EFFICACY OF SOME BOTANICALS AND FUNGICIDES IN CONTROLING LEAF BLIGHT OF MUSTARD

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CERTIFICATE

This is to certify that the thesis entitled, *"EFFICACY OF SOME BOTANICALS AND FUNGICIDES IN CONTROLLING LEAF BLIGHT OF MUSTARD"* Submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of *MASTER OF SCIENCE IN PLANT PATHOLOGY*, embodies the result of a piece of bonafide research work carried out by *Md. Mozahid*, *Registration No. 04-01271*, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

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

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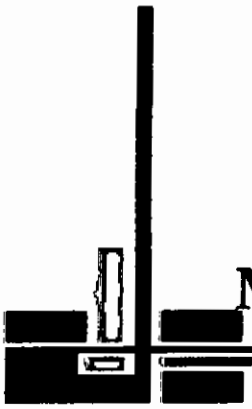

DEDICATED
TO
MY BELOVED PARENTS

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Abstract

The efficacy of some selected fungicides and botanicals were evaluated against *Alternaria brassicae* and *Alternaria brassicicola* causing leaf blight of mustard (var. BARI sharisha-15). Experiments were conducted at the farm of Bangladesh Agricultural Reasearch Institute , Gajipur, Joydebpur during rabi season from the month of October 2009 to March 2010. Three fungicides viz. Alphadeone, Aristodeone, Movral and three botanical extracts viz. Garlic clove extract, Tulshi and Dhutora leaf extract were employed in the experiment. Among the fungicides and botanicals tested, movral showed the best performance in reducing disease severity as well as increasing seed yield against gray blight of mustard. Leaf infection by Alternaria sp was reduced by 51.17 % and seed yield was increased by 20.64 % over control by the application of Movral. No promising results were shown by the botanicals against leaf blight of mustard.

INTRODUCTION

Rapeseed-mustard (*Brassica spp.*) is the major oilseed crops of Bangladesh. Out of total cropped area of 13.53 million hectare, oilseedcrops occupy only 0.561 million hectare which is about 4.2% of the cropped area. Rapeseed-mustard covers 0.336 million hectare of land (60%) among the oil-cropped area and produces 0.246 million tons yield which is 52.2% of the total production (Anonymous, 2002).

A good number of oilseed crops like mustard, sesame, groundnut, linseed, niger, safflower, sunflower and soybean are being cultivated in Bangladesh. The first three are considered as the major oilcrops. From our internal production, one-third of the total requirement can be met up. The shortfall is met up by import at the cost of about US $160 million per year (Anonymous, 2001). The major imports are soybean oil and palm oil. From import we get only 6-7 g/h/day. Nevertheless, we get 10-12 g/h/day from internal production and import. The developed countries like USA and EU countries, the consumption rate are 60 g/h/day. Mustard seeds contain 40-45% oil and 20-25% protein. Using local ghani average 33% oil may be extracted. In this sub-continent three species of *Brassica* are cultivated for oil purposes, viz. *Brassica campestris, Brassica juncea* and *Brassica napus* (Anonymous, 2001). Variety BARI Sarisha-15 is *Brassica campestris*.

Many factors are associated with the poor yield of rapeseed-mustard in Bangladesh. Diseases have been identified as one of the major factors (Ahmed, 1992).

Rapeseed-mustard suffer from about 14 diseases (fungus-9, virus-2, bacteria-1, nematode-1 and parasitic plant-1) in Bangladesh. Among theses diseases leaf blight, downy mildew and the parasitic plant are the important (Anonymous, 2007). Leaf blight caused by *Alternaria brassicae* is widely distributed and the serious disease of rapeseed-mustard. The characteristic symptoms are the

development of circular spots on leaves and pods with concentric ring. Later on spots coalesce and ultimately the leaves become blighted. The disease may cause 25% yield reduction at severe condition of infection (Anonymous, 2001).

Gray blight (*Alternaria brassicae*) (Berk) Sacc is the synonym of the disease and causes blight of leaf, pod and stem (Meah *et al.*, 1988) and seed abnormalities (Howlider *et al.*, 1991). It is endemic in Bangladesh and all the cultivated *B. campestris* and *B. napus* varieties are susceptible to the disease. This disease causes an average yield loss of 40-70% in India and 30-60% in Bangladesh (Meah *et al.*, 1988, Fakir, 1980). In addition to direct yield losses the disease adversely affects the seed quality reducing seed size, seed discolouration and reduction in oil contents (Howlider *et al.*, 1991; Kaushik *et al.*, 1984). Seed cleaning before sowing has recently been proved effective in reducing infection of seed-borne pathogens and increasing production of healthy seeds (Hossain and Doullah, 1998).

There is no information available on the resistance sources. Chemicals are being successfully used in controlling the disease (Meah *et al.*, 1988 and Howlider *et al.*, 1985). Non-chemical methods of disease control may include use of biological agents, botanicals, adjustment in cultural practices etc. Researches with these ideas have yielded good results but not better than the use of chemicals.

However, the issue of environmental pollution is linked with indiscriminate and unplanned use of chemicals, which causes health hazards. So, a better alternative is to use minimum chemical and search for ecofriendly approaches. Thus the present study was undertaken to achieve the following objectives-

1. To determine the effect of different fungicides and plant extracts on the incidence and severity of gray blight/leaf blight of mustard.

REVIEW OF LITERATURE

Effect of Fungicides

Kolte and Tewari (1978) conducted an experiment on the efficacy of certain chemicals for the control of Alternaria leaf blight of Yellow Sarson in two successive cropping seasons. They used seven fungicides namely Dithane M-45 (0.2%), Dithane Z-78 (0.2X), Captan (0.2%), Difolatan (0.2%), Bavistin (0.5%) and Thiophanate methyl (0.05%). TPTH, Difolatan and Mancozeb were used singly and in combination among them following 7 days interval during 1976. They reported that TPTH (0.2%) or Difolatan (0.2%) significantly reduced the number of spots per siliqua, average number of infected siliqua per 30 cm top portion of a vain rachis and increased seed yield per 100 siliqua, 1000 seed weight and yield per plot when they used even singly.

Gupta et al. (1978) evaluated the effectiveness of eleven fjngicide for the control of white rust and Alternaria leaf flight of mustard in two consecutive cropping reasons. The fungicides were Difolatan, Brestan, Bas-305, Dithane M-45, Benlate, Dithane Z-78, Miltox, Thiovit and Aureofungin in the year 1973-74. In 1974-75, Bas-305, Miltox, Dithane Z-78, and Aureofungin were deleted, Calixin and Blitane were included. Disease severity was graded in 0-5 scale. They opined that Brestan (0.1%) is the best for controlling alternaria leaf blight followed by Miltox (0.3%). They sprayed fortnightly starting at the age of two months of the crops only two times.

The experiment of Chahal and Kang (1979) on different levels of alternaria blight in relation to grain yield of Brown sarson showed that different intensities of the disease on Indian Mustard were obtained with different number of Bordeaux mixture sprays. The amount of disease on siliqua were more significant than that of leaves in case of yield loss concerned. Yield losses were negligible, when intensity on siliqua was reduced from 10 to 7% with the six sprays.

Maude and Humpherson (1980) reported that control of *A. brassicae* was obtained in the field by applying 2-3 sprays of Iprodione (rovral) from early pod stage of mustard onwards.

Rai and Singh (1983) conducted an experiment on the influence of foliar application of three different concentrations (0.2, 0.4 and 0.8%) of Dithane M-45 and Zincop on the leaf surface mycoflora of young mustard plants (B. campestris L. var.Ys-42) in the natural field at different intervals. The fungicides significantly decreased the number of fungi cm-2 of leaf and reduced species diversity.

Humpherson and Maude (1983) mentioned that three sprays of Iprodione (Rovral 50 wp) at 0.5-1.0 kg a.i./ha applied to *Brassaca oleracea* seed crops at three week intervals from the young green siliqua stage to until cutting controlled pod infection caused by *Alternaria brassicicola*. As a result seed yield were increased and their germination was improved. Bordeaux nixture also was as effective as Iprodione when disease levels were low but was ineffective when infection pressure was severe.

Humpherson et aJ, (1983) described that seed treatment (Brassica seed crop) with Iprodione formulation resulted effective control of *ALternaria brassicae* and *A. brassicicola* while thiabendazole was ineffective against the Alternaria spp. In natural field conditions no infected plants were obtained when infested seed was sown after treatment with Iprodione (2.5ga.i./kg seed). They also reported that the application of Iprodione (0,5 kg a,i/ha) to a kale seed crops at the young pod stage and three week later gave lower rates of seed infection than other fungicide treatments.

Sharma (1984) reported that best results in controlling alternaria blight of mustard were obtained with 4 sprays of Dithane M-45 at 10 days intervals starting with the

onset of disease, followed by Daconil, Difolatan (0.3%) and Dithane Z-78 (0.2X). The fungicide reduced the infection rate by 16.6-30.1%.

Ogilvy (1984) studied the effect of *Atlternaria brassicae* in reducing the yield of winter oilseed rapes (*B. napus*). He showed that when fungicides were used to control the disease yeilds were increased. Iprodione FLO proved to be the most effective. Although time and level of disease infection varied from season to season. Sprays applied immediately after flowering stage consistently gave the most effective and economic control.

Singh and Bhowmik (1985) studied the persistence of efficacy of eight fungicides against *A. brassicae* of rapeseed and mustard. They opined that fungicides which were more toxic were also more persistent than those with low toxicity. Among the various fungicides tested, Difolatan was the most persistent and effective both in reducing the leaf blight intensity and in increasing seed yield in pusa Rai followed by Dithane M-45. Syllit and Cuman-L also showed good performance but Fytolan caused phytotoxicity. The pods bearing an average number of 3.0, 14.0, 80.0 and 100.0 infection units, suffered respectively 24.5, 41.5, 60.5 and 71.5% loss in seed yield as compared to the yield of healthy pods.

Ayub and Ahmed (1985) evaluated the efficacy of five fungicides namely Outer (0,2%), Benlate (0,05%), Cuirmn-L (0,10%), Trimiltox forte (0.2%) and Dithane M-45 (0.2%) for controlling alternaria blight of mustard. Sprayings were started at 40, 50 and 60 days after sowing with three applications at 10 days intervals. Disease incidence was evaluated 7 days before each application and graded using a 0-8 rating scale. They reported that all the fungicides except Benlate were effective in controlling the disease. They concluded that Outer was the best fungicide followed by Trimiltox Forte, Dithane M-45 and Cuman-L. Disease control was maximum when application were initiated at 40 lays after emergence.

Sachin (1985) assessed the effect of three foliar fungicides on four varieties of mustard. Five sprays were done at 10 days interval starting just before the onset of the disease up to maturity of the siliqua. Dithane M-45 (0.75%) reduced leaf spot severity and siliqua infection by 50% and 44% respectively and increasing yield per plot, yield per plant and 1000 seed weight 27%, 33% and 30% respectively over control. Among the varieties Sambal and M-257 of *B. juncea* suffered less from the disease and gave more yield than other two varieties, Sonali and Sanpad.

Howlider et al (1985) stated the effect of five foliar fungicides namely Dithane M--45, Outer, Trimiltox Forte, Benlate Cupravit against alternaria blight of mustard. Fingicides rayed at 8 days interval starting from 30 days after sprouting crop maturity significantly reduced leaf defoliation, leaf spot severity, average number of spots per siliqua and increased yield. Dithane M-45 significantly increased seed yield, 1000 seed weight by 21.1%, yield per plant by 38.5% and yield per plot by 27.3% over control.

Singh and Singh (2006) conducted a field experiment in India during 2002-03 and 2003-04 to develop spray schedule(s) for the management of blight caused by *Alternaria brassicae* and *A. brassicicola*, and white rust caused by *Albugo candida* using Indian mustard (*Brassica juncea*) cv. Narendra Rai sown on 15 and 30 October, and 15 November. Mancozeb and Ridomil MZ-72 were sprayed in spray schedule combinations. Sowing on 15 October resulted in the lowest incidence of leaf blight, pod blight and white rust intensity and the highest 1000-seed weight and yield. Three consecutive sprays of Mancozeb 75 WP (0.2%) at fortnightly intervals, beginning at the disease initiation resulted in the lowest leaf blight incidence and pod blight intensity. Seed yield and 1000-seed weight under all the dates of sowing were highest with 2 consecutive sprays of Mancozeb followed by a third spraying with Ridomil MZ 72 (0.25%).

Prasad (2006) conducted a field trial during rabi 2002/03 and 2003/04, in India to evaluate the efficacy of different spraying combinations of three fungicides (ridomil [metalaxyl], carbendazim and mancozeb) and five plant extracts (*Datura stramonium*, *Eucalyptus globosus*, *Azadirachta indica*, *Allium sativum* and *Allium cepa*) against *Alternaria* blight (*Alternaria brassicae*) of Indian mustard cv. Varuna. Comparative analysis of various spraying schedules revealed that first spray of carbendazim (0.1%) + mancozeb (0.2%) followed by two sprays of mancozeb (0.2%) at early sowing (20 October) was the best combination in reducing the disease severity on leaves (18.7%) and pods (10.4%) and in increasing yield (1295.8 kg/ha), 1000-seed weight (5.12 g) and oil content (42.6%). Sowing on 20 October also gave higher seed yield and reduced disease intensity on leaves and pods in comparison to later sowing. Among the botanicals integrated with the standard fungicide (mancozeb), 5% aqueous extract of *D. stramonium*, *E. globosus* and *Allium sativum* reduced the disease intensity by 21.7, 23.3 and 25.5% on leaves, respectively. However, mancozeb provided the highest reduction (20.9%) of the disease on leaves and was statistically at par to these plant extracts. Apart from mancozeb, *D. stramonium* was found to be most effective in increasing seed yield.

Singh *et al.* (2006) reported that six seed dressing fungicides, i.e. metalaxyl, carbendazim, mancozeb, thiophanate-methyl, iprodione and BAS 38601 F (a seed dressing fungicide, 40% carbendazim+32% mancozeb), in combination with spray of mancozeb (0.25%) were tested for the control of foliar diseases, *Alternaria* leaf spot (*Alternaria brassicae*) and white rust (blister) [*Albugo candida*] of Indian mustard. All the seed treatments improved germination and reduced disease intensity. Seed treatment with mancozeb and spray of same fungicide was most effective against *Alternaria* leaf spot controlling up to 58.8 to 74.7% disease. The most effective seed treatment fungicides for white rust were carbendazim reducing 75.8-80.8% infection at first location and mancozeb controlling 62.0-81.8% disease. Results with iprodione were at par with mancozeb. Thiophanate-methyl

was very effective against both the diseases. The highest yields were recorded with iprodione (16.0-17.36 q/ha) and mancozeb (26.0-31.12 q/ha). The seed treatment with mancozeb or carbendazim and three spray of mancozeb was therefore, recommended for management of foliar diseases of Indian mustard.

Singh and Singh (2005a) conducted an experiment in India for controlling *Alternaria* blight (AB) caused by *Alternaria brassicae* and *A. brassicicola* and observed that seed treatment combined with three foliar sprays of Mancozeb 75% WP (0.2%) at 15-day intervals, beginning at 45 days after sowing, resulted in the lowest AB incidence and the highest seed yield and cost-benefit ratio of 1:5.2. It was followed by foliar sprays of Mancozeb 75% WP alone in all cases. Highest avoidable losses due to the combined effect of these diseases in seed yield, seed test weight and oil content were 34.7, 13.1 and 4.2%, respectively.

Singh and Singh (2005b) investigated on timely sown (15-20 October) mustard crops during 1995/96-2001-02 revealed *Alternaria* blight [*Alternaria brassicae*] (AB), white rust [*Albugo candida*] (WR) and downy mildew (DM, *Peronospora parasitica*) were the major mustard diseases in mid-eastern India and, together, caused 44.06% avoidable yield loss. In trials conducted in the same field during 2001-02 and 2002-03 crop seasons, 3 sprays of iprodione 50 WP (Rovral; 0.20%), followed by mancozeb 75 WP (Indofil M 45; (0.20%)) and propineb 70 WP (Antracol; 0.20%), gave the most effective AB control and yield gain. Significantly superior WR control was obtained by 2 sprays of metalaxyl+mancozeb 72 WP (Ridomil MZ; 0.25%) followed by 3 sprays of captan 50 WP (Captaf; 0.20%) and mancozeb.

Chand and Singh (2004) studied the effects of extracts of oak (*Calotropis procera*), eucalyptus (*Eucalyptus globulens* [*E. globulus*]), jatropha (*Jatropha multifida*), neem (*Azadirachta indica*) and bulbs of garlic (*Allium sativum*) on *Alternaria* blight (*Alternaria brassicae*) of Indian mustard cv. RH-30 were studied

under laboratory conditions. *Alternaria brassicae* was isolated from infected leaves and mass multiplied on potato dextrose agar (PDA) medium. Indian mustard leaves were sprayed with spore suspension, and after 24 h, were sprayed with the various plant extracts (obtained from leaves and bulbs) at different concentrations (10, 20 and 30%) except for the (untreated) control. All the extracts effectively reduced the disease. Foliar spray with bulb extract of *Allium sativum* showed the lowest disease intensity (2.87%), followed by *E. globulens* (5.3%) and *Azadirachta indica* (7.4%) compared to 20% in the control. *J. multifida* and *C. procera* were comparatively less effective than the other plant extracts, but these also reduced the disease intensity from 20% to 7.5 and 11.9%, respectively. Generally, the disease intensity decreased non-significantly with increasing extract concentration. However, in *A. indica*, the disease intensity at 30% concentration (2.3%) was significantly less than that at 10% concentration (13.3%). Similar observations were recorded for *C. procera*.

Kumar *et al.* (2004) studied that the efficacy of different fungicides (Emisan 6 [2-methoxyethylmercury chloride], wettable sulfur, Ridomil MZ-72 [mancozeb + metalaxyl], Blitox-50 [copper oxychloride], Dithane M-45 [mancozeb], Kitazin [iprobenfos], Bavistin [carbendazim] and Baynate [thiophanate-methyl]) and neem products (Furpume, Bioneem, Nimbicidine and Achook) were tested against 15 isolates of *Alternaria brassicae* collected from different locations in Haryana, India. Kitazin was highly effective against all the isolates in inhibiting spore germination. It was followed by Dithane M-45 and Ridomil MZ-72 but was statistically at par. Similarly, Achook and Bioneem were also effective compared to furpume and nimbicidine. Variations were also observed among isolates in their sensitivity against these fungicides. The isolates BHI, CHR-I and CHR-III were sensitive to all the fungicides whereas JHR was sensitive only to Dithane M-45, Kitazin and Bavistin.

Chattopadhyay and Bhunia (2003) studied with seven fungicides viz; mancozeb 0.2%, captan 0.2%, metalaxyl m.z 0.25%, iprodione 0.2%, bayletan 0.05%

[triadimefon], copper oxychloride 0.3% and antracol 0.2% [propineb] against *Alternaria* leaf blight of rapeseed-mustard (*Brassica campestris* cv. Yellow Sarson) caused by *Alternaria brassicae*. Best control of disease was observed by iprodione followed by mancozeb. Highest seed yield and significant increase of 1000-seed weight were also recorded from single spray of iprodione at post-flowering stage. But maximum economic return was obtained from two spraying of mancozeb at 45 DAS and 60 DAS.

Singh and Maheshwari (2003) conducted a study during the rabi seasons of 1993 and 1994 in Haryana, India, to determine the effect of Baycor (bitertanol), Blitox-50 (copper oxychloride), Akomin-40 (phosphoric acid salt), Contaf 5E (hexaconazole), Validicin (validamycin), Bavistin (carbendazim) and Dithane M-45 (mancozeb) sprays twice at 15-day intervals on *Alternaria* leaf spot (*Alternaria brassicae*) of *Brassica juncea* cv. PR-45 (Pusa Raya). The disease caused 71 and 44% average leaf and pod infection, respectively, during both years. Among the fungicides, Contaf exhibited the most effective control of the disease on leaves and pods. The disease index was lowest (16.08) in Contaf-sprayed plots whereas it was 59.09 in unsprayed control plots. The average yield was higher by 23, 10 and 9% in Contaf, Dithane M-45 and Blitox-50 sprayed plots, respectively, over the control. Two sprayings of 0.5% Contaf at 15-day intervals was effective for the control of the disease.

Prasad *et al.* (2003) conducted an experiment in Kanpur, Uttar Pradesh, India, during the 1999/2000 and 2000/01 rabi seasons on Indian mustard genotypes PAB 9534, PAB 9511, JMM 915, RN 490 and Varuna to determine the losses due to *Alternaria* blight (*Alternaria brassicae*) under protected and unprotected conditions. Varuna and PAB 9511 were used as the susceptible and resistant controls, respectively. The protected plots were sprayed with 0.25% mancozeb starting from 40 days after sowing and 3 subsequent sprays at 15-day intervals. The disease appeared 45 days after sowing. The highest disease intensity was

recorded at flowering and pod formation. Treatment with mancozeb reduced disease incidence in all the genotypes. There was a 72.6 and 59.0% reduction in disease severity for RN 490 and the lowest disease intensity (17.8 and 16.1%) was recorded in the protected plots compared to the unprotected plots (39.6 and 32.5%) in both the years. The highest seed yield loss (20.8 and 21.9%) was observed in Varuna under unprotected conditions; however, it also gave the highest seed yield (20.3 and 19.5 q/ha) followed by RN 490 (18.5 and 18.3 q/ha) in the protected plots. Pooled analysis of data revealed that Varuna had the highest disease intensity (22.0 and 44.0%) and yield performance (19.9 and 15.7 q/ha) in protected and unprotected plots, respectively. The 1000-seed weight of RN 490 in protected (5.2 g) and unprotected (4.8 g) plots was similar with Varuna.

Mukherjee *et al.* (2003) studied the efficacy of iprodione against *Alternaria* blight [*Alternaria brassicae*] infecting Indian mustard cv. Pusa Bold in New Delhi, India, during 1998-2000. Iprodione was sprayed to plants at 500 g a.i./ha during the early pod stage. Iprodione was more effective than mancozeb (control) in the reduction of *Alternaria* blight incidence. The increase in Indian mustard yield in iprodione-treated plots was higher by 24-59% than that in the control plots.

Ferdous *et al.* (2002) conducted an experiment to investigate the effect of 3 plant extracts and one fungicide on the incidence of *Alternaria* blight (caused by *Alternaria brassicae*) of mustard (*Brassica sp.*) cv. Sonali Sarisha under natural field conditions in Gopalganj, Bihar, India, during 1997-98. Young leaves of neem [*Azadirachta indica*], mustard (*Brassica sp.*) cv. Sambal (30-35 days old) and garlic cloves were macerated in tap water and 1% spray solution was prepared using the crude extracts. The fungicide Rovral [iprodione] at 0.1% was used. All the 4 treatments were used at 1 litre/10 m^2 area. Two sprays at flowering (35-45 days) and fruiting (45-55 days) were given at 7 days interval. The fungicide treatment was the best in reducing *Alternaria* blight intensity and in increasing yield. Among the non-fungicidal treatments, the spray of garlic and neem leaf

crude extracts proved promising. Spray of these 2 extracts at flowering stage suppressed disease incidence and increased yield.

Godika and Pathak (2002) studied the efficacy of 0.2% mancozeb, 0.2% Antracol [propineb], 0.25% Ridomil MZ [mancozeb+metalaxyl], 0.05% Bayleton [triadimefon] and 0.3% copper oxychloride in controlling blight disease (*Alternaria brassicae*) and white rust (*Albugo candida*) in Indian mustard in a field experiment conducted during 1997-2000. All treatments resulted in lower disease severity and higher crop yield compared to the control. Antracol spraying resulted in the lowest *Alternaria* blight severity, whereas Ridomil MZ resulted in the lowest white rust severity. The highest yield (13.47 q/ha) and cost benefit ratio were recorded with Ridomil MZ spraying.

Anwar and Khan (2001) conducted a study in 1997 to evaluate the most effective seed dressing fungicide for the control of leaf blight disease (*Alternaria brassicae*) and ultimately increasing the yield of Indian mustard. Indian mustard cv. RL-18 seeds were treated with four fungicides: Benlate [benomyl], Vitavax [carboxin], Ridomil [metalaxyl] or Thiovit [sulfur] at 2 g/kg seed. All the fungicides reduced the disease incidence. Benlate showed the best performance and reduced the disease incidence by 76.6%, followed by Vitavax, Ridomil and Thiovit which reduced disease incidences by 70.0, 63.3 and 53.5%, respectively. The maximum increase in yield i.e. 51.4% was observed in plots treated with Benlate followed by Vitavax, which recorded increased yield (44.6%). Ridomil and Thiovit were the least effective in reducing the disease incidence and increasing the yield. Benlate was the most effective in reducing the disease incidence and in improving the yield.

Godika *et al.* (2001) conducted a field experiment from 1994/95 to 1996/97 in Rajasthan, India to evaluate the efficacy of different fungicides, mancozeb, Ridomil MZ (mancozeb+metalaxyl), captan, Rovral (iprodione), Bayletan

[triadimefon], and copper oxychloride, against *Alternaria* blight (*Alternaria brassicae*) and white rust (*Albugo candida*) of Indian mustard. All the fungicides significantly controlled both the diseases, but their efficacy varied. Rovral was the most effective in controlling of *Alternaria* blight; mean disease intensity on leaf and pod was 8.75 and 5.6%, respectively. On the other hand, Ridomil MZ was the most effective in controlling white rust; mean disease intensity in leaves and staghead were 8.5 and 0.5%, respectively. Yield was highest with Rovral (2.1 t/ha), followed by Mancozeb and Ridomil MZ, each recording a yield of 1.9 t/ha.

Panja *et al.* (2000) studied with four different fungicides: Indofil M-45 [mancozeb + thiophanate-methyl], Mancozeb, 75% WP at 0.25%, Fytolan (copper oxychloride, 50% WDP) at 0.4%, Bavistin (carbendazim, 50% WP) at 0.1% and Ridomil MZ, (metalaxyl + mancozeb 72% WP) at 0.15% and their two specific combinations viz., Ridomil at 0.075% + Fytolan at 0.2% and Ridomil at 0.075% + Bavistin at 0.05% were tested against *Alternaria*-leaf blight (*Alternaria brassicae* and/or *A. brassicicola*) and white rust diseases of mustard. Fytolan alone or in combination with Ridomil was superior to other treatments with respect to the reduction of leaf blight incidence and increase of crop yield. However, Fytolan + Ridomil treatment was better than Fytolan alone because of its effectiveness against white rust of mustard aside from a lower blight incidence and increased crop yield. A positive correlation existed between the reduction of leaf blight incidence and the increase in seed yield, which was absent in case of white rust. Reduction of disease incidence of leaf blight by fungicides was found to be associated with inhibition of mycelial growth and spore germination.

Pandya *et al.* (2000) reported that four sprays of Ridomil MZ [mancozeb + metalaxyl] at 45, 60, 75 and 90 days after sowing in each of three concentrations viz., 0.5, 0.3 and 0.2%, were found significantly superior to the other tested chemicals for the control of white rust leaf (local) and staghead (systemic) infestation. Although the maximum control of white rust was obtained in the

treatment Ridomil 0.5% (PDI = 7.17), it was not significantly superior to the treatment Ridomil 0.3% (PDI = 8.8) and Ridomil 0.2% (PDI = 10.5). The maximum PDI was obtained in control (49.6%). Four sprays of iprodione (0.2%) gave the maximum control of *Alternaria* blight. Maximum yield was obtained in the treatment Ridomil 0.5% (3392 kg/ha), while it was minimum in the control (2896 kg/ha).

Meah *et al.* (1999) conducted a field experiments in Bangladesh during October 1997 to February 1998 to determine the effect of some management practices on mustard (cultivars Sampad and BINA) seed infection. Weeding treatments include: no weeding and weeding once at 30 days after sowing. Insecticide (Malathion 50EC at 0.2%) applications include no insecticides, once at 40 days after sowing, and twice at 40 and 55 days after sowing. Fungicide (Rovral 50WP, iprodione at 0.2%) applications include no fungicides, once at 40 days after sowing, and twice at 40 and 55 days after sowing. Weeding, and spraying of insecticides and fungicides, on mustard resulted in 9.5 to 7.3%, 12.7 to 3.6% and 8.3 to 4.1% reduction of infected seeds, respectively. In the control, 36-39% was infected by *A. brassicae*, while among the seeds under the various treatments; only 19-31% was affected. A greater percentage of healthy seeds were taken from treated crops.

Ghosh and Das (1999) mentioned that ten fungi were found to be associated with both mustard (*Brassica campestris*) and cauliflower (*B. oleracea* var. *botrytis*) seeds. Out of them, *Alternaria alternata* and *A. brassicicola* appeared in high frequency on both seeds. These two pathogenic fungi are borne by seeds externally and internally. Five fungicides, viz. Dithane M-45 [mancozeb], Bavistin [carbendazim], Blitox-50 [copper oxychloride], Thiram and Captan 50w, were applied on both seeds to control mycoflora. Of these, Bavistin (500 ppm) eliminated most of the fungi. Moreover, Bavistin treated seeds yielded maximum percentage of seed germination.

Zaman *et al.* (1997) stated that seven fungal genera namely *Alternaria, Fusarium, Aspergillus, Penicillium, Rhizopus, Chaetomium* and *Curvularia* were associated with mustard seeds. Percentage incidence of different fungi varied with location of collection and duration of storage period. The frequency of *Alternaria* decreased with the increase of storage period; while *Fusarium* and *Aspergillus* increased with increasing storage period. Four plant extracts tested were effective in decreasing the prevalence of seed borne fungi. However, garlic and neem leaf were superior among the extracts followed by ginger and onion bulb. All the extracts gave highest control when used in crude form and their efficacy declined with increasing dilution.

A field was experiment conducted at Joydebpur and Jessore during Rabi 1996-97 season. The treatment T_6 was modified at Jessore with an additional spray i.e. at disease iniciation stage, Rovral 50 wp (0.2%) was sprayed once at disease iniciation stage. Control plots were sprayed with plain water. Results showed that leaf blight incidence was the lowest in the plant treated at pod formation and seed formation stage in both the locations. The highest seed yield was also recorded from the same treatment in both the locations. 1000-seed weights were higher in the seeds of treated plants (Anonymous, 1997)

Daya and Ram (1997) studied the *in vitro* fungitoxicity of leaf extracts of *Cassia tora, Azadirachta indica, Anisomeles ovata, Aegle marmelos, Adhatoda vasica, Mentha arvensis, Dalbergia sissoo, Tinospora cordifolia, Pongamia pinnata, Cyperus rotundus, Ocimum adscendens* and *Ocimum sanctum*, a resin extract of Ferulafioetida and bulb extracts *of Allium sativum* and *A. cepa*. The leaf extract of *O. sanctum* was found to be most effective and completely inhibited spore germination of *A. brassicae*, the causal agent of *Alternaria* blight of mustard at 10000 ppm. *A. sativa* and *A. cepa* were next in efficacy and inhibited spore germination by 40% at 10000 ppm. Control of *Alternaria* blight of mustard with *O. sanctum* at different concentrations under field conditions is under investigation.

Ayub *et al.* (1996) conducted an experiment to evaluate the efficacy of 7 fungicides to control *Alternaria* blight of mustard caused by *A. brassicae* and *A. brassicicola*. Carbendazim (as Bavistin) and Benomyl (as Benlate) at 0.1%, ziram (as Cuman L), mancozeb (as Dithane M-45), fentin hydroxide (as Duter), iprodione (as Rovral) and copper salts + mancozeb (as Trimiltox forte) at 0.2%, were applied 3 times to plants which were 40-, 50- and 60-days-old. Experiments were carried out in Gazipur, Bangladesh during the rabi season between 1986 and 1989. Iprodione reduced disease severity the most and increased seed weight and yield. Fentin hydroxide was the second best fungicide. Maximum reduction of disease severity and increased yield was achieved when the spraying was carried out on plants at 40-days-old.

Kumar and Kumar (1996) stated that the effects of 4 fungicides on *Alternaria brassicae, Albugo candida* and *Peronospora parasitica* infection of Indian mustard in field trials. Minimum Alternaria blight infection was recorded with Rovral [iprodione, 0.2%], followed by Difolatan [captafol, 0.2%], Indofil M-45 [mancozeb + thiophanate-methyl, 0.2%] and Ridomil MZ [mancozeb + metalaxyl, 0.25%]. Maximum yield was recorded with iprodione but Indofil M-45 is recommended on the basis of the cost-benefit ratio.

Priya *et al.* (1995) stated that eight fungal species were associated with Indian mustard seeds in Haryana, India. These were: *Aspergillus niger; A. flavus; Penicillium sp.; Rhizopus sp.; Cochliobolus lunatus; C. sativus; Alternaria alternata* and *Mucor sp.* Bavistin [carbendazim] at 750 p.p.m. completely inhibited the fungi and enhanced seed germination.

Mridula *et al.* (1994) five fungicides, Blitox-50 [copper oxychloride], Bavistin [carbendazim], Dithane M-45 [mancozeb], Topsin-M [thiophanate-methyl] and thiram, were tested *in vitro* against *A. brassicae*, which causes leaf blight in

[Indian] mustard. Mancozeb was the most effective fungicide for inhibiting growth.

Chattopadhyay and Bagchi (1994) reported that the severity of leaf blight of mustard, caused by *Alternaria brassicae*, was negatively correlated with seed yield. The lowest severity and the highest yields were obtained following 4 foliar sprays of mancozeb (0.2%) at intervals of 15 d, starting from 30 d after sowing. Three sprays at 45, 60 and 75 d after sowing gave the highest benefit ratios (3.9 and 3.88 in 2 yr, estimated for cost of treatment =1).

Seed-health test was carried out after harvest of the crops at the laboratory to evaluate the seed-borne infection by standard blotter method. Seed germination on the top of the blotter was also recorded and expressed in percentage. The experiment with cv. SS-75 (HYV) was conducted at ORC, BARI, Joydebpur. In the laboratory test it was observed that the Rovral spray reduced the seed-borne pathogen infection and increased the germination percentage of mustard seeds. Seed-borne *Alternaria spp.* infection was reduced above 90% and germination increase was above 9% over the control. Seed infection was reduced up to 18.8% with three times Rovral spray (Anonymous, 1992).

An experiment was conducted at BARI, Joydebpur, RARS, Ishurdi and Jessore during the Rabi season of 1991-92 using mustard variety Tori-7. Rovral 50wp @ 0.2% was sprayed at an interval of 10 days starting from initiation of leaf blight disease. It was observed from the field test that the increase in number of Rovral spray had significant effect in reduction of *Alternaria* leaf blight disease and increases in seed yield and 1000 grain weight. The disease reduction was observed from 37.5 to 74.3% over control at the three locations for three times sprayed that influenced the increase in yield from 40.5 to 60.3%. But the maximum yield increase 62.8% observed in case of four time spray at Joydebpur. The 1000 grain weight was also increased 21.9 to 44.9% over control at three times spray and

maximum increase of 1000 grain weight (47.8%) was found in four times spray at Ishurdi (Anonymous, 1992).

In a field trial, Howlider *et al.* (1991) used 5 fungicides (Dithane M-45, Thiovit, Delan, Topsin M and Cupravit) at 3 doses in controlling *Alternaria* blight of mustard. Five sprays were applied with first spray at 40 days growth stage maintaining an interval of 8 days. Dithane M-45 was proved the best. A reduction of 73 and 72% in leaf spot severity and siliqua spotting corresponding to an increase of 30% seed yield -was obtained. Some 92% apparently healthy seeds, 3 and 5%, respectively deformed and discoloured seeds were produced as against 78, 4 and 18% respectively apparently healthy, deformed and discoloured seeds in untreated plot. The benefit of increase in dose of fungicide in reducing disease severity and decreasing abnormal seeds was not significant.

Ferdous (1990) evaluated extracts of garlic, neem and Shambal Sarisha against *Alternaria* blight of mustard. Garlic extract proved promising when 64.3% reduction in leaf area disease (%) and an increase in yield by 28.7% were obtained.

Saha (1989) mentioned that *in vitro* growth of *A. brassicae* and *A. brassicicola* isolated from rape and Indian mustard was reduced by each of 10 fungicides tested: ziram and Ceresan Wet [phenylmercury acetate] completely inhibited growth of those fungi. The second highest growth reductions occurred when *A. brassicae* was treated with Dithane M-45 [mancozeb] or Difolatan [captafol] and when *A. brassicicola* was treated with Dithane Z-78 [zineb] or mancozeb. In all cases, increasing the concentration of fungicides increased growth inhibition.

Shivpuri *et al.* (1988) conducted an experiment during 1986-87, six fungicide treatments (Rovral (iprodione), Captafol, Dithane M-45 [mancozeb], Thiram, Blitox-50 [copper oxychloride], Bavistin [carbendazim]) were applied to Indian

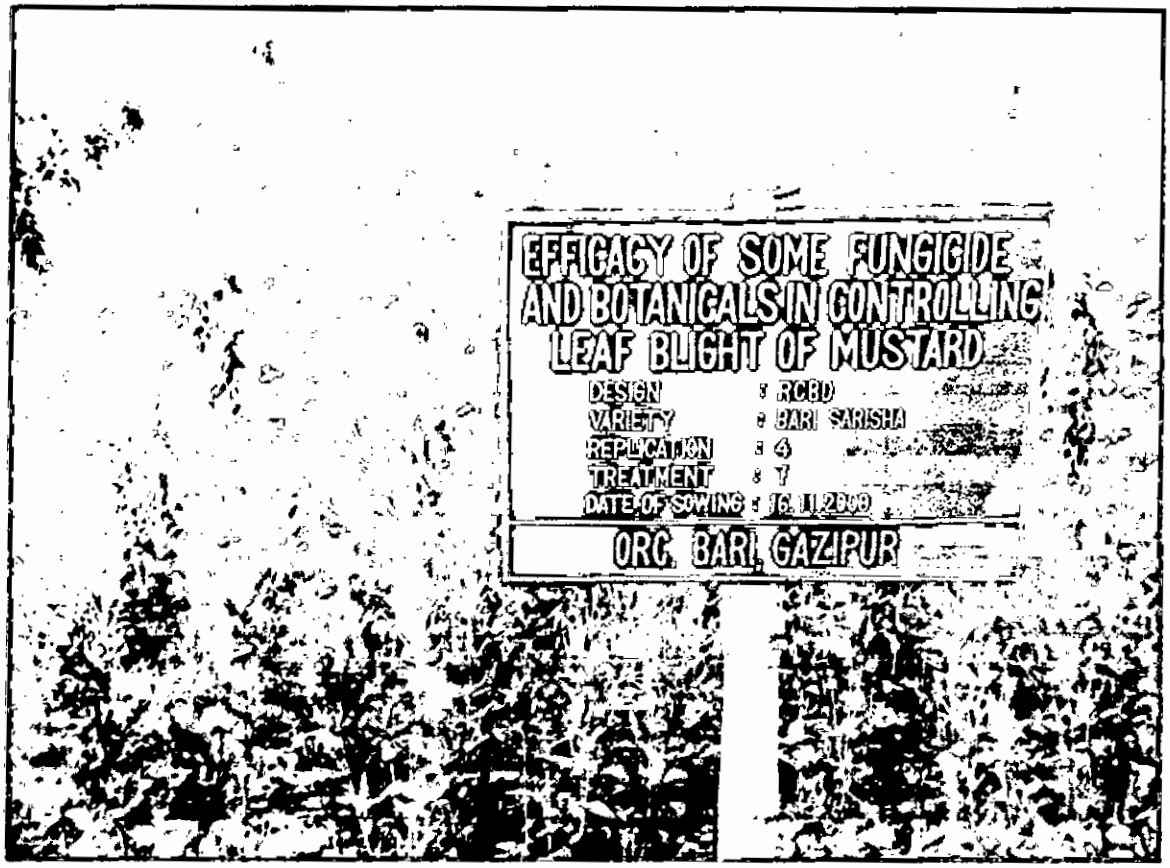
mustard infected by *A. brassicae* in field trials in Rajasthan, India. All of the fungicides controlled the disease but copper oxychloride was phytotoxic. The best treatment was iprodione followed by captafol and mancozeb; iprodione caused minimum defoliation.

Tripathi *et al.* (1987) reported that *A. brassicae* caused severe yield reduction and quantitative differences in oil contents of rape and mustard crops. A captafol spray followed after 15 d by a mancozeb spray gave effective disease control. A spray schedule involving 4 sprays of captafol starting 30 d after sowing at 15-d intervals was the best combination for maintaining a disease free crop.

MATERIALS AND METHODS

3.1 Experimental sites

The experiment was conducted in Block No. 15 in central farm of Bangladesh Agricultural Research Institute (BARI) at Joydevpur in Gazipur (Photograph 1). Details are in Appendix.1.



Photograph 1. Field experiment in controlling leaf blight of mustard with botanicals and fungicides

3.2 Experimental period

The experiment was carried out during the Rabi season form October, 2009 to March, 2010

.3.3 Soil type

The soil of the experimental plot was loam to clay loam in texture belonging to the Madhupur Tract (AEZ-28) (Appendix-I).

3.4 Climate

The climate of the experimental field area was of sub-tropical in nature characterized by high temperature associated with heavy fog and dew during Rabi season (October to March).

3.5 Weather

The monthly mean of daily maximum, minimum and average temperature, relative humidity and monthly total rainfall received at the experimental site during the period of the study have been collected from the surface synoptic Data card, Bangladesh Meteorological Department, Dhaka (Appendix-II).

3.6 Variety

The mustard (*Brassica campestries*) variety BARI Sarisha-15 released from Bangladesh Agricultural Research Institute was used for the experiment. Seeds were collected from Oilseed Research Centre of Bangladesh Agricultural Research Institute, Gazipur.

3.7 Treatments of the experiment

Seven treatments were assessed in the experiment as follows:

T_1 = Control

T_2 = Foliar application of Garlic

T_3 = Foliar application of Dhutora leaf extract

T_4 = Foliar application of Tulshi leaf extract

T_5 = Foliar application of Alphadeone

T_6 = Foliar application of Aristodeone

T_7 = Foliar application of Movral (iprodione)

3.8 Design and layout

The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. The whole plot was divided into four blocks each containing seven (7) plots of 4m x 3m size, giving 28 units plots. The space was kept 1m between the blocks and 0.5 m between the plots (Appendix-III).

3.9 Land preparation

The land was firstly ploughed with a power tiller in the first week of November 2009 and left exposed to sunlight for 7 days. Then the land was ploughed and cross-ploughed by a power draw cultivator until the soil had a good tilth. It required different times ploughing and every ploughing was followed by laddering to level the land and break up clods. After each ploughing, weeds and rubbish were removed. Finally spade (Kodal) was used to prepare plots and drains.

3.10 Application of manure and fertilizers

Manure and fertilizers were applied as per standard recommendation (Anonymous, 2001). The following doses were used to the plot for mustard cultivation.

Manures /Fertilizers	Rate /ha
Urea	250 kg
TSP	170 kg
MP	85 kg
Gypsum	150 kg
Zinc oxide	5 kg
Boric acid	10 kg

3.11 Collection of botanicals and preparation of extract

Botanicals such as leaf of Garlic, Dhutora, Tulshi were collected from Bangladesh Agricultural Research Institute area. For preparation of extract, collected plant materials were weighed in an electric balance and then were washed in water. After washing these were chopped into small pieces. For getting extract, chopped plant materials were blended in an electric blender and then distilled water was added to make the solution 1:10 (w/v) for foliar spray.

3.12 Preparation and application of spray solution

The suspensions of fungicides were prepared by mixing with required amount of water. Some suspensions of fungicides, some plant extract (concentration @ 1:10) and plain water was sprayed with compressed hand sprayer. Sprays were done at 45, 55, 65 days after sowing. Adequate precautions were taken to avoid drifting of spray materials from one plot to the neighboring ones.

3.13 Thinning

Thinning was done to keep the population in proper ratio and to maintaining the suitable density and number of plant in the plot. It was done at 15 days after sowing. It is also helpful for maintaining proper spacing of plants.

3.14 Intercultural operations

Weeding was done when necessary followed by split doze fertilizer application. After weeding and fertilizer application flood irrigation was given by filling the drains surrounding the beds by pumping water in those drains with a water pump. After soaking the plots excess water was allowed to be drained out. Malathion 57 EC was applied three times at 10 days intervals to control aphid.

3.15 Collection of data

The following parameters were considered for data collection.

On diseases incidence

Percent leaf infection

Percent leaf area diseases (% LAD)

Percent pod infection

Number of spots/pod

On growth parameters

Number of leaf/plant

Number of branches/plant

Plant height (cm)

On yield and yield contributing characters

a. Number of pods/plant

b. 1000-seed weight

c. Yield (Kg/ha)

3.16 Procedure of data collection

Ten plants per plot were randomly selected and tagged for collection of data. Data on percent leaf infection were recorded 50, 60 and 70 days after sowing by visual observation of symptoms. Percent leaf infection was calculated by the following formula.

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

Data on percent leaf area diseased were recorded 50, 60 and 70 days after sowing by visual observation of symptoms. Total leaf area was calculated by leaf area meter while the leaf area infected was recorded on eye estimation. Percent leaf area diseased was calculated as follows:

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

Data on percent pod infection were recorded 60, 70 and 80 days after sowing by visual observation of symptoms. Percent pod infection was calculated by the following formula.

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

3.17 Analysis of data

The data were statistically analyzed using computer package program. Treatment means were compared by DMRT (Duncan's Multiple Range Test). ANOVA table was shown in appendix-V.

RESULTS AND DISCUSSION

4.1 Percent leaf infection (%LI)

The effect of different treatments on percent leaf infection of mustard at different days after sowing (DAS) was summarized and presented in table 1. Different fungicides and plant extracts had significant influence on reduction of percent leaf infection of mustard (BARI Sarisha-15) at different days after sowing (DAS). Percent leaf infection of mustard increased gradually with the advancement of crop growth. The highest percent leaf infection (25.67%) was found in control at 70 days after sowing (DAS), and the lowest percent leaf infection (10.22%) was recorded in Movral treated plot followed by T_6 (Aristodeone), T_3 (Garlic), T_5 (Alphadeone), T_4(Tulshi), T_3(Dhutora).and T_2(Garlic) . The positive effect of Iprodion has earlier reports. Godika *et al.* (2001) reported that Rovral was the most effective in controlling of *Alternaria* blight of mustard. Similarly, Hossain and Rahman (2007) also reported that three sprays with Rovral(iprodeone) 0.02% at 10 days intervals could effectively control Alternaria blight of mustard.

Table 1: Effect of different treatment on percent leaf infection of mustard at different days after sowing (DAS)

Treatment	% leaf infection		
	50 DAS	60 DAS	70 DAS
T_1(control)	14.60 a	28.07 a	25.67 a
T_2(Garlic)	10.17 c	22.8 b	21.59 b
T_3(Dhutora)	11.41 b	20.52 c	17.73 c
T_4(Tulshi)	10.11 c	21.71 bc	16.89 c
T_5(Alphadeone)	10.10 c	20.36 c	16.77 c
T_6(Aristodeone)	10.80 bc	10.68 d	10.99 d
T_7(Movral)	10.36 bc	11.88 d	10.22 d
$LSD_{0.05}$	1.087	1.970	2.048
CV (%)	3.08	4.20	5.39

In a column means having same letter (s) denote no significant difference at 5% level.

4. 2 Percent leaf area diseased (% LAD)

The effect of different treatments on percent leaf area diseased (% LAD) of mustard at different days after sowing (DAS) was summarized and presented in Table 2. Percent leaf area diseased (% LAD) of mustard was found to be

significant at different days after sowing (DAS) in response to the application of different treatments. Percent leaf area diseases (LAD) of BARI Sarisha-15 increased gradually with the advancement of crop growth. At 70 days after sowing the highest percent leaf area diseased (14.09%) was found at T_1 (control) treatment and the lowest percent leaf area diseased (2.207% s) was recorded from the treatment T_7 (Movral) followed by T_6 (Aristodeone), T_5 (Alphadeone), , T_4 (Tulshi)), and T_2 (Garlic). Pandya *et al.* (2000) reported that four sprays of Rovral (iprodione)(0.2%) gave the maximum control of *Alternaria* blight that suport to the present findings.

Table 2: Effect of different treatment on percent leaf area diseased (%LAD) of mustard at different days after sowing (DAS)

Treatment	% leaf area diseased		
	50 DAS	60 DAS	70 DAS
T_1(control)	5.165 a	10.19 a	14.09 a
T_2(Garlic)	4.468 b	9.212 b	9.890 b
T_3(Dhutora)	4.592 b	7.970 c	8.165 c
T_4(Tulshi)	4.055 c	7.918 c	8.100 c
T_5(Alphadeone)	2.213 d	4.867 d	5.215 d
T_6(Aristodeone)	2.102 d	3.050 e	3.243 e
T_7(Movral)	1.225 e	1.952 f	2.207 f
$LSD_{0.05}$	0.2739	0.4357	0.3986
CV (%)	5.40	4.54	3.68

In a column means having same letter (s) denote no significant difference at 5% level.

4. 3 Percent pod infection

The effect of different treatments on percent pod infection of mustard at different days after sowing (DAS) was summarized and presented in table 3. Significant variation of the effect of different treatments on percent pod infection of mustard (BARISarisha-15) was found at different days after sowing (DAS). Percent pod infection of mustard increased gradually with the increase of crop age. Very little pod infection 1.13 to 4.39% was recorded at 60 DAS while it was raised to the range from 7.16 to 15.66% at 70 DAS due to different treatments while, the percent pod infection reached to the range of 10.18 to 29.25% at 80 DAS in response of applying different treatments. At 80 days after sowing (DAS) the

lowest percent pod infection 10.18% was recorded from T_7 (Movral) treatment (Photograph-3) while the highest 29.25% was obtained from T_1 (control) treatment (Photograph-2) which was followed by T_5 (Aristodeone), T_5 (Alphadeone), T_4 (Tulshi), T_2 (Garlic) and T_3 (Dhutora). Godika *et al.* (2001) reported that Rovral was the most effective in controlling of *Aalternaria* blight in respect of pod infection.

Table 3: Effect of different treatments on percent pod infection of mustard at different days after sowing (DAS)

Treatment	% pod infection		
	60 DAS	70 DAS	80 DAS
T_1(control)	4.390 a	15.66 a	29.25 a
T_2(Garlic)	3.750 b	14.47 b	26.69 b
T_3(Dhutora)	3.392 b	12.29 c	29.21 a
T_4(Tulshi)	2.735 c	11.39 cd	24.07 c
T_5(Alphadeone)	2.072 d	11.49 cd	19.04 d
T_6(Aristodeone)	1.265 e	10.53 d	18.87 d
T_7(Movral)	1.130 e	7.155 e	10.18 e
$LSD_{0.05}$	0.4530	1.054	1.828
CV (%)	6.37	3.34	5.36

In a column means having same letter (s) denote no significant difference at 5% level.

4. 4 Number of spots per pod

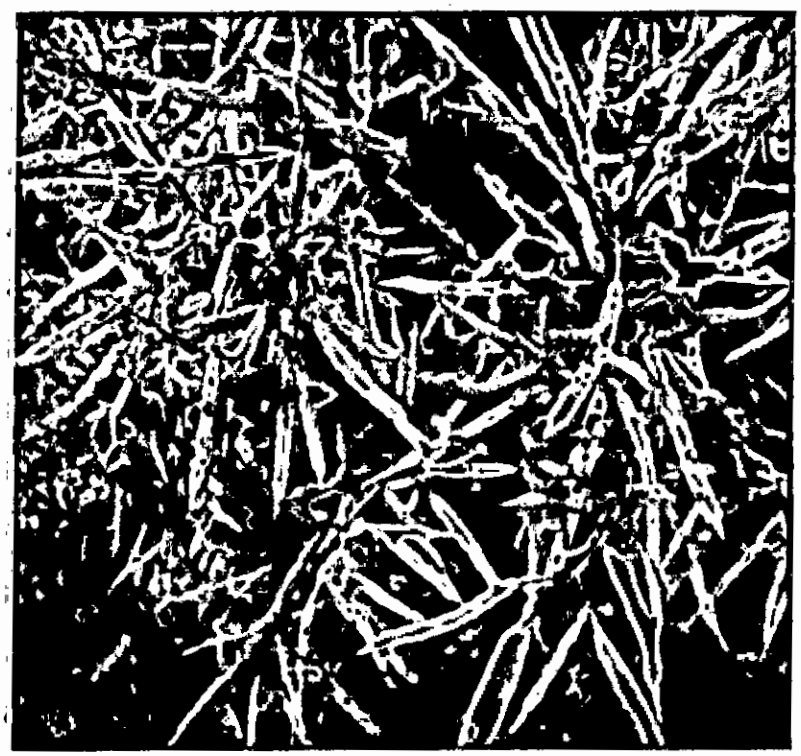
The effect of different treatments on number of spots per pod of mustard at 60, 70 and 80 days after sowing (DAS) was summarized and presented in Table 4. Number of spots per pod of mustard (BARI Sarisha-15) was influenced significantly with the application of different fungicides and plant extracts at different days after sowing Number of spots per pod was very few at 60 days after sowing while the number of spots per pod increased gradually from 70 DAS to 80 DAS. Only few spots per pod was recorded at 70 DAS. At 80 DAS, the maximum number of spots per pod (1.947) was recorded from T_1 (control) treatment and minimum number of spots per pod (1.17) was obtained from applying with T_7 (Movral) treatment followed by T_6 (Aristodone). Application of T_5 (Alphadeone), T_2 (Garlic), T_4 (Tulshi) and T_3 (Dhutora) was found to be statistically insignificant. These findings are in agreement with the findings of Godika *et al.* (2001) and Pandya *et al.* (2000) who reported that Rovral (Iprodion) was the most effective in

controlling *Alternaria* blight of mustard. Similarly, Hossain and Rahman (2007) also reported that three sprays with Rovral 0.02% at 10 days intervals could effectively control Alternaria blight of mustard.

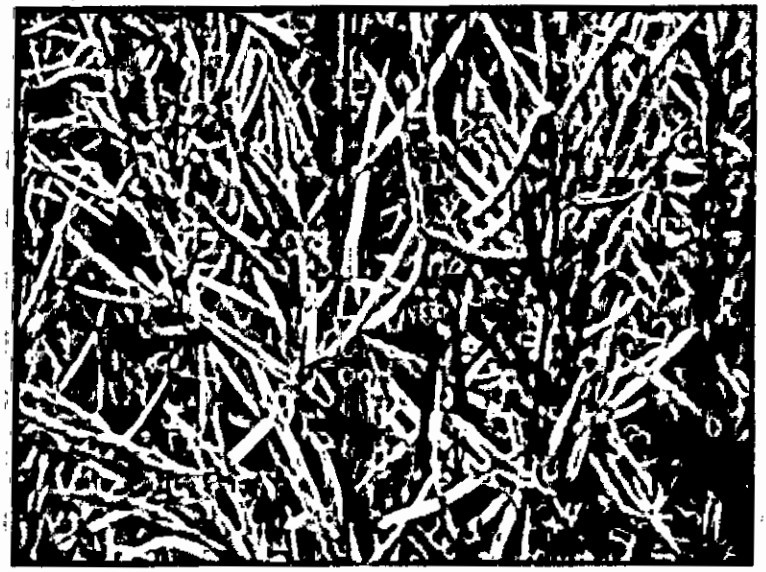
Table 4: Effect of different treatments on number of spots/pod of mustard at different days after sowing (DAS)

Treatment	Number of spots/pod		
	60 DAS	70 DAS	80 DAS
T_1(control)	0.1230 a	1.253 ab	1.947 a
T_2(Garlic)	0.08350a	1.303 a	1.655 b
T_3(Dhutora)	0.08000a	1.200 ab	1.747 b
T_4(Tulshi)	0.07225ab	1.217 ab	1.730 b
T_5(Alphadeone)	0.02875bc	0.9750bc	1.325 c
T_6(Aristodeone)	0.01325c	0.8500cd	1.235 c
T_7(Movral)	0.00025c	0.6500d	1.175 c
$LSD_{0.05}$	0.04698	0.2779	0.1758
CV (%)	4.33	3.74	2.93

In a column means having same letter (s) denote no significant difference at 5% level



Photograph 2: Untreated plot of mustard plant



Photograph 3: Movral treated plot of mustard plant

4. 5. 1 Number of leaf/plant

Number of leaf per plant was found to be significant due to the application of different fungicides and plant extracts. The highest number of leaf per plant (10.05) was recorded in treatments in which the fungicide Movral (T_7) was applied as foliar spray while the leaf per plant in other treatments where fungicides like Alphadeone (T_5) and Aristodeone (T_6) did not vary significantly. The lowest number of leaf per plant (8.60) was recorded from the treatment where nither any fungicide nor any leaf extract was applied (T_1) i.e. control (Table-5). These findings are in agreed with the findings of Shivpuri *et al.* (1988).

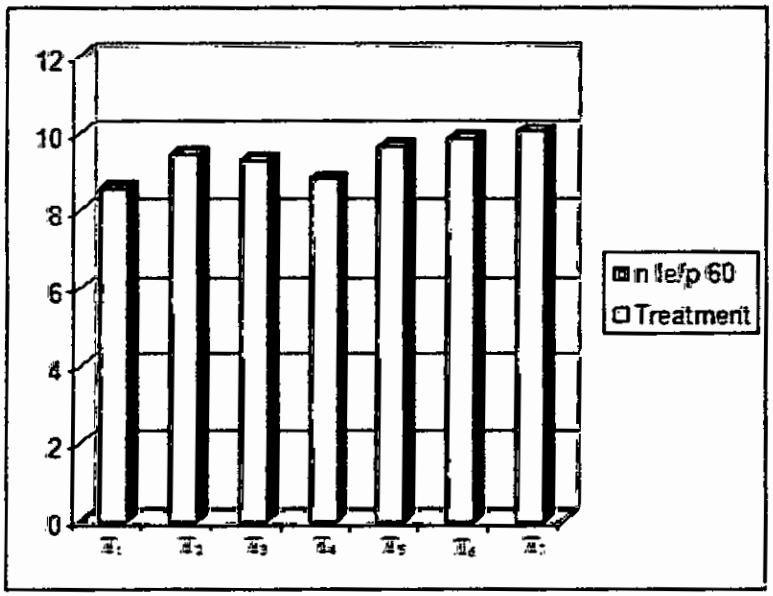


Fig.1. Effect of fungicides and plant extract on **number of leaf/plant**

T_1(control), T_2(Garlic), T_3(Dhutora), T_4(Tulshi)
T_5(Alphadeone), T_6(Aristodeone), T_7(Movral)

4. 5. 2 Number of branches/plant

Number of branches per plant differed significantly in different treatments, i.e. due to application of fungicides and plant extracts. The maximum number of branches (6.747) was recorded in case of T6 (Aristodeone) which was statistically similar with T_7 (Movral), and T_5 (Alphadeone) . T_1 (control) produced the lowest (5.92) number of branches per plant (Table 5).

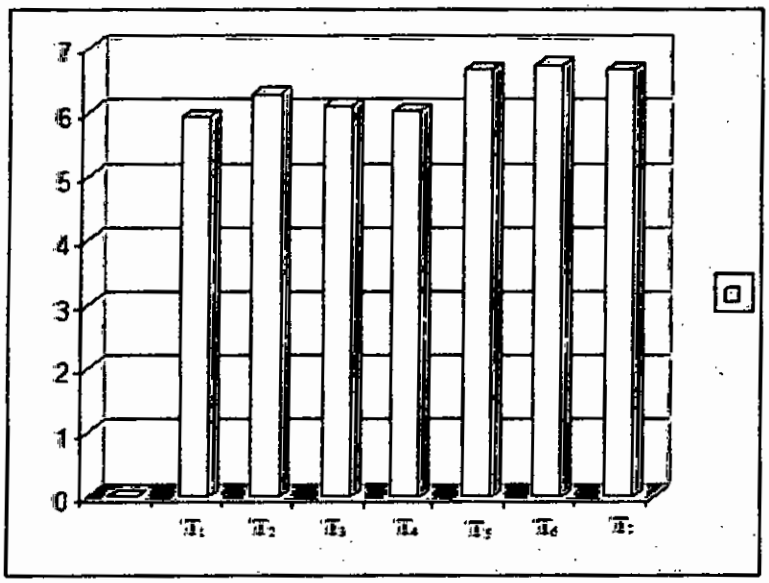


Fig.2. Effect of fungicides and plant extract on number of branches/plant
T_1(control), T_2(Garlic), T_3(Dhutora), T_4(Tulshi)
T_5(Alphadeone), T_6(Aristodeone), T_7(Movral

4. 5. 3 Plant height (cm)

Different fungicides and plant extracts had significant influence on plant height (cm) of mustard. The tallest plant was obtained from T_5 (alphadeone) (95.17 cm) which was statistically identical with T_7 (movral) and T_6 (aristodeone). The lowest plant height (85.42cm) was recorded in case of T_1 (Control) (Table 5).

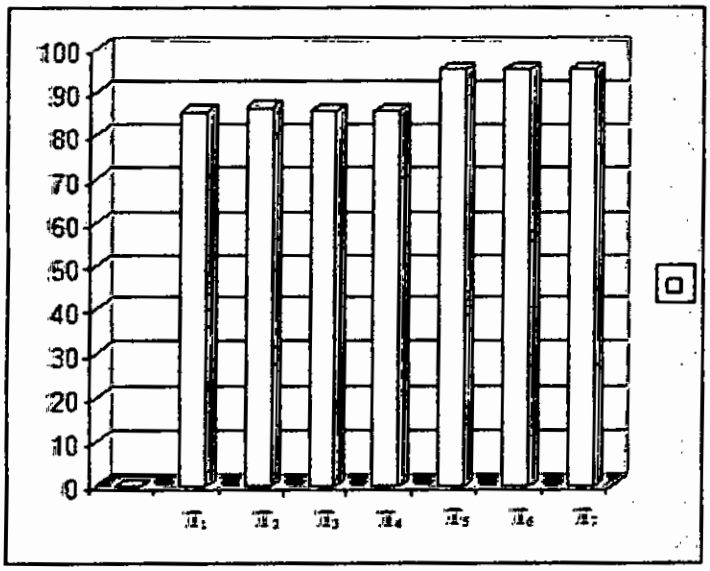


Fig.3. Effect of fungicides and plant extract on plant height (cm)
T_1(control),T_2(Garlic),T_3(Dhutora), T_4(Tulshi)
T_5(Alphadeone),T_6(Aristodeone),T_7(Movral)

Table 5: Effect of different treatments on growth parameters of mustard

Treatment	No leaf/pl 60	No br/pl 60	Pl height	No pod/pl
T_1(control)	8.605 d	5.920 c	85.42 b	69.14 g
T_2(Garlic)	9.450 bc	6.275 b	86.39 b	72.21 d
T_3(Dhutora)	9.300 c	6.085 c	85.85 b	71.32 e
T_4(Tulshi)	8.818 d	6.020 c	85.69 b	70.92 f
T_5(Alphadeone)	9.667abc	6.668 a	95.17 a	74.01 c
T_6(Aristodeone)	9.868ab	6.747 a	95.16 a	75.49 b
T_7(Movral)	10.05 a	6.660 a	95.15 a	77.44 a
$LSD_{0.05}$	0.4530	0.1879	2.088	0.3355
CV (%)	3.25	3.75	4.85	2.31

In a column means having same letter (s) denote no significant difference at 5% level.

4. 6.1 Number of pods/plant

Highest Number of pods per plant was recorded 77.44 incase of T_7 (movral) and lowest was recorded 69.14 incase of T_1 (control)

4. 6. 2 1000-Seed weight

1000-seed weight was found to be significantly different which seems to be due to application of different fungicides. Spraying with Aristodeone (T_6) produced the highest 1000-seed weight (3.484g) while the lowest 1000-seed weight (3.27g) was recorded in T_1 (Control) (Table-6). However, the 1000 seed weight obtained in Movral (T_7) sprayed plots did not show any statistical difference from Aristodeone. But the application of plant extract did not show significant effect from the control. The 1000-seed weight increased due to Rovral spray however, is in agreement with the previous finding (Annonymous, 1992). The present finding also similar with the result of Ayub *et al.* (1996).

4. 6. 3 Yield

Significant variation of different treatments was found on yield Kg per hectare. Maximum yield per hectare (1317.975 kg) was obtained from T_7 (Movral) treated

plot followed by T_5 (Alphadeone), T_6 (Aristodeone) and T_4 (Tulshi) in both the cases. The minimum yield per hectre (1091.57 kg) was recorded from T_1 (Control) treatment (Table-6). Singh *et al.* (2006) reported that spraying of Rovral (iprodione) was more effective than other fungicides and the highest yields were recorded with Rovral. These findings are agreed with the findings of Chattopadhyay and Bhunia (2003), Mukherjee *et al.* (2003), Pandya *et al.* (2000) and Ayub *et al.* (1996).

Table 6: Effect of different treatments on yield and yield contributing characters of mustard

Treatment	1000 Seed wt(g)	yield (kg/ha)
T_1(control)	3.279 c	1091.575 c
T_2(Garlic)	3.210 c	1308.250 a
T_3(Dhutora)	3.238 c	1295.950 b
T_4(Tulshi)	3.269 c	1289.850 b
T_5(Alphadeone)	3.352 b	1317.825 a
T_6(Aristodeone)	3.484 a	1316.275 a
T_7(Movral)	3.445 a	1317.975 a
$LSD_{0.05}$	0.06644	13.65
CV (%)	4.42	7.72

In a column means having same letter (s) denote no significant difference at 5% level.

SUMMARY AND CONCLUSION

The experiment was conducted at central farm of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur, during the period from October, 2009 to March, 2010. The objectives of this experiment were to control leaf blight of mustard through some selected types of fungicides and plant extracts.

The experiment was laid out in a RCBD with four replications. There were seven treatments, Viz.T_1 (Control), T_2 (Extract of Garlic clove), T_3 (Leaf extracts of Dhutora), T_4 (Leaf extract of Tulshi), T_5 (Alphadeone), T_6 (Aristodeone) and T_7 (Movral). The unit plot size was 4m x 3m with row and plant spacing of 25 cm × 15 cm. The spaces between blocks and unit plots were 1 m and 0.5 m, respectively. Data were collected on disease incidence and severity of the disease, yield and yield contributing characters. Data were analyzed and the mean values were adjudged with Duncan Multiple Range Test (DMRT).

The study revealed that application of Movral and plant extract significantly influenced all most all of the parameters. The lowest percent leaf infection (10.22%), percent leaf area diseases (2.207%), percent pod infection (10.18%) and number of spots per pod (1.175) were recorded from spraying with Movral. The highest percent leaf infection (25.67%), percent leaf area diseased (14.09%), percent pod infection (29.25%) and number of spots per pod (1.947) were recorded from control.

The highest yield (1316.875 kg/ha) was obtained from the plot spraying with Movral. The highest germination percentage and the lowest seed infection obtained from the plot spraying with Movral. The lowest germination percentage and the highest seed infection of harvested seeds were obtained from the control treatment. The lowest yield (1091.575 kg/ha) was obtained from untreated plot.

Among the botanicals the lowest percent leaf infection (16.89 %), percent leaf area diseases (8.100%), percent pod infection (24.07%) and number of spots per pod (1.730) were recorded from spraying with Tulshi. Among the botanicals the highest yield (1289.850kg/ha) was obtained from the plot spraying with Tulshi. So Tulshi had good effect in controlling *Alternaria* blight which was found significantly higher among all other botanicals.

From the present findings it may be concluded that seed treatment as well as spraying with Movral was found to be best and Tulshi was also better in case of botanicals for lowering leaf blight incidence and severity and the highest yield of good quality seed of mustard (BARI sarisha-15).However further investigation need to be carried out incorporating more fungicides and plant extracts to authenticate the results against the disease.

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APPENDICES

Appendix-I: Particulars of the Agro-ecological Zone of the Experimental site

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

Land type : High land.

General soil type : Shallow and brown terrace soil

Soil series : Tejgaon

Topography : Fairly leveled

Location : Central farm of BARI

Field level : Above flood level.

Drainage : Well drained.

Firmness (consistency): Compact to friable when dry.

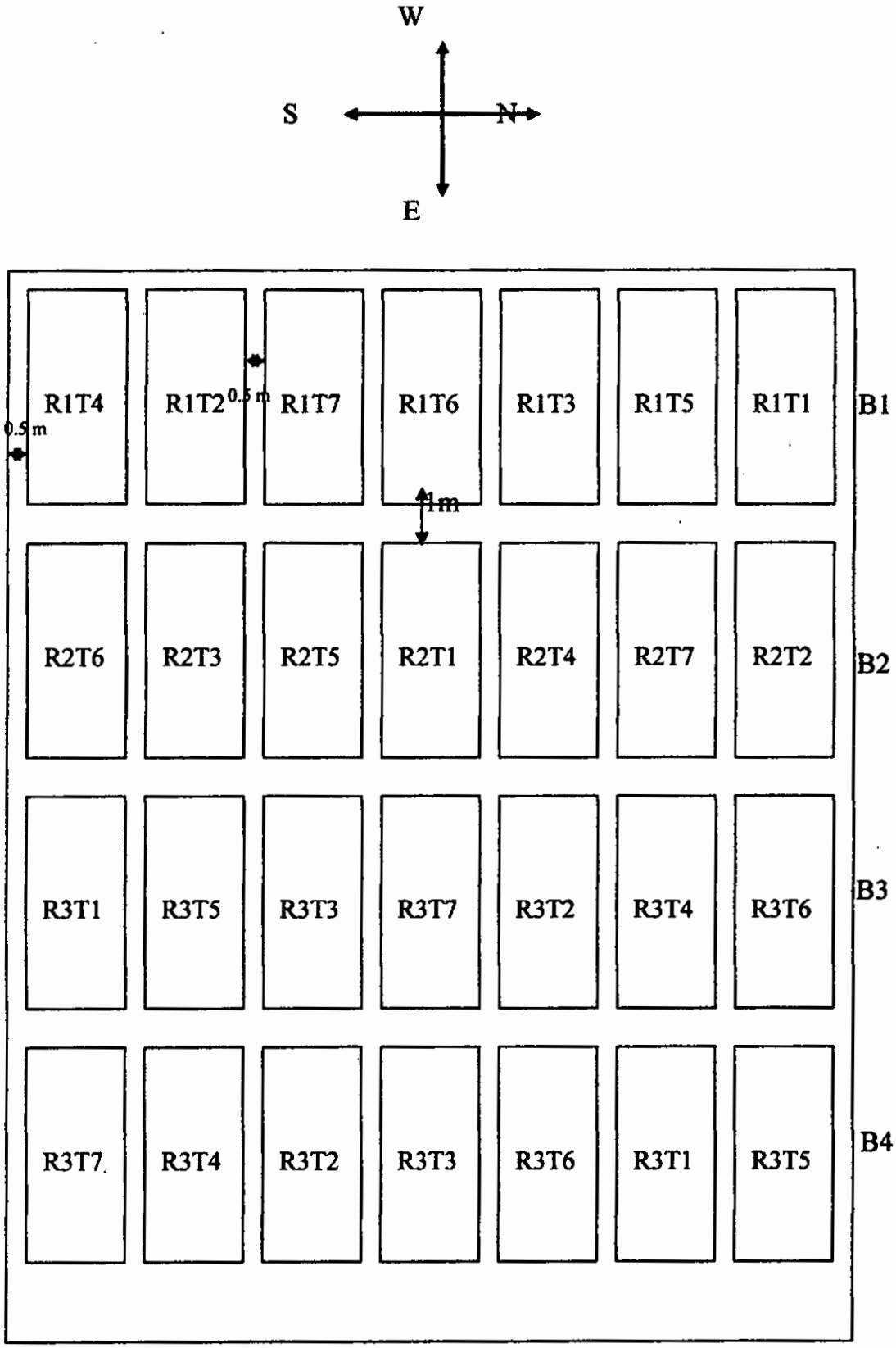
Appendix-II: Monthly mean weather

Monthly mean of daily maximum, minimum and average temperature, relative humidity and total rainfall during November/2009 to February/2010.

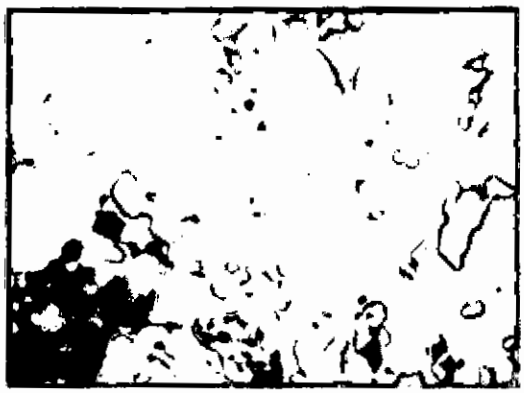
Year	Month	Air temperature (^{0}c)			Relative humidity (%)		Rain fall (mm)
		Maximum	Minimum	Mean	Max	Min	
2009	October	32.15	23.15	27.65	97	62	1.57
2009	November	30.38	18.19	24.29	97	59	1.5
2009	December	25.69	13.13	19.41	98	53	0.0
2010	January	24.10	11.22	17.66	99	31	0.0
2010	February	28.66	13.81	21.24	99	31	5.0
2010	March	34.14	21.5	27.82	98	23	12.0

Source: Bangladesh Meteorological Department (Climate division) of Bangladesh Agricultural Research Institute (BARI) at Joydevpur in Gazipur.

Appendix-III: Layout of the field experiment



Appendix-IV: Photographs of infected leaf and conidium



Photograph 4: Symptom of infected leaf of Mustard

Photograph 5: Conidium of *Alternaria*

Appendix-V: ANOVA table of the experiment

1.% Leaf infection;

Source of variation	Degrees of freedom	Mean square		
		% leaf infection		
		50 DAS	60 DAS	70 DAS
Replication	3	7.465	85.957	11.672
Factor A	6	10.546**	151.292*	119.285*
Error	18	0.535	1.758	1.900

* significant at 5% level
** significant at 1% level

2.% Leaf area diseased;

Source of variation	Degrees of freedom	Mean square		
		% leaf area diseased		
		50 DAS	60 DAS	70 DAS
Replication	3	0.045	0.149	0.005
Factor A	6	9.287*	40.275*	67.316**
Error	18	0.034	0.086	0.072

* significant at 5% level
** significant at 1% level

3.% Pod infection;

	Degrees of freedom	Mean square		
		% pod infection		
		60 DAS	70 DAS	80 DAS
Replication	3	0.166	8.122	14.807
Factor A	6	6.236*	30.468*	191.757*
Error	18	0.093	0.503	1.514

* significant at 5% level
** significant at 1% level

4.Number of spot per pod;

Source of variation	Degrees of freedom	Mean square		
		n spot/pod		
		60 DAS	70 DAS	80 DAS
Replication	3	0.000	0.013	0.000
Factor A	6	0.008**	0.240**	0.354**
Error	18	0.001	0.013	0.014

* significant at 5% level
** significant at 1% level

5.Different growth parameters;

Source of variation	Degrees of freedom	Mean square			
		n leaf/p 60	n branch/p 60	pl hight	n pod/p
Replication	3	0.060	0.027	66.178	0.065
Factor A	6	1.131*	0.483**	99.730*	33.080**
Error	18	0.093	0.016	18.975	0.051

* significant at 5% level
** significant at 1% level

6.Yield parameters;

Source of variation	Degrees of freedom	Mean square	
		1000 seed w	yield kg/ha
Replication	3	0.011	811.554
Factor A	6	0.044**	2819.233*
Error	18	0.002	84.402

* significant at 5% level
** significant at 1% level