YIELD LOSS ASSESSMENT OF MUSTARD FOR GREY BLIGHT DISEASE CAUSED BY *Alternaria* spp.

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CERTIFICATE

This is to certify that thesis entitled, *"YIELD LOSS ASSESSMENT OF MUSTARD FOR GREY BLIGHT DISEASE CAUSED BY Alternaria spp."* 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 **Md. Gaziul Haque**, **Registration No. 10-04233** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma in any institute.

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

……
Dated: **(Dr. Md. Rafiqul Islam)**
Place: Dhaka, Bangladesh

Supervisor

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ABSTRACT

The experiment was conducted in the farm of Sher-e-Bangla Agricultural University and in the Seed Health Laboratory Department of Plant Pathology, Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from November 2011 to July 2012. Multiple treatments viz. T_1 (No field spraying), T_2 (One field spraying with Rovral 50 WP @ 0.2%), T_3 (Two field spraying with Rovral 50 WP@ 0.2%), T_4 (Three field spraying with Rovral 50 WP @ 0.2%), T_5 (Four field spraying with Rovral 50 WP @ 0.2%), T_6 (Five field spraying with Rovral 50 WP @ 0.2%), T_7 (Six field spraying with Rovral 50 WP @ 0.2%), T_8 (Seven field spraying with Rovral 50 WP @ 0.2%), T_9 (Eight field spraying with Rovral 50 WP @ 0.2%), T_{10} (Nine field spraying with Rovral 50 WP @ 0.2%) were exposed in the experiment, to make variation in the disease severity and respective yield of treated plot. Different treatments comprising different number of spraying had remarkable influence the disease severity of grey blight, yield and yield contributing characters of mustard. The lowest (0.0%) Percent Disease Index (PDI) and the highest yield (1882.50 kg/ha) was recorded in case of treatment T_{10} where 9 spraying were done with Rovral 50 WP @ 0.2%. The highest PDI (80%) and the lowest yield (1266.55 kg/ha) was counted in case of treatment T_1 (control). The disease severity (PDI) and yield were varied in case of other treatments on the basis of number of spraying. Using the varied disease severity (PDI) and corresponding, yield the mathematical yield loss assessment model was constructed as $\hat{Y} = 0.32 + 0.38Xi$ using the regression equation.

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CHAPTER 1

INTRODUCTION

There are many oil seed crops like mustard, sesame, groundnut, linseed, niger, safflower, sunflower and soybean which are being cultivated in Bangladesh. Among these, mustard is considered as the major oil crop.

Mustard (*Brassica* spp.) is one of the major oil seed crops in Bangladesh which is widely cultivated during the winter season 5(October- February) and its contribution in total oil seed production is approximately 70%. The crop is well adapted to almost all agro-climatic zones of the country. Yield of mustard is very low in Bangladesh in comparison to other countries. About 598254 acres of land were used for mustard cultivation which produced 221928 metric tons of mustard. But the average mustard production was only 387kg /acre in the year 2009-2010 (BBS, 2010). Almost two-third of the edible oil consume annually in Bangladesh is imported and foreign exchange spent for the year 2004 about 690 millions US dolor (BBS, 2004). The per capita consume of edible oil in the country is 10-12gm/head/day. The seeds of *Brassica* spp. contain 42% oil and 25% protein (Khaleque, 1985).

Mustard oil plays a vital role in human nutrition. It is also an important row material for industrial use such as; soaps, paints, varnish, hair oil, lubricants, etc. Mustard oil cake used as animal feeds also as manure. Many factors are associated with the poor yield of mustard in Bangladesh. Diseases have been identified as one of the major causes (Ahmed, 1992). Rapeseed mustard suffers from about 14 diseases (Fungi 9, Virus -2, Bacteria-1, Nematode-1, and parasitic plant-1) in Bangladesh. Among these diseases, leaf blight disease 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 affected leaf and pod become blighted. The disease may cause 25% yield reduction at severe condition of infection (Anonymous, 2001).

Grey blight (*Alternaria brassicae*) (Bark) Sace causes blight of leaf, pod and stem (Meah *et al.,* 1988) and seed abnormalities (Howlider *et al.,* 1991). It appears as endemic disease in Bangladesh and all the cultivated *B. campestris and B. napus* varities are suceptible 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 discoloration 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)

The yield losses of mustard due to grey blight disease affect the market price of edible oil in the country. The market price closely depend on the local oilseed production. Thus, for the national import policy of edible oil in the country, simulation of crop loss assessment model is essential. But for such as important disease, the crop loss assessment model is not yet been construced. Thus, the present study was undertaken to estimate the yield losses of grey blight of mustard caused by *Alternaria* spp

Objectives:

1. To calculate the disease severity in the critical disease stage.
2. To calculate yield loss of mustard for grey blight disease caused by *Alternaria* spp.
3. To develop a mathematical model for yield loss of mustard due to grey blight disease.

CHAPTER 2

REVIEW OF LITERATURE

Gray blight disease of mustard caused by *Alternaria* spp. is a common and most important disease in our country. This disease causes serious yield loss of the crop. Researchers all over the world have carried out intensive investigation on the gray blight of mustard. Literature in relation to management, severity and yield loss assessment of gray blight of mustard is reviewed and presented below.

Akhter *et al.* (2012) reported that, eight mustard varieties (SAU-1, BINA-6, TORI-7, BARI-9, BARI-6, SOFOL, AGRANI and SS-75) were evaluated for their reaction against Alternaria blight (*Alternaria brassicae*) under natural condition at the experimental field of Sher-e-Bangla Agricultural University, Dhaka during winter season from November 2007 to February 2008. At 60 days after sowing (DAS) disease severity did not exceed 5% and no symptoms were observed in the siliqua. Results revealed that, among the varieties the lowest disease severity was observed in Agrani in all stages of plant growth. Maximum disease severity (97.17%) was found in SAU Sarishsa 1 giving lowest yield (1266.55kg/ha).

Kumar (2008) conducetd field resistance/partial resistance to Alternaria blight (*Alternaria brassicae*) was assessed in nine genotypes of Indian mustard under field conditions. Three genotypes viz. PR 8988, PR 9024 and Kranti exhibited partial resistance and had lowest severity. The yield potential of the genotypes was negatively correlated with the disease severity.

Alam (2007) evaluated the efficacy of some selected fungicides and plant extracts against *Alternaria brassicae* and *Alternaria brassicicola* causing grey 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 during 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 (00.15 and two plant extracts viz. Garlic clove extract, Allamanda leaf extract were employed in the experiment. Among the fungicides and plant extracts tested, Rovral 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 50 WP.

Singh *et al.* (2006) reported that, six seed dressing fungicides, i.e. Metalaxyl, Carbendazrm, Mancozeb, Thiophanate-methyl, Iprodione and BAS 38601 F (a seed dressing fungicide containing 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 (*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 highest yield was recorded with Iprodione (16.0-17.36 q/ha) and Mancozeb (26.0-31.12 q/ha).

Shrestha *et al.* (2005) reported that mancozeb and iprodione had effectively reduced grey blight disease in the sprayed plots and increased seed yield by 48% and 130%, respectively. The correlation between disease severity and yield, and yield components was negative and highly significant. Average yield loss was estimated to be in the range of 32 to 57%. Seed infection was also significantly higher in non sprayed treatment than sprayed one. The disease showed a negative effect on oil content causing losses on oil between 4.2 to 4.5%.

Mukherjee *et al.* (2003) studied the efficiency 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.

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) aganist Alternaria leaf blight of rapseed-mustard (Brassica campestris cv. Yellow Sarson) caused by Alternaria brassicae. Best control of the disease was observed by iprodione followed by mancozeb. Higher seed yield and significant increase of 1000-seed weight were also recorded from single spray of 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.

Ferdous *et al*. (2002) conducted an experiment to investigate the effect of three plant extracts and one fungicide on the incidence of Alternaria blight (caused by *Alternaria brassicae*) of mustard (*Brassica* sp.) cv. Sonali Sarisha under neutral field conditions in Gopalgonj, 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 also used. All the 4 treatments were used at 1 litre/10m^2 areas. 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 suppresed disease incidence and increased yield.

Singh and Singh (2002) investigated on timely sown (15-20 october) of mustard crops during 1995/96-2001-02 revealed Alternaria blight (AB-*Alternaria brassicae*), white rust (WR-*Alugo candida*), downy mildew (DM-*Peronospora parasitica)* were the major mustard diseases in mid eastern India and together caused 44.06% avoidable yield loss. In trails conducted in the same field during 2001-02 and 2002-03 crop seasons, 3 spray of Iprodione 50 WP (Rovral @ 0.20%). Follwed by mancozeb 75 WP (Indofil M 45 @ 0.2%) and propineb 70 WP (Antracol @ 0.2%) 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%).

Godika *et al*. (2001) conducted a fiefd experiment from 1994/95 to 1996/97 in Rajasthan, India to evaluate the efficacy of different fungicides, named Mancozeb, Ridomil MZ, (mancozeb+metalaxyl), Captan, Rovral (iprodione), Bayletan (tridimefon), and copper oxycloride, against Alternaria blight (*Alternaria brassicae*) and white rust (*Albugo candida*) of Indian mustard. All the fungicides significantly controlled both diseases, but their efficacy varied. Rovral was the most effective in controlling of Alternaria blight; mean disease intensity in 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 o.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.

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

An experiment was conducted at BARI, Joydebpur; RARS, Ishurdi and RARS, Jessore during the Rabi season of 1991-92 using mustard variety Tori-7. Rovral 50 WP @ 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 increases 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 increaase 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).

An experiment with cv. SS-75(HYV) was conducted at ORC, BARI, Joydebpur. Seed health test was carried out after harvest of the crops at the laboratory to evaluate the seed-borne infection using standard blotter method. Seed germination on the top of the blotter was also recorded and expressed in percentage. In the laboratory test it was observed that the Rovral spray reduced the seed-borne pathogen infection and incresed 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).

Meah *et al.*, (1992) observed the effects of frequencies, doses and time of application and their combination in controlling Alternaria blight of mustard in two consecutive cropping seasons under natural conditions. They found Rovral (1.0 Litre/ha) significantly reduced disease severities and incresed seed yield by 147% over control when applied two times commencing from fruiting stage(50 days age) at 10 days intervals.

Humpherson and Maude (1983) suggested three sprays of Rovral at 0.5-10.0 kg/ha applied in *Brassica oleracea* seed crops at three-week intervals from the young green siliqua stage to control pod infection caused by *A. brassicicola*. Their findings demonstrated that seed yield was increased and spray improved the seed germination. They reported that Bordeaux mixture was also as effective as Rovral when disease levels were low but inffective when infection pressure was severe.

CHAPTER 3

MATERIALS AND METHODS

The details of the materials and methods of this research work were described in this chapter. The experimental materials, site, climate and weather, land preparation, experimental design, layout, data collection on disease incidence and severity, growth parameters, yield and yield contributing characters etc. are discussed under the following headings and sub-headings:

3.1 Experimental sites

The experiment was conducted in the farm of Sher-e-Bangla Agricultural University, Dhaka. The location of the site was 23°74 N latitude and 90° 35 longitude with an elevation of 8.2 meter from sea level.

3.2 Experimental period

The experiment was carried out during the Rabi season from November 2011 to February 2012. Seeds of mustard were sown on 1st November 2011 and were harvested on 2nd February 2012.

3.3 Soil type

The experimental site was situated in the subtropical zone. The soil of the experimental site lies in agro-ecological regions of "Madhupur Tract" (AEZ No. 28). Its top soil is clay loam in texture and olive gray with common fine to medium distinct dark yellowish brown mottles. The pH 4.47 to 5.63 and organic carbon contents is 0.82 (Appendix I).

3.4 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 Bangladesh Meteorological Department, Agargaon, Dhaka (Appendix II)

3.5 Variety

The mustard (*Brassica campestries*) variety SAU Sharisha 3 released from Sher-e- Bangla Agricultural University was used for the experiment. Seed was collected from Department of Genetics and Plant Breeding, Sher-e- Bangla Agricultural University, Dhaka.

3.6 Treatments of the experiment

Multiple treatments were applied in the experiment. Altogether 10 tretments were applied comprising different number of sprays as follows:

T_1= No field spraying
T_2= One field spraying with Rovral 50 WP @ 0.2%
T_3 = Two field spraying with Rovral 50 WP @ 0.2%
T_4= Three field spraying with Rovral 50 WP @ 0.2%
T_5= Four field spraying with Rovral 50 WP @ 0.2%
T_6= Five field spraying with Rovral 50 WP @ 0.2%
T_7= Six field spraying with Rovral 50 WP @ 0.2%
T_8= Seven field spraying with Rovral 50 WP @ 0.2%
T_9= Eight field spraying with Rovral 50 WP @ 0.2%
T_{10}= Nine field spraying with Rovral 50 WP @ 0.2%

3.7 Experimental design and layout

Field layout was done after final land preparation. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. The whole plot was divided into four blocks each containing ten (10) plots of 3m x 2m size, giving 40 unit plots. The space was kept 1.5 m between the blocks and 1m between the plots , 30 cm from row to row and 10 cm from plant to plant where maintained. Seeds were sown in lines in the experimental plots. The seeds were placed at about 1.5 cm depth in the soil. (Appendix III)

3.8 Land Preparation

The experimental field was thoroughly ploughed and cross ploughed and cleaned prior to seed sowing and application of fertilizers and manure was done in the field. The experimental field was prepared by thorough ploughing followed by laddering to have a good tilth. Finally the land was properly leveled before seed sowing. Finally plots were prepared as per the design.

3. 9 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)

Manure and fertilizers	Rate/ha
Cow dung	10000 kg
Urea	250 kg
TSP	170 kg
MP	85 kg
Gypsum	150 kg
Zinc oxide	5 kg
Boric acid	10 kg

Urea was applied by two installments. Half of Urea, full dose of TSP, MP, Gypsum, Zinc oxide, Boric acid and Cow dung were applied at the time of final land preparation as a basal dose. Remaining half of Urea was applied at the time of flower initiation.

3.10 Intercultural operation

Intercultural operations, such as weeding, thinning, irrigation, pest management, etc. were done uniformly in the plots. One post sowing irrigation was given by sprinkler after sowing of seeds to bring proper moisture condition of the soil to ensure uniform germination of the seeds. A good drainage system was maintained for immediate release of rainwater from the experimental plot during the growing period. The first weeding was done at 15 days after sowing. During the same time, thinning was done for maintaining a proper distance. Second weeding was done after 35 days after sowing. The crop was protected from the attack of aphids by spraying Ektara @ 2 ml/litre of water. The insecticide was applied for the first time 15 days after sowing and it was applied with a regular interval. The insecticides were applied in the evening and not spray in same days of fungicide spray.

3.11 Preparation and application of spray solution

The fungicidal suspension was prepared by mixing with required amount of fungicide (Rovral 50 WP @ 0.2%) with tap water. 20 g Rovral 50 WP was mixed in 10 L water for preparing 0.2% spray solution. Total numbers of sprays were nine. The first spray was done at 7 days after sowing and others were sprayed with 7 days interval. The last spray was done at 63 days after sowing. Every time the fungicide was freshly prepared prior to application and the spray tank was thoroughly cleaned before filling with new materials. The insecticides were applied in the evening and not spray in same days of insecticide spray. 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 neighboring ones.

Table 1: Details of Fungicide

Common name	Chemical name	Active ingredients	Doses used
Rovral 50 WP	3- (3, 5 dichlorophenyl)- N-(methylethyl)-2,4 dioxoimidazolidene carboxamide$(C_3H_{13})_3N_3C_{l2}$	Iprodione (50%)	0.2% of the commercial formulation

3.12 Tagging and data collection

Randomly ten plants were selected from each plot and tagged for data collection and mean values were determined to get rating score of each treatment.

3.13 Isolation and identification of pathogens from leaf

From experimental plot, diseased leaves were collected and cut into pieces (4 diameter) and surface sterilized with $HgCl_2$ (1:1000) for 30 seconds. Then the cut pieces were washed in sterile water thrice and then blot dry and placed into acidified PDA media in petridish. The plates containing leaf pieces were placed at room temperature for seven days for incubation. When the fungus grew well and sporulated, then the slide was prepared from the pure culture and was identified under microscope with the help of relevant literature.

3.14 Harvesting of crop

When 80% of the plants showed symptoms of maturity i.e. straw coloured leave, stem, siliquae was noticed the crop was harvested as seed yield taken. At maturity, ten plants were harvested by uprooting and then they were tagged properly. Data were recorded on different parameters from these harvested plants.

3.15 Collection of data

The following parameters were considered for data collection.

Disease incidence and severity

a. Percent leaf infection
b. Percent leaf area diseased (% LAD)
c. Percent pod infection
d. Percent pod area diseased (% PAD)

Growth parameters

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

Yield and yield contributing characters

a. Number of pods/plant
b. 1000-seed weight (g)
c. Yield (kg/ha)

Harvested seed

a. Percent seed germination
b. Percent seed infection

3.16 Procedure of data collection

3.16.1 Percent leaf infection

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

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

3.16.2 Percent leaf area diseased

Data on percent leaf area diseased (LAD) were recorded at 65, 75, and 85 days after sowing by visual observation of symptoms. Percent leaf area diseased was calculated by the following formula.

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

3.16.3 Percent pod infection

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

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

3.16.4 Percent pod area diseased

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

$$\% \text{ Pod area diseased} = \frac{\text{Infected pod area}}{\text{Total pod area infested}} \times 100$$

3.16.5 Number of leaves per plant

Number of leaves per plant data was also recorded at before and after flowering from the randomly selected 10 (ten) plants of each plot.

3.16.6 Number of branch per plant

Number of branch per plant data was also recorded at before and after flowering from the randomly selected ten (10) plants of each plot.

3.16.7 Plant height

Plant height was measured in centimeter by a meter scale at vegetative and reproductive stage and their average data was recorded per replication. Data were also recorded as the average of randomly selected ten (10) plants from each plot. For plant height the ground surface to the top of the main shoot and the mean height were expressed in cm.

3.16.8 Number of pod per plant

Number of pod per plant data was recorded as the average of randomly selected ten (10) plants from each plot.

3.16.9 1000 seed weight (g)

One thousand grains were randomly counted and selected from the stock seed and weighed in gram by digital electric balance. It was expressed as 1000-seed weight in gram (g).

3.16.10 Yield (kg/ha)

Seed yield were recorded from each plot. After harvesting the plot was sun-dried and threshed. Seed were properly sun-dried and their weights recorded. Seed yield was then converted to kg/ha.

3.16.11 Estimation of percent disease index (PDI)

Percent disease index is the measurement of the amount of a disease in a population. It is also named as percent disease index (PDI) and measured by the following formula-

$$\text{Percent disease index (PDI)} = \frac{\text{Sum of total disease ratting}}{\text{Total no. of observation X Maximum grade in the scale}} \times 100$$

Disease severity scale:

Disease severity was calculated by using "0-5" scale (Harsfall and Barnet, 1945), is given bellow-

% Leaf Area Diseased (LAD)	Grade	No. of observation	Disease rating (No. of observation X Grade)
0	0		
0.1-5	1		
5.1-12	2		
12.1-25	3		
25.1-50	4		
>50	5		
Total		Total No. of observation =	Total sum of disease ratting =

Regression equation:

For simulation of mathematical point model for estimation of yield loss, regression equation was used as bellow

$\hat{Y} = \bar{Y} + b\,(Xi - \bar{X})$ (working formula)

Here, $\hat{Y}$ = Predicted yield loss (%)

$\bar{Y}$ = Estimated yield loss (%)

Xi = Disease severity (i = 1, 2, 3,……n)

b = Regression value

$\bar{X} = \frac{\sum x}{n}$ (n= No. of observation)

$\bar{Y} = \frac{\sum Y}{n}$ (n= No. of observation)

$b = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sum (Xi - X)^2}$

3.17 Germination and seed health test

For germination and seed health testing 400 seeds randomly drawn from each sample were tested in the standard technique (ISTA, 2000). Seeds were placed on three layers of moist blotting paper (Whatman no. 1) contained in petridishes. In each petridish, 25 seeds were placed in equidistace. All the plates with seeds were incubated at room tempareture (25± 2^0C) under 12 hours cycle of alternate Near Ultra Violet (NUV) light and darkness. 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. After 7-10 days of incubation, each seed was observed under sterio-binocular microscope to detect the presence of *Alernaria* spp.

3.18 Statistical analysis

The collected data for different parameters were compiled and tabulated. Appropriate statistical analysis was made by MSTAT-Computer package program. The treatment means were compared by Duncan's Multiple Range Test (DMRT). ANOVA table was shown in appendix V.

CHAPTER 4

RESULTS

4.1 Percent leaf infection

The effect of different treatments on leaf infection of mustard at different days after sowing (DAS) summarized and presented in Table 2. Different treatments had significant influence on percent leaf infection of mustard (SAU Sharisha 3) 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 (60.76%) was found in T_1 (control) and no leaf infection (0.00%) was recorded in treatment T_{10} where nine spraying were done with Rovral 50 WP (0.2%). The inhibition of leaf infection was 100% in case of T_{10} where 9 sprays were applied. The inhibition of leaf infection gradually decreased with the decrease of number of sprays. (Table 2)

4.2 Percent leaf area diseased

The effect of different treatments on leaf area diseased (LAD) of mustard at different days after sowing (DAS) summarized and presented in Table 3. Different no. of spray had significant influence on percent leaf area diseased of mustard (SAU Sharisha 3) at different days after sowing (DAS). Percent leaf area diseased of mustard increased gradually with the advancement of crop growth. At 85 days after sowing (DAS), the highest percent leaf area diseased (24.42 %) was found in T_1 (control) and the lowest percent leaf area diseased (0.00%) was recorded in treatment T_{10} where nine field spraying applied with Rovral 50 WP (0.2%). The reduction of leaf area diseased (LAD) was cent percent while 9 sprays with Rovral 50 WP (0.2%) were done and the LAD was found to be decreased gradually with the decrease of number of sprays (Table 3)

Table.2 Effect of different treatments on percent leaf infection of mustard at different days after sowing (DAS)

Treatments	% Leaf infection			% Inhibition of leaf infection over control at 85 DAS
	65 DAS	75 DAS	85 DAS	
T_1	30.55 a	49.05 a	60.76 a	0
T_2	19.67 b	28.92 b	29.50 b	51.44
T_3	12.63 c	16.13 c	21.63 c	64.40
T_4	8.470 d	12.49 d	19.47 c	67.95
T_5	4.625 e	7.925 e	15.38 d	74.69
T_6	3.465 f	4.960 f	10.47 e	82.77
T_7	2.570 g	3.915 g	8.070 e	86.72
T_8	1.283 h	2.132 h	3.908 f	93.57
T_9	0.5650 hi	0.8950 i	1.590 fg	97.38
T_{10}	0.0000 i	0.0000 i	0.0000 g	100
% LSD	0.8322	0.9700	2.403	
% CV	6.84	5.29	9.7	

In a column means having same letter(s) do not differ significantly at 5% level.

T_1= No field spraying
T_2= One field spraying with Rovral 50 WP@ 0.2%
T_3 =Two field spraying with Rovral 50 WP @ 0.2%
T_4=Three field spraying with Rovral 50 W@ 0.2%
T_5=Four field spraying with Rovral 50 WP @ 0.2%
T_6=Five field spraying with Rovral 50 WP @ 0.2%
T_7=Six field spraying with Rovral 50 WP @ 0.2%
T_8=Seven field spraying with Rovral 50 WP @ 0.2%
T_9=Eight field spraying with Rovral 50 WP@ 0.2%
T_{10}=Nine field spraying with Rovral 50 WP @ 0.2%

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

Treatments	% Leaf area diseased (LAD)			% Inhibition of LAD over control at 85 DAS
	65 DAS	75 DAS	85 DAS	
T_1	7.008 a	16.99 a	24.42 a	0
T_2	6.255 b	12.43 b	19.37 b	20.68
T_3	5.380 c	10.72 c	17.10 c	29.97
T_4	4.470 d	8.825 d	14.85 d	39.19
T_5	3.375 e	6.585 e	12.30 e	49.63
T_6	2.465 f	5.677 f	10.20 f	58.23
T_7	1.820 g	3.838 g	6.680 g	72.64
T_8	1.308 h	2.260 h	3.168 h	87.03
T_9	0.5900 i	0.9075 i	1.750 i	92.83
T_{10}	0.0000 j	0.0000 j	0.0000 j	100
% LSD	0.4425	0.8322	1.342	
% CV	9.36	8.40	8.42	

In a column means having same letter(s) do not differ significantly at 5% level.

T_1= No field spraying
T_2= One field spraying with Rovral 50 WP@ 0.2%
T_3 =Two field spraying with Rovral 50 WP @ 0.2%
T_4=Three field spraying with Rovral 50 W@ 0.2%
T_5=Four field spraying with Rovral 50 WP @ 0.2%
T_6=Five field spraying with Rovral 50 WP @ 0.2%
T_7=Six field spraying with Rovral 50 WP @ 0.2%
T_8=Seven field spraying with Rovral 50 WP @ 0.2%
T_9=Eight field spraying with Rovral 50 WP@ 0.2%
T_{10}=Nine field spraying with Rovral 50 WP @ 0.2%

4.3 Percent pod infection

The effect of different treatments on pod infection of mustard at different days after sowing (DAS) calculated and presented in Table 4. Different treatmets had significant influence on percent pod infection of mustard (SAU Sharisha 3) at different days after sowing (DAS). Percent pod infection of mustard increased gradually with the advancement of crop growth. At 90 days after sowing (DAS), the highest percent pod infection (41.01 %) was found in T_1 (control) and no pod infection (0.0%) was recorded in treatment T_{10} where nine field spraying were applied with Rovral 50 WP(0.2%). The pod infection was completely controlled (100% inhibition) while 9 sprays were applied with Rovral (0.2%) and the inhibition of pod infection were gradually increased with the increased of number of sprays (Table 4).

4.4 Percent pod area diseased (PAD)

The effect of different treatments on pod area diseased of mustard at different days after sowing (DAS) summarized and presented in table 3. Different treatments had significant influence on percent pod area diseased of mustard (SAU Sharisha 3) at different days after sowing (DAS). Percent pod area diseased increased gradually with the advancement of crop growth. At 90 days after sowing (DAS), the highest percent leaf area diseased (19.26%) was found in T_1 (control) and the lowest percent pod area diseased (0.0%) was recorded in treatment T_{10} where nine field spraying were applied with Rovral 50 WP (0.2%). The inhibition of pod area diseased (PAD) was recorded 100% over control while altogether 9 field sprays were done with with Rovral 50 WP (0.2%) and the inhibition of PAD gradually decreased with the decrease of number of sprays (Table 5).

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

Treatments	% Pod infection			% Inhibition of pod infection over control at 90 DAS
	70 DAS	80 DAS	90 DAS	
T_1	1.832 a	30.70 a	41.01 a	0
T_2	1.385 b	20.00 b	29.38 b	28.36
T_3	0.9175 c	15.83 c	21.03 c	48.72
T_4	0.5975 d	12.27 d	19.44 d	52.60
T_5	0.3525 e	7.985 e	15.18 e	62.98
T_6	0.2125 f	4.743 f	10.24 f	75.03
T_7	0.1175 g	3.863 g	7.970 g	80.56
T_8	0.08250 gh	2.082 h	3.780 h	90.78
T_9	0.04000 hi	0.8950 i	1.490 i	96.37
T_{10}	0.0000 i	0.0000 j	0.0000 j	100
% LSD	0.04588	0.7759	1.472	
% CV	5.53	5.44	6.78	

In a column means having same letter(s) do not differ significantly at 5% level.

T_1= No field spraying
T_2= One field spraying with Rovral 50 WP@ 0.2%
T_3 =Two field spraying with Rovral 50 WP @ 0.2%
T_4=Three field spraying with Rovral 50 W@ 0.2%
T_5=Four field spraying with Rovral 50 WP @ 0.2%
T_6=Five field spraying with Rovral 50 WP @ 0.2%
T_7=Six field spraying with Rovral 50 WP @ 0.2%
T_8=Seven field spraying with Rovral 50 WP @ 0.2%
T_9=Eight field spraying with Rovral 50 WP@ 0.2%
T_{10}=Nine field spraying with Rovral 50 WP @ 0.2%

Table.5 Effect of different treatments on percent pod area diseased (%PAD) of mustard at different days after sowing (DAS)

Treatments	% Pod area diseased (PAD)			% Inhibition over control at 85 DAS
	70 DAS	80 DAS	90 DAS	
T_1	7.398 a	12.41 a	19.26 a	0
T_2	6.762 b	10.76 b	16.50 b	14.33
T_3	4.425 c	8.972 c	15.22 c	20.97
T_4	4.090 c	7.220 d	12.72 d	33.95
T_5	2.740 d	6.375 e	11.13 e	42.21
T_6	1.425 e	4.940 f	9.440 f	50.98
T_7	1.135 ef	3.635 g	7.135 g	62.95
T_8	0.7700 fg	2.465 h	3.943 h	79.52
T_9	0.4250 gh	0.9900 i	1.868 i	90.30
T_{10}	0.0000 h	0.0000 j	0.0000 j	100
% LSD	0.4519	0.8013	0.8801	
% CV	10.70	9.56	6.24	

In a column means having same letter(s) do not differ significantly at 5% level.

T_1= No field spraying
T_2= One field spraying with Rovral 50 WP@ 0.2%
T_3 =Two field spraying with Rovral 50 WP @ 0.2%
T_4=Three field spraying with Rovral 50 W@ 0.2%
T_5=Four field spraying with Rovral 50 WP @ 0.2%
T_6=Five field spraying with Rovral 50 WP @ 0.2%
T_7=Six field spraying with Rovral 50 WP @ 0.2%
T_8=Seven field spraying with Rovral 50 WP @ 0.2%
T_9=Eight field spraying with Rovral 50 WP@ 0.2%
T_{10}=Nine field spraying with Rovral 50 WP @ 0.2%

4.5.1 Number of leaf per plant

Number of leaf per plant was differ significantly due to the application of different treatments. The highest number of leaf per plant (21.90) was recorded in T_{10} (nine field spraying with Rovral 50 WP) treatment and the lowest number of leaf per plant (15.83) was obtained from T_1 (control) treatment (Table 6).

4.5.2 Number of branches per plant

Number of branches per plant differs significantly due to the application of different treatments. The highest number of branches per plant (8.448) was recorded in case of T_{10} (nine field spraying with Rovral 50 WP) treatment and the lowest number of branches per plant (5.575) was obtained from T_1 (control) treatment (Table 6).

4.5.3 Plant height (cm)

Different treatments had influence on plant height (cm) of mustard. The tallest plant was obtained from T_{10} (nine field spraying with Rovral 50 WP) treatment (119.5 cm). The lowest plant height (94.02 cm) was recorded in case of control plot (Table- 6).

4.6.1 Number of pods per plant

Number of pod per plant was found to differ significantly due to the application of different treatments. The highest number of pod per plant (147.2) was recorded in case of T_{10} (nine field spraying with Rovral 50 WP) treatment and the lowest number of pod per plant (104.3) was obtained from T_1 (control) treatment (Table 7).

4.6.2 1000-Seed weight (g)

Thousand seed weight differed significantly due to the application of different treatments. The maximum 1000-seed weight (4.023g) was obtained from T_{10} (nine field spraying with Rovral 50 WP) treatment while T_1 control yielded the minimum 1000-seed weight (2.92g) (Table 7).

4.6.3 Yield (kg/ha)

Significant variation of different treatments was found on yield (kg/ha). Maximum yield (1882.50 kg/ha) was obtained from T_{10} (nine field spraying with Rovral 50 WP) treated plot followed by T_9 (1818.69 kg/ha), T_8 (1752.50 kg/ha), T_7 (1684.00 kg/ha). The lowest yield (1266.55 kg/ha) was recorded from T_1 (control).

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	15.83 g	5.575 f	94.02 j
T_2	16.81 f	5.892 f	97.94 i
T_3	18.09 e	6.225 e	102.2 h
T_4	18.50 e	6.560 d	105.1 g
T_5	19.48 d	6.938 c	109.3 f
T_6	20.06 c	7.153 c	111.7 e
T_7	20.50 bc	7.565 b	113.5 d
T_8	20.90 b	7.855 b	115.8 c
T_9	21.48 a	8.315 a	117.7 b
T_{10}	21.90 a	8.448 a	119.5 a
% LSD	0.4877	0.3308	1.679
% CV	1.74	3.22	1.06

In a column means having same letter(s) do not differ significantly at 5% level.

T_1= No field spraying with fungicide Rovral 50 WP @ 0.2%
T_2= One field spraying with Rovral 50 WP@ 0.2%
T_3 =Two field spraying with Rovral 50 WP @ 0.2%
T_4=Three field spraying with Rovral 50 W@ 0.2%
T_5=Four field spraying with Rovral 50 WP @ 0.2%
T_6=Five field spraying with Rovral 50 WP @ 0.2%
T_7=Six field spraying with Rovral 50 WP @ 0.2%
T_8=Seven field spraying with Rovral 50 WP @ 0.2%
T_9=Eight field spraying with Rovral 50 WP@ 0.2%
T_{10}=Nine field spraying with Rovral 50 WP @ 0.2%

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

Treatments	Yield and yield contributing characters			% Yield increased over control
	No. of pod/plant	1000-seed weight(g)	yield (kg/ha)	
T_1	104.3 j	2.928 d	1266.55j	0
T_2	113.7 i	3.076 cd	1331.88 i	4.90
T_3	117.7 h	3.19 cd	1393.60 h	9.12
T_4	121.5 g	3.305 cd	1472.30 g	13.98
T_5	125.9 f	3.395 c	1541.34 f	17.83
T_6	130.5 e	3.487 bc	1619.45 e	21.79
T_7	133.8 d	3.822 ab	1684.00 d	24.79
T_8	138.5 c	3.910 a	1752.50 c	27.73
T_9	143.4 b	3.973 a	1818.69 b	30.36
T_{10}	147.2 a	4.023 a	1882.50 a	32.72
% LSD	1.565	0.3783	6.020	
% CV	0.84	7.44	0.26	

In a column means having same letter(s) do not differ significantly at 5% level.

T_1= No field spraying
T_2= One field spraying with Rovral 50 WP@ 0.2%
T_3 =Two field spraying with Rovral 50 WP @ 0.2%
T_4=Three field spraying with Rovral 50 W@ 0.2%
T_5=Four field spraying with Rovral 50 WP @ 0.2%
T_6=Five field spraying with Rovral 50 WP @ 0.2%
T_7=Six field spraying with Rovral 50 WP @ 0.2%
T_8=Seven field spraying with Rovral 50 WP @ 0.2%
T_9=Eight field spraying with Rovral 50 WP@ 0.2%
T_{10}=Nine field spraying with Rovral 50 WP @ 0.2%

4.7.1 Percent seed germination

Percent seed germination was found to be significant due to the application of different treatments (Fig.1). Seed obtained from T_{10} (Nine field spraying with Rovral 50 WP) treated plot showed the maximum percent seed germination (100%). Seed obtained from control plots showed the minimum germination percentage (81.89%).

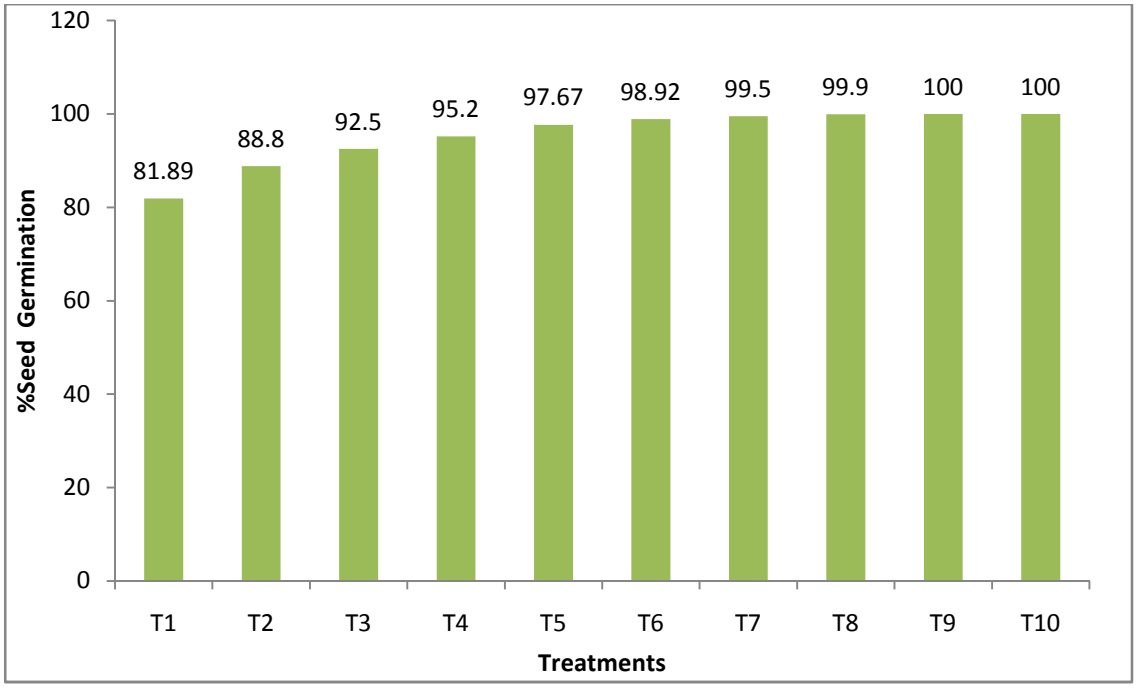

Fig 1: Effect of different treatments on percent seed germination of mustard.

T_1= No field spraying
T_2= One field spraying with Rovral 50 WP@ 0.2%
T_3 =Two field spraying with Rovral 50 WP @ 0.2%
T_4=Three field spraying with Rovral 50 W@ 0.2%
T_5=Four field spraying with Rovral 50 WP @ 0.2%
T_6=Five field spraying with Rovral 50 WP @ 0.2%
T_7=Six field spraying with Rovral 50 WP @ 0.2%
T_8=Seven field spraying with Rovral 50 WP @ 0.2%
T_9=Eight field spraying with Rovral 50 WP@ 0.2%
T_{10}=Nine field spraying with Rovral 50 WP @ 0.2%

4.7.2 Percent seed infection

Percent seed infection by *Alternaria* spp. of harvested seeds was varied due to the application of different treatments. Comparatively lower seed infection was found in the seed lot obtained from treated plot with higher number of sprays. Seeds obtained from control treatment showed the higest percent seed infection (19.57%) while seeds obtained from T_{10} (nine field spraying with Rovral 50 WP) treated plots showed the lowest seed infection (0.0%).

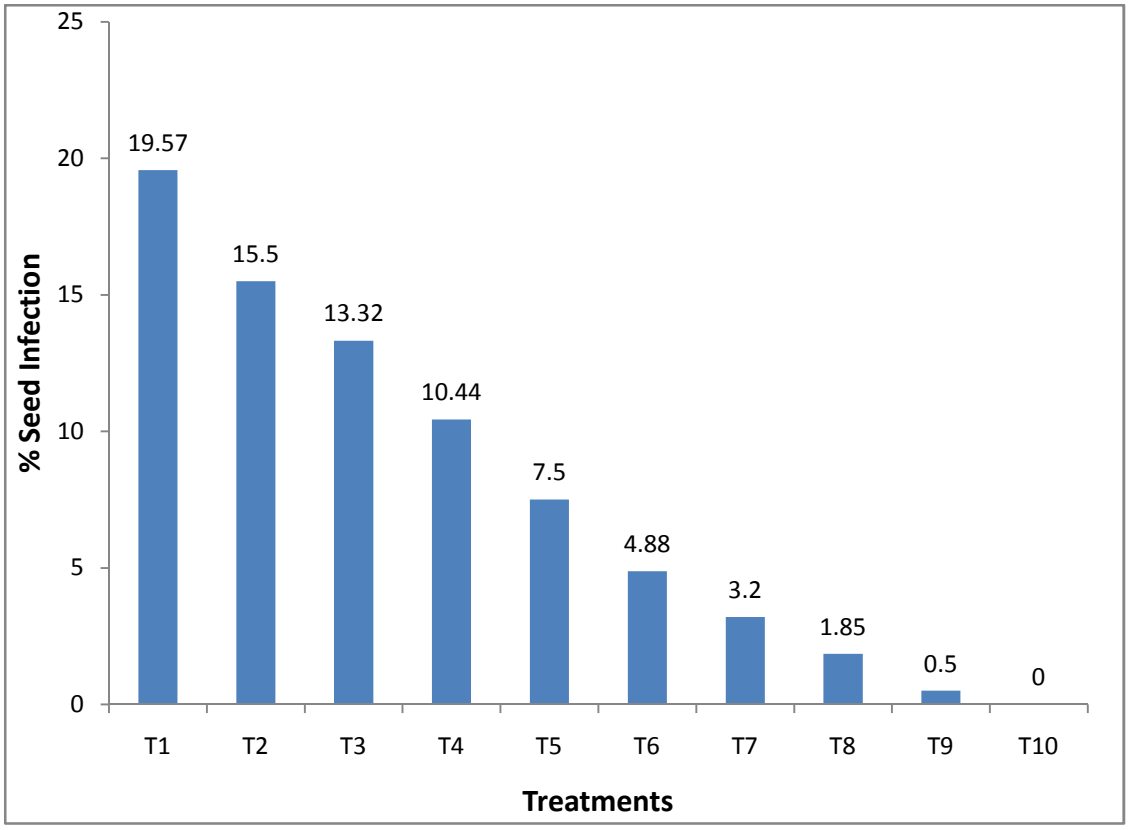

Fig .2: Effect of different treatments on percent seed infection of mustard.

T_1= No field spraying
T_2= One field spraying with Rovral 50 WP@ 0.2%
T_3 =Two field spraying with Rovral 50 WP @ 0.2%
T_4=Three field spraying with Rovral 50 W@ 0.2%
T_5=Four field spraying with Rovral 50 WP @ 0.2%
T_6=Five field spraying with Rovral 50 WP @ 0.2%
T_7=Six field spraying with Rovral 50 WP @ 0.2%
T_8=Seven field spraying with Rovral 50 WP @ 0.2%
T_9=Eight field spraying with Rovral 50 WP@ 0.2%
T_{10}=Nine field spraying with Rovral 50 WP @ 0.2%

4.8 Estimation of mathametical model for yield loss assessment

Using the variation of Percent Disease Index (PDI) and corresponding yield loss from multiple treatment experiment, the predicted yield loss (Y) was calculated using the working formula of regression equation and presented in Table 8. Further, using the predicted yield loss and corresponding disease severity the yield loss assessment model was constructed as Y = 0.32 + 0.38 Xi. By setting any Xi's value (PDI) in the formula, the yield loss of mustard due to grey blight disease could be estimated.

Table 8 Predicted yield loss calculated by percent disease index (PDI) and corresponding yield loss from multiple treatment experiment

Multiple Treatments	Percent Disease Index (PDI)	Yield (kg/ha)	Yield loss (kg/ha)	% Yield loss (Y)	XY	Predicted % yield loss
T_1	Xi=80	1266.55j	615.95	Yi=30.72	2617.6	30.72
T_2	Xii=75	1331.88 i	550.62	Yii=28.82	2193.75	28.82
T_3	Xiii=70	1393.60 h	491.90	Yiii=26.92	1829.1	26.92
T_4	Xiv=60	1472.30 g	410.20	Yiv=23.12	1307.4	23.12
T_5	Xv=45	1541.34 f	341.16	Yv=17.42	815.535	17.42
T_6	Xvi=36	1619.45 e	263.05	Yvi=14.0	503.028	14.01
T_7	Xvii=28	1684.00 d	198.50	Yvii=10.96	295.232	11.24
T_8	Xviii=18	1752.50 c	130.0	Yviii=7.16	124.308	7.16
T_9	Xix=8	1818.69 b	63.81	Yix=3.36	27.112	3.44
T_{10}	Xx=0	1882.50 a	0	Yx=0.32	0	0.32
Total =	420			162.825	9713.06	

Calculation:

$\bar{X} = \frac{\Sigma x}{n}$ (n= No. of observation).

= 420/10

= 42

$\bar{Y} = \frac{\Sigma Y}{n}$ (n= No. of observation)

= 162.825/10

=16.28

We know, Regression equation

$\hat{Y} = \bar{Y} + b(Xi - \bar{X})$ (working formula)

Here, $\hat{Y}$ = Predicted yield loss (%)

$\bar{Y}$ = Estimated yield loss (%)

Xi = Disease severity (i = 1, 2, 3,……n)

b = Regression value

$$b = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sum (Xi - X)^2}$$

$$= \frac{9713 - \frac{42 \times 16.28}{10}}{(80-42)^2 + (75-42)^2 + \cdots\ldots\ldots + (0-42)^2}$$

= 0.38

Now putting The $\bar{X}$, $\bar{Y}$ and b values in the regression equitation,

$\hat{Y} = \bar{Y} + b(Xi - \bar{X})$

=16.28+0.38 (Xi-42)

=16.28+0.38Xi-15.96

= 0.32+0.38Xi

$\hat{Y}$= 0.32+0.38Xi

Now Setting Xi's values in the Regression equation

When Xi= 80, Y= 0.32+0.38×80= 30.72

When Xii= 75, Y= 0.32+0.38×75= 28.82

When Xiii= 70, Y= 0.32+0.38×70= 26.92

When Xiv= 60, Y= 0.32+0.38×60= 23.12

When Xv= 45, Y= 0.32+0.38×45= 17.42

When Xvi= 36, Y= 0.32+0.38×36= 14.01

When Xvii= 28, Y= 0.32+0.38×28= 11.24

When Xviii=18, Y= 0.32+0.38×18= 7.16

When Xix=8, Y= 0.32+0.38×8= 3.44

When Xx=0, Y= 0.32+0.38×0= 0.39

Now, making a correlation graph using the corresponding Xi's and Y values we with the following graph

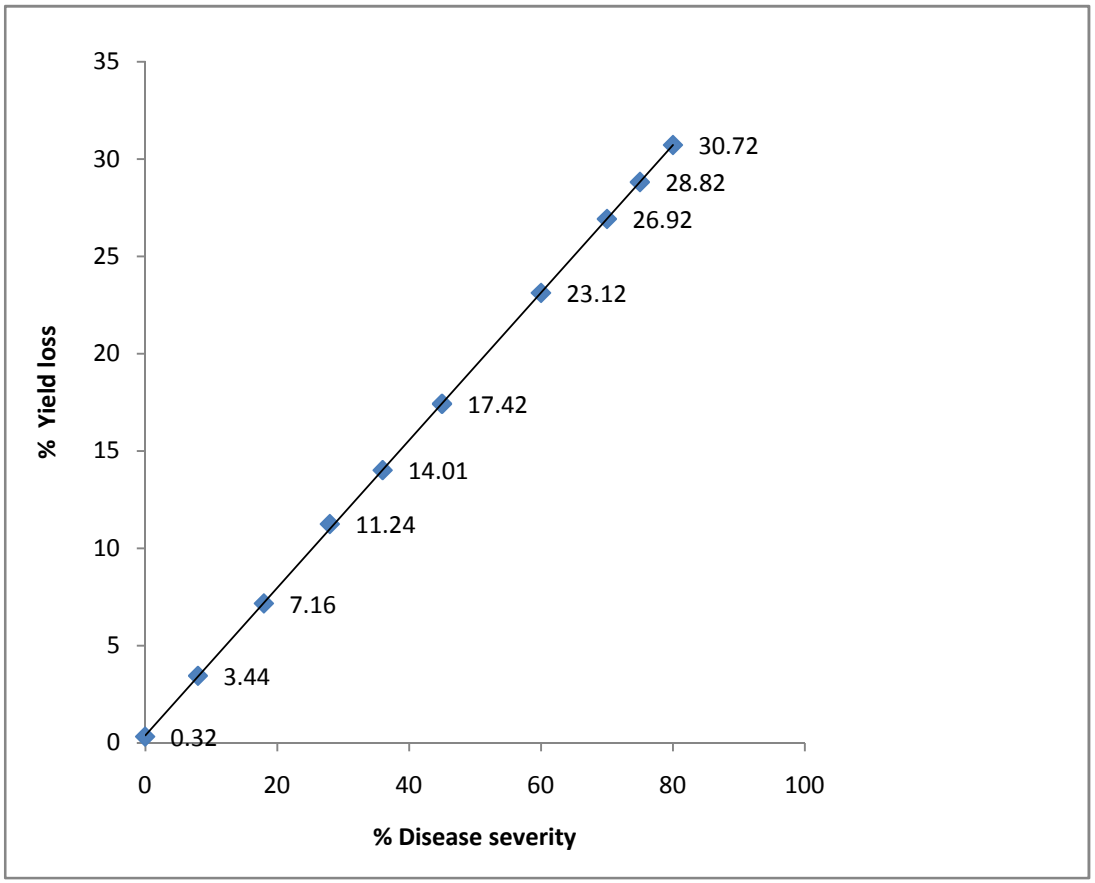

Fig. 3 Mathematical model point for estimation of yield loss of mustard due to grey blight disease caused by *Alternaria brassiciae* and *Alternaria brassicicola.*

Fig.4: Field view at flowering stage of mustard


Fig.5: Field view at fruiting stage of mustard

Fig.6: Infected (Grey blight diseases) leaves of mustard

Fig.7 : Infected (Grey blight diseases) pods of mustard

Fig.8: Conidia of *Alternaria* spp. under stereo microscope at 50x

CHAPTER 5

DISCUSSION

In the field experiments the application of fungicides with different spray schedule had significant effect in reducing the disease incidence, severity and increasing the seed yield. Among the treatments, nine field spraying with Rovral 50 WP @ 0.2% completely controlled leaf infection which was statistically identical with the application of eight field spraying. In case of percent leaf area diseased (LAD), no disease was observed in response to the application of nine field spraying with Rovral 50 WP @ 0.2%. It was observed that percent leaf infection and leaf area diseased increased gradually with the advancement of crop growth but inhibited disease incidence and severity with the increasing number of spraying of Rovral 50 WP @ of 0.2%.

In case of pod infection, the highest reduction was recorded while nine field spraying with Rovral 50 WP @ 0.2% was applied and it was 100% over control. Second highest performance was recorded in case of eight field spraying with Rovral 50 WP @ 0.2% and it was 96.37% over control. In case of percent leaf area diseased, the significant reduction was also observed in response to the application of nine field spraying with Rovral 50 WP @ of 0.2% that reduced 100% LAD compared to control. In case of percent pod area diseased (PAD), the 100% reduction was observed in response to the application of nine field spraying with Rovral 50 WP @ 0.2% compared to control. It was observed that percent pod infection and pod area diseased increased gradually with the advancement of crop growth and reduced disease incidence and severity with the increase of number of spraying of Rovral 50 WP @ 0.2%.

The effect of treatments on yield contributing characters like number of leaves per plant, number of branches per plant, plant height and 1000 seed weight was remarkably influenced in seed yield. The highest seed yield (1882.50kg/ha) was obtained from the plot where nine field spraying was applied with Rovral 50 WP @ 0.2% against the disease that increased seed yield by 32.72% compared to control. The second highest seed yield (1818.69kg/ha) was obtained from the plot where eight field spraying was applied with Rovral 50 WP @ 0.2% against the disease that increased seed yield by 30.36% compared to control. It was observed that seed yield incrased gradually with the increase of number of spraying of Rovral 50 WP @ of 0.2%. The findings of the field

experiments are well supported by the previous researchers. Alam (2007) while working with fungicides and plant extracts against the Alternaria blight of mustard caused by *Alternaria brassicae* and *Alternaria brassicicola*, reported that Rovral 50 WP (0.2%) was the potential fungicide in controlling disease incidence and severity and increasing seed yield by 48.19 % over control. Hossain and Miah (2006) reported that, in field trial, Rovral 50 WP (iprodione) significantly reduced the disease incidence and severity and increased seed yield when applied alone or in combination with other fungicides. Ferdous *et.al* (2002) reported that foliar spray of Rovral 0.1% concentration given at 7 days interval remarkably reduced Alternaria blight intensity increasing seed yield.

Seed health regarding seed infection and seed germination were found to differ significantly due to the application of different treatments. No seed infection by *Alternaria* spp. And 100% seed germination was obtained from the plot treated with nine field spraying with Rovral 50 WP @ 0.2%. Seeds obtained from control plots showed the lowest seed germination and maximum seed infection. The present findings corroborate with the findings of previous research report. Anonymous (1992) reported that foliar spray of Rovral significantly reduced the seed borne infection of *Alternaria* spp. and increased germination percentage of mustard seed. It was reported that, seed born infection of *Alternaria* spp. was reduced above 90% and seed germination was increased above 9% over control while seed infection was reduced up to 18.8% with 3 times foliar spray of Rovral.

The mathematical yield loss assessment model was simulated as $Y = 0.32 + 0.38Xi$ where Y stands for percent predicted yield loss and Xi stands for the disease severity (PDI) of grey blight of mustard in the standing crop. Calculating the disease severity in the regression equation, the percent yield loss could be calculated prior to harvest. Thus, in case of epidemic outbreak of grey blight of mustard, the Government will receive the information about the natural yield loss and would able to take the necessary initiatives to meet up the national demand edible oil and relief the nation from the market crisis or unstable market price.

CHAPTER 6

SUMMARY AND CONCLUSION

The experiment was conducted in farm of Sher-e-Bangla Agricultural University, Dhaka during the period from November, 2011 to February, 2012 to determine the yield loss assessment of mustard due to grey blight disease.

The experiment was laid out in a RCBD (one factor) with four level replications. There were ten treatments, Viz. T_1 (No field spraying with Rovral 50 WP @ 0.2%); T_2 (One field spraying with Rovral 50 WP @ 0.2%); T_3 (Two field spraying with Rovral 50 WP @ 0.2%); T_4 (Three field spraying with Rovral 50 WP @ 0.2%); T_5 (Four field spraying with Rovral 50 WP @ 0.2%); T_6 (Five field spraying with Rovral 50 WP@ 0.2%); T_7 (Six field spraying with Rovral 50 WP@ 0.2%); T_8 (Seven field spraying with Rovral 50 WP@ 0.2%); T_9 (Eight field spraying with Rovral 50 WP@ 0.2%); T_{10} (Nine field spraying with Rovral 50 WP@ 0.2%). The unit plot size was 2m X 3m with spacing of 30 X 10 cm. the space between blocks and unit plots were 1.5 m and 1 m respectively. Data were collected on disease incidence and severity, yield and yield contributing characters. Data were analyzed and the mean value was adjudged with Duncan Multiple Ranges Test (DMRT).

The study revealed that application of fungicide (Rovral 50 WP @ 0.2%) significantly influenced allmost all of the parameters. The lowest percent of leaf infection (0.0%), percent leaf area diseased (0.0%), pod infection (0.0%), pod area diseased (0.0%), were recorded from nine field spraying with Rovral 50 WP. The highest percent of leaf infection (60.76%), percent leaf area diseased (24.42%), pod infection (41.01%), pod area diseased (19.26%) were recorded from control (T_1). Leaf infection, leaf area diseased, pod infection, pod area diseased dicreased with increasing no. of spraying with Rovral 50 WP @ 0.2%.

The highest yield (1882.50 kg/ha) was obtained from the plot of nine field spraying with Rovral 50 WP. The lowest yield (1266.55 kg/ha) was obtained from the plot of control (T_1). Yield increased with more times spraying of Rovral 50 WP @ 0.2%.

The highest seed germination percentage and lowest seed infection obtained from the plot of ten field spraying with Rovral 50 WP @ 0.2%. The lowest

seed germination percentage and highest seed infection obtained from untreated plot (control).

From the experiment it may be concluded that spraying with Rovral 50 WP @ 0.2% (nine times) was found to best for controlling grey blight incidence and severity and giving highest yield of good quality seed of mustard (SAU Sharisa 3). However the multiple treatment experiments need to be carried out in different Agro. Ecological Zone (AEZ) for at least 3 consecutive years to justify to constructed yield loss assessment model.

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APPENDICES

Appendix I: Experimental location on the map of agro-ecological zones of Bangladesh

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.

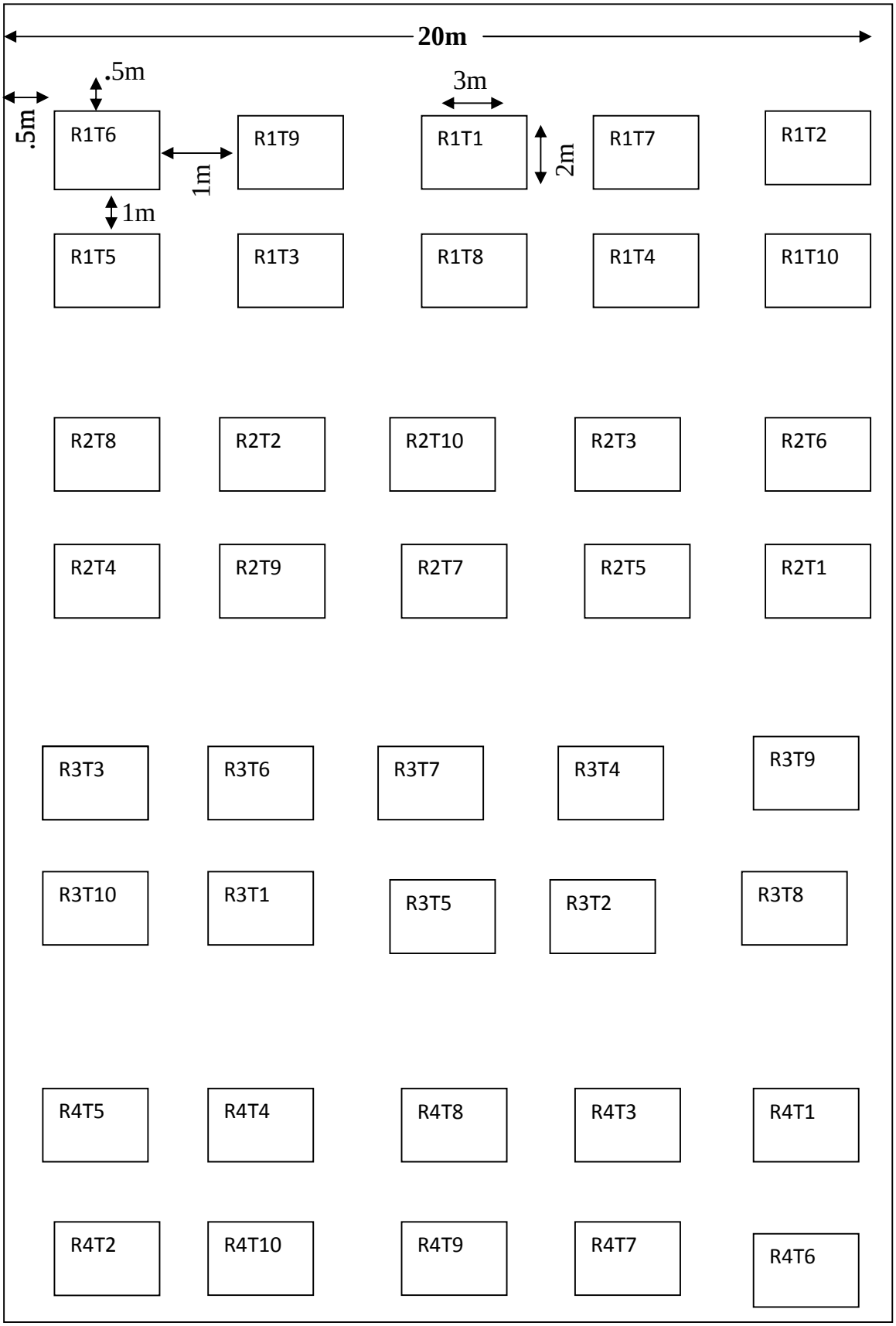
Appendix II: Monthly mean weather of the experimental site

Monthly mean of daily maximum, minimum and average temperature, relative humidity, total rainfall and sunshine hours during November/2011 to February/2012 are given bellow:

Year	Month	Air temperature (0^0)			Relative humidity (%)	Rainfall (mm)	wind speed (Km/h)
		Maximum	Minimum	Average			
2011	November	31.2	17.3	23.4	66.6	0.00	0.6
	December	25	15.7	19.5	68	0.00	1.3
2012	January	24.4	16.4	19.6	72.2	1.27	1.2
	February	29.5	16.9	22.4	51.3	0.00	1.4

Source: Bangladesh Meteorological Department (Climate Division), Agargoan, Sher-e-Bangla Nagar, Dhaka-1207

Appendix III: Layout of the field experiment



Appendix-IV: Some abbreviations and symbols used in the body of the thesis

Abbreviations	Full word
%	Percent
@	At the rate of
AEZ	Agro-Ecological Zone
Agric.	Agriculture
Agril.	Agricultural
Agron.	Agronomy
ANOVA	Analysis of variance
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BD	Bangladesh
BSMRAU	Bangladesh Sheikh Mujibur Rahman Agricultural University
CEC	Cation Exchange Capacity
cm	Centi-meter
CV%	Percentage of coefficient of variation
DAI	Days After Incubation
DAS	Days After Sowing
df	Degrees of Freedom
DMRT	Duncan's Multiple Range Test
EC	Emulsifiable concentration
et al.	and others
etc.	Etcetera
FAO	Food and Agricultural Organization
g	Gram
hr.	Hours
j.	Journal

Kg/ha	kiligrams per hectare
kg	kilogram
LAD	Leaf area diseased
m	Meter
m^2	Square meter
MOA	Ministry of Agriculture
MSE	Mean square of the error
No.	Number
NUV	Near Ultra Violet
PDI	Percent disease index
PDA	Potato dextrose agar
PAD	Pod Area Diseased
ppm	Parts per million
RCBD	Randomized complete block design
Rep.	Replication
Res.	Research
SAU	Sher-e-Bangla Agricultural University
Sc.	Science
SE	Standard Error
Univ.	University
var.	variety
WP	Wetable Powder

Appendix-v: ANOVA table of the experiment

01: Percent leaf infection at 65 DAS

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	1.687	0.562	1.7081	0.1889
Factor A	9	3563.372	395.930	1202.5059	0.0000
Error	27	8.890	0.329		
Total	39	3573.949			
Coefficient of Variation: 6.84%					

02: Percent leaf infection at 75 DAS

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	2.942	0.981	2.1953	0.1117
Factor A	9	8674.207	963.801	2157.9327	0.0000
Error	27	12.059	0.447		
Total	39	8689.208			
Coefficient of Variation: 5.29%					

03: Percent leaf infection at 85 DAS

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	12.625	4.208	1.5336	0.2285
Factor A	9	11686.183	1298.465	473.1608	0.0000
Error	27	74.094	2.744		
Total	39	11772.902			
Coefficient of Variation: 9.70%					

04: Percent leaf area disease at 65 DAS

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	0.719	0.240	2.5644	0.0755
Factor A	9	213.038	23.671	253.3959	0.0000
Error	27	2.522	0.093		
Total	39	216.278			
Coefficient of Variation: 9.36%					

05: Percent leaf area disease at 75 DAS

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	9.872	3.291	10.0113	0.0001
Factor A	9	1066.096	118.455	360.3930	0.0000
Error	27	8.874	0.329		
Total	39	1084.842			
Coefficient of Variation: 8.40%					

06: Percent leaf area disease at 85 DAS

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	8.690	2.897	3.3893	0.0323
Factor A	9	2365.301	262.811	307.5069	0.0000
Error	27	23.076	0.855		
Total	39	2397.066			
Coefficient of Variation: 8.42%					

07: Percent pod infection 70 DAS

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	0.008	0.003	3.0148	0.0473
Factor A	9	14.401	1.600	1705.1378	0.0000
Error	27	0.025	0.001		
Total	39	14.435			
Coefficient of Variation: 5.53%					

08: Percent pod infection 80 DAS

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	0.981	0.327	1.1420	0.3499
Factor A	9	3529.091	392.121	1368.8742	0.0000
Error	27	7.734	0.286		
Total	39	3537.807			
Coefficient of Variation: 5.44%					

09: Percent pod infection 90 DAS

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	0.669	0.223	0.2168	
Factor A	9	6178.394	686.488	667.2223	0.0000
Error	27	27.780	1.029		
Total	39	6206.843			
Coefficient of Variation: 6.78%					

10: Percent pod area diseased at 70 DAS

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	4.753	1.584	16.2682	0.0000
Factor A	9	253.097	28.122	288.7575	0.0000
Error	27	2.630	0.097		
Total	39	260.479			
Coefficient of Variation: 10.70%					

11: Percent pod area diseased at 80 DAS

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	6.014	2.005	6.5756	0.0018
Factor A	9	616.201	68.467	224.5692	0.0000
Error	27	8.232	0.305		
Total	39	630.447			
Coefficient of Variation: 9.56%					

12: Percent pod area diseased at 90 DAS

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	7.360	2.453	6.6672	0.0016
Factor A	9	1498.128	166.459	452.3436	0.0000
Error	27	9.936	0.368		
Total	39	1515.424			
Coefficient of Variation: 6.24%					

13: No. of leaf/plant

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	1.861	0.620	5.4824	0.0045
Factor A	9	145.729	16.192	143.1014	0.0000
Error	27	3.055	0.113		
Total	39	150.645			
Coefficient of Variation: 1.74%					

14. No. of branchs/plant

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	0.785	0.262	5.0660	0.0065
Factor A	9	35.703	3.967	76.7888	0.0000
Error	27	1.395	0.052		
Total	39	37.883			
Coefficient of Variation: 3.22%					

15: Plant height (cm)

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	142.492	47.497	35.4662	0.0000
Factor A	9	2664.908	296.101	221.0974	0.0000
Error	27	36.159	1.339		
Total	39	2843.559			
Coefficient of Variation: 1.06%					

16. No. of pods/plant

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	676.833	225.611	194.0446	0.0000
Factor A	9	6695.482	743.942	639.8536	0.0000
Error	27	31.392	1.163		
Total	39	7403.708			
Coefficient of Variation: 0.84%					

17. 1000-seed weight (g)

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	1.539	0.513	7.5271	0.0008
Factor A	9	5.681	0.631	9.2602	0.0000
Error	27	1.841	0.068		
Total	39	9.061			
Coefficient of Variation: 7.44%					

18. Yield (kg/ha)

Source of variance	Degree of freedom	Sum of squares	Mean square	F value	Probablity
Replication	3	2.363	0.788	0.0458	
Factor A	9	1591580.095	176842.233	10273.0811	0.0000
Error	27	464.782	17.214		
Total	39	1592047.239			
Coefficient of Variation: 0.26%					

Appendix VI: 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.