MANAGEMENT OF GRAY BLIGHT OF MUSTARD THROUGH SOME SELECTED TREATMENTS

A THESIS

BY

KH. HABIBUL ALAM

DEPARTMENT OF PLANT PATHOLOGY
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA-1207

JUNE, 2007

MANAGEMENT OF GRAY BLIGHT OF MUSTARD THROUGH SOME SELECTED TREATMENTS

BY

KH. HABIBUL ALAM

Registration No. 06-02152

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

MASTER OF SCIENCE

IN

PLANT PATHOLOGY

SEMESTER: JANUARY-JUNE, 2007

APPROVED BY:

(Dr. Md. Rafiqul Islam)	**(Dr. F.M. Aminuzzaman)**
Professor	**Assistant Professor**
Supervisor	**Co-Supervisor**

(Prof. Nasim Akhtar)
Chairman
Examination Committee

Department of Plant Pathology
Sher-e-Bangla Agricultural University, Dhaka-1207
Phone: 9144270-9 Ext.273, Fax: +88029112649, e-mail: vcs@dhaka.net

Ref: ---------- Date: ----------

CERTIFICATE

This is to certify that the thesis entitled "MANAGEMENT OF GRAY BLIGHT OF MUSTARD THROUGH SOME SELECTED TREATMENTS" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in PLANT PATHOLOGY, embodies the result of a piece of bona fide research work carried out by Kh. Habibul Alam, registration no. 06-02152, under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated: 28-06-2007
Dhaka, Bangladesh.

(Dr. Md. Rafiqul Islam)
Professor
Department of Plant Pathology
Sher-e-Bangla Agricultural University

Supervisor

Dedicated to
My
Beloved Parents

ACKNOWLEDGEMENT

First of all the author expresses his gratitude to the merciful and almighty Allah without Whose grace he would have never been able to pursue his higher studies in this field of science and to complete this thesis for the degree of MS in Plant Pathology.

The author expresses his ever indebtedness, deepest sense of gratitude, sincere appreciation and profound regards to his reverend and beloved teacher and Research Supervisor Dr. Md. Rafiqul Islam, Professor, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for his scholastic supervision, uncompromising principles, valuable advices, constant inspiration, radical investigation and constructive criticism in all phases of this study and preparing the manuscript.

The author finds it a great pleasure in expressing his heartfelt gratitude and immense indebtedness to his honorable and respected teacher and Research Co-Supervisor, Dr. F. M. Aminuzzaman, Assistant Professor, Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka for his kind co-operation, creative suggestions, continuous encouragement and constructive criticism for the completion of the research work and preparation of the thesis.

The Author is pleased to submit his gratefulness to all of his respected teachers of the Department of Plant Pathology, Sher-e-Bangla Agricultural University for their inspiration and cooperation during the study period.

The Author desires to convey special thanks to Dr. Md. Mahfuzul Haque Selim, Senior Scientific Officer; Hirendra Nath Barman, Scientific Officer, PRC, Bangladesh Agricultural Research Institute and A. N. Faruq Ahmmed, Lecturer, Department of Plant Pathology, Sher-e-Bangla Agricultural University.

It is a great pleasure to convey cordial appreciation to younger brothers Elius, Rony, Faysal and sisters Bonita, Popy and Tuli for their friendly association and cooperation during the research work and MS study period.

Thanks are extended to Dr. Md. Mostafizur Rahman, Senior Scientific Officer, Plant Pathology Division, RARS, Bangladesh Agricultural Research Institute, Rahmatpur, Barishal.

Last but not in the least, he is also extending his cordial thanks to his parents, son Amir Hamza and beloved wife Ismat Ara Kalpona, Assistant Professor, University of Rajshahi, Rajshahi for their sacrifice for me during the study period.

The Author

CONTENTS

MATERIALS AND METHODS (CONTD.)

CHAPTER-IV RESULTS AND DISCUSSION 26-41

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHS

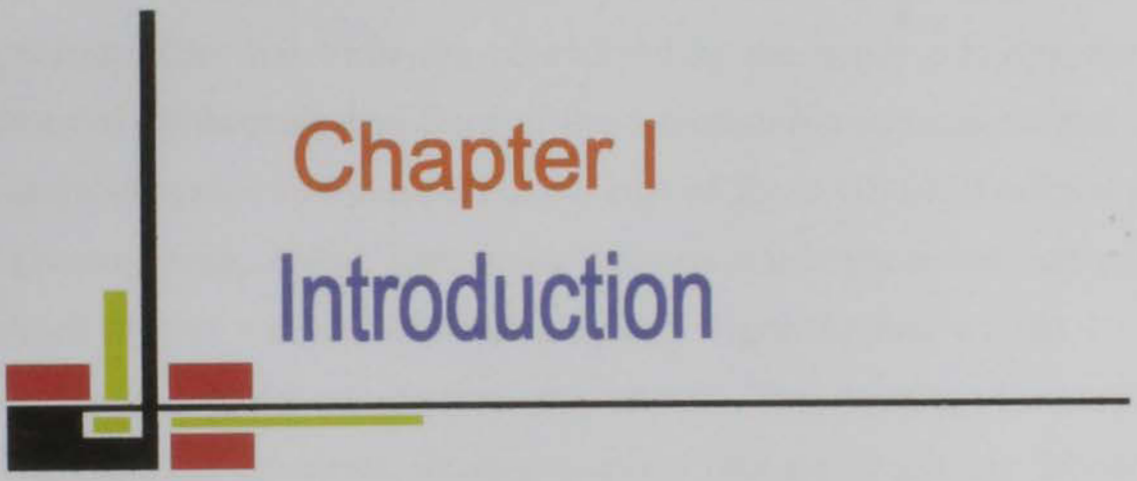
LIST OF PLATES

LIST OF APPENDICES

Management of gray blight of mustard through some selected treatments

ABSTRACT

The efficacy of some selected fungicides and plant extracts was evaluated against *Alternaria brassicae* and *Alternaria brassicicola* causing gray blight of mustard (var. SAU Sarisha-1, *Brassica campestris*). Experiments were conducted at the Farm of Sher-e-Bangla Agricultural University, Dhaka and in the laboratory of Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Rahmatpur, Barishal during rabi season from the month of November, 2006 to February, 2007. Four fungicides viz. Rovral 50 WP (0.2%), Dithane M-45 (0.3%), Ridomil 68 WP (0.2%), Bavistin DF (0.1%) and two plant extracts viz. Garlic clove extract, Allamanda leaf extract were employed in the experiment. Among the fungicides and plant extracts tested, Rovral 50 WP (0.2 %) showed the best performance in reducing disease incidence and disease severity as well as increasing seed yield against gray blight of mustard. Seed infection by *Alternaria spp.* was reduced by 64.90% and seed yield was increased by 48.19% over control by the application of Rovral. No promising results were shown by the rest of the treatments against gray blight of mustard.



Chapter I
Introduction

INTRODUCTION

Rapeseed-mustard (*Brassica spp.*) is the major oilseed crop of Bangladesh. Out of total cropped area of 13.53 million hectare, oilcrops occupy only 0.561 million which is about 4.2% of the total cropped area. Rapeseed-mustard covers 0.336 million hectare of land (60%) of the total oil-cropped area and produces 0.246 million tons yield (52.2%) (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 SAU Sarisha-1 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).

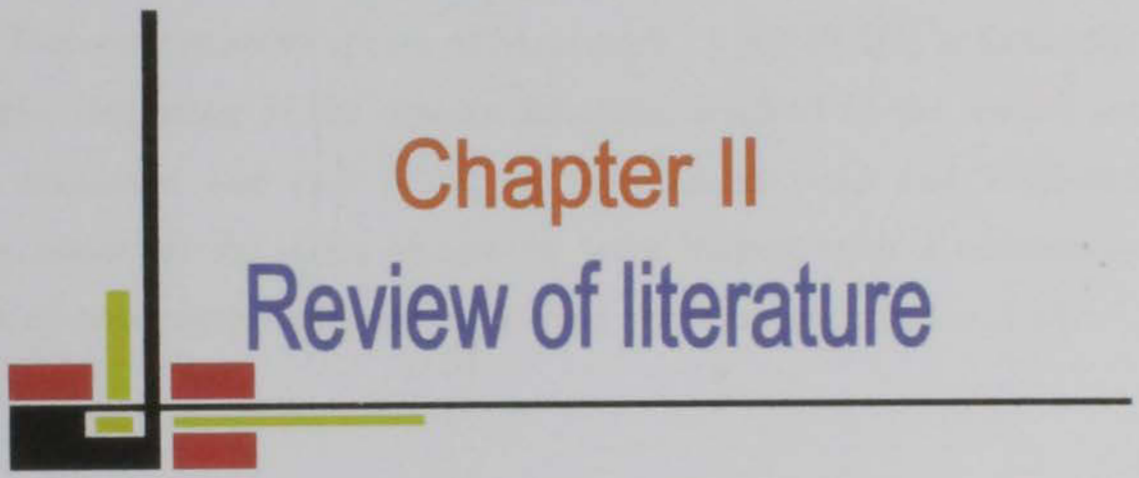
Rapeseed-mustard suffers from about 14 diseases (fungus-9, virus-2, bacteria-1, nematode-1 and parasitic plant-1) in Bangladesh. Among theses diseases leaf blight, downy mildew and the parasitic plant are the important (Anonymous, 2007). Leaf blight caused by *Alternaria brassicae* is widely distributed and the most serious and devastating disease of rapeseed-mustard. The characteristic symptom is 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 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). 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 chemical, 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 of mustard.
2. To determine the effect of fungicides and plant extracts on incidence of *Alternaria spp.* on harvested seeds of mustard.



Chapter II
Review of literature

REVIEW OF LITERATURE

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.

Chapter III

Materials and Methods

MATERIALS AND METHODS

3.1 Experimental sites

The experiment was conducted in the farm of Sher-e-Bangla Agricultural University, Dhaka and the laboratory of Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Rahmatpur, Barisal.

3.2 Experimental period

The experiment was carried out during the Rabi season from November 2006 to February 2007. Seeds were sown on 23, November 2006 and were harvested on 10, February 2007.

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 mature characterized by high temperature associated with heavy rainfall during Kharif season (April to September) and scanty rainfall with moderately low temperature during Rabi season (October to March).

3.5 Weather

The monthly mean of daily maximum, minimum and average temperature, relative humidity, monthly total 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, Dhaka (Appendix-II).

3.6 Variety

The mustard (*Brassica campestries*) variety SAU Sarisha-1 released from Sher-e-Bangla Agricultural University was used for the experiment. Seed were collected from Department of Genetics and Plant Breeding, Sher-e-Bangla Agricultural University, Dhaka.

3.7 Treatments of the experiment

Seven treatments were assessed in the experiment as follows:

T_1= Control (Seed treatment with water + Foliar spray with water)

T_2= Allamanda (Seed treatment + Foliar spray)

T_3= Garlic (Seed treatment + Foliar spray)

T_4= Bavistin DF (Seed treatment + Foliar spray)

T_5= Dithane M-45 (Seed treatment + Foliar spray)

T_6= Ridomil MZ-72 (Seed treatment + Foliar spray)

T_7= Rovral 50 WP (Seed treatment + Foliar spray)

3.8 Design and layout

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The whole plot was divided into three blocks each containing seven (7) plots of 2m x 1.5m size, giving 21 units plots. The space was kept 1m between the blocks and 0.5m between the plots (Appendix-III).

3.9 Land preparation

The land was ploughed with a power tiller in the first week of November 2006 and left exposed to sunlight for 7 days. Then the land was ploughed and cross-ploughed by a country plough 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. The following doses were used for carrying out the field study (Anonymous, 2001).

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 Allamanda (*Allamanda cathartica*) and clove of Garlic (*Allium sativum*) were collected from Sher-e-Bangla Agricultural University campus and local market. For preparation of extract, collected plant materials were weighed in an electric balance and then washed in water. After washing, that was 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 1:1 (w/v) for seed treatments and 1:10 (w/v) for foliar spray.

3.12 Seed treatment

Seeds were divided into three treatment groups. Among these three treatment groups one group of seeds were treated by using plant extract with dipping method separately in different petridishes. Both plant extracts @ 1:1 concentration were taken in different petridishes as per requirement. Then seeds were dipped in the solution for five minutes. The treated seeds were then taken off the extract and kept in blotting paper to remove excess moisture from the seed surface. Another group of seeds were treated with different fungicides of different concentrations by using same procedure. The last group of seeds was treated with water as a control.

3.13 Preparation and application of spray solution

The fungicidal solutions were prepared by mixing with required amount of fungicides with tube well water. Four fungicidal solutions, both plants extract (concentration @ 1:10) and plain water were sprayed with compressed hand sprayer. Sprays were done at 30, 40, 50, 60 days after sowing. Every time the fungicide was freshly prepared prior to application and the spray tank was thoroughly cleaned before filling with new spray materials. Special attention was given to complete coverage of the growing plants with the fungicides. Adequate precaution was taken to avoid drifting of spray materials from one plot to the neighboring ones. Details of the fungicides used as spray materials are given in Table 1.

Table 1: Details of Fungicides

Common name	Chemical name	Active ingredients	Doses Used
1. Bavistin DF	Carbendazim	Carbendazim (50%)	0.1%
2. Dithane M-45	Manganous ethylene bisdithio carbamate-ion($C_4H_6N_2S_4$)	Mancozeb (50%)	0.3%
3. Ridomil MZ-72	N-(2,6 dimethyl phenyl)- N-(methoxyacetyl)-alanine methyl ester($C_{14}H_{21}NO_4$)	Mancozeb + Metalaxyl (72%)	0.2%
4. Rovral 50 WP	3-(3,5dichlorophenyl)-N-(Imethylethyl)-2,4 dioxoimidazolidene carboxamide $(C_{13}H_{13})_3N_3CI_2$	Iprodione (50%)	0.2%

3.14 Intercultural operations

Weeding was done when necessary followed 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 Germination and seed health test

Germination test of SAU Sarisha-1 seeds received from treated plot with different treatments was conducted in glass petridishes. Four hundred seeds were randomly collected from each treatment. Seeds were placed on three layers of moist blotting paper (Whatman No.1) contained in plastic petridishes. Twenty-five seeds were placed in each petridishes and incubated at $25\pm1^{0}C$ under 12-hrs cycle of alternate Near Ultra Violet (NUV) light and darkness. The experiment was laid out in CRD. Watering was done as and when required. Germination of seedling and seed infection by *Alternaria spp.* were recorded. Results were expressed as percent seed germination.

Each seed was observed under stereo-binocular microscope in order to record the presence of fungal colony 7 days after incubation. Temporary slides were prepared from the fungal colony and observed under compound microscope. Germination and seed health test related photographs were presented in appendix-IV.

3.16 Collection of data

The following parameters were considered for data collection.

On diseases incidence

a. Percent leaf infection
b. Percent leaf area diseases (% LAD)
c. Percent pod infection
d. Number of spots/pod

On growth parameters

a. Number of leaf/plant
b. Number of branches/plant
c. Plant height (cm)

On yield and yield contributing characters

a. Number of pods/plant
b. 1000-seed weight
c. Yield/plant (gm)
d. Yield (Kg/ha)

On harvest seed

a. Percent seed germination
b. Percent seed infection

3.17 Procedure of data collection

Ten plants per plot were selected and tagged for collection of data. Data on percent leaf infection were recorded 65, 75 and 85 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 65, 75 and 85 days after sowing by visual observation of symptoms. Percent leaf area diseased was calculated by the following formula.

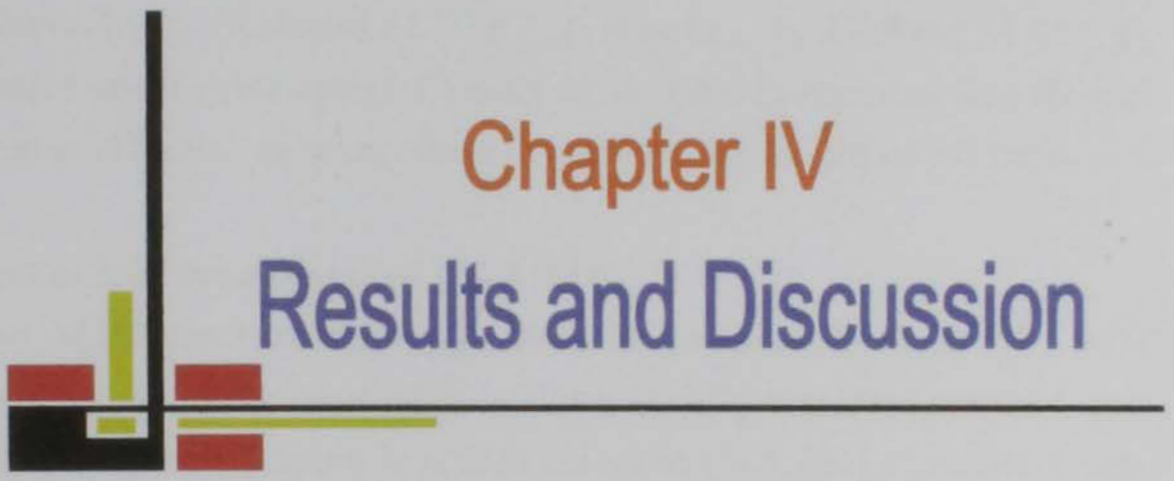
$$\% \text{ Leaf area diseased} = \frac{\text{Infected leaf area}}{\text{Total leaf area}} \times 100$$

Data on percent pod infection were recorded 70, 80 and 90 days after sowing by visual observation of symptoms. Percent pod infection was calculated by the following formula.

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

3.18 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. Correlation and Regression study was done to determine the relationship between percent leaf infection, percent leaf area diseased (% LAD) and percent pod infection with days after sowing for each of the treatments.



Chapter IV

Results and Discussion

RESULTS AND DISCUSSION

4.1 Percent leaf infection

The effect of different treatments on percent leaf infection of mustard at different days after sowing (DAS) was summarized and presented in table 2. Different fungicides and plant extracts had significant influence on percent leaf infection of mustard (SAU Sarisha-1) at different days after sowing (DAS). Percent leaf infection of mustard increased gradually with the advancement of crop growth. At 85 days after sowing (DAS), the highest percent leaf infection (57.25%) was found in control and the lowest percent leaf infection (10.76%) was recorded in Rovral treated plot followed by T_6 (Ridomil MZ-72), T_3 (Garlic), T_5 (Dithane M-45), T_1 (Allamanda) and T_4 (Bavistin). Godika *et al.* (2001) reported that Rovral was the most effective in controlling of *Aalternaria* blight of mustard.

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 3. 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 mustard (SAU Sarisha-1) increased gradually with the advancement of crop growth. At 85 days after sowing the highest percent leaf area diseased (18.45%) was found at T_1 (control) treatment and the lowest percent leaf area diseased (2.59%) was recorded from the treatment T_7 (Rovral) followed by T_2 (Allamanda), T_5 (Dithane M-45), T_4 (Bavistin), T_6 (Ridomil MZ-72) and T_3 (Garlic). There is no significant difference among the treatment T_3, T_4, T_5 and T_6. 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 infection of mustard at different days after sowing (DAS)

Treatments	% Leaf infection		
	65 DAS	75 DAS	85 DAS
T_1 (control)	30.50 a	47.51 a	57.25 a
T_2 (Allamanda)	12.50 e	19.30 c	39.99 b
T_3 (Garlic)	21.60 b	25.69 bc	36.53 bc
T_4 (Bavistin DF)	18.50 c	27.82 b	43.92 b
T_5 (Dithane M-45)	16.00 d	21.50 bc	38.66 bc
T_6 (Ridomil MZ-72)	11.80 e	19.08 c	28.29 c
T_7 (Rovral 50 WP)	2.95 f	4.52 d	10.76 d
CV (%)	6.84%	18.14%	15.71%

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

Table 3: Effect of different treatment on percent leaf area diseased (% LAD) of mustard at different days after sowing (DAS)

Treatments	% Leaf area diseased (LAD)		
	65 DAS	75 DAS	85 DAS
T_1 (control)	5.18 a	12.65 a	18.45 a
T_2 (Allamanda)	2.15 b	3.50 bc	5.98 bc
T_3 (Garlic)	1.95 b	3.21 cd	7.58 b
T_4 (Bavistin DF)	2.18 b	3.75 bc	7.10 b
T_5 (Dithane M-45)	2.16 b	4.25 b	6.68 b
T_6 (Ridomil MZ-72)	1.53 b	2.55 d	7.37 b
T_7 (Rovral 50 WP)	0.46 c	1.45 e	2.59 c
CV (%)	18.97%	11.10%	24.83%

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 4. Significant variation of the effect of different treatments on percent pod infection of mustard (SAU Sarisha-1) 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 was recorded at 70 DAS while it was raised to the range from 9.52 - 41.52 at 90 DAS in response of applying different treatments. At 90 days after sowing (DAS) the highest percent pod infection (41.52%) was obtained from T_1 (control) treatment (Photograph-1) and the lowest percent pod infection (9.52%) was recorded from T_7 (Rovral) treatment (Photograph-2) followed by T_5 (Dithane M-45), T_6 (Ridomil MZ-72), T_2 (Allamanda), T_3 (Garlic) and T_4 (Bavistin). Godika *et al.* (2001) reported that Rovral was the most effective in controlling of *Aalternaria* blight in respect of pod infection.

4. 4 Number of spots per pod

The effect of different treatments on number of spots per pod of mustard at different days after sowing (DAS) was summarized and presented in Table 5. Number of spots per pod of mustard (SAU Sarisha-1) influenced significantly with the application of different fungicides and plant extracts at different days after sowing (DAS). Number of spots per pod increased gradually from 70 DAS to 90 DAS. Very little number of spots per pod was recorded at 70 DAS. At 90 DAS, the maximum number of spots per pod (1.81) was recorded from T_1 (control) treatment and minimum number of spots per pod (0.62) was obtained from applying with T_7 (Rovral) treatment followed by T_6 (Ridomil MZ-72). Application of T_2 (Allamanda), T_3 (Garlic), T_5 (Dithane M-45) and T_4 (Bavistin) was found to be statistically insignificant. These findings are in agreed with the findings of Godika *et al.* (2001) and Pandya *et al.* (2000).

Table 4: Effect of different treatments on percent pod infection of mustard at different days after sowing (DAS)

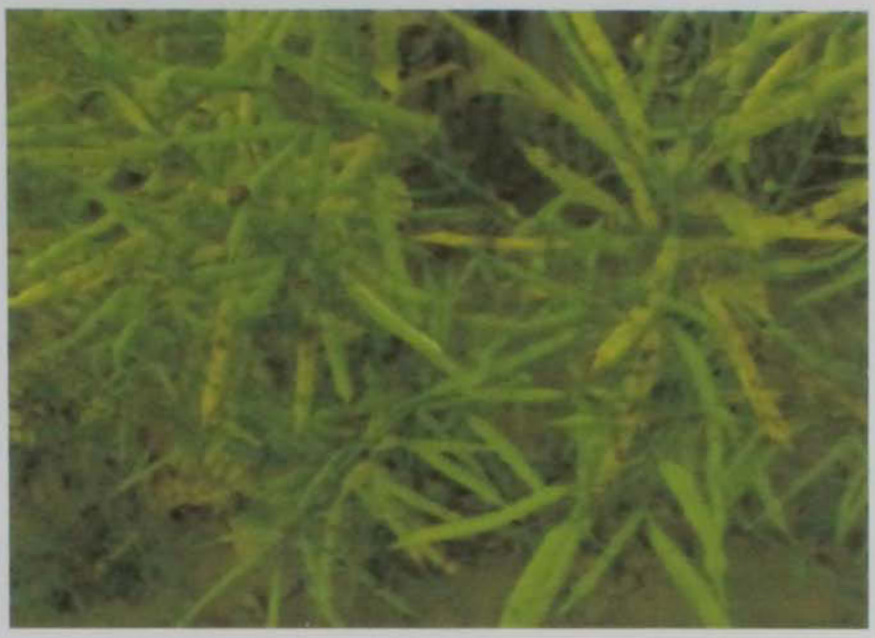
Treatments	% Pod infection		
	70 DAS	80 DAS	90 DAS
T_1 (control)	1.50 a	30.79 a	41.52 a
T_2 (Allamanda)	0.50 d	15.85 cd	21.39 cd
T_3 (Garlic)	0.65 c	18.90 c	24.82 c
T_4 (Bavistin DF)	0.75 b	24.93 b	30.68 b
T_5 (Dithane M-45)	0.45 d	12.68 d	19.06 d
T_6 (Ridomil MZ-72)	0.00 e	13.15 d	20.51 d
T_7 (Rovral 50 WP)	0.00 e	4.06 e	9.52e
CV (%)	8.65%	13.37%	8.47%

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

Table 5: Effect of different treatments on number of spots/pod of mustard at different days after sowing (DAS)

Treatments	Number of spots/pod		
	70 DAS	80 DAS	90 DAS
T_1 (control)	0.067 a	1.27 a	1.81 a
T_2 (Allamanda)	0.064 b	0.93 b	1.16 b
T_3 (Garlic)	0.051 c	0.82 b	1.22 b
T_4 (Bavistin DF)	0.030 e	0.84 b	1.37 b
T_5 (Dithane M-45)	0.038 d	0.87 b	1.26 b
T_6 (Ridomil MZ-72)	0.000 f	0.62 c	0.85 c
T_7 (Rovral 50 WP)	0.000 f	0.34 d	0.62 d
CV (%)	17.25%	12.71%	9.55%

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



Photograph 1: Untreated plot of mustard plant

Photograph 2: Rovral 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 (8.1) was recorded in case of T_7 (Rovral) treatment and the lowest number of leaf per plant (6.83) was obtained from T_4 (Bavistin) treatment (Table-6). These findings are in agreed with the findings of Shivpuri *et al.* (1988).

4. 5. 2 Number of branches/plant

Number of branches per plant differed significantly due to application of different fungicides and plant extracts. The maximum number of branches (5.23) was recorded in case of T_3 (Garlic) which was statistically identical with T_1 (Control), T_2 (Allamanda), T_5 (Dithane M-45), T_6 (Ridomil MZ-72) and T_7 (Rovral). T_4 (Bavistin) produced the lowest (4.1) number of branches per plant (Table 6).

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_6 (Ridomil MZ-72) (98.67 cm) which was statistically identical with T_2 (Allamanda) and T_7 (Rovral). The lowest plant height (87.89cm) was recorded in case of T_1 (Control) (Table 6).

4. 6.1 Number of pods/plant

Number of pods per plant of mustard did not differ significantly due to the application of different fungicides and plant extracts (Table-7).

4. 6. 2 1000-Seed weight

1000-seed weight was found to be significant due to application of different fungicides and plant extracts. Spraying with Rovral (T_7) produced the maximum 1000-seed weight (3.63g) (Table-7) while T_1 (Control) produced the minimum 1000-seed weight (2.87g). The 1000-seed weight was increased due to Rovral spray (Annonymous, 1992) which is supporting the present findings. 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 per plant (g) and yield Kg per hectare. Maximum yield per plant (4.01 g) and per hectare (1067 kg) was obtained from T_7 (Rovral) treated plot followed by T_6 (Ridomil MZ-72), T_5 (Dithane M-45) and T_3 (Garlic) in both the cases. The minimum yield per plant (2.42 g) and per hectare (720 kg) was recorded from T_1 (Control) treatment which was statistically identical with T_4 (Bavistin) treatments (Table-7). 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 growth parameters of mustard

Treatments	Growth parameters		
	No. of leaf/plant	No. of branches/plant	Plant height(cm)
T_1 (control)	7.43 ab	4.83 ab	87.89 d
T_2 (Allamanda)	7.70 ab	5.06 ab	97.54 a
T_3 (Garlic)	7.73 ab	5.23 a	92.12 bcd
T_4 (Bavistin DF)	6.83 b	4.10 b	89.70 cd
T_5 (Dithane M-45)	7.03 ab	5.03 ab	92.87 bc
T_6 (Ridomil MZ-72)	7.46 ab	4.40 ab	98.67 a
T_7 (Rovral 50 WP)	8.13a	4.43 ab	96.41 ab
CV (%)	7.70%	11.07%	2.50%

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

Table 7: Effect of different treatments on yield and yield contributing characters of mustard

Treatments	Yield and yield contributing characters			
	No. of pods/plant	1000-Seed weight (g)	Yield/plant (g)	Yield (kg/ha)
T_1 (control)	37.10 a	2.87 d	2.42 d	720 d
T_2 (Allamanda)	41.27 a	2.91 d	2.95 c	815.2 c
T_3 (Garlic)	41.00a	3.22 bc	3.21 b	853.9 b
T_4 (Bavistin DF)	36.90 a	3.01 cd	2.67 d	730.4 d
T_5 (Dithane M-45)	38.90 a	2.96 cd	3.32 b	865.3 b
T_6 (Ridomil MZ-72)	40.87 a	3.32 b	3.46 b	920.4 b
T_7 (Rovral 50 WP)	45.53 a	3.63 a	4.01 a	1067 a
CV (%)	17.44%	4.68%	9.15%	6.57%

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

4. 7. 1 Percent seed germination

Percent seed germination was found to be significant due to the application of different fungicides and plant extracts in comparison to control. Seed obtained from Rovral (T_7) treated plot showed the maximum percent germination (99%) (Plate 1) which was statistically similar (98.67%) to seed obtained from Allamanda leaf extract (T_2) treated plot. Seed obtained from control (T_1) showed the minimum percent germination (94.33%)(Plate 2). The percent seed germination in case of rest of the treatment revealed statistically identical (Fig 1). These findings are agreed with the findings of Annonymous, 1992 where reported that Rovral was found to be more effective for increasing germination percentage of harvested seeds.

4. 7. 2 Percent seed infection

After harvest percent seed infection was examined. Percent seed infection by *Alternaria brassicae* and *Alternaria brassicicola* of harvested seed received from treated plot with different fungicides and plant extracts was found to be significant. Seed obtained from control treatment showed the highest percent seed infection (18.52%) while seed obtained from Rovral (T_7) treated plot showed the lowest seed infection (6.5%) preceded by Allamanda (11.8%), Ridomil MZ-72 (12%) and Garlic (12.58%), Dithane M-45 (14.5%) and Bavistin (16.47%)(Fig 2). Annonymous, 1992 reported that three times spray of Rovral was found more effective for controlling seed borne *Alternaria brassicae* and *A. brassicicola* of harvested mustard seeds.

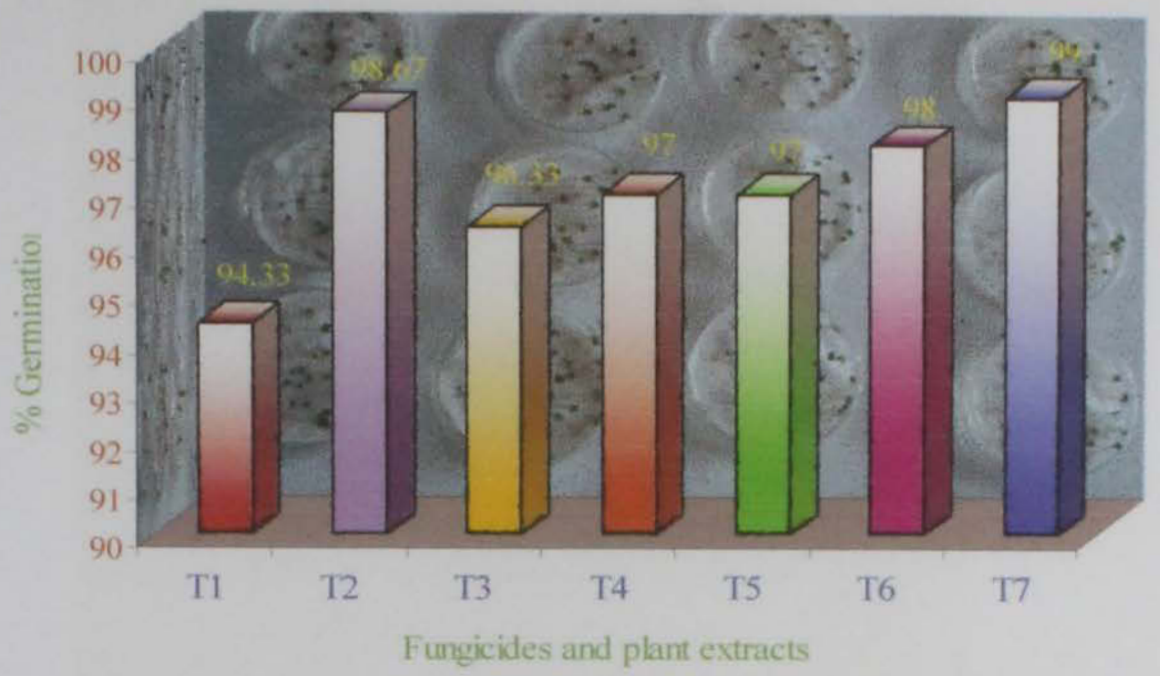


Fig 1: Effect of different treatments on germination percentage of mustard seed

Legend:

T_1 = Control, T_2 = Allamanda, T_3 = Garlic, T_4 = Bavistin, T_5 = Dithane M-45, T_6 = Ridomil MZ-72 and T_7 = Rovral

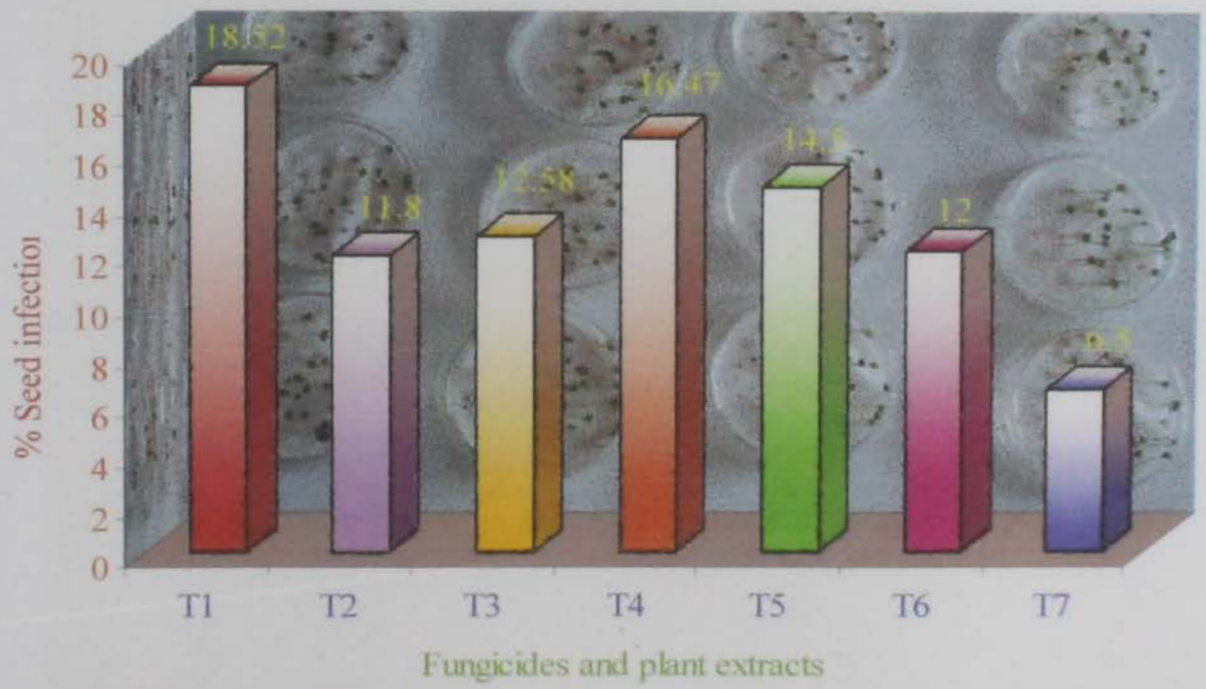


Fig 2: Effect of different treatments on percent infection of harvested mustrad seed caused by *Alternaria spp.*

Legend:

T_1 = Control, T_2 = Allamanda, T_3 = Garlic, T_4 = Bavistin, T_5 = Dithane M-45, T_6 = Ridomil MZ-72 and T_7 = Rovral

Plate 1: Showing maximum germination and minimum or no infection of seed obtained from Rovral treated plot.

Plate 2: Showing poor germination and maximum infection of seed obtained from Control plot.

4. 8 Correlation and regression study

4. 8. 1 Correlation and regression study between percent leaf infection and different days after sowing (DAS) in response to the application of different treatments

Correlation study was done to determine the relationship between percent leaf infection and different days after sowing (DAS), which presented in Figure-3. Percent leaf infection of gray blight of mustard was increased significantly with the progress of time (DAS) and the positive correlation between percent leaf infection and different days after sowing (DAS) were obsered. From the regression equations, it was revealed that due to application of Rovral, percent leaf infection was increased only by 0.3905 units while it was 0.7465, 0.8245, 1.133, 1.271, 1.3375 and 1.3745 units for Garlic, Ridomil MZ-72 , Dithane M-45, Bavistin, Allamanda and Control, respectively. It indicated that though the leaf infection increased positively with time but the rate of increase was not similar because of the varied treatment effects.

4. 8. 2 Correlation and regression study between percent leaf area diseased and different days after sowing (DAS) in response to the application of different treatments

Correlation study was done to determine the relationship between percent leaf area diseased and different days after sowing (DAS) (Figure-4). Percent leaf area diseased (%LAD) of gray blight of mustard was increased significantly with the progress of time (DAS) and a positive correlation between percent leaf area diseased and different days after sowing (DAS) were noticed. From the regression equations, it was

revealed that due to application of Rovral, percent leaf area diseased was increased only by 0.1065 units while it was 0.1915, 0.226, 0.246, 0.2815, 0.292 and 0.6635 units for Allamanda, Dithane M-45, Bavistin, Garlic, Ridomil MZ-72 , and Control, respectively. The varied inhibitory effects of the different treatments caused the different increasing rate of %LAD with the progress of time.

4. 8. 3 Correlation and regression study between percent pod infection and different days after sowing (DAS) in response to the application of different treatments

Correlation study was done to determine the relationship between percent pod infection and different days after sowing (DAS), which presented in Figure-5. Percent pod infection of gray blight of mustard was increased significantly with the progress of time (DAS) and a positive correlation between percent pod infection and different days after sowing (DAS) were observed. From the regression equations, it was revealed that due to application of Rovral, percent pod infection was increased only by 0.476 units while it was 0.9305, 1.0255, 1.0445, 1.2085, 1.4965 and 2.001 units for Dithane M-45, Ridomil MZ-72 , Allamanda, Garlic, Bavistin and Control, respectively. The unit of increasing percent pod infection differed due to the varied inhibitory effect of the treatments.

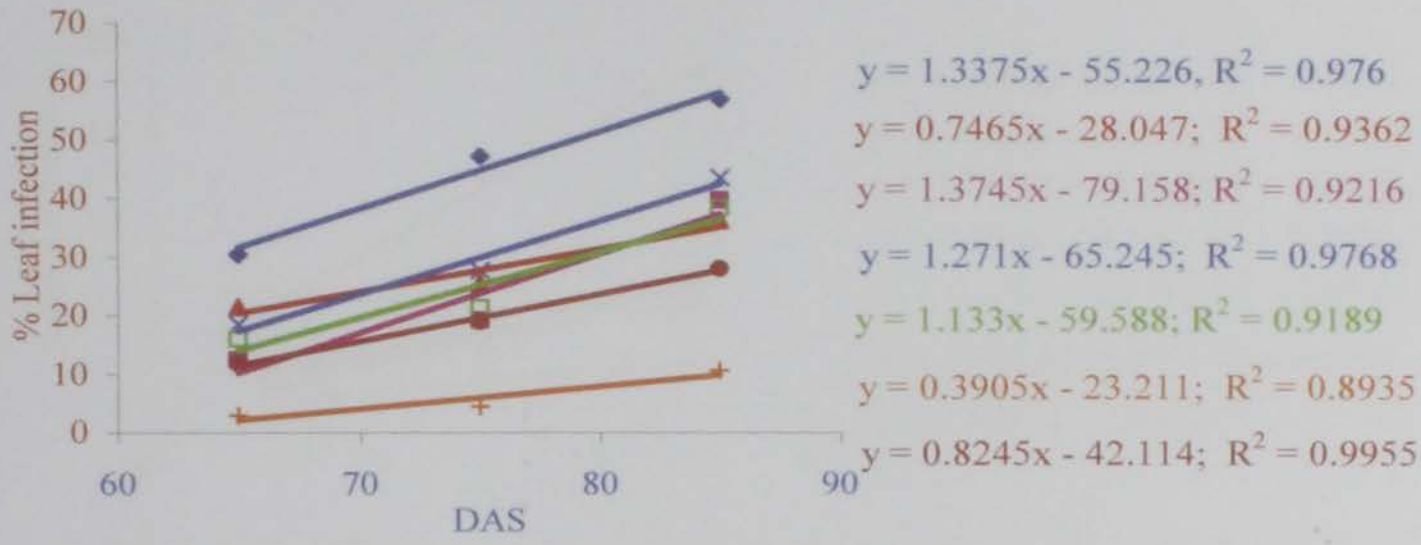


Fig 3: Relationship between percent leaf infection and different days after sowing (DAS) of gray blight of mustard

Treatments

◆ T1(control) ■ T2(Alamanda) ▲ T3(Garlic)
× T4(Bavistin) □ T5(Dithane M45) ● T6(Ridomil)
+ T7(Rovral)

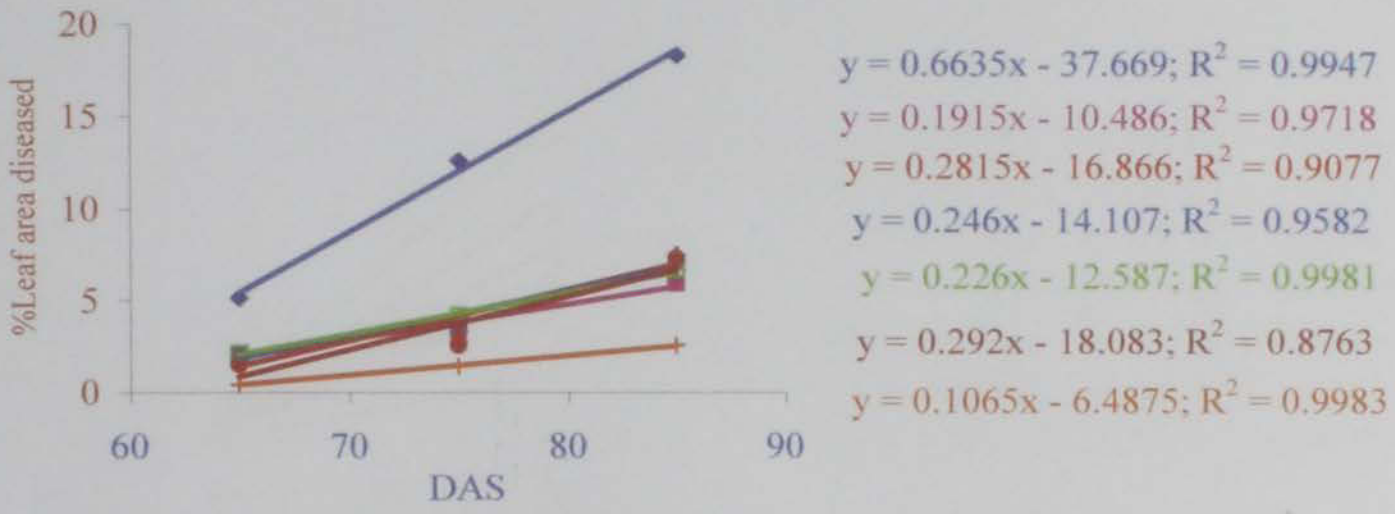


Fig 4: Relationship between percent leaf area diseased (LAD) and different days after sowing (DAS) of gray blight of mustard

Treatments

- ◆ T1(control)
- ■ T2(Allamanda)
- ▲ T3(Garlic)
- × T4(Bavistin)
- □ T5(Dithane M-45)
- ● T6(Ridomil)
- \+ T7(Rovral)

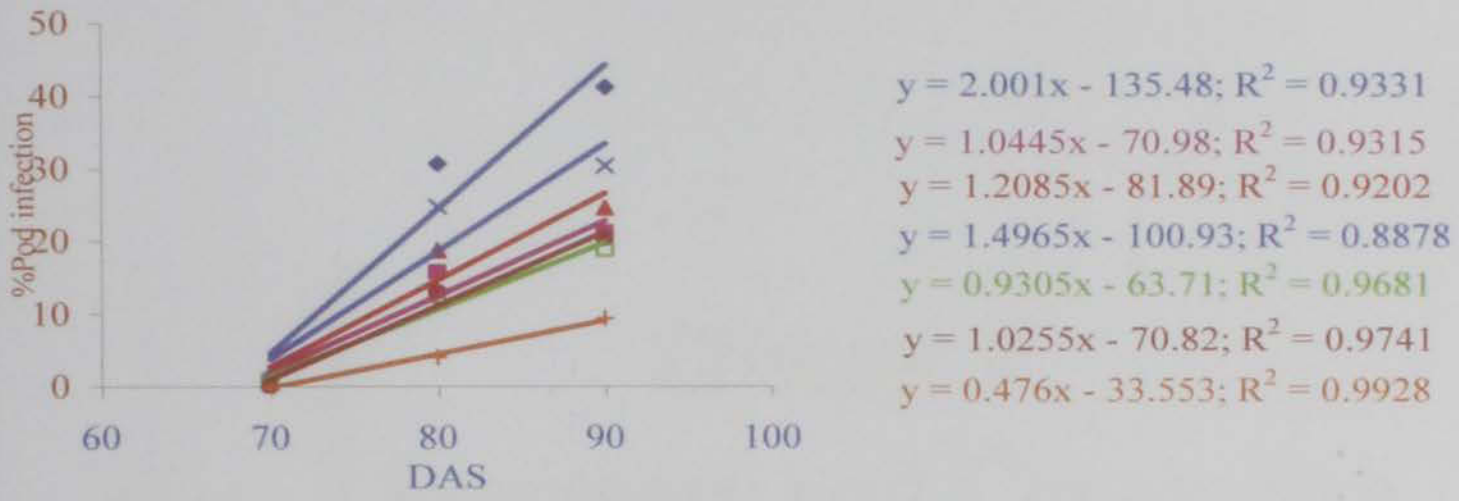
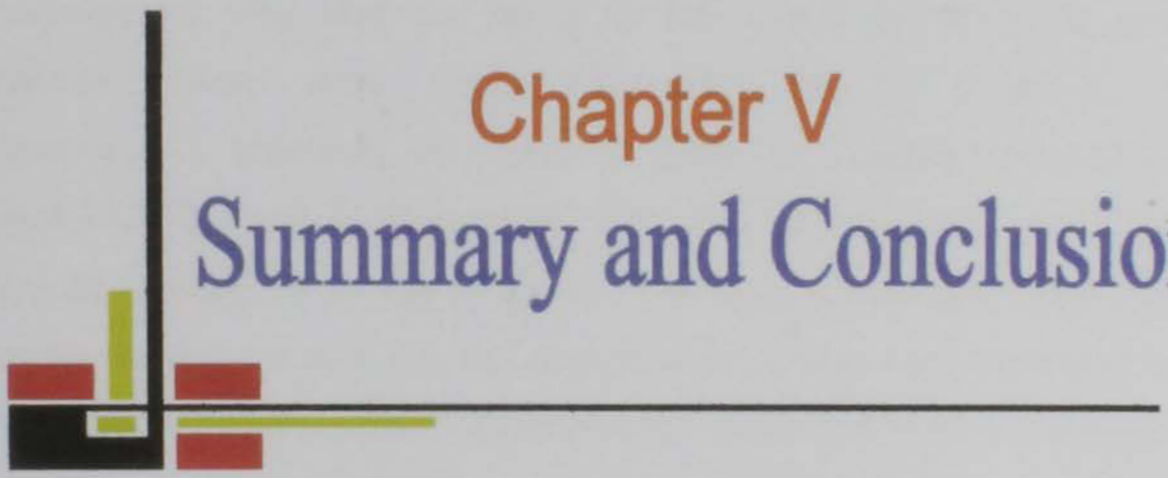


Fig 5: Relationship between percent pod infection and different days after sowing (DAS) of gray blight of mustard

Treatments

- T1(control)
- T2(Alamanda)
- T3(Garlic)
- T4(Bavistin)
- T5(Dithane M45)
- T6(Ridomil)
- T7(Rovral)



Chapter V

Summary and Conclusion

SUMMARY AND CONCLUSION

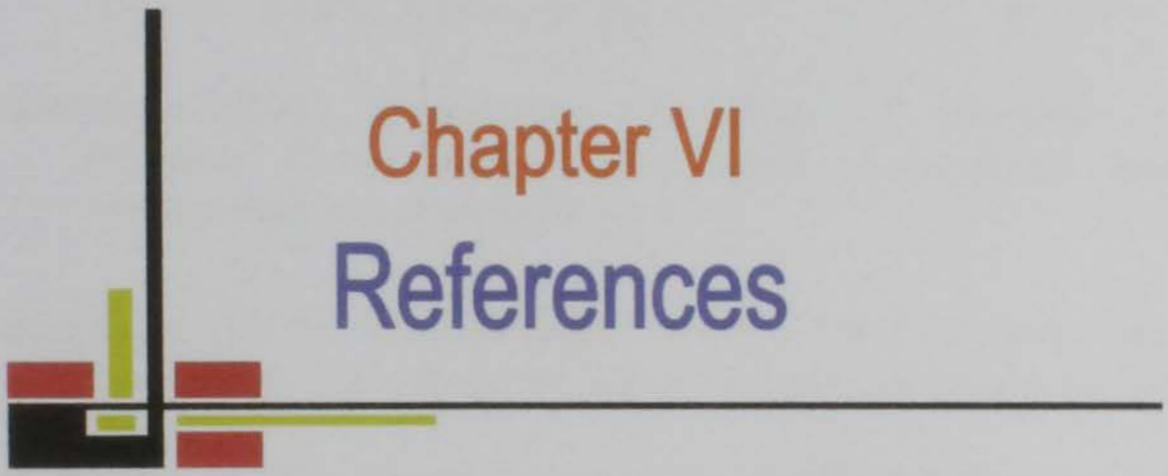
The experiment was conducted at experimental field of Sher-e-Bangla Agricultural University, Dhaka and in the laboratory of Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Rahmatpur, Barishal, during the period from November, 2006 to February, 2007. The objectives of this experiment were to control of Gray Blight of mustard through some selected fungicides and plant extracts.

The experiment was laid out in a RCBD (One factor) with three replications. There were seven treatments, Viz.T_1 (Control), T_2 (Allamanda), T_3 (Garlic), T_4 (Baristin DF), T_5 (Dithane M-45), T_6 (Ridomil MZ-72) and T_7 (Rovral 50 WP). The unit plot size was 2 m × 1.5 m with 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 value were adjudged with Duncan Multiple Range Test (DMRT).

The study revealed that application of fungicide and plant extract significantly influenced all most all of the parameters. Seed treatment with Rovral as well as spraying resulted better performance. The lowest percent leaf infection (10.76%), percent leaf area diseases (2.59%), percent pod infection (9.52%) and number of spots per pod (0.62) were recorded from spraying with Rovral. The highest percent leaf infection (57.25%), percent leaf area diseased (18.45%), percent pod infection (41.52%) and number of spots per pod (1.81) were recorded from control.

The highest yield (1067 kg/ha) was obtained from the plot spraying with Rovral 50 WP. The highest germination percentage and the lowest seed infection obtained from the plot spraying with Rovral. The lowest germination percentage and the highest seed infection of harvested seeds were obtained from the control treatment. The lowest yield (720 kg/ha) was obtained from untreated plot.

From the present findings it may be concluded that seed treatment as well as spraying with Rovral 50 WP was found to be best for lowering gray blight incidence and severity and the highest yield of good quality seed of mustard (SAU sarisha-1). Allamanda also has some promising effect among the plant extracts against the disease. However, further investigation need to be carried out incorporating more fungicides and plant extracts to authenticate the results against the disease.



Chapter VI
References

REFERENCES

Ahmed, H.U. (1992). Diseases of oilseed crops in Bangladesh. Paper presented in the 2nd Biennial conference of the Bangladesh Phytopathological Society, held in 1992. Gazipur.

Anonymous. (2007). Oilseed Crop Diseases and Control. Oilseed Research Center (ORC), Bangladesh Agricultural Research Institute (BARI), Joydebpur. pp.7.

Anonymous. (2002). Status of Oilcrop Production in Bangladesh. Oilseed Research Center (ORC), Bangladesh Agricultural Research Institute (BARI), Joydebpur. pp. 13.

Anonymous. (2001). Production Technology of Oilcrops. Oilseed Research Center (ORC), Bangladesh Agricultural Research Institute (BARI), Joydebpur. pp.4-26.

Anonymous. (1997). Annual Report (1996-97). Plant Pathology Division. Bangladesh Agricultural Research Institute, Joydebpur. pp. 46.

Anonymous. (1992). Annual Report (1991-92). Plant Pathology Division, Bangladesh Agricultural Research Institute, Joydebpur. pp. 55-58.

Anwar, M.J. and Khan, S.M. (2001). Efficacy of some fungicides for the control of leaf blight on rapeseed-mustard. *Pakistan J. Phytopath.* **13**(2): 167-169.

Ayub, A., Dey, T.K., Jahan, M., Ahmed, H.U. and Alam, K.B. (1996). Foliar spray of fungicides to control *Alternaria* blight of mustard. *Annals Bangladesh Agric.* **6**(1): 47-50.

Chand, H. and Singh, S. (2004). Effect of plant extracts on *Alternaria* blight of mustard *Alternaria brassicae* (Berk.) Sacc. *Indian J. Plant Protec.* **32**(2): 143-144.

Chattopadhyay, A.K. and Bhunia, C.K. (2003). Management of *Alternaria* leaf blight of rapeseed-mustard by chemicals. *J. Mycopath. Res.* **41**(2): 181-183.

Chattopadhyay, A.K. and Bagchi, B.N. (1994). Relationship of disease severity and yield due to leaf blight of mustard and spray schedule of mancozeb for higher benefit. *J. Mycopath. Res.* **32**(2): 83-87.

Daya, R. and Ram, D. (1997). Fungitoxicity of some plant extracts against *Alternaria brassicae. J. Agri. Bio. Res.* **2**(1): 25-26.

Ferdous, S.M. (1990). Effect of fertilizers, organic amendments and plant crude extracts on the incidence of *Alternaria* blight of mustard. M.Sc. Ag. Thesis. Dept. of Plant Pathology, Bangladesh Agricultural University, Mymensingh. pp. 53.

Ferdous, S.M., Meah, M.B. and Hossain, M.M. (2002). Comparative effect of plant extracts and fungicide on the incidence of *Alternaria* blight of mustard. *Bangladesh J. Training Dev.* **15**(1-2): 207-210.

Ghosh, S.K. and Das, N. (1999). Effect of fungicides on seed mycoflora and seed germination of mustard and cauliflower. *J. Mycopath. Res.* **37**(1): 37-39.

Godika, S. and Pathak, A.K. (2002). Efficacy of some fungicides against white rust and *Alternaria* blight disease of mustard. *Plant Dis. Res.* **17**(1): 138-140.

Godika, S., Jain, J.P. and Pathak, A.K. (2001). Evaluation of fungitoxicants against *Alternaria* blight and white rust diseases of Indian mustard (*Brassica juncea*). *Indian J. Agric. Sci.* **71**(7): 497-498.

Hossain, M. and Doullah, A.M. (1998). Report on pilot project research of the Seed Pathology Laboratory BAU, paper presented at the DGISP workshop II "Future Strategies for Research, Training and Development of Seed Pathology in Bangladesh" held on December, 1998 at BARC, Dhaka, Bangladesh.

Howlider, M.A.R., Meah, M.B., Uddin, M.J. and Rahman, A. (1991). Effect of fungicides on *Alternaria* blight, yield and seed quality of mustard. *Bangladesh J. Agril. Sci.* **18**(1): 127-132.

Howlider, M.A.R., Meah, M.B., Uddin, M.J. and Rahman, M.A. (1985). Effect of fungicides in reducing intensity of *Alternaria* blight of mustard. *Bangladesh J. Agric.* **10**(4): 41-46.

Kaushik. C.D., Saharan, G.S. and Koushik, T.C. (1984). Magnitude of loss in yield and management of *Alternaria* blight in rapeseed-mustard. *Indian phytopath.* **37**:398.

Kumar, A. and Kumar, A. (1996). Efficacy of different fungicides against *Alternaria* blight and white rust infection of mustard. *Plant Dis. Res.* **11**(2): 174-177.

Kumar, S., Mehta, N., Sangwan, M.S. and Kumar, R. (2004). Relative sensitivity of various isolates of *Alternaria brassicae* (Berk.) Sacc. to fungicides. *J. Mycology Plant Path.* **34**(1): 28-32.

Meah, M.B., Howlidar, M.A.R., Uddin, M.J. and Rahman, A. (1988). Effect of fungicide spray at different time and frequencies on *Alternaria* blight of mustard. *Thai. J. Agric. Sci.* **21**:101-107.

Meah, M.B., Islam, M.T., Rahman, S.L. and Rahman, H. (1999). Reduction of *Alternaria* infection in mustard seeds through management practices. *Bangladesh J. Plant Path.* **15**(1-2): 5-8.

Mridula, K., Mohanty, A.K., Acharya, N.N. and Sethi, P.N. (1994). Efficacy of some selected fungicides against *Alternaria brassicae* causing leaf blight of mustard. *Orissa J. Agric. Res.* **7**:90-91.

Mukherjee, I., Gopal, M. and Chatterjee, S.C. (2003). Persistence and effectiveness of iprodione against *Alternaria* blight in mustard. *Bulletin Environ. Contamin. Toxico.* **70**(3): 586-591.

Pandya, R.K., Tripathi, M.L., Singh, R. and Singh, R. (2000). Efficacy of fungicides in the management of white rust and *Alternaria* blight of mustard. *Crop Res. Hisar.* **20**(1): 137-139.

Panja, B.N., Chawdhury, A., Chakraborty, A. and Laha, S.K. (2000). Management of *Alternaria* leaf blight and white rust diseases of mustard in tarai agro-ecological zone of West Bengal. *J. Mycopath. Res.* **38**(2): 85-88.

Prasad, R. (2006). Management of *Alternaria* blight of mustard with combination of chemicals and botanicals. *Annals Plant Protec. Sci.* **14**(2): 400-403.

Prasad, R., Saxena, D. and Chandra, S. (2003). Yield losses by *Alternaria* blight in promising genotypes of Indian mustard. *Indian Phytopath.* **56**(2): 205-206.

Priya, R., Ashok, A., Rani, P. and Aggarwal, A. (1995). Effect of fungicides on seed mycoflora and seed germination on mustard. *Adv. Plant Sci.* **8**(2): 342-344.

Saha, L.R. (1989). Efficacy of some fungicides against *Alternaria brassicae* (Berk) Sacc. and *Alternaria brassicicola* (Schw) Wiltshire, the cause of leaf blight of rapeseed and mustard. *Pestology.* **13**(6): 19-21.

Shivpuri, A., Siradhana, B.S. and Bansal, R.K. (1988). Management of *Alternaria* blight of mustard with fungicides. *Indian Phytopath.* **41**(4): 644-646.

Singh, D. and Maheshwari, V.K. (2003). Effect of *Alternaria* leaf spot disease on seed yield of mustard and its management. *Seed Res.* **31**(1): 80-83.

Singh, R.B. and Singh, R.N. (2006). Spray schedule for the management of Alternaria blight and white rust of Indian mustard (*Brassica juncea*) under different dates of sowing. *Indian J. Agric. Sci.* **76**(9): 575-579.

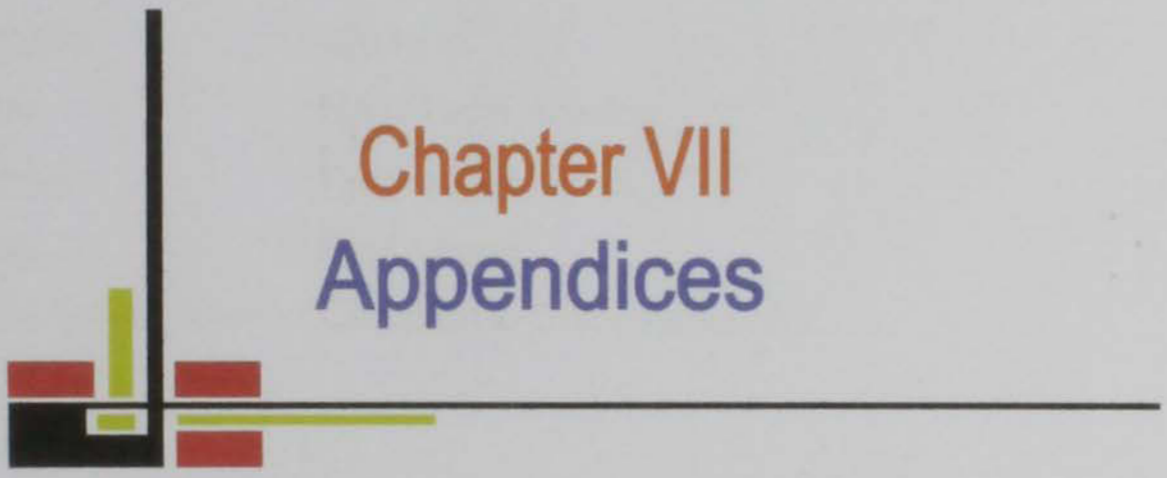
Singh, J., Ratan, V. and Singh, R. (2006). Management of foliar diseases of mustard through chemicals. *Annals Plant Protec. Sci.* **14**(1): 142-145.

Singh, R.B. and Singh, R.N. (2005a). Fungicidal management of foliar diseases of mustard in mid-eastern India. *Indian-Phytopath.* **58**(1): 51-56.

Singh, R.B. and Singh, R.N. (2005b). Status and management of foliar diseases of timely sown mustard in mid-eastern India. *Plant Dis. Res. Ludhiana.* **20**(1): 18-24.

Tripathi, N.N., Saharan, G.S., Kaushik, C.D., Kaushik, J.C. and Gupta, P.P. (1987). Magnitude of losses in yield and management of *Alternaria* blight of rapeseed-mustard. *J. Res.* **17**(1): 14-18.

Zaman, M.A., Saleh, A.K.M., Rahman, G.M.M. and Islam, M.T. (1997). Seed-borne fungi of mustard and their control with indigenous plant extracts. *Bangladesh J. Plant Path.* **13**(1-2): 25-28.



Chapter VII
Appendices

APPENDICES

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

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
Location	: SAU Farm, Dhaka.
Field level	: Above flood level.
Drainage	: Fairly good.
Firmness (consistency)	: Compact to friable when dry.

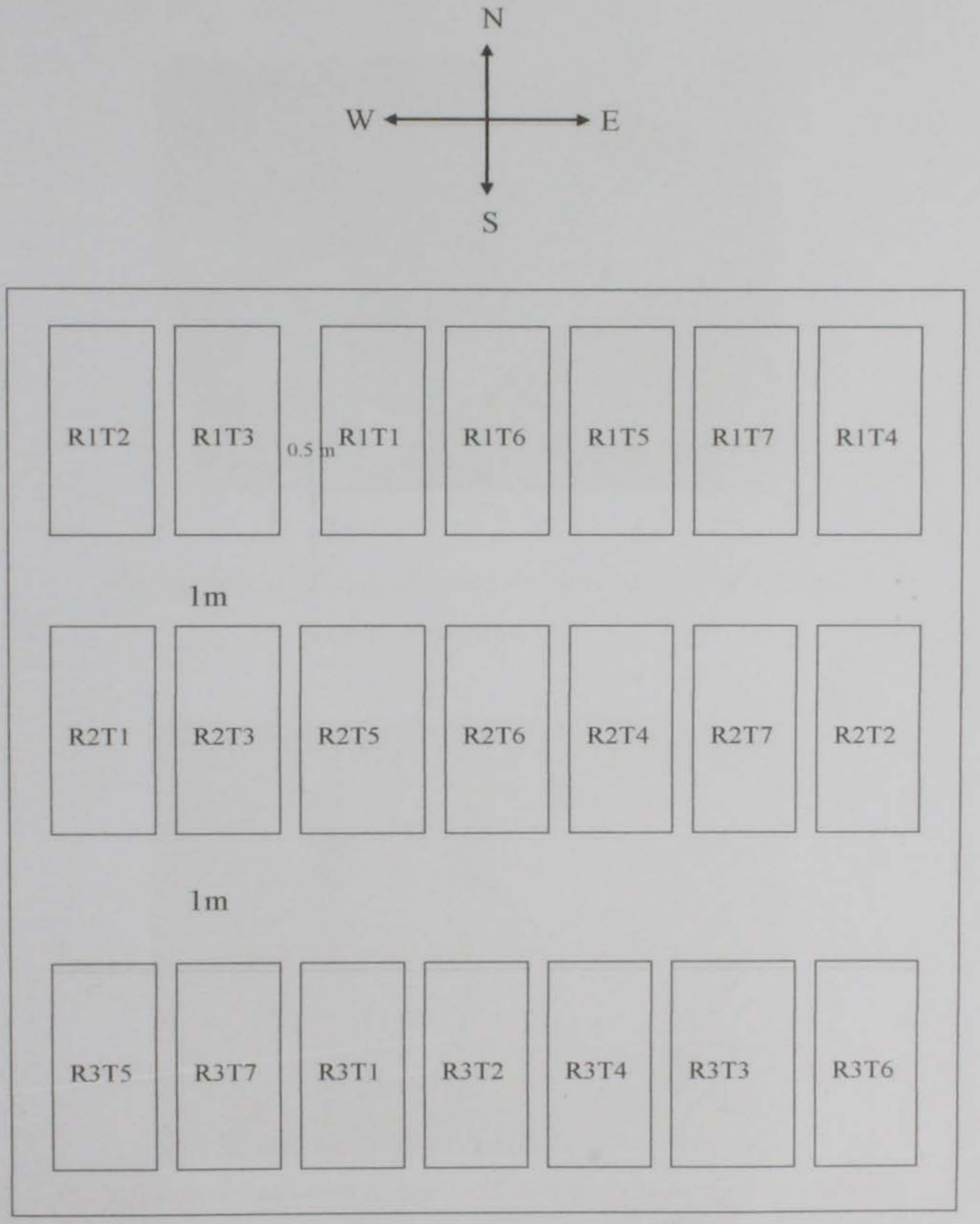
Appendix-II: Monthly mean weather

Monthly mean of daily maximum, minimum and average temperature, relative humidity, total rainfall and sunshine hours during November/2006 to February/2007.

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

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

Appendix-III: Layout of the field experiment



Appendix-IV: Germination and seed health test related photograph

Photograph 3: Plating of seeds for the seed health testing by bloter method.

Photograph 4: Isolation of the seed borne microflora from infected seed in laminar airflow cabinet for identification of *Alternaria spp.*

Appendix-V: ANOVA table of the experiment

01: Percent leaf infection at 65 DAS

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	103.143	51.571	41.6538	0.000**
Factor A	6	1342.691	223.782	180.7468	0.000**
Error	12	14.857	1.238		
Total	20	1460.691			
Coefficient of variation: 6.84%					

02: Percent leaf infection at 75 DAS

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	299.975	149.987	8.1658	0.0058
Factor A	6	3003.183	500.531	27.2507	0.000**
Error	12	220.412	18.368		
Total	20	3523.570			
Coefficient of variation: 18.14%					

03: Percent leaf infection at 85 DAS

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	20.902	10.451	0.3183	
Factor A	6	3696.984	616.164	18.7643	0.000**
Error	12	394.044	32.837		
Total	20	4111.930			
Coefficient of variation: 15.71%					

**Significance at 5% level

04: Percent LAD at 65 DAS

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.067	0.034	0.1186	
Factor A	6	149.094	24.849	87.9204	0.000**
Error	12	3.392	0.283		
Total	20	152.552			
Coefficient of variation: 18.97%					

05: Percent LAD at 75 DAS

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	3.440	1.720	6.9600	0.0098
Factor A	6	248.416	41.403	167.5220	0.000**
Error	12	2.966	0.247		
Total	20	254.822			
Coefficient of variation: 11.10%					

06: Percent LAD at 85 DAS

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	3.918	1.959	0.5008	
Factor A	6	436.805	72.801	18.6107	0.000**
Error	12	46.941	3.912		
Total	20	487.664			
Coefficient of variation: 24.83%					

**Significance at 5% level

07: Percent Pod infection at 70 DAS

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.018	0.009	3.9474	0.0482
Factor A	6	4.710	0.785	347.0525	0.000**
Error	12	0.027	0.002		
Total	20	4.755			
Coefficient of variation: 8.65%					

08: Percent Pod infection at 80 DAS

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	7.701	3.850	0.7279	
Factor A	6	1376.145	229.357	43.3584	0.000**
Error	12	63.478	5.290		
Total	20	1447.323			
Coefficient of variation: 13.37%					

09: Percent pod infection at 90 DAS

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	19.226	9.613	2.3430	0.1384
Factor A	6	1815.913	302.652	73.7637	0.000**
Error	12	49.236	4.103		
Total	20	1884.376			
Coefficient of variation: 8.47%					

**Significance at 5% level

10: No. of spots/pod at 70 DAS

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	ÿÿ000	0.000	2.1681	0.1571
Factor A	6	0.014	0.002	60.6211	0.000**
Error	12	0.000	0.000		
Total	20	0.014			
Coefficient of variation: 17.25%					

11: No. of spots/pod at 80 DAS

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.042	0.021	1.9322	0.1873
Factor A	6	1.477	0.246	22.8215	0.000**
Error	12	0.129	0.011		
Total	20	1.648			
Coefficient of variation: 12.71%					

12: No. of spots/pod at 90 DAS

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.011	0.006	0.4344	
Factor A	6	2.599	0.433	33.7385	0.000**
Error	12	0.154	0.013		
Total	20	2.764			
Coefficient of variation: 9.55%					

**Significance at 5% level

13: No. of branches/plant

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.466	0.233	0.8499	
Factor A	6	3.190	0.532	1.9403	0.1547
Error	12	3.288	0.274		
Total	20	6.943			
Coefficient of variation: 11.07%					

14: No. of leaf/plant

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	1.401	0.700	2.1125	0.1637
Factor A	6	3.478	0.580	1.7482	0.1931
Error	12	3.979	0.332		
Total	20	8.858			
Coefficient of variation: 7.70%					

15: Plant height (cm)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	388.111	194.055	35.4566	0.000**
Factor A	6	299.049	49.842	9.1067	0.0007
Error	12	65.676	5.473		
Total	20	752.836			
Coefficient of variation: 2.50%					

**Significance at 5% level

16: No. of pods/plant

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	40.921	20.460	0.4156	
Factor A	6	158.558	26.426	0.5368	0.000**
Error	12	590.739	49.228		
Total	20	790.218			
Coefficient of variation: 17.44%					

17:1000-Seed weight

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.002	0.001	0.0425	
Factor A	6	1.360	0.227	10.5392	0.0003
Error	12	0.258	0.022		
Total	20	1.620			
Coefficient of variation: 4.68%					

18: Yield/plant(g)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	0.040	0.020	0.2573	
Factor A	6	5.939	0.990	12.6024	0.0001
Error	12	0.942	0.079		
Total	20	6.921			
Coefficient of variation: 9.15%					

**Significance at 5% level

19: Percent Germination

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	15.524	7.762	1.6492	0.2329
Factor A	6	45.238	7.540	1.6020	0.2292
Error	12	56.476	4.706		
Total	20	117.238			
Coefficient of variation: 2.23%					

20: Percent seed infection

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	87.290	43.645	40.3025	0.000**
Factor A	6	268.108	44.685	41.2626	0.000**
Error	12	12.995	1.083		
Total	20	368.393			
Coefficient of variation: 7.89%					

21: Yield (Kg/ha)

Source of variance	Degrees of freedom	Sum of squares	Mean square	F value	Prob
Replication	2	6013.229	3006.614	1.0030	0.3956
Factor A	6	313489.526	52248.254	17.4293	0.000**
Error	12	35972.743	2997.729		
Total	20	355475.498			
Coefficient of variation: 6.57%					

**Significance at 5% level