preceeded by allamanda leaf extract (5.71) which was statistically similar with *T. harzianum* (6.40) and Dithane M 45 (6.41). polythene solarization (7.00) showed medium severity.

4.2.5. Effect of different seed treatments on the incidence and severity of sheath blight disease caused by *Rhizoctonia soloni*

Results regarding the incidence and severity of sheath blight caused by *Rhizoctonia solani* under different treatments are shown in Table 7. The incidence of sheath blight at flowering stage ranged from 0.82% to 2.86%. The highest incidence of sheath blight was observed under control (2.86%) which was statistically identical with polythene solarization (2.85%) and neem leaf extract (2.50%) follwed by Bavistin 50 WP (2.35%). The lowest incidence of sheath blight was observed on hot water treatment (0.82%) preceded by Provax 200 (0.88%).The rest of the treatments showed medium incidence and statistically similar with both the highest and the lowest incidence.

The incidence of sheath blight at milking stage ranged from 5.73% to 9.44%. The highest incidence of sheath blight was observed under control (9.44%) closely followed by polythene solarization (9.19%) which was statistically identical with neem leaf extract (8.66%) and Bavistin 50 WP (8.43%). The lowest incidence of sheath blight was observed on hot water treatment (5.73%) which was statistically identical and proceeded by Provax 200 (6.23%) and *T. harzianum* (6.50%).The rest of the treatments showed medium incidence.

The incidence of sheath blight at maturity stage ranged from 15.87% to 20.30%. The highest incidence of sheath blight was observed under untreated control (20.30%) closely followed by polythene solarization (20.24%) which statistically identical with neem leaf extract (19.81), Bavistin 50 WP (19.75)

and sun drying (18.93). The lowest incidence of sheath blight was observed on hot water treatment (15.87%) closely preceded by Provax 200 (16.06%) which was statistically similar with *T. harzianum* (17.01%) and Dithane M 45 (17.31%).The rest of the treatments showed medium incidence.

The severity of sheath blight at flowering stage ranged from 0.15 to 0.86 (0-9 scales). The highest severity of sheath blight was observed under control (0.86) closely followed by polythene solarization (0.79) which was statistically identical with neem leaf extract (0.74), Bavistin 50 WP (0.72) and brine solution (0.57). The lowest severity of sheath blight was observed on hot water treatment (0.15) closely preceded by Provax 200 (0.16) which was statistically similar with *T. harzianum* (0.35), Dithane M 45 (0.36) and allamanda leaf extract (0.43). Sun drying (0.52) showed medium severity.

The severity of sheath blight at milking stage ranged from 1.88 to 2.76 (0-9 scales). The highest severity of sheath blight was observed on untreated control (2.76) closely followed by neem leaf extract (2.69), Bavistin 50 WP (2.68) and polythene solarization (2.66).The lowest severity of sheath blight was observed on hot water treatment (1.88) closely follwed by Provax 200 (2.00) which was statistically similar with *T. harzianum* (2.06).The rest of the treatments showed medium severity and statistically identical with the highest and the lowest severity.

Table 7. Effect of different seed treatments on disease incidence and severity of sheath blight caused by *Rhizoctonia solani* (2010-2011)

Treatments	Disease Incidence (%)			Disease severity grade (0-9 scales)		
	Flowering stage	Milking stage	Maturity stage	Flowering stage	Milking stage	Maturity stage
Control	**2.86 a**	**9.44 a**	**20.30 a**	**0.86 a**	**2.76 a**	**7.80 a**
Sun drying	1.90 abc	7.93 a-d	18.93 ab	0.52 a-d	2.41 abc	7.27 abc
Polythene solarization	2.85 a	9.19 a	20.24 a	0.79 ab	2.66 ab	**7.79 a**
Brine solution	1.99 abc	8.04 a-d	18.57 abc	0.57 abc	2.16 abc	7.20 a-d
Neem leaf extract	2.50 a	8.66 ab	19.81 ab	0.74 abc	2.69 ab	7.72 ab
Allamanda leaf extract	1.76 abc	7.43 a-d	18.07 abc	0.43 bcd	2.38 abc	7.13 a-d
Hot water treatment	**0.82 c**	**5.73 d**	**15.87 c**	**0.15 d**	**1.88 c**	**6.47 d**
Provax 200	0.88 bc	6.23 cd	16.06 c	0.16 d	2.00 c	6.55 cd
Bavistin 50 WP	2.35 ab	8.43 abc	19.75 ab	0.72 abc	2.68 ab	7.64 ab
Dithane M 45	1.61 abc	7.10 a-d	17.31 bc	0.36 cd	2.33 abc	7.00 bcd
Trichoderma harzianum	1.42 abc	6.50 bcd	17.01 bc	0.35 cd	2.06 bc	6.77 cd
LSD (P≤ 0.005)	1.342	2.112	2.562	0.3613	0.5700	0.6918

Values within the same column having a common letter(s) do not differ significantly (P≤ 0.005)

The severity of sheath blight at maturity stage ranged from 6.47 to 7.80 (0-9 scales). The highest severity of sheath blight was observed on untreated control (7.80) closely followed by polythene solarization (7.79) which was statistically identical with neem leaf extract (7.72), Bavistin 50 wp (7.64) and sun drying (7.27). The lowest severity of sheath blight was observed on hot water treatment (6.47) which was statistically similar with Provax 200 (6.55), *T. harzianum* (6.77) and Dithane M 45 (7.00). The rest of the treatments showed medium severity.

4.2.6. Effect of field diseases on plant growth and yield contributing characters under different treatments

Results regarding the effect of field diseases i.e. brown spot, narrow brown leaf spot, leaf blast, bacterial leaf blight, and sheath blight on plant height, panicle length, no. of effective panicle/hill, no. of ineffective panicle/hill, no. of filled grain/panicle, no. of rachis/ panicle under different treatments are shown in Table 8.

Plant height

Plant height ranged from 89.73 cm to 94.03cm. The highest plant height (94.03 cm) was recorded under Dithane M 45 treated plot which was statistically identical and closely followed by neem leaf extract (93.03 cm), allamanda leaf extract (92.51 cm) and Bavistin 50 WP (92.50 cm). The lowest plant height (89.73 cm) was noted under seed treatment with brine solution which was statistically similar with hot water treatment (90.58 cm) closely preceded by Provax 200 (91.20 cm), untreated control (91.53 cm), *T. harzianum* (91.68 cm) and sun drying (91.76 cm). Polythene solarization (91.82 cm) showed medium plant height.

Panicle length

Panicle length ranged from 14.56 cm to 21.20 cm. The highest panicle length (21.20 cm) was recorded under seed treatment with hot water which was statistically similar with Bavistin 50 wp (21.17 cm). The lowest panicle length (14.56) was recorded under the treatment, neem leaf extract. The rest of the treatments showed medium plant height.

Number of effective panicles/hill

Number of effective panicles/hill ranged from 8.58 to 10.73. The maximum number of effective panicles/hill was recorded under the treatment Dithane M 45 (10.73) followed by Bavistin 50 WP (10.19) and Provax 200 (9.90). The minimum number of effective panicles/hill was noted under polythene solarization (8.58) closely preceded by neem leaf extract (9.05), untreated control (9.08), and brine solution (9.12). The rest of the treatments showed medium no. of effective panicle/hill.

Number of ineffective panicles/hill

Number of ineffective panicles/hill ranged from 0.51 to 1.34. The maximum number of ineffective panicles/hill was recorded under the treatment, allamanda leaf extract (1.34) which was statistically identical with all other treatments except the minimum number of ineffective panicles/hill was noted under Dithane M 45 (0.51).

Number of filled grains/panicle

Number of filled grains/panicle ranged from 119.0 to 170.3. The maximum number of filled grain/panicle was recorded under Dithane M 45 treated plots (170.3) followed by Bavistin 50 WP (147.9) and Provax 200 (145.2). The minimum number of filled grains/panicle (119.0) was found on the plots treated with polythene solarization closely followed by untreated control

(120.1) which was statistically similar with sun drying (122.8) and *T. harzianum* (126.1). The rest of the hybrids had medium no. of filled grains/panicle.

Number of unfilled grains/panicle

Number of unfilled grains/panicle ranged from 2.25 to 11.79. The maximum number of unfilled grains/panicle was recorded under brine solution treated plots (11.79) which was statistically identical with sun drying (10.37) follwed by untreated control (10.20) and polythene splarization (9.31). The minimum number of unfilled grains/panicle was recorded under Dithane M 45 treated plots (2.25) which was statistically similar with *T. harzianum* (3.37). The rest of the treatments showed medium no. of unfilled grains/panicle.

Number of rachis/ panicle

Number of rachis/ panicle ranged from 10.97 to 12.47. The maximum number of rachis/ panicle was recorded under Bavistin 50 WP (12.47) which was statistically similar with hot water treatment (12.43) and Dithane M 45 (12.43). The minimum number of rachis/ panicle was recorded under sun drying (10.97) treated plots which was statistically identical with allamanda leaf extract (10.99) and *T. harzianum* (11.00).The rest of the treatments resulted medium number of rachis/ panicle.

Table 8. Effect of different seed treatments on plant growth and yield contributing characters of hybrid variety (Taj-1) in aman season (2010-2011)

Treatments	Plant height (cm)	Panicle length (cm)	No. of effective panicles/hill	No. of ineffective panicles/hill	No. of filled grains/panicle	No. of unfilled grains/panicle	No. of rachis/panicle
Control	91.53 bcd	20.30 ab	9.05 e	1.22 a	**120.1 h**	10.20 b	11.55 abc
Sun drying	91.76 bcd	20.45 ab	9.16 de	1.16 a	122.8 gh	10.37 ab	**10.97 c**
Polythene solarization	91.82 bc	20.004 ab	**8.58 f**	1.10 a	**119.0 h**	9.31 bc	11.37 abc
Brine solution	**89.73 d**	19.83 ab	9.12 e	1.11 a	129.4 efg	**11.79 a**	11.27 abc
Neem leaf extract	93.03 ab	**14.56 b**	9.08 e	1.08 a	131.5 def	8.21 c	11.24 bc
Allamanda leaf extract	92.51 abc	20.15 ab	9.28 de	**1.34 a**	135.9 de	6.33 d	10.99 c
Hot water treatment	90.58 cd	**21.20 a**	9.65 cd	1.03 a	139.2 cd	6.56 d	12.43 ab
Provax 200	91.20 bcd	20.32 ab	9.90 bc	1.07 a	145.2 bc	5.44 de	12.19 abc
Bavistin 50 WP	92.40 abc	21.17 a	10.19 b	0.99 a	147.9 b	4.17 ef	**12.47 a**
Dithane M 45	**94.03 a**	19.47 ab	**10.73 a**	**0.51 b**	**170.3 a**	**2.25 g**	12.43 ab
Trichoderma harzianum	91.68 bcd	20.95 ab	9.43 cde	1.06 a	126.1fgh	3.37 fg	11.00 c
LSD (P≤ 0.005)	1.811	5.691	0.4664	0.4030	7.656	1.452	1.073

Values within the same column having a common letter(s) do not differ significantly (P≤ 0.005)

4.2.7. Effect of diseases on yield and yield contributing characters of hybrid (Taj-1) rice variety under different treatments

Results regarding the effect of field diseases i.e. brown spot, narrow brown leaf spot, leaf blast, bacterial leaf blight, and sheath blight on weight of grain/panicle, weight of grain/hill, weight of straw/hill, grain yield/plot, straw yield/plot 1000 seed weight and grain yield under different treatments are shown in Table 9.

Weight of grains/panicle

Weight of grains/panicle ranged from 5.68 gm to 8.13 gm. The highest weight of grains/panicle was recorded under Dithane M 45 (8.13 gm) treated plots followed by Bavistin 50 WP (7.06 gm), Provax 200 (6.93 gm) and hot water (6.64 gm). The lowest weight of grains/panicle was noted under polythene solarization (5.68 gm) which was statistically identical with sun drying (5.73 gm), untreated control (5.86 gm) and T. hzrzianum (6.02 gm).

Weight of grains/hill

Weight of grains/hill ranged from 45.42 gm to 65.00 gm. The highest weight of grains/hill was recorded under the treatment, Dithane M 45 (65.00 gm) followed by Bavistin 50 WP (56.46 gm) and Provax 200(55.42 gm). The lowest weight of grains/hill was noted under polythene solarization (45.42 gm) which was statistically identical with control (45.84 gm), sun drying (46.88 gm) and T. harzianum (48.13 gm).The rest of the treatment resulted medium weight of grains/hill.

Weight of straw/hill

Weight of straw/hill ranged from 158.5 gm 226.8 gm. The highest weight of straw/hill was recorded unde rDithane M 45 (226.8 gm) closely followed by the Bavistin 50 WP (197.0 gm), Provax 200 (193.4 gm) and hot water treatment (185.4 gm). The lowest weight of straw/hill was recorded under

polythene solarization (158.5 gm) which was statistically identical with control (159.9 gm), sun drying (163.6 gm) and T. harzianum (167.9 gm). The rest of the treatments resulted medium weight of straw/hill.

Grain yield/plot

Grain yield/plot ranged from 2.91 kg to 4.16 kg. In case of seed treatments, the highest grain yield/plot was recorded under Dithane M 45 (4.16 kg) followed by Bavistin 50 WP (3.61 kg), Provax 200 (3.55 kg) and hot water treatment (3.40 kg). The lowest grain yield/plot was found under polythene solarization (2.91 kg) which was statistically similar with untreated control (2.93 kg), sun drying (3.00 kg) and T. harzianum (3.08 kg). The rest of the treatments resulted medium grain yield/plot.

Straw yield/plot

Straw yield/plot ranged from 10.14 kg to 14.51 kg. The highest straw yield/plot was recorded under Dithane M 45 (14.51 kg) followed by Bavistin 50 WP (12.61 kg), Provax 200 (12.37 kg) and hot water treatment (11.86 kg). The lowest straw yield/plot was found under polythene solarization (10.14 kg) which was statistically similar with untreated control (10.24 kg), sun drying (10.47 kg) and T. harzianum (10.75 kg). The rest of the treatments resulted medium straw yield/plot.

1000 Seed Weight

1000 seed weight ranged from 38.23 gm to 54.71 gm. The highest 1000 seed weight was recorded under Dithane M 45 (54.71 gm) followed by Bavistin 50 WP (47.52 gm), Provax 200 (46.64 gm) and hot water treatment (44.71 gm). The lowest 1000 seed weight was noted under polythene solarization (38.23 gm) which was statistically similar with untreated control (38.58 gm), sun drying (39.45 gm) and T. harzianum (40.50 gm).

Table 9. Effect of different seed treatments on yield and yield contributing characters of hybrid variety (Taj-1) in aman season (2010-2011)

Treatments	Wt. of grains/panicle (gm)	Wt. of grains/hill (gm)	Wt. of straw/hill (gm)	Grain yield/plot (kg)	Straw yield/plot (kg)	1000 seed wt.(gm)	Grain yield (t/ha)
Control	**5.73 h**	**45.84 h**	**159.9 h**	**2.93 h**	**10.24 h**	**38.58 h**	**7.33 h**
Sun drying	5.86 gh	46.88 gh	163.6 gh	3.00 gh	10.47 gh	39.45 gh	7.50 gh
Polythene solarization	**5.68 h**	**45.42 h**	**158.5 h**	**2.91 h**	**10.14 h**	**38.23 h**	**7.27 h**
Brine solution	6.17 efg	49.38 efg	172.3 efg	3.16 efg	11.03 efg	41.56 efg	7.90 efg
Neem leaf extract	6.28 def	50.21 def	175.2 def	3.21 def	11.21 def	42.26 def	8.03 def
Allamanda leaf extract	6.48 de	51.88 de	181.0 de	3.32 de	11.58 de	43.66 de	8.30 de
Hot water treatment	6.64 cd	53.13 cd	185.4 cd	3.40 cd	11.86 cd	44.71 cd	8.50 cd
Provax 200	6.93 bc	55.42 bc	193.4 bc	3.55 bc	12.37 bc	46.64 bc	8.87 bc
Bavistin 50 WP	7.06 b	56.46 b	197.0 b	3.61 b	12.61 b	47.52 b	9.03 b
Dithane M 45	**8.13 a**	**65.00 a**	**226.8 a**	**4.16 a**	**14.51 a**	**54.71 a**	**10.40 a**
Trichoderma harzianum	6.02 fgh	48.13 fgh	167.9 fgh	3.08 fgh	10.75 fgh	40.50 fgh	7.70 fgh
LSD (P≤ 0.005)	0.3653	2.921	10.19	0.1866	0.6508	2.460	0.4664

Values within the same column having a common letter(s) do not differ significantly (P≤ 0.005)

Grain yield

Grain yield ranged from 7.27 t/ha to 10.40 t/ha. In case of seed treatments, the highest grain yield was recorded under Dithane M 45 (10.40 t/ha) followed by Bavistin 50 WP (9.03 t/ha), Provax 200 (8.87 t/ha) and hot water treatment (8.50 t/ha). The lowest grain yield/plot was found under polythene solarization (7.27 t/ha) which was statistically similar with untreated control (7.33 t/ha), sun drying (7.50 t/ha) and T. harzianum (7.70 t/ha). The rest of the treatments resulted medium grain yield/plot.

CHAPTER 5
DISCUSSION

The present investigation was carried out to evaluate the efficacy of different seed treatments against seed borne pathogens and major diseases under natural epiphytic conditions of Bangladesh during aman season at Sher-e-Bangla Agricultural University. The research work was aimed at recording the influence of some selected seed treatments on the seed borne pathogens (*in vitro*) and on incidence and severity of diseases (*in vivo*) i.e. brown spot, narrow brown leaf spot, leaf blast, bacterial leaf blight and sheath blight on hybrid rice variety (Taj-1) grown in aman season. Field diseases caused considerable loss of rice crop. The present research work was also under taken to evaluate the effect of field diseases on the yield and yield contributing characters of hybrid rice variety (Taj-1) in aman season.

5.1. Effect of different seed treatments on the incidence of major seed borne pathogens of rice

In blotter method, 9 seed borne pathogens were identified. These were a gram negative bacteria, *Rhizopus stolonifer, Aspergillus* spp., *Fusarium moniliforme, Phoma sp., Bipolaris oryzae, Curvularia lunata, Penicillium* sp. and *Alternaria padwickii.* It was observed that germination percentage of rice seeds varied significantly from 77.31% to 94.60. The highest seed germination was found under Dithane M 45 (94.60) followed by Bavistin 50 WP (92.85%), Provax 200 (94.60), and hot water treatment (89.91%), respectively. The lowest germination was recorded under untreated control (77.31%) preceeded by sun drying (79.17%), polythene solarization (79.87%), and brine solution (83.19%). The incidence of *Xanthomonas oryzae* ranged from 0.96% to 11.19%. The highest incidence was

observed under polythene solarization (11.19%) and the lowest incidence was found under Dithane M 45 (0.96%). The incidence of *Rhizophus stolonifer* ranged from 1.38% to 8.30. The highest incidence was observed under control (8.30) and the lowest incidence was found under Dithane M 45 (1.38%) preceeded by Bavistin 50 WP (1.86%), Provax 200 (2.98%) and hot water treatment (3.12%). The incidence of *Aspergillus* spp. ranged from 0 to 2.07%. The highest incidence was observed under untreated control (2.07%) and no incidence was found under Dithane M 45 and Bavistin 50 WP, respectively. The incidence of *Fusarium moniliforme* ranged from 0 to 3.20%. The highest incidence was under untreated control (3.20). No incidence was found under Dithane M 45, Bavistin 50 WP, Provax 200 and hot water treatment, respectively. The incidence of *Phoma* spp. ranged from 0 to 0.95%. The highest incidence was found under untreated control (0.95%). Brine solution, neem leaf extract, allamanda leaf extract, hot water treatment, Provax 200, Bavistin 50 WP and Dithane M 45 showed no pathogen incidence. The incidence of *Bipolaris oryzae* ranged from 0 to 3.24%. The highest incidence was observed under untreated control (3.24%) and no incidence was found under Dithane M 45, Bavistin 50 WP, Provax 200 and hot water treatment respectively. The incidence of *Curvularia lunata* ranged from 0 to 2.03%. The highest incidence was observed under control (2.03%) and no incidence was found under Dithane M 45, Bavistin 50 WP, Provax 200 and hot water treatment respectively. The incidence of *Penicillium* sp. ranged from 0 to 1.75%. The highest incidence was observed under control (1.75%) and No incidence was found under Dithane M 45, Bavistin 50 WP, Provax 200, hot water treatment neem leaf extract, respectively. The incidence of *Alternaria padwickii* ranged from 0 to 0.61%.The highest incidence was observed under untreated control (0.61%) and most of the treatments showed no incidence.

The present findings were supported previous research reports (Ou, 1972; Fakir and Ahmed, 1974; Hossain and Fakir, 1974 and Sharma *et al.,* 1992). Sharma *et al.,* (1992) detected 10 fungal species of fungi from the rice seeds where *Fusarium moniliforme (Gibberella fujikuroi), Curvularia lunata (Cochliobolus lunata), Aspergillus flavus and Rhizopus* spp. were the most common. Of all the pathogens *Xanthomonas oryzae, Rhizopus stolonifer, Aspergillus* spp., *Bipolaris oryzae, Fusarium moniliforme* were found predominant.These pathogen were designated as predominant, because each of them constituted at least 5.0 of the total seed borne pathogens infection. Mian and Fakir (1989) reported that the most predominant fungi in order of prevalence were *Helminthosporium oryzae, Curvularia lunata, Cladosporium cladosporioides, Aspergillus* spp. and *Trichoconis padwickii.*

In agar plate method, 8 seed borne pathogenic genera were identified. These were *a gram negative bacteria, Rhizopus stolonifer, Aspergillus flavus, Fusarium moniliforme, Bipolaris oryzae, Curvularia lunata, Penicillium* spp., and *Alternaria padwickii.*It was observed that germination percentage of rice seeds varied significantly from 78.32% to 91.45%. The highest seed germination was found under Dithane M 45 (91.45%) followed by Bavistin 50 WP (907%), Provax 200 (88.07%), and hot water treatment (86.94%), respectively and the lowest germination was recorded under untreated control (78.32%). The incidence of *Xanthomonas oryzae* ranged from 0.98% to 12.75%. The highest incidence was observed under control (12.75%) and the lowest incidence was observed under Dithane M 45 (0.98%) which was statistically identical with Bavistin 50 WP (1.15%) preceeded by Provax 200 (1.58%). The incidence of *Bipolaris oryzae* ranged from 0 to 9.63%. The highest incidence was noticed under untreated control (9.63%) and no incidence was found under Dithane M 45, Bavistin 50 WP, Provax

200 and hot water treatment respectively.The incidence of *Fusarium moniliforme* ranged from 0 to 3.85%. The highest incidence was recorded under control (3.85%) and no incidence was found under Dithane M 45, Bavistin 50 WP, Provax 200 and hot water treatment respectively. The incidence of *Rhizopus stolonifer* ranged from 0 to 2.53%. The highest incidence of *Rhizopus stolonifer* was observed under control (2.53%) and no incidence was found under Dithane M 45, Bavistin 50 WP, Provax 200, hot water treatment and allamanda leaf extract respectively. The incidence of *Alternaria padwickii* ranged from 0 to 1.63%. The highest incidence was observed under control (1.63%) which was statistically identical with *T. harzianum* (1.57%) and polythene solarization (1.56%) followed by brine solution (1.25%). The rest of the treatments showed no incidence. The incidence of *Curvularia lunata* ranged from 0 to 2.25%. The highest incidence was found under untreated control (2.25%) and most of the treatments showed no pathogen incidence. The incidence of *Penicillium* sp. ranged from 0 to 1.56%. The highest incidence was observed under control (1.56%) and most of the treatments showed no incidence. The incidence of *Aspergillus flavus* ranged from 0 to 3.20. The highest incidence was observed under control (3.20). No incidence was found under Dithane M 45, Bavistin 50 WP and hot water treatment respectively. Of all the pathogens *Xanthomonas oryzae, Bipolaris oryzae, Aspergillus* spp, *Fusarium moniliforme, Rhizopus stolonifer* were predominant.

The fungi and bacteria isoloated in the present study comprise the genera *Bipolaris, Rhizoctonia, Fusarium, Aspergillus, Penicillium, Alternaria, Phoma,* and *Xanthomonas* have also been reported in rice seeds by different scientists at home and abroad (Hossain and Fakir, 1974; Ribeiro (1980); Sing and Kang (1987); Basak and Mridha (1988); Fakir *et al.*(1990); Sharma *et al.* (1992); Ilyas and Javid (1995); Ali and Deka (1996). *Bipolaris oryzae, Trichoconis padwickii, Curvularia*

lunata, Nigrospora oryzae, Alternaria tenuis, Aspergillus spp. and *Penicillium* spp. were identified by Rahman *et al.* (2000) on BR 11.

5.2. Effect of different seed treatments on incidence and severity of major field diseases of hybrid rice variety (Taj-1) in Aman season

Different methods of seed treatment differed significantly in respect of incidence and severity of major diseases of rice. The incidence of brown spot caused by *Bipolaris oryzae* under different treatments ranged 0 to 3.27%, 1.06% to 9.12% and 5.48% to 13.89% at flowering, milking and maturity stage respectively. The severity of brown spot under different treatments in grade (0-9 scales) ranged 0 to 0.28, 0 to 0.48 and 0.91 to 1.67 at flowering, milking and maturity stage, respectively. In flowering stage, the highest incidence (3.27%) and severity (0.28) was recorded under untreated control. No incidence and severity was observed under Dithane M 45 and Bavistin 50 WP respectively. In milking stage, the highest incidence (9.12%) and severity (0.48) was observed under untreated control. The lowest incidence (1.06%) was observed under Dithane M 45 and no severity was observed under Dithane M 45 and Bavistin 50 WP. In maturity stage, the highest incidence (13.89%) and severity (1.67) was recorded under untreated control. The lowest incidence (5.48%) and severity (0.91) was observed under Dithane M 45. These findings were supported by Rashed, (2001), who reported that the incidence and severity of brown spot were observed 30.75% to 62.75% and 25.25% to 47.50, respectively at 50 days after transplanting on the hybrids line 321H. The incidence and severity 40.50 to 80 and 45% to 77%, respectively at 70 days after transplanting on the hybrids line 321H. Saifulla (1994) reported that mean brown spot severity ranged 23.0 in IR9924-14 to 36.5% in IR9924-14.

The incidence of narrow brown leaf spot caused by *Cercospora oryzae* ranged 0 to 1.40, 0 to 3.16% and 1.49% to 7.79% at flowering, milking and maturity stage

respectively. The severity in grade (0-9 scales) ranged 0 to 0.32, 0 to 1.59 and 0.63 to 3.44 at flowering, milking and maturity stage, respectively. In flowering stage the highest incidence (1.40) and severity (0.32) was recorded under untreated control. No disease incidence and severity was recorded under Dithane M 45. In milking stage, the highest incidence (3.16%) (1.59) was recorded under untreated control. No incidence and severity was recorded under Dithane M 45. In maturity stage, the highest incidence (7.79%) and severity (3.44) was recorded under untreated control. The lowest incidence (1.49%) and severity (0.63) was observed under Dithane M 45. These findings were supported by Rai *et al.* (2001), who reported that the increasing trend of disease severity of disease development at later stages of growth and the maximum disease severity 22.08% was recorded at dough stage. Jha *et al.* (2004) reported that the average disease severity at the mature and dough stage were 23.8% and 26.2%, respectively.

The incidence of leaf blast caused by *Pyricularia oryzae* ranged 0.50% to 4.49%, 3.11% to 9.37% and 5.96% to 16.11% at flowering, milking and maturity stage respectively. The severity in grade (0-9 scales) ranged 0.006 to 0.79, 1.53 to 3.87 and 2.63 to 5.86 at flowering, milking and maturity stage, respectively. In flowering stage the highest incidence (4.49%) and severity (0.79) was recorded under control. The lowest incidence (0.50) and severity (0.006) was recorded under hot water treatment. In milking stage, the highest incidence (9.37%) and severity (3.87) was recorded under untreated control. The lowest incidence (3.11%) and severity (1.53) was recorded under hot water treatment. In maturity stage, the highest incidence (16.11%) and severity (5.86) was recorded under untreated control. The lowest incidence (5.96%) and severity (2.63) was observed under hot water treatment. These findings were supported by Kumar (2001), who reported

that the severity ranged from 0 to 6.03%. The highest (6.03%) severity was recorded on the accession number 74R and lowest (0) in 72R in boro season.

The incidence of BLB caused by *Xanthomonas campestris* pv. *oryzae* ranged 4.15% to 8.01%, 8.50 to 13.75% and 13.62% to 23.20 at flowering, milking and maturity stage, respectively. The severity in grade (0-9 scales) ranged 1.57 to 2.33, 2.59 to 4.05 and 5.64 to 8.29 at flowering, milking and maturity stage respectively. In flowering stage the highest incidence (8.01%) and severity (2.33) was recorded uder control. The lowest incidence (4.15%) and severity (1.57) was found under hot water treatment. In milking stage, the highest incidence (13.75%) and severity (4.05) was recorded under untreated control. The lowest incidence (8.50) and severity (2.59) was recorded under hot water treatment. In maturity stage, the highest incidence (23.20) and severity (8.29) was recorded under untreated control. The lowest incidence (13.62%) and severity (5.64) was observed under hot water treatment. These findings were supported by Zakaria (2001), who reported that the maximum incidence and severity of BLB was recorded 33.08% and 33.87%, respectively.

The incidence of sheath blight caused by *Rhizoctonia solani* ranged 0.82% to 2.86%, 5.73% to 9.44% and 15.87% to 20.30 at flowering, milking and maturity stage, respectively. The severity in grade (0-9 scales) ranged 0.15 to 0.86, 1.88 to 2.76 and 6.47 to 7.80 at flowering, milking and maturity stage, respectively. In flowering stage the highest incidence (2.86%) and severity (0.86) was recorded under control. The lowest incidence (0.82%) and severity (0.15) was recorded under hot water treatment. In milking stage, the highest incidence (9.44%) and severity (2.76) was recorded under untreated control. The lowest incidence (5.73%) and severity (1.88) was recorded under hot water treatment. In maturity

stage, the highest incidence (20.30) and severity (7.80) was recorded under control. The lowest incidence (15.87%) and severity (6.47%) was observed under hot water treatment. These findings were supported by Alam (2007), who reported that the maximum infection index (28.90 %) was recorded at soft dough stage and minimum (13.77%) infection index was found at maximum tillering stage.

It was observed that disease incidence and severity was gradually increased from flowering stage to milking stage to maturity stage. These findings were supported by Klomp (1977), who reported that the susceptibility of the disease increased with plant age. From the results, for most of the diseases at maturity stage it was also observed that the incidence and severity was higher under untreated control than all other treatments. Results revealed that all the treatment showed better perfomance over control in reducing disease incidence and severity. Fugicidal treatments i.e., Dithane M 45, Bavistin 50 WP and Provax 200 showed the best results in reducing disease incidence and severity of brown spot and narrow brown spot disease. These findings are similar with Dharma *et al.* (1970), who reported the complete control of seed-borne *D. oryzae*, *D. sativa* and *D. avenae* on rice, barley and oats, respectively through seed tratmemt with Dithane M 45 at 0.3g/kg seed.

Results also revealed that, hot water treatment was the most effective in reducing the incidence and severity of BLB, leaf blast and sheath blight disease. These findings is similar with Nega *et al.* (2000) who stated that seed borne pathogens could be reduced without significant losses of seed germination by hot water treatments at 50^0 C for 20 to 30 min up to 53^0 C for 10 to 30 min.

5.3. Effect of major diseases on yield and yield contributing characters of hybrid rice Taj 1 under different treatments

Plant height ranged from 89.73 cm to 94.03 cm where the highest (94.03 cm) was in Dithane M 45 and the lowest (89.73 cm) was under brine solution. Panicle length ranged from 14.56 cm to 21.20 cm where the highest (21.20 cm) was observed under hot water treatment and the lowest (14.56 cm) was under neem leaf extract. Number of effective panicle/hill ranged from 8.58 to 10.73. The highest (10.73) was in Dithane M 45 and lowest (8.58) was under polythene solarization. Number of ineffective panicle/hill ranged from 0.51 to 1.34 where the highest (1.34) was under allamanda leaf extract and lowest (0.51) was under Dithane M 45. Number of filled grain/panicle ranged from 119.0 to 170.3 where the highest (170.3) was under Dithane M 45 and the lowest (119.0) was under polythene solarization. Number of unfilled grain/panicle ranged from 2.25 to 11.79 where the highest (11.79) under brine solution and the lowest (2.25) was under Dithane M 45. Weight of grain/panicle ranged from 5.68 gm to 8.13 gm. The highest (8.13 gm) was under Dithane M 45 and the lowest (5.68 gm) was under polythene solarization. Weight of grain/hill ranged from 45.42 gm to 65.00 gm where the highest (65.00 gm) was under Dithane M 45 and the lowest (45.42 gm) was under polythene solarization. Grain yield/plot ranged from 2.91 kg to 4.16 kg. The highest was (4.16 kg) under Dithane M 45 and the lowest (2.91 kg) was under polythene solarization. Straw yield/plot ranged from 10.14 kg to 14.51 kg where the highest (14.51 kg) was under Dithane M 45 and the lowest (10.14 kg) was under polythene solarization. 1000 seed weight ranged from 38.23 gm to 54.71 gm. The highest 1000 seed weight (54.71 gm) was recorded under Dithane M 45 and the lowest (38.23 gm) was under polythene solarization.

Grain yield ranged from 7.27 t/ha to 10.40 t/ha. In case of treatments, the highest grain yield was recorded under Dithane M 45 (10.40 t/ha) followed by Bavistin 50 WP (9.03 t/ha), Provax-200 (8.87 t/ha) and hot water treatment (8.50 t/ha). The lowest grain yield/plot was found under polythene solarization (7.27 t/ha) which was statistically similar with untreated control (7.33 t/ha), sun drying (7.50 t/ha) and *T. harzianum* (7.70 t/ha). The rest of the treatments resulted medium grain yield/plot.

From the results it was observed that Dithane M 45 remarkably reduced the incidence and severity of most of the diseases and high grain yield (10.40 t/ha) and better growth performance. Blotter and agar plate method of seed health test revealed that seed germination was higher under Dithane M 45 treated seeds. These findings corroborate with Dharma *et al.* (1970) who reported the complete control of seed-borne *D. oryzae*, *D. sativa* and *D. avenae* on rice, barley and oats respectively through seed tratmemt with Dithane M 45 at 0.3g/kg seed. Such treatment was also found to increase seed germination. It was also observed that Dithane M 45, and Bavistin 50 showed the best result in reducing incidence and severity of major diseases and increasing seed gemination, yield and other growth and yield characters. These findings are similar with Anon. (1988) where reported that seeds of BR10 and BR11 with natural infection of seed borne pathogens were treated with Bavistin, Benlet, Dithane M 45, Homai, Rovral-50, Tecto-60, Topsin-M and Vitavex-200 at the rate of 3g/kg and among the nine fungicides tested, Dithane M 45 gave a very good control of all the fungal pathogens associated with seeds of BR10 and BR11. The best control of *D. oryzae* was obtained with Rovral-50 WP and Dithane M 45, followed by Vitavax-200. Seed germination increased in all the cases over control.

CHAPTER 6

SUMMARY AND CONCLUSION

The present study was conducted to evaluate the efficacy of some selected seed treatments on seed germination, seed borne pathogens, incidence and severity of major field diseases and yield and yield contributing characters of imported hybrid aman rice (Taj-1). The experiment was carried out in the Seed Pathology Laboratory and Plant Disease Diagnostic Laboratory of Department of Plant Pathology and in the Field of SAU (Sher-e-Bangla Agricultural University) farm allotted for the Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from November 2009 to December 2010. The seed treatments used in the experiment were untreated control, sun drying, polythene solarization, brine solution, neem leaf extract, allamanda leaf extract, hot water treatment, Provax 200, Bavistin 50 WP, Dithane M 45 and *Trichoderma harzianum*. In Bangladesh 31 different diseases are known to occur on rice. In field experiment, five major field diseases were found and identified under different treatments in hybrid aman rice (Taj-1). These field diseases are brown spot (*Bipolaris oryzae*), narrow brown spot (*Cercospora oryzae*), leaf blast (*Pyricularia grisea)*, BLB (*Xanthomonas campestris* pv. *oryzae)*, and sheath blight (*Rhizoctonia solani)*.

Laboratory experiment revealed that more than 9 seed borne pathogens namely a gram negative bacteria (unidentified), *Rhizopus stolonifer, Aspergillus* spp., *Fusarium moniliforme, Phoma* sp., *Bipolaris oryzae, Curvularia lunata, Penicillium* sp. and *Alternaria padwickii* were associated with the seeds of the variety (Taj-1). Different seed treatment methods were effective against these pathogens and field diseases. Some treatments were effective against a specific pathogen and disease whereas others were effective against some other pathogen and diseases. Some seed treatment methods performed moderately in

reducing seed borne pathogens and reducing the incidence and severity of field diseases.

In blotter and agar plate method the highest seed germination (94.60%) and (91.45%), respectively were recorded under Dithane M 45 and the lowest germination (77.31%) and (78.32%), respectively were recorded under untreated control. For all the pathogens observed, the highest pathogen incidence was observed under untreated control and all the treatments except polythene solarization and sun drying significantly reduced the pathogen incidence. Dithane M 45, Bavistin 50 WP, Provax 200 and hot water treatment showed the best performance in reducing pathogen incidence in both the method of seed health test.

In case of field diseases, brown spot disease, in maturity stage, the highest incidence (13.89%) and severity (1.67) was recorded under untreated control with second lowest yield (7.33 t/ha). The lowest incidence (5.48%) and severity (0.91) was observed under Dithane M 45 with higher yield (10.40 t/ha). The second highest incidence (12.06%) and severity (1.57) was recorded under polythene solarization with the lowest yield (7.27 t/ha).

In case of narrow brown leaf spot disease in maturity stage, the highest incidence (7.79%) and severity (3.44) was recorded under untreated control with second lowest yield (7.33 t/ha). The lowest incidence (1.49%) and severity (0.63) was observed under Dithane M 45 with higher yield (10.40 t/ha). The second highest incidence (7.60%) and severity (3.23) was recorded under polythene solarization with the lowest yield (7.27 t/ha).

In case of leaf blast disease in maturity stage, the highest incidence (16.11%) and severity (5.86) was recorded under untreated control with second lowest yield (7.33 t/ha). The lowest incidence (5.96%) and severity (2.63) was observed under hot water treatment with fourth highest yield (8.30 t/ha). The

second lowest incidence (7.34%) and severity (2.80) was recorded under Dithane M 45 with higher yield (10.40 t/ha).

In case of BLB disease in maturity stage, the highest incidence (23.20%) and severity (8.29) was recorded under untreated control with second lower yield (7.33 t/ha). The lowest incidence (13.62%) and severity (5.64) was observed under hot water treatment with fourth highest yield (8.30 t/ha).

In case of sheath blight disease in maturity stage, the highest incidence (20.30%) and severity (7.80) was recorded under control with second lowest yield (7.33 t/ha). The lowest incidence (15.87%) and severity (6.47%) was observed under hot water treatment with fourth highest yield (8.30 t/ha). The second highest incidence (16.06%) and severity (6.55) was recorded under Provax 200 with third lowest yield (8.87 t/ha).

The highest growth and yield contributing characters recorded under the fungicidal seed treatment followed by hot water treatment considering plant height, panicle length, effective panicle and filled grain. Grain yield ranged from 7.27 t/ha to 10.40 t/ha. In case of treatments, the highest grain yield was recorded under Dithane M 45 (10.40 t/ha) followed by Bavistin 50 WP (9.03 t/ha), Provax 200 (8.87 t/ha) and hot water treatment (8.50 t/ha). The lowest grain yield/plot was found under polythene solarization (7.27 t/ha) which was statistically similar with untreated control (7.33 t/ha), sun drying (7.50 t/ha) and T. harzianum (7.70 t/ha). The rest of the treatments resulted medium grain yield/plot.

From the results, it was revealed that Dithane M 45, hot water treatment, Bavistin 50 WP and Provax 200 showed better performance against all the seed borne pathogens and field diseases. Dithane M 45 was the best among all the treatments against brown spot and narrow brown spot diseaes whereas hot water treatment showed the best performance in reducing incidence and

severity of blast, bacterial leaf blight and sheath blight disease. Provax 200, Bavistin 50 WP and Dithane M 45 were not effective against BLB and sheath blight disease. allamanda leaf extract, neem leaf extract, brine solution and *T. harzianum* showed medium performance over control. Polythene solarization and sun drying had no significant effect against the diseases.

The maximum incidence and severity of the diseases was found in untreated control, polythene solarization, sun drying and *T. harzianum* with minimum number of effective panicles/hill, number of filled grains/panicle, number of rachis/panicle and therefore, with minimum weight of grains/panicle (gm), weight of grains/hill (gm), 1000 seed weight (gm) and grain yield/plot (kg). The minimum incidence and severity of the diseases was found in Dithane M 45, Bavistin 50 WP, Provax 200 and hot water treatment with maximum number of effective panicles/hill, number of filled grains/panicle, number of rachis/panicle and therefore, with maximum weight of grains/panicle (gm), weight of grains/hill (gm), 1000 seed weight (gm) and grain yield/plot (kg).

From the results, it was also observed that minimum incidence and severity results maximum yield. It was also observed that disease incidence and severity was gradually increased from flowering stage to milking stage to maturity stage. Fungicidal seed treatments and hot water treatment were highly effective. Seed treatment with plant extracts were moderately effective and *T. harzianum* and physical seed treatment methods i.e sun drying and polythene solarization were less effective over control.

However, more studies need to be carried out to evaluate the performance of different physical, chemical and biological seed treating agents against major disease under epiphytic condition for consecutive years including other Agro Ecological Zones (AEZs) of the country.

Chapter 7

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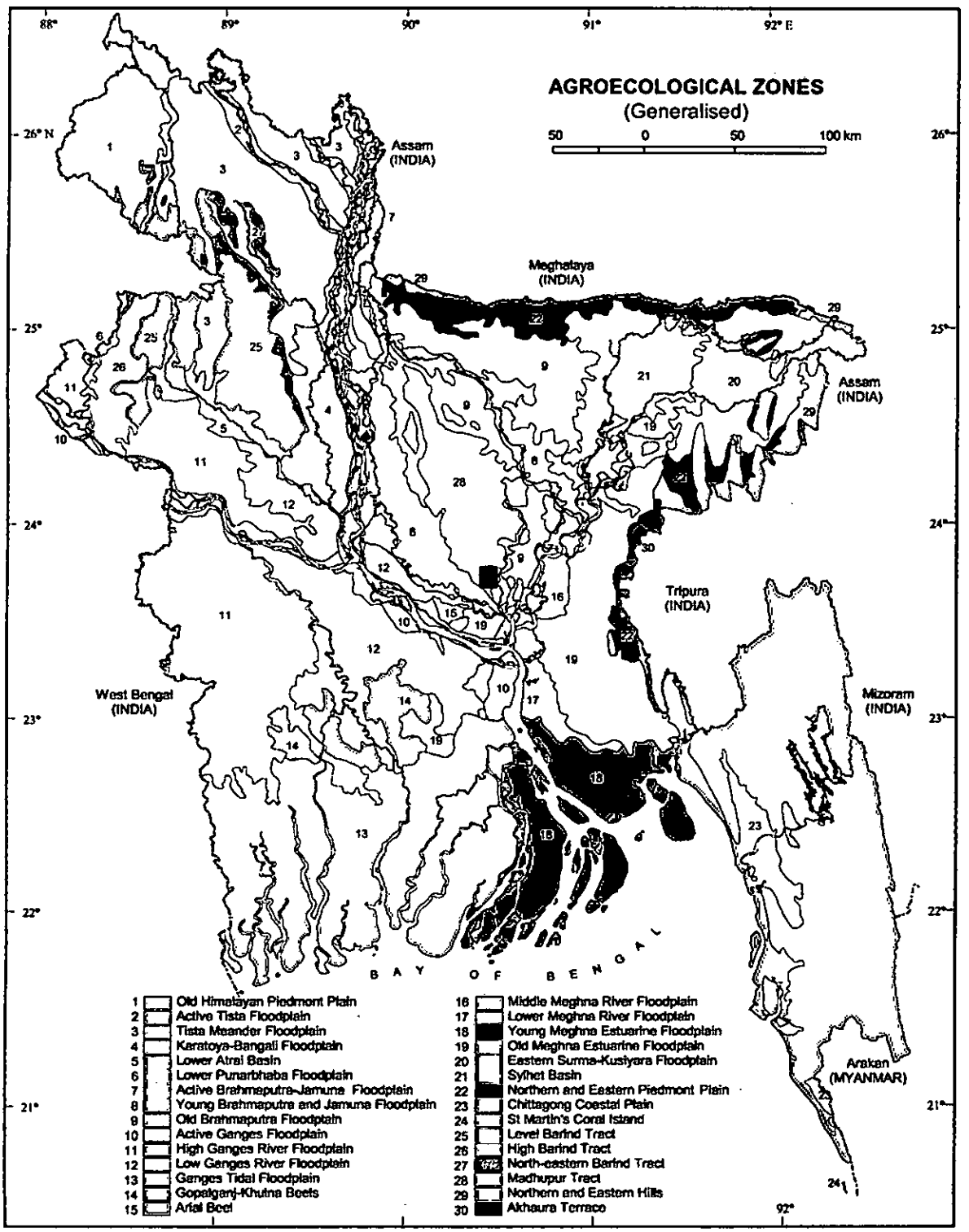
APPENDICES

Appendix I. Map showing the location of experimental site



■ Indicate the experimental site

Source: www.fao.org.

Appendix II. Monthly average record of air temperature, rainfall, relative humidity and Sunshine of the experimental site during the period from July 2010 to December 2010

Months	Air temperature (°c)			Relative humidity (%)	Rainfall (mm) (total)	Sunshine (hr)
	Maximum	Minimum	Average			
July, 2010	35.1	25.3	29.7	77	167	4.9
August, 2010	35.1	25.0	29.5	78	340	4.4
September, 2010	34.0	24.8	28.9	79	169	3.8
October, 2010	35.7	21.5	28.3	74	174	5.8
November, 2010	33.2	16.6	24.9	68	0	6.2
December, 2010	29.7	11.0	20.1	66	810	6.2

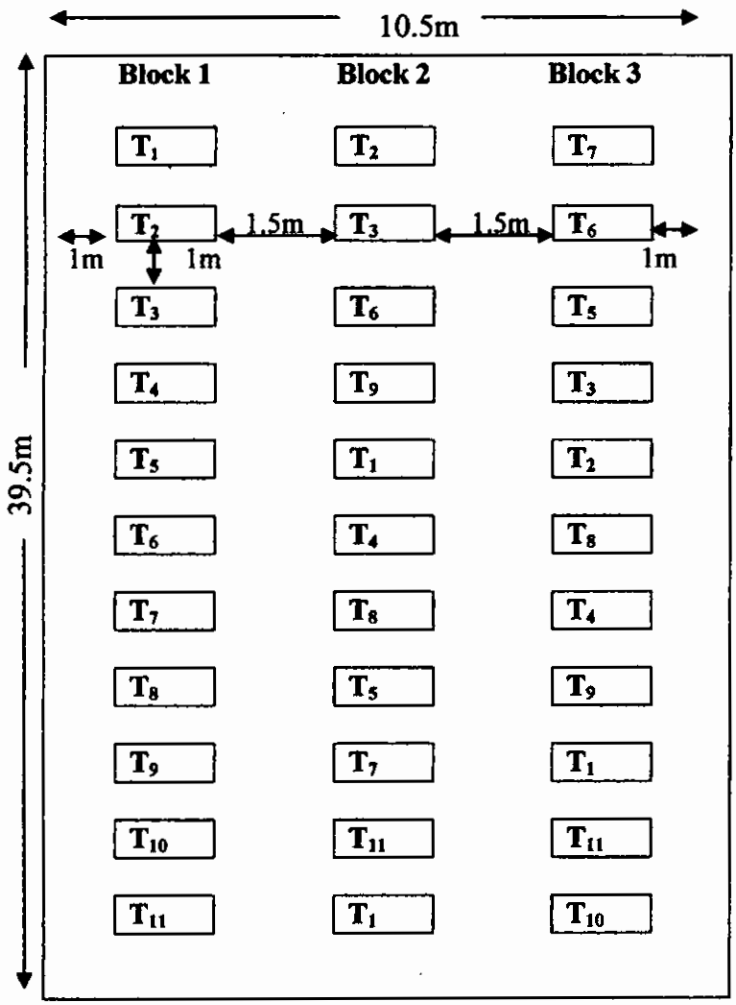
Source: Bangladesh Meteorological Department (Climate & Weather Division) Agargoan, Dhaka - 1212

Appendix II. Monthly average record of air temperature, rainfall, relative humidity, and Sunshine of the experimental site during the period from July 2010 to December 2010

Months	Air temperature (°c)			Relative humidity (%)	Rainfall (mm) (total)	Sunshine (hr)
	Maximum	Minimum	Average			
July, 2010	35.1	25.2	29.7	77	167	4.9
August, 2010	35.1	25.0	29.5	78	340	4.4
September, 2010	34.0	24.8	28.9	79	189	3.8
October, 2010	33.7	23.5	28.3	77	174	5.8
November, 2010	33.2	19.6	26.9	68	0	6.2
December, 2010	29.7	17.0	29.1	66	810	6.2

Source: Bangladesh Meteorological Department (Climate & Weather Division) Agargaon, Dhaka - 1212

Appendix III. Showing the layout of the experiment



Block to Block distance = 1.5m
Plot to Plot distance = 1m
Unit Plot size =2.5m × 1.5m
Border length =1m
Total plot area = 39.5m × 10.5m

Treatments:

T_1=Untreated control
T_2= Sun drying
T_3=Polythene solarization
T_4=Brine solution
T_5=Neem leaf extract
T_6=Allamanda leaf extract
T_7=Hot water treatment
T_8=Provax 200
T_9=Bavistin 50 WP
T_{10}=Dithane M 45
T_{11}=*Trichoderma harzianum*