EFFECT OF VARIETIES OF MUSTARD AND CHEMICAL INSECTICIDES ON THE INFESTATION OF APHID

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EFFECT OF VARIETIES OF MUSTARD AND CHEMICAL INSECTICIDES ON THE INFESTATION OF APHID

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CERTIFICATE

This is to certify that the thesis entitled ***"INFESTATION OF APHIDS IN TWO VARIETIES OF MUSTARD AND THEIR CONTROL WITH SOME CHEMICAL INSECTICIDES "*** *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 (MS) IN ENTOMOLOGY,*** *embodies the result of a piece of bona fide research work carried out by* ***MD. AL-ARAFAT TOPU, Registration No. 12-05238*** *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 source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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DEDICATED
TO
MY BELOVED
PARENTS

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ABSTRACT

This study was conducted to investigate the effect of varieties of mustard and chemical insecticideson the infestation of mustard aphid *Lipaphiserysimi* (Kalt) during the period from November 2012 to February 2013 at the Sher-e-Bangla Agricultural University farm, Dhaka.The study consisted of five treatments and two varieties.These were as follows:T_1: (Spraying of Dursban 25EC @ 2.5ml/L of water),T_2:(Spraying of Malathion 57EC @ 2.5ml/L of water), T_3: (Spraying ofSumi-Alpha 5EC@ 1ml/L of water), T_4: Spraying of Sevin 85 SP @ 2.5g/L of water and T_5: (Untreated Control) treatment and all the spraying were done at 15 days interval. Two varieties were BARI shorisha-9 and BARI shorisha-11.The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The result revealed that among the treatment combinations, T_3V_2 (Sumi-Alpha + BARI shorisha-11) was the most effective in controlling mustard aphid (85.78%) after first spray and (88.11%) after second spray. On the other hand T_4V_2(Sevin + BARI shorisha-11) was less effective in controlling mustard aphid(71.45%) after first spray and (67.11%) reduction of aphid population after second spray. The combination of Sumi-Alpha and BARI shorisha-11 was better in terms of controlling mustard aphid *L. erysimi* and yield of mustard.

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LIST OF ABBRIVIATIONS

% = Percent
^0C = Degree Centigrade
a.i = Active ingredient
ACI = Agro-Chemical Industries
AEZ = Agro Ecological Zone
BARC = Bangladesh Agricultural Research Council
BARI = Bangladesh Agricultural Research Institute
BBS = Bangladesh Bureau of Statistics
cm= Centimeter
CRD = Completely Randomized Design
CV % = Percentage of Coefficient of Variance
DAT = Days After Treatment
EC = Emulsifiable concentrate
FAO = Food and Agriculture Organization
g = gram
Kg = Kilogram
LC = Lethal Conccntration
Lit = Liter
SP = Soluble Powder
ml = Milliliter
MP = Muriate of Potash
N = Nitrogen
No. = Number
P = Phosphorus
K = Potassium
RARS = Regional Agricultural Research Station
RCBD = Randomized Complete Block Design
SAU = Sher-e-Bangla Agricultural University
S = Sulpher
TSP = Triple Super Phosphate
UNDP = United Nations Development Programmme
WSC = Water Soluble Concentrate
Wt = Weight
LSD = Least Significant Difference

CHAPTER I
INTRODUCTION

Mustard (*Brassica* sp.) is one of the major oil seed crops in Bangladesh which is widely cultivated during the winter season and its performance in total seed production is approximately 70%. The crop is well adapted to almost all agro-climatic zones of the countries. About 279235 hectares of land were used for mustard cultivation in 2005which produced 520108 tons of mustard but the average mustard production was only 753 kg/ha (BBS, 2007). The incidence of aphid pest is one of the most important factors for lower yield of this oil seed crop.

The mustard aphid, *Lipaphis erysimi* (Kalt.) (Homoptera: Aphidae) is the most important damaging insect pest of mustard in Bangladesh (Das and Islam, 1986; Haque and Miah 1979; Ahmed and Mannan, 1977; Ahmed et al., 1977; and Alam *et al*.,1964a). It is also a pest of many cruciferous vegetables (Kim *et al.*,1988; Lee, 1986). This pest is distributed in Bangladesh,India,Pakisthan, U.S.A and many other countries of the world and is recognized as a serious pest of mustard (Hamid and Ahmed, 1980; Mukhopadhayay and Ghosh, 1979; Srivastava and Srivatawz, 1970; Jarvis, 1970; and Arora *et al*., 1969).

The mustard occurs in the field during December to February. Both the adults and nymphs of mustard aphid, *L. erysimi* cause damage to mustard plant from seedling to maturity (Verma and Singh, 1987), but maximum damage is caused at flowering stage (Brar and Sandu, 1974) they suck sap from leaves,flowers,flower-buds, pods and twigs of the plants and secrete sticky honeydew which acts as a medium for sooty mould fungus. As a result, the photosynthetic efficiency of the plant is reduced. The aphid infestation also cause stunted growth of plant. Severely attacked plants often fail to bear pods or end up with very poor pod settings (Das and Islam, 1986).

In Bangladesh, very little report is available on the estimation of damages caused by this pest. But it is reported from India that the yield losses to rapeseed/ mustard due to the attack of *L. erysimi* alone varied from 35.4 to 96% depending upon the season (Bakhetia, 1983; Phadke, 1980;Singvi *et al*., 1973; Pradhan 1970;Chanal and Sukhija, 1969;;Saini and Chabra, 1966;andSidhu and Singh, 1964).

The control of aphid in Bangladesh is principally carried out by the conventional use of insecticides. Many workers have tried to control this pest with varying degrees of success by frequent application of insecticides as foliar treatments (Chowdhury and Roy, 1975). It is difficult to emphasize the effectiveness of particular synthetic insecticides out of many commercially available ones against a certain insect pest. These chemicals should be applied at appropriate dose and at right time against the target pests. For controlling the mustard aphid successfully and to save *Coccinella septempunctata*, judicious application of insecticide is essential. With this view in mind, the effectiveness of different insecticides in controlling mustard aphid was selected for this study. In this study, an effort will be taken to find out the most effective insecticide in controlling mustard aphid.

Objectives

1. To know theeffectiveness of insecticide(s) for aphid management.

2. To evaluate the performance of two varieties of mustard against aphid.

Chapter II
REVIEW OF LITERATURE

Mustard aphid is one of the major problems in the production of mustard. Mustard crop suffers heavy losses every year due to the attack of mustard aphid. Reports on the effect of insecticides in controlling mustard aphid and yield of mustard pertinent to this study are reviewed here.

2.1 General review of Mustard aphid, *L. erysimi* Kalt.

2.1.1 Systematic position

Kingdom: Animalia
Phylum: Arthropoda
Class: Insecta
Order: Homoptera
Family: Aphididae
Genus: *Lipaphis*
Species: *L. erysimi*

2.1.2 Nomenclature of mustard aphid *L. erysimi* Kalt.

The mustard aphid *L. erysimi* (Kaltenbach) was originally described by Kaltenbach as *Aphis erysimi* Kaltenbach as its type species. Prior to his, Davis (1914) described a new species, *Aphispseudobrassica* which was considered by Dobrovliancy (1916) to be a synonym of *Aphis erysimi* Kaltenbach. The correct zoological name of *L. erysimi* was confined by David in 1975 as reported by Bakhetia and Sidhu (1980).

2.1 3 Status and distribution

Mahal *et al.* (1999) reported that the population size of *L. erysimi* (44.5%) in the field was greater than that of *Myzus persicae* (26.0%) 1985-1986 and 1986-87. It was 52.8% and 43.9% for *L. erysimi*and *M. persicae*, respectively. In net house multiplication the population of *L. erysimi* was 3.3 times more than that of *M. persicae* when aphids of both species were placed on the plants in 1:1 ratio.

Mahal *et al*. (1998) conducted a field experiment in Punjab (India) between 1979 and 1986 and revealed that the aphid, *L. erysimi* had an aggregated distribution on *Brassica juncea* (Indian mustard), which varied with pest density. The density also affected the number of samples required for population estimation. Similar report was made by Ramkishore and Phadke (1988a).

Atwal (1976) reported that the mustard aphid found worldwide in distribution but occurred principally in the South East Asia as a serious pest of cruciferous oilseeds. The mustard aphid, *L. erysimi* is a serious pest of mustard in Bangladesh. Bakhetia (1986) and Khurana (1986) reported *L. erysimi* as major pest of mustard.

Prasad and Pradhan (1971) studied the distribution and sampling of mustard aphid, *L. pseudobrassicae* (Davis) under cultivation of rape and mustard in 3.3 million hectares in India. Amongst the various pest causing damage to mustard, *L. pseudobrassicae* was the most serious on infesting leaves, stems, pods and thus reducing the yield and quality of the produce to a considerable extent.

2.1.4 Biology of aphid

Vekaria and Patel (1999) conducted field studies during the Rabi season in Gujrat, India, to determine the biology of *Lipaphis erysimi* on three indian mustard cultivars (GM-1, Varuna and Pm-67). The nymphal period was shortest (5.88±0.67 days)nonPM-67 and longest (6.58±0.65days) on GM-1. Adult longevity and total life span were shortest on GM-1 (8.71±0.69 and 15.29±0.69 days, respectively) and longest on PM-67 (10.36±0.99 and 16.24±1.09 days, respectively). Fecundity was lowest on GM-1, intermediate on Varuna and highest on MP-67.

Vekaria and Patel (1998) reported the total number of generation completed by the mustard aphid, *L. erysimi* (kalt.) between January and March. The aphid completed 11 overlapping generations at 21.9ºc and 52% relative humidity during the first season. And 8 generations at 23.7ºC and 57% RH during the second season. The average duration of each generation was 6.04 days during 1996 and 7.15 days during 19997.

Shahjahan (1994) studied the adult longevity of mustard aphid, *L. erysimi* on 10 different varieties from 8.7-10.7 days. The duration of adult longevity was the highest (10.7 days) on Nap-3 and the lowest (8.7 days) on Tori-7.

Mondal *et al.* (1992) studied the biology of *L. erysimi* (Kalt.) in the laboratory of young leaf of different host plants. They reported that the mean nymphal period were 10.67±0.38, 10.92±0.8, 9.67±0.32, and 9.50±2.05 days on *B. chinensis* (China cabbage), *B. juncea* (mustard plant), *Raphanus sativus* (radish) and *Solanum melongena* (brinjal), respectively.

Amjad and Peters (1992) studied the fecundity, survival rate and days to maturity of *L. erysimi* and found fewer days to mature in *Brassica campestris* var. Tori A (7.9 days) than in *B. carinata* and *B. juncea*. Fecundity was significantly higher in *B. campestris* and lower in *B. juncea*. The intrinsic rate of population increase was significantly higher in *B. campestris* than other host plants, while it was the lowest in *B. carinata*. The survival of nymphs was significantly higher *B. campestris* (95%) and the lower in *B. juncea* (57%).

Phadke (1982) studied the life table and growth rate of mustard aphid, *L. erysimi* on different varieties of *Brassica spp.* And reported that highest net reproduction rate of 119.38 was found in T9 and lowest one of (86.12) was found in Pusabold.

Sharma and Khatri (1979) studied the biology of mustard aphid, *L. erysimi* (kalt.) on mustard and observed that the mean number of progeny/female during the winter crop season was 96.87±27.94 and the rate of population increase was 2.95 in 15 days.

2.1.5 Ecology ofmustard aphid

Biswas and Das (2000) in relation to weather parameters. They observed that the aphid population build up was noticed during January reaching the peak on the 8th February in both 1997 (98.26 per plant) and 1998 (76.22 aphid per plant). The ambient sunshine (5.76-8.60 hr) and the maximum temperature (23.66° to 25.37°C) during January- February appeared to be the conductive factors for aphid multiplication. Relative humidity (RH) ranging from 62.00 to 74.28% during January and February was congenial for aphid population build up, while the activity of aphids ceased at 52.43% RII and below.

Sinha *et al.* (1998) observed the duration of the different stages in life cycle of *L. erysimi* under ambient temperature and humidity conditions from December to March (18°±7.9°C and 62.4±11.00% RH%). The nymphal period showed a positive correlation with ambient temperature during December to April while reproductive, post reproductive periods and longevity were negatively correlated with ambient temperature. The fecundity of the aphid was positively correlated with ambient relative humidity and negatively correlated with temperature. The fecundity of offspring from apterous aphids (40.0/female) was greater than in those from alatae aphids (32.6/ female). The longest duration of total life span (39.0 days for apteral and 43.7days for alatas) occurred in January – February and the hottest (24.0 days for apteral and 29.7 days for alatas) in March to April.

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Nasir *et al.* (1998) studied on the population dynamics of mustard aphid *(L. erysimi*) in relation to abiotic factors. Adults appeared on the crop in the last week of February. The population peaked in the third week of March and disappeared by the third week of April. Aphid population was positively correlated with the average daily temperature, but negatively correlated with relative humidity and rainfall.

Samdur *et al.* (1997) observed the effect of environmental factors on mustard aphid. The mean aphid infestation index (MAII) we found significantly and negatively correlated with maximum temperature, evaporation, sunshine and wind velocity and was significantly and positively correlated with maximum RH for *B. juncea* sown in first and third weeks of November.

Bishnol *et al*. (1992) observed that the effect of temperature. Relative humidity and cloudiness on infestation of mustard aphid. They observed that a temperature of 10°-13°C and relative humidity of 72°-85°C in tile region could he used to predict the rapid multiplication of aphids in rapeseed, *Brassica napus* L. and Indian mustard. *Brassica juncea* L. A sharp rise in air temperature by 6°-10°C, the population build-up of aphids further intensified on these crops. The temperature of 10˚-13˚C and relative humidity of 72-85% proved to be optimum.

Bakheitia and Sidhu (1983) observed the response of temperature and rainfall on the population buildup of *L. erysimi* on mustard (Rain). They found that the faculty, life span and reproduction of the aphid were adversely affected by rainfall. Mustard aphid *L. erysimi* develop and reproduced most rapidly at temperature between 20˚-30˚C.

2.1.6 Natural enemies

The mustard aphid like most other aphid is preyed upon by the larvae of syrphids and coccinnellids. Six coccincllids, 16 syrphids, one species each of chamaeyiids, chrysopids, hemerobiids as insect predator, four species of hymenopterous parasites, four spccics of entomorenous and one predator bird are known as natural enemies of *L. erysimi* (Bakhetia and Sekhon (1984).

2.1.7 Nature of damage by aphids

Like other soft bodied insects such as leaf hoppers, mealy bugs and scale insects, aphids produce honeydew. The honeydew serves as a medium on which a sooty fungus called sooty mold grows. Aphids serves as vector for many plant diseases that cause greater losses than caused by direct feeding injury. This is often the greatest impact of an aphid infestation (Blackman and Eastop, 1994).

The aphid, *L. erysimi* directly affects the whole part of the mustard plants except root. Aphids mostly attack the soft portions like apical twig, inflorescence and pods. The aphid infestation caused unhealthy growth of the plant. The poor and stunted growth together with curling of the leaves, drying up of the inflorescence, discoloration of plant leaves and flowers, ultimately caused the plants to lodge in the field. The pods and seeds become unhealthy and unproductive (Kabir and Khan 1980).

2.1.8 Aphid population

Biswas and Das (2000) observed the population dynamics of the mustard aphid *L. erysimi* at the Oilseed Research center, Bangladesh Agricultural Research Institute. Joydebpur, during 1997 and 1998 crop season. They reported that the aphid population build-up was noticed January-February, reaching its peak on the 8th February in both 1997 (98.26 aphids per plant) and 1998 (76.22 aphids per plant). Among the fifteen genotypes. Nap-8901 suffered the highest aphid infestation (45.87 aphids per plant) while the lowest aphid infestation (21.18 aphids per plant) was recorded from BC-1592. January-February was found to be Congenial for aphid population build-up.

Sonkar and Desai (1999) reported that delay in sowing caused increase in the aphid Population and ultimately resulted in a reduction of`yield. The peak incidence of the occurred between the first fortnight of` January and the second fortnight to February.

Singh and Lal (I999) studied mustard aphid, *L. erysimi*, infestation on *B. juncea* (Indian mustard) crops during two successive crop seasons (25th December 1989 to 6th March 1990, and 1st January to 31 March 1990), in India. They found that *L. erysimi* occurred from the last week December to the first week of March in 1990 and the first week of January to the second week of March in 1990. The peak Infestation of *L. erysimi* 414.15 per 10 cm terminal shoot per plant) was recorded on I3th February in the first year, while the maximum infestation (471.10 per 10 cm terminal shoot per plant) was recorded on 6th February.

Begum (1994-95) conducted an experiment at RARS , Rajbari, Dinajpur during rabi season 1994-95 to find out the population activities of mustard aphid. She observed that aphid population increases gradually as Sowing delayed. It was evident that the mustard yield decreased as the aphid population increased and the percent of pod infestation had positive correlation to aphid population.

Awasthi (1993) investigated the incidence of aphid in a mustard growing region of Balsamand, Rajasthan. India, in January. The aphid popularion decreased after the end of January and was lowest in the last week of February.

Kher and Ratul (1992a) tested nineteen strains of rape under field condition in Panjab, India for their resistance to *L. erysimi* during 1987-89. They reported that all strais of *B. napus* except Regent and Gullivar were found relatively resistant. Strains of *B. campestris* had a very high aphid population and were considered highly susceptible and strains of *B. juncea* was moderately resistant.

Kher and Ratul (1992b) carried out a field trial in Ludhiana, India and assessed the resistance of 7 strains of *B. campestris*, strains of *B. juncea* (Indian mustard) and 5 strains of *B. napus* (rape) to *L. erysimi*. They stated that the population level of 10 and 15 aphids/plant proved optimal for resistance, screening at the cotyledonary and 2-leaf stage respectively.

2.1.9 Yield loss due to mustard aphid infestation

Aggarwal *et al*. (1996), carried out a field experiment under agro climatic conditions of Haryana. India to find out the effect ofinfestation by *L. erysimi* on yield contributing traits of 20 rape/ mustard genotypes. They investigated on the basis of lesser influence of aphid infestation on yield contributing traits such as plant height, primary branches, main shoot length, pods on main shoot, pods length, seeds/pods and 1000-secd weight, the four genotypes HC-2 (*B. carinata*), T-6342(*B. juncea*). TMN - 528 (*Eruca sativa*) and *B.tournefortii* appeared promising.

Srivastava *et al*. (1996), performed field trails in Himachal Pradeh, India during 1991 -94 to assess the vield loss of mustard due to infestation *Myzus persicae* and *L. erysimi.* They observed that the yellow sarson cultivar (YST-841) showed the maximum yield loss (46.12%) and brown sarson BSH-1 showed (43.58%).*B. juncea* (Varuna) and *B. napus* (HPN-1) showed lower susceptibility with yield losses ranging from 30.90 to 36.01% and *B. carinata* (HPC-1) was the least susceptible cultivar with 22.84% yield loss.

Rouf and Kabir(1994-95) conducted an experiment RARS, jessore during 1994-95 with four mustard varieties for investigation of the most vulnerable growth stage of mustard to the attack of aphids. The reported that the maximum loss of TK. 11,322.60 to 15,460.20 per hectare be incurred if no control measures were undertaken against aphids

Field studies were conducted by Mandal *et at*., (1994) in Orissa, India during the *rabi* season of 1991-1993 to screen out 25 varieties of rapeseed and mustard for resistance to aphids. They concluded that yield in both years varied from 28.2 to 83.3%.

Kabir and Rouf (1993-94) conducted an experiment at RARS (Rajshahi Agricultural Research Station) are during robi season of 1993 with four mustard varieties to determine the most vulnerable growth stage of mustard to the attack of aphids. The results revealed that a loss of Tk 10,260.00 to 21,420.00 per hectare could be incurred if no control measures were under taken against aphids.

Begum (1993-94) conducted a research experiment with three varieties of mustard in Joydebpurin the year 1993-94 to assess the loss due to aphid Infestation. It was found that second highest losses occur in the flowering and podding stages and the lowest losses occur in the pod formation and ripening stage.

Rohilla *et al.* (1987) conducted a four year investigation with six Brassica genotypes for their resistance to *L.erysimi*(Kali). The investigators used the yield loss as the criteria of resistance and reported decreasing order of resistance *Eruca sativa* T -27 (16.44% yield loss), *B. juncea* parkesh (23.64%), RH30 (27-31%), *B. campestris* brown sarson BSHI (32.73%), yellow sarson YSPb-24 (34.80%) and *B. napus* HNS (61.32%). Sekhon and Ahman (1992) expressed that *L. erysimi* (kalt) is most devastating insect pest in India.

2.3 Effect of insecticides on aphid infestation

Nirmala *et al*, (2001) conducted an experiment to determine the field efficacy of four insecitides viz., Metasystox , Dimethoate, phosphamid and Cypermethrin against *L. erysimi* on Brassica campeestris var. brown sarson (8SH-1) during 1998-99. Results showed that highest reduction in aphid population was obtained treatment with Phosphamidon (0.03%) and Cypermethrin (0.01%) followed by Metasystox (O.025%) and Dimethoate (O.03%) after 5 days of treatment.The laboratory test or the relative toxicity of insecticides against *L. erysimi* revealed that Phosphamidon was most toxic insecticide followed by Dimethoate, Lindane, `Thiometon and Chlorpyrifos (Sinha *et al* , 2001)

Five organophosphorus insecticides viz. Phosphamidon, Quinalphos, Malathion, Dimethoate and Diazinon were tested against mustard aphid in field and net house condition. All these insecticides (0.05%) controlled mustard aphid, Quinalphos was comparatively more effective in controlling *L. erysimi*followed by Phosphamidon ((Gazi *et al*.,2001)

A field experiment was carried out in India to compare the efficacy of 5 insecticides at 3 different contentrations against musterd aphid. The best result in redusing *L. erysimi* popularion was obtained with Fluvalinate (0.023, 0.045 and 0.068%), followed by Deltamethring (0,002, 0.004 and 0.006%), Phosphamidon (0.026. 0.055 and 0.079%) and Dimethoate (0.028, 0.056 and 0.084%), Oxydemeton-methyl (0 025, 0.05 and 0.075%) showed the least effectiveness.Thehighest percentage reduction of *L. erysimi* popularion was observed withFluvalinate at 0.068% (Sikha *et al.*,1999).

Eight insecticides were tested against mustard aphid and their toxic effect was evaluated. Phosphamidon and Dimethoate 0.05% were found to be significantly toxic to *L. erysimi* than other insecticides (Sonkar and Desai, 1998)

Prasad (1997) studied the efficacy of four neem products is Oxvdemeton methyl against *L. erysimi* on rapeseed crop under field condition. Oxydemeton-methyl 0.05% giving 75 to 99% reduction and (0.025%) giving

82 to 97% reduction of aphid population at 1 , 3,7 and 14 days after spraying. The population of these days in neem oil treated plots were between giving 4 to 28% reduction.

Field trials were conducted in Bangladesh to determine the effectiveness of the insecticides viz. Malathion. Lebayield (Fenthion), Surnithion (Fenitrion), Nogos (Dichlorvos), Zolone (Phosalone), Roxion (Dimethoate), Ripcord (Cypermethrin), Cymbush (Cypermethrin). Azodrin (Monocrotophos).Diazinon and Dimecron (Phosphamidon) against *L. erysimi* and observed that 3 to 4 sprays with either Azodrin or Malathion at 2.0 ml/lit of water effectively controlled the pest (Roar and Kabir. 1997).

Toxicity of 10 insecticides was evaluated against *L. erysimi* in India. All the tested insecticides significantly reduced the pest population. Chlopuriphos was 1.488 and Methyl-o-demeton (0.05%) and Monocrotophos (0.040%) were most toxic, while Malathion (0.05%) was least toxic (Kumar et al. 1996).

On the basis of LC50, Oxydemeton-methyl(0.025%) was shown more effective to the *L. erysimi* than Chlorpyrifos or Quinalphos. Chlorpyrifos was 1.488 and Oxydemeton-methyl 42.13 times more effective to aphids (Thomas and Phadke, 1996).

Investigations were conducted to evaluate the effectiveness of Chloropyriphos, Quinalphos and Oxydemeton-methyl to aphid. *L. erysimi* through laboratory bioassay. The treatments include foliar sprays with Chloropyriphos and Quinalphos at 0.03 and 0.05% and Oxydemeton-methyl at 20 days corrected percentagc of mortality counted at different days after treatment. The corrected mortality percentage of Oxydemeton-methyl at 0.025% were 100 and 84.72 at 1, 3 and 7 daysafter treatment (Thomas and Phadke. 1993).

A field experiment was carried out by Upadhyay and Aggrawal (1993a) to instigate the effects of Monocrotophos, Phosphamidon. Methyl-Dmethoate, Endosulfan, Chlorpyrifos, Malathion, Cypermethrin an Fenvalerate on *L. erysimi* in Madhya Pradesh, India in 1988-90. It was reported that all treatments except Dimethoate resulted in 100% monality after 1 day.

Upadhyay and Aggrawal (1993b) conducted an experiment during winter season to study the toxicity of 9 insecticides viz, Moonocrotophos 0.04%, Phosphamidon 0.03%. 0xydemeton-mcthyl 0.025%, Dimethoat 0.04%, Malathion 0.05%, Chloropyrifos 0.05% (6 are organophosphorus group) and Cypermethrin 0.03%. Fenvalerate 0.01% (2 are synthetic pyrithroid) and Endosulfan 0.07% (Organochlorine) for controlling the *L. erysimi* on " varuna`. Indian mustard. It was reported that Oxydemeton-methvl 0.025% and Phosphamidon 0.03% were the mosttoxic to mustard aphid.

Dust application of both the tested insecticides were less effective than their foliar spray. The bio-efficacy of inssecticides against mustard aphid under field condition was as follows Oxydemeton-methyl 0.05 >Chlorpyrifos 0.05> Quinalphos 0.05> Chloropyriphos 0.03>Quinalophos 0.03>Quinalphos 1.5>Chlorpyriphos 1.5D (Thomas and Phadke.1992)

In field experiment with different does of Chloropyrifos and Quinalphos EC and Dusts (0.03%, 05%, and 25 kg/ha) were compared to Oxydemeton-methyl 25 EC (0.025%) to evaluate their effects on L. erysimi percent reduction of aphid over control was recorded 1, 3, 5. 10 and 15 days after first spraying and was continued on the same days after second spraying. It was showed that Chloropyrifos EC was more effective than Quinalphos EC` in giving maximum reduction of aphids, although Oxydemeton-methyl was the most effective which reduced 90.48, 92.71, 88.70, 89.60 and 89.34% aphid population of the corresponding days after first spray and 96.73, 97.67, 95.41 , 83.22 and 64.56% after second spray.

The relative toxicity of 11 insecticides to apterous adult of *L. erysimi* was studied in the laboratory in India. On the basis of LC50, Oxyderneton-methyl, (Chloropyrifos, Dimethoate, Parathion methyl and Pyrethrum (0.050%) were 25.61. l l .92, 7.56, 3.79 and 1-37 times toxic as Lindane and the other 5 compounds were less toxic than Lindane (0.58 to 0.98 time) (Dhingra. 1991)

In a Field trial Zaman (l990b) studied the effectiveness of somr insecticides against L. erysimi and reported that Dimethoate (80 ml a.i/ 100 lit water). Formothion (49.5 ml a,i/100 lit water) and Pirimicarb (75 gm a.i/ 100 lit water) were highly toxic and significantly reduced aphid population/or more than 3 weeks.

A field experiment was conducted on mustard for the control of *L. erysimi* with eight insecticides viz. Carbosulfan (Marshal 20 EC), Malathion (Henpthion 57 EC), Malathion (Maladan 57 EC). Dimethoate (polygor 40 EC), Oxydemeton methyl (Metasystox 25 EC) at the dose of 2 ml/litre of water and Phosphamidon (Benicorn 100 WSC), Phosphamidon (Pillacron 100 EC), and Fenvalerate (Sumieidin 20 EC) at the dose of 1 ml/ lit water were applied as foliar spray. It was found that all the insecticides were very toxic against the aphid and reduced 100% aphid population after 120hours of spray and suggested that Malathion will be very effective in controlling mustard aphid in addition to Carbosulphan (Islam *et al*., 1990).

Carbosulfan 57.14 ml a.i/100 lit, Dimethoate 60ml/100 lit, Dichlorvos 50 ml/100 lit and Dinobuton 75ml/100 lit water were tested in the field on rape in Pakisthan ir. 1986-87 against *L. erysimi*. Carbosulfan and Dimethoate were significantly toxic than other chemicals (Zaman. 1990a)

A field experiment was conducted in 1987-88 in Bangladesh to determine the effectiveness of insecticides against *L. erysimi*, On the basis of number of aphids per 5 plants at various intervals after spraying and considering the yields.It was reported that the most effective compounds were Ripcord (Cypermethrin) 1 ml/ lit, Zolone(Phosalone) 2 ml/ lit and Malathion 2 ml/lit of water(Ahmad and Miah, 1989).

The effectiveness of 13 insecticides (5 systemic, 5 contact insecticides and 3 pyrithoids) in controlling *L. erysimi* was studied on late sown mustard during the *rabi* seasons in India by Khurana and Batra(1989). Oxydenton-methyl, Monocrotophos, Cypermethrin and Fenvalerate were the most effective of` the tested insecticides. Considering effectiveness, crop yield and economics of the different treatments Fenvalerate, Monocrotophos, Phosphamidon, Dimethoate, Oxydemeton-methyl and Cypermethrin were recommended.

The relative efficacy of eight insecticides namely Fenvalerate (0.03%), porrnothrin (0.03%), Decis (0.03%), Phosalone (0.05%), Chloropyriphos(0.02%), Cyperrnethrin (0.03%), Endosulfan and Metasystox (0.025%) were used in the field and laboratory against *L. erystmi.* Among the insecticides. Chloropyriphos (0.02%) was the most toxic to aphid (Kumar et al., I986). Tripathi et al (1988a) studied the effectiveness of several pyrethroids and organophosphate insecticides to *L.erysimi* in the laboratory. On the basis of LC50, it was concluded that the order of effectiveness of the compounds were Decamethrin (Deltamethrin) > Cypermethrin >Methyl-o-demoton > Fenvalerate > permethrin>Dimethoate > Phosphamidon > Quinal-phos.

In a trial on mustard in India, 8 Insecticides viz, Decamethrin (0.00 1%), Oxydemeton methyl and Monocrotophos(0.03%), Permethrin, Chloropyriphos 0.03%, Cypermethrin (0.05%). Phosphamidon (0.03%), Endosulfan (0.035%) were applied in sprays to the drip point against *L. erysimi* all caused 90 to 100% mortality on the first day (Nagia *et al*, 1989).

Tripathi *et al*. (1985) worked on an experiment to evaluate the relative toxicity of 10 insecticides against the aphid *L. erysimi* on *Brassica campestris* var. toria and reported that the order of toxicity of the different insecticides was Dccamethrin. Cypermethrin. Phosphamidon Methyl-o-demeton, Dimethoate,Monocrotophos. Quinalphos. Carbaryl. Endosulfan and Sevisuif.

2.6 Effect of insecticides on crop characters and seed yield of mustard

Kanchan *et al*. (2001) conducted an expenment to test Monochrotophos 0.05%, Chlorpyrifos 0.05%, Fenvalerate 0.01%, Cypermethrin 0.04%. Phosphamidon 0.04%, Endosulfan 0.06% and Dimethoate 0.04% to determine their effect on B. Compestris cv yellow carson B-9 yield. The highest yield was recorded in plants treated with Chlorpyrifos and lowest in the untreated control. Phosphamidon and Endosulfan gave the highest and lowest benefit cost ratio. From the above presentation it may he concluded that incidence have got a decisive influence on controlling the mustard aphid and their toxic effect to the predator.

Hossain (1993) observed that the growth parameters namely, plant height, number of branches, number of pods,number of seeds per pod and yield was increased significantly with the application of insecticiddes both in the field and net house condition. Ekalux (0.075%) was found to comparatively more suitable for various growth parameters and yield followed by Dimecron (0.075%),Roxion and Diazinon (0.075%), Fyanon (0.075%) was the least responsive.

The effect of one to five applicantions of 0.025%, Oxydemeton methyl at 800 lit/ ha, for the control of *L. erysimi* on mustard was studied by Ramkishore and Phadke (1988b) and reported that 2 sprays applied to an 80 to 116 days old crop resulted the greatest yield (4.00 to 4.55 tons/ha).The efficacy of 0.025% Methyl-demeton, 0 025% Quinalphos, 0,025% Formothion, 0.025%Monocrotophos, 0.03% Dimethoate, 2% Ascorbic acid and l% Acetic acid against *L. erysimi* mustard were evaluated in field by Baral *et al*, (1986) and found that Methyl-demeton was produced higher yield.Eleven varieties of Indian mustard were screened against *L. erysimi* in the field in Rajasthan. India. Aphid infstation reduced plant height, number of secondary branches per plant, numher of siliqua per plant and seed weight. Treatment with 4 sprays of 0.03% Dimethoate at fortnightly intervals gave significantly higher yields and increased economic returns (Vir and Henry, 1987)

CHAPTER III
MATERIALS AND METHODS

This chapter consists of the materials and methods those were used in conducting the experiment. It consists of a short description of location of' the experimental plot, characteristics of soil, climate, material used, treatments, layout and design of experiment, land preparation , sowing, intercultural operations, harvesting, and collection of data. These are described below:

3.1 General description of the experimental site

3.1.1 Location

The experiment was conducted in the Farm of Sher-e-Bangla Agricultural University, Dhaka during November 2012 to February 2013.

Plate 1: Experimental plot at the Farm of Sher-e-Bangla Agricultural University, Dhaka

3.1.2 Soil

The soil was silty clay in texture having 26% sand, 45% silt and 29% clay and the pH was 5.6. The physio-chemical properties of the soil are presented in Appendix I. The experimental site belongs to the Madhupur Tract Agro Ecological Zone (AEZ-28) as shown in Appendix III. The experimental site was a medium high land.

3.1.3 Climate

The climate of experimental site was under the sub-tropical climate, characterized by three distinct seasons, the winter season from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October (Edris *et al*., 1979).There was no rainfall during the month of November and December, little rain in January and February. The average maximum temperature during the period of experiment was33.8°C and the average minimum temperature was 13°C. Details of the meteorological data related to the temperature, relative humidity and rainfalls during the period of the experiment was collected from the Bangladesh Meteorological Department, Dhaka and presented in Appendix II.

3.2 Materials used

3.2.1 Planting material

The recommended variety of musrard,BARI sorisha-9 and BARI sorisha-11were used as a test crop for the study and the seeds of these varieties were collected from Bangladesh Agricultural Research Institute, Gazipur. This variety was developed by BARI and exposed for cultivation through the selection process among the different germ plasms that generally has been cultivated in different areas of Bangladesh. It is a spreading type plant and can be easily grown in minimum or shading light.

3.3Experimental Design and layout

The experiment was laid out in factorial Randomized Complete Block Design (RCBD). There were two factors A: Variety having two levels (V_1& V_2), and B: Insecticides having five levels (T_1,T_2,T_3,T_4&T_5). Each treatment was allocated randomly in three replications. The unit plot size was 2 m ×2.5 m having 0.5 m space between the blocks and 0.75 m between the plots. Each plot contains two rows having 30cm distance between the rows.

3.4 Land preparation and fertilization

The plot selected for the experiment was opened in the first week of November 2012 with a power tiller, and was exposed to the sun for a week, after which the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Each ploughing was followed by laddering to have a desirable fine tilth. Weeds and stubbles were removed, and finally obtained a desirable tilth of soil for sowing. During land preparation 10 t/ha decomposed cow dung were mixed with soil and following fertilizers were applied. Urea, TSP, MP and Boric acid as the source of Nitrogen (N), Phosphorus (P_2O_5), Potassium (K_2O) and Boron (B) fertilizers were applied @ Urea 50 kg/ha, TSP 85 kg/ha, MP 40 kg/ha and Boric acid 10 kg/ha.

3.5 Treatments of the Experiment

V_1=BARI shorisha-9

V_2=BARI shorisha-11

T_1 = Dursban

T_2 = Malithion
T_3 = Sumi-Alpha
T_4 =Sevin
T_5 = Control

Treatment combinations
[T_1V_1 = Dursban + BARI sorisha-9, T_1V_2 = Dursban + BARI sorisha-11, T_2V_1 = Malathion + BARI sorisha-9, T_2V_2 = Malathion + BARI sorisha-11, T_3V_1 = Sumi-Alpha + BARI sorisha-9, T_3V_2 = Sumi-Alpha + BARI sorisha-11, T_4V_1 = Sevin + BARI sorisha-9, T_4V_2 = Sevin + BARI sorisha-11, T_5V_1 = Control + BARI sorisha-9, T_5V_2 = Control + BARI sorisha-11]

3.6 Seed processing and treatment

The seeds of BARI sorisha-9 and BARI sorisha-11 of mustard were collected from Bangladesh Agricultural Research Institute, Gazipur. Germination test was done before sowing. The rate of germination was found more than 95%. The seeds were treated with Vitavax 200 at the rate of 2 g per kg seed to protect seedlings against alternaria leaf spot diseases.

3.7 Sowing of seeds

The seeds of mustard were sown in different plots of the experimental field on 24 November 2012 in rows with spacing 30 cm × 15 cm.

3.8 Intercultural operations

Intercultural operations like thinning, weeding and mulching were done as and when necessary for proper growth and development of the crop.

3.8.1 Irrigation

Four irrigations were given throughout the growing period. The first irrigation was given at 7 days after sowing for well growth and development of mustard plant followed by irrigation 15 days after the first irrigation and the other was done in the same way. Mulching was also done by breaking the soil crust after irrigation properly.

3.9 Diseases management

The crop damage by diseases like *Alternaria* leaf spot of mustand was negligible.

3.10 Insecticides application

Crops were infested with mustard aphids. A knapsack sprayer sprayed the selected four insecticides in the field when the inflorescence, leaves and shoots were infested with aphids. Insecticides were sprayed at 4.00 pm as requirements.

3.11 Sampling, harvesting, threshing,cleaning and processing

Maturity of crop was determined when some of 80-90% of the siliqua become golden yellow. Five plants (excluding border plant) were selected randomly from each unit plot and uprooted before harvesting for recording of necessary data. After sampling all the plants in each plot were harvested. The harvested crop of each plot was properly tagged separately bundled, and brought to the threshing floor. The harvesting crop was threshed by hand. The seed were cleaned and sundried properly. Finally seed yields/plot were recorded and converted to kg/ha.

3.12 Aphid infestation on mustard

The aphid suck sap from leaves. flowers, flower buds, pods and twigs of the plants. In case of severe infestation leaves become curled plants fail to develop pods. The infested young pods failed to mature and did not produce healthy seeds.

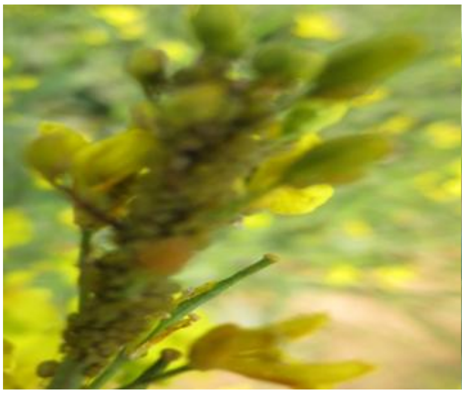

Plate-2: Aphids on inflorescence in   Plate-3: Aphids on stem in

mustard

mustard plant.plant.

3.13 Collection of data

The data were collected on following broad steps at different dates as per experimental requirement.

Step I. Data collection on mustard aphid under field condition

i. Percent of plant infested with aphids

ii. Number of aphids per plant

Step II. Data collection on crop characters

i. Plant height at harvest (cm)

ii. Number of branches per plant

iii. Number of pods per plant

iv. Pod length (cm)

v. Number of seeds per pod

vi. Weight of 1000 seed (g)

vii. Seed yield (kg/ha)

Step III: Economic evaluation of insecticides on the field of mustard

3.13.1 Percent of plant infested by aphid

At first infestations of mustard plant by mustard aphid were recorded before spraying of insecticides and then one, four and seven days after first and second application of insecticides. First spray was done after one month of seed sowing. Total number of infested and healthy plants were collected from five randomly selected rows of each plot to calculate the infestation percent of mustard plants by mustard aphid infestation percent was calculated by the following formula:

Percent of plants infested = B/A x 100

Where,

A = Total number of plants

B = Number of infested plants

The percent of plant infestation was usually converted into percent reduction of aphid infested plant by the following formula.

Percent reduction of aphid infested plant = $T_o - T_1 \div T_o \times 100$

Where

T_o = % of aphid infested plant before spraying

T_1 = % of aphid infested plant after spraying

3.13.2 Number of aphids per plant

The population of aphids in the field on the five randomly selected plants from each plot were counted before spraying of insecticides and then 1,4 and 7 days after first and second spraying of insecticides. The top 5 cm epical twigs of these selected plants were cut and brought to the laboratory in polythene bags separately. The aphids were removed from the plants with the help of a soft brush and placed on a piece of white paper. Their number was counted with the help of magnifying glass and hand tally counter. Infested twigs and inflorescence were checked carefully, so that not a single aphid could escape at the time of counting. The numbers of aphids per plant were converted in percent reduction of aphid population by using the following formula.

Percent reduction of aphid population $= T_o - T_1 / T_o \times 100$

here,

T_o = Number of aphid before spraying

T_1 = Number of aphid after spraying

3.14 Data Collection on crop characters

3.14.1 Plant height

After ripening of siliqua about 80% harvesting time was determined. Firstly five plants were randomly selected from each plot and then plant height was measured from the ground level to the tip of the selected plants.

3.14.2 Numbers of branches per plant

Total number of branchwas counted from the randomly selectedfive plants from each plot

3.14.3 Number of siliqua per plant

Total Numbers of siliqua were counted from the randomly selectedfive plantsfrom each

plot.

3.14.4 Siliqua length (cm)

Total siliqua length o randomly selected five plants per plot was regarded from the basal node of the siliqua to the apex of each siliqua.

3.14.5 Number of seeds per siliqua

Total numbers of seeds per siliqua was counted from therandomly selected five plants from each plot.

3.14.6 Weight of 1000 seeds (g)

One thousand seed were randomly collected from a sample drawn from the bulk of each plot and were dried and weighed by an electric balance.

3.14.7 Seed yield (kg/ha)

The yield obtained from each plot was converted into kg per hectare.

3.15 Statistical Analysis

The collected data on different parameters were statistically analyzed by using the Statistic 10.0 analytical software.The mean differences among the treatments were adjusted by using Tukey's HSDtest at 5% level of significance.

CHAPTER IV
RESULTS AND DISCUSSION

Results obtained from the present study regarding the performances of four insecticides and two varieties of mustard on the control of mustard aphid*Lipaphis erysimi*are presented and discussed in this chapter. The results have been presented in Table 1 to 4 and graph 1 to 7. The data on different parameters as per experimental requirement were recorded and analysis of variance were done. The results of each parameter have been adequately interpreted, elaborated and discussed in the light of relevant available research report wherever necessary.

4.1 Interactioneffect of insecticides and mustard varieties on percent reduction of aphid infested plant after first spray

The aphid suck sap from leaves, flowers, flower buds, pods and twigs of the plants. Percent reduction of aphid was significantly ($P>0.05$) influenced by insecticides at different dates of sampling. The percent reduction of aphid infested plant in different combinations at 1 ,4 and 7 Days After Treatment (DAT) are presented in Table1. Percent reduction of aphid infested plant ranged from 15.00 to 71.67% at 1 days after treatment, 18.00 to 84.337% at 4 days after treatment and 17.67 to 76.00% at 7 days after treatment. The combined effect of insecticides and varieties on percent reduction of aphid infested plant are elaborated and discussed below.

1 Days After Treatment (DAT): The highest percent reduction of aphid infested plant (71.67%) was found under the combination of T_3V_2 followed by $T_3V_1$and T_2V_2 and there was no significant difference between the combinations of T_3V_2 and T_3V_1 but significantly different between T_3V_2 and T_2V_2 combination.T_2V_2 was statistically similar with T_2V_1 and T_1V_2 but significantly different with T_1V_1 combination. T_2V_1 and T_1V_2were statistically non-significant with T_1V_1 but significantly different with T_4V_2 combination. The lowest percent reduction of aphid infested plant (15.00%) was observed under the combination of T_5V_1 and which was significantly different with all other combinations.

4 Days After Treatment (DAT): On the basis of 4 days after treatment the highest percent reduction of aphid infested plant (84.33%) was found under T_3V_2 combination, which was statistically non-significant with $T_3V_1$and T_2V_2. T_3V_1 and T_2V_2 were statistically similar with T_2V_1 and T_1V_2 but significantly different with T_1V_1 combination. T_1V_1 was significantly different with T_4V_1 and T_4V_2 combination. The lower percent reduction of aphid infested plant (64.00% and 66.33%) was observed under the combination of T_4V_1andT_4V_2 respectively, which were statistically similar with each other but significantly different with all other combinations.

7Days AfterTreatment (DAT): On the basis of 7 days after treatment the highest percent reduction of aphid infested plant (76.00%) was found under T_3V_2 combination, which was statistically non-significant with $T_3V_1$and T_2V_2 combination. T_3V_1 and T_2V_2 were statistically similar with T_2V_1, T_1V_2 and T_1V_1 combination. T_1V_1 was significantly different with T_4V_1 combination but non-significant with T_4V_2. The lowest percent reduction of aphid infested plant (59.33%) was observed under the combination of T_4V1 which was significantly different with all other combinations.

Table 01: Interactioneffect of insecticides and mustard varieties on percent reduction of aphid infested plant after first spray

Treatment Combination	% Reduction of aphid infested plant after (1^{st} spray)		
	1 DAT	4 DAT	7 DAT
T_1V_1	59.00de	73.00c	65.67bcd

T_1V_2	62.33cd	77.33bc	68.00b
T_2V_1	61.67cd	78.00bc	67.00bc
T_2V_2	64.33bc	81.67ab	69.33ab
T_3V_1	67.67ab	82.00ab	71.33ab
T_3V_2	71.67a	84.33a	76.00a
T_4V_1	52.33f	64.00d	59.33d
T_4V_2	56.67e	66.33d	60.67cd
T_5V_1	15.00h	18.00f	17.67f
T_5V_2	19.67g	23.67e	27.67e
$LSD_{(0.05)}$	4.18	5.43	6.88
CV (%)	2.69	2.86	4.03

*DAT= Days After Treatment
In a column, means having the same letter (s)are not significantly different by Tukey's HSD test.
[T_1V_1 = Dursban + BARI sorisha-9, T_1V_2 = Dursban + BARI sorisha-11, T_2V_1 = Malathion + BARI sorisha-9, T_2V_2 = Malathion + BARI sorisha-11, T_3V_1 = Sumi-Alpha + BARI sorisha-9, T_3V_2 = Sumi-Alpha + BARI sorisha-11, T_4V_1 = Sevin + BARI sorisha-9, T_4V_2 = Sevin + BARI sorisha-11, T_5V_1 = Control + BARI sorisha-9, T_5V_2 = Control + BARI sorisha-11]

4.2.1 Interactioneffect of insecticides and mustard varieties on percent reduction of aphidinfested plant after second spray

There was significant (P >0.05) effect on percent reduction of aphid-infested plant due to the combination of insecticides and varieties at different sampling dated after second spray under field condition. The reduction of aphid infested plant after second spray under field condition are presented in table 2. The percent reduction of aphid infested plant ranged from 17.67% to 74.33 % at 1 days after treatment, 20.33% to 86.67% at 4 days after treatment and 21.67% to 78.33% at 7 days after treatment. The combined effect of insecticides and varieties on percent reduction of aphid infested plant are elaborated and discussed below.

1 Days After Treatment (DAT): The highest percent reductionof aphid infested plant (74.33%) was found under T_3V_2 combination , which was statistically non-significant with T_3V_1 but significantly different with T_2V_2. T_3V_1 and T_2V_2 were statistically similar with each other but T_3V_1 was significantly different with T_2V_1 combination. T_1V_1 was significantly different with T_4V_1 and T_4V_2 combination. The lower percent reduction of aphid infested plant (64.00% and 66.33%)was observed under the combination of $T_4V_1$and T_4V_2 respectively, which were statistically similar with each other but significantly different with all other combinations

4 Days After Treatment (DAT): The highest percent reduction of aphid infested plant (86.67%) was found under T_3V_2 combination followed by T_3V_1, T_2V_2 and T_2V_1 which were statistically similar with each other. T_3V_1,T_2V_2,$T_2V_1$and T_1V_2 were statistically similar with each other but significantly different with T_1V_1 combination. T_1V_1 was significantly different with T_4V_1 and T_4V_2 combination. The lower percent reduction of aphid infested plant (65.33% and 67.67%) was observed under the combination of $T_4V_1$and T_4V_2 respectively, which were statistically similar with each other but significantly different with all other combinations

7 Days After Treatment (DAT): The highest percent reduction of aphid infested plant (78.33%) was found under T_3V_2 combination followed by $T_3V_1$and T_2V_2 which were statistically similar with each other. T_2V_1, T_1V_2 and T_1V_1 were statistically similar with each other but significantly different with T_4V_1 and T_4V_2 combination. The lower percent reduction of aphid infested plants (60.33% and 67.67%) was observed under the combination of $T_4V_1$and T_4V_2 respectively, which were statistically similar with each other but significantly different with all other combinations
In case of seconds spraying similar percent reduction of aphid infested plant was recorded as first spray at 1,4 and 7 days after treatment . Significant percent reduction of aphid infested plants were recorded after 4 days both first and second spraying of insecticides. The highest percent reduction of aphid-infested plants was observed at 4 days after treatment.

Table 02. Interactioneffect of insecticides and mustard varieties on percent reduction of aphidinfested plant after second spray

Treatment Combination	% Reduction of aphid infested plant after (2nd spray)		
	1 DAT	4 DAT	7 DAT
T_1V_1	60.67de	74.33c	69.00bc
T_1V_2	64.00cd	78.00bc	69.33bc

T_2V_1	63.33cd	80.33abc	69.67bc
T_2V_2	66.33bc	82.33ab	70.67ab
T_3V_1	70.00ab	84.00ab	73.67ab
T_3V_2	74.33a	86.67a	78.33a
T_4V_1	53.67f	65.33d	61.33cd
T_4V_2	57.67ef	67.67d	60.67d
T_5V_1	17.67g	20.33e	21.67e
T_5V_2	20.00g	23.33e	25.33e
$LSD_{(0.05)}$	4.39	6.59	8.66
CV (%)	2.74	3.40	4.96

*DAT= Days After Treatment

In a column, means having the same letter (s)are not significantly different by Tukey's HSD test.

[T_1V_1 = Dursban + BARI sorisha-9, T_1V_2 = Dursban + BARI sorisha-11, T_2V_1 = Malathion + BARI sorisha-9, T_2V_2 = Malathion + BARI sorisha-11, T_3V_1 = Sumi-Alpha + BARI sorisha-9, T_3V_2 = Sumi-Alpha + BARI sorisha-11, T_4V_1 = Sevin + BARI sorisha-9, T_4V_2 = Sevin + BARI sorisha-11, T_5V_1 = Control + BARI sorisha-9, T_5V_2 = Control + BARI sorisha-11]

4.3.1 Interactioneffect of insecticides and mustard varieties on percent reduction of aphid population after first spray

The percent reduction of aphid population varied at different times significantly (P>0.05) among the insecticides. Table 3 shows that the reduction of aphid population ranged from 19.67% to 87.67% at 1 days after treatment, 21.67% to 92.67% at 4 days after treatment and 22.67 % to 77.00% at 7 days after treatment.Percent reduction of aphid population after first spray under field condition are presented and discussed here.

1 Days after treatment (DAT): The highest percent reduction of aphid infested plant (87.67%) was found under T_3V_2 combination followed by T_3V_1, T_2V_2, T_2V_1 andT_1V_2combination,which were statistically similar with each other.T_2V_2 and T_1V_2 were statistically similar with each T_1V_1 but significantly different with T_4V_1 and T_4V_2 combination. The lower percent reduction of aphid infested plant (72.00% and 72.67%) was observed under the combination of $T_4V_1$and T_4V_2 respectively which were statistically similar with each other.

4 Days After Treatment (DAT): The highest percent reduction of aphid population(92.5%) was observed under the combination of T_3V_2 Followed by T_3V_1, T_2V_2 andT_2V_1which were statistically similar with each other. T_2V_2 and T_2V_1 werestatistically similar with T_1V_2 and T_1V_1 combination but statistically non-significant with T_4V_1 and T_4V_2 combination. T_1V_2 was statistically non-significant with all other treatments.The lowest percent reduction of aphid population (80.67)was observed under T_4V_2 combination.

7 Days After Treatment (DAT): The highest percent reduction of aphid population(77.00%) was recorded in T_3V_2 followed by T_3V_1, T_2V_2, T_2V_1 and T_1V_2 combination which were statistically similar with each other. T_2V_2, T_2V_1 and T_1V_1 were statistically similar with each other but significantly different with T_4V_1 and T_4V_2 combination.The lowest result was observed in T_4V_1 (60.67%) combination which was statistically non-significant with T_4V_2 but significantly different with all other combinations.

Table 03.Interactioneffect of insecticides and mustard varieties on percent reduction of aphid population after first spray

Treatment Combination	% Reduction of aphid population after (1st spray)		
	1 DAT	4 DAT	7 DAT
T_1V_1	77.67bc	84.67bc	71.67ab
T_1V_2	81.00ab	88.00abc	73.00a
T_2V_1	84.67ab	89.33ab	71.67ab
T_2V_2	87.00a	91.33ab	71.33ab
T_3V_1	86.67a	92.33a	75.33a
T_3V_2	87.67a	92.67a	77.00a
T_4V_1	72.67c	81.00c	60.67c
T_4V_2	72.00c	80.67c	61.67c
T_5V_1	19.67d	21.67d	22.67d
T_5V_2	24.33d	25.67d	26.33d
$LSD_{(0.05)}$	7.42	7.51	9.03
CV (%)	3.66	3.43	5.03

*DAT= Days After Treatment

In a column, means having the same letter (s)are not significantly different by Tukey's HSD test.

[T_1V_1 = Dursban + BARI sorisha-9, T_1V_2 = Dursban + BARI sorisha-11, T_2V_1 = Malathion + BARI sorisha-9, T_2V_2 = Malathion + BARI sorisha-11, T_3V_1 = Sumi-Alpha + BARI sorisha-9, T_3V_2 = Sumi-Alpha + BARI sorisha-11, T_4V_1 = Sevin + BARI sorisha-9, T_4V_2 = Sevin + BARI sorisha-11, T_5V_1 = Control + BARI sorisha-9, T_5V_2 = Control + BARI sorisha-11]

4.4.Interactioneffect of insecticides and mustard varieties on percent reduction of aphidpopulation after 2nd spray under field condition

All the combination of insecticides and varieties were significant ($P>0.05$) in respect of percent reduction of aphid population. Table 4 it revealed that the reduction of aphid population ranged from 18.67 to 87.33% at 1 days after treatment, 21.33 to 95.00% at 4 days after treatment and 21.67 to 82.00% at 7 days after treatment. Percent reduction of` aphid population are affected by the application of insecticides are elaborated and described here.

1 Days After Treatment (DAT): The highest percent reduction of aphid population(87.33%) was found in T_3V_2 combination followed by T_3V_1, T_2V_2 and T_2V1 and there is no statistically significant difference among them. T_2V_2 and T_2V_1 was non-significant with T_1V_2 and T_1V_1 but significantly different with T_4V_1 and T_4V_2 combination. The lowest percent reduction of aphid population (65.67%) was recorded from T_4V_2, which was statistically non-significant with T_4V_1.

4 Days After Treatment (DAT): The highest percent reduction of aphid population(95.00%) was observed under the combination of T_3V_2 combination followed by T_3V_1, T_2V_2 and T_2V_1combination but they were statistically non-significant with each other. T_2V_2 and T_2V_1 was statistically similar with T_1V_1 and T_1V_2 but statistically significant with T_4V_1 and T_4V_2 combination. The lowest percent reduction of aphid population (75.00)was observed under the combination of T_4V_2 that was statistically non-significant with T_4V_1.

7 Days After Treatment (DAT): The highest percent reduction of aphid population(82.00%) was recorded from T_3V_2 combination followed by T_3V_1 and T_2V_2. T_3V_2 was statistically similar with T_3V_1 and T_2V_2. T_3V_1 and T_2V_2 were statistically non-significant with T_2V_1 but significantly different with T_1V_2. T_2V_1 was statistically non-significant with T_1V_1 and T_1V_2 but significantly different with T_4V_1. The lowest value was observed in T_4V_2 combination (61.17%) that is statistically similar with T_4V_1 but significantly different with all other treatments

Table 04.Interactioneffect of insecticides and mustard varieties on percent reduction of aphid population after second spray

Treatment Combination	% Reduction of aphid population after (2^{nd} spray)		
	1 DAT	**4 DAT**	**7 DAT**
T_1V_1	73.00bc	81.33bc	69.67cd
T_1V_2	73.67bc	81.67bc	68.67cd
T_2V_1	81.33ab	87.33ab	73.00bc
T_2V_2	83.00ab	89.33ab	78.00ab
T_3V_1	85.00a	94.67a	81.00ab
T_3V_2	87.33a	95.00a	82.00a
T_4V_1	69.33c	77.00c	60.78e
T_4V_2	65.67c	75.00c	60.67e
T_5V_1	18.67d	21.33d	21.67f
T_5V_2	21.67d	23.00d	24.33f
$LSD_{(0.05)}$	10.03	9.36	8.09
CV (%)	5.21	4.41	4.46

*DAT= Days After Treatment

[T_1V_1 = Dursban + BARI sorisha-9, T_1V_2 = Dursban + BARI sorisha-11, T_2V_1 = Malathion + BARI sorisha-9, T_2V_2 = Malathion + BARI sorisha-11, T_3V_1 = Sumi-Alpha + BARI sorisha-9, T_3V_2 = Sumi-Alpha + BARI sorisha-11, T_4V_1 = Sevin + BARI sorisha-9, T_4V_2 = Sevin + BARI sorisha-11, T_5V_1 = Control + BARI sorisha-9, T_5V_2 = Control + BARI sorisha-11]

4.7.2 Number of branches per plant

Figure 1: showed that the number of branches per plant ranged from 5.33 to 11.67.The highest number of branch per plant (11.67) was obtained in T_1V_1 combination which was statistically non-significant with T_2V_1, T_4V_2 and T_3V_1 combination. T_1V_2 and T_2V_2 combination have no significant difference with T_3V_2 and T_4V_1 combination but significantly different with T_5V_2. The lowest number of branch was found in T_5V_2 (5.33) that was statistically non-significant with T_5V_1but significantly different with T_1V_2 and T_2V_2 combination.

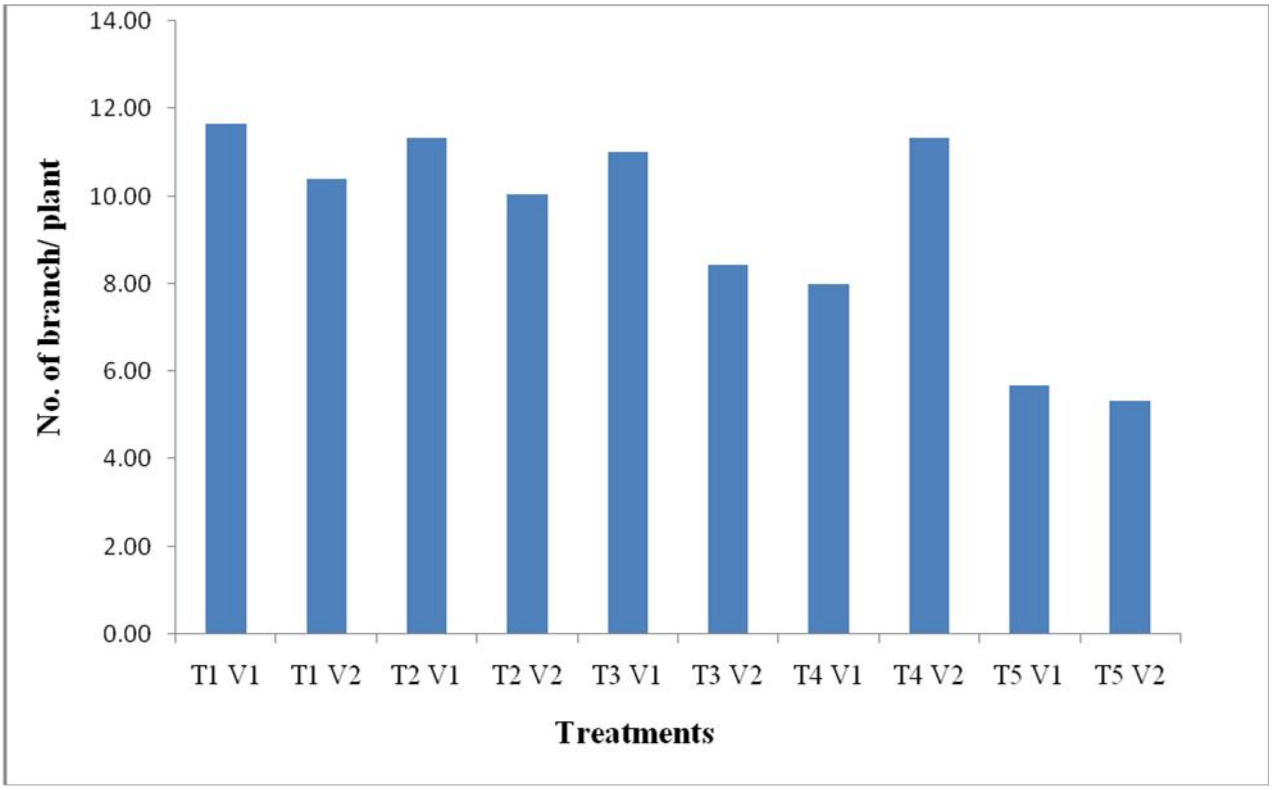

Figure1: Interaction effect of insecticides andvarieties on numberof branch /plant

[T_1V_1 = Dursban + BARI sorisha-9, T_1V_2 = Dursban + BARI sorisha-11, T_2V_1 = Malathion + BARI sorisha-9, T_2V_2 = Malathion + BARI sorisha-11, T_3V_1 = Sumi-Alpha + BARI sorisha-9, T_3V_2 = Sumi-Alpha + BARI sorisha-11, T_4V_1 = Sevin + BARI sorisha-9, T_4V_2 = Sevin + BARI sorisha-11, T_5V_1 = Control + BARI sorisha-9, T_5V_2 = Control + BARI sorisha-11]

4.7.3 Number of siliqua per plant

The number of siliqua per plant is one of the most contributing characters towards seed yield per unit area in mustard. Number of pods per plant ranged from 61.67 to 134.33 (Fig.2). The highest number of pod per plant was obtained from T_3V_2 combination which is statistically non-significant with T_3V_1 and T_4V_2 combination. T_2V_1 combination is statistically non-significant with T_3V_1, T_4V_2 and T_2V_2 combination but significantly different with T_3V_2 combination. T_1V_2 was statistically significant with T2V2 combination. T_1V_1 was not significantly different with T_5V_2 and T_4V_1 but significantly different with T_1V_2 combination. The lowest number of pod per plant was observed in T_5V_1 combination which was significantly different with all other treatments. It was observed that T3V2 combination produced the maximum number of pods per plant whereas the minimum of pods per plant was found in control treatment. So T_3V_2 combination would be suggested for best result.

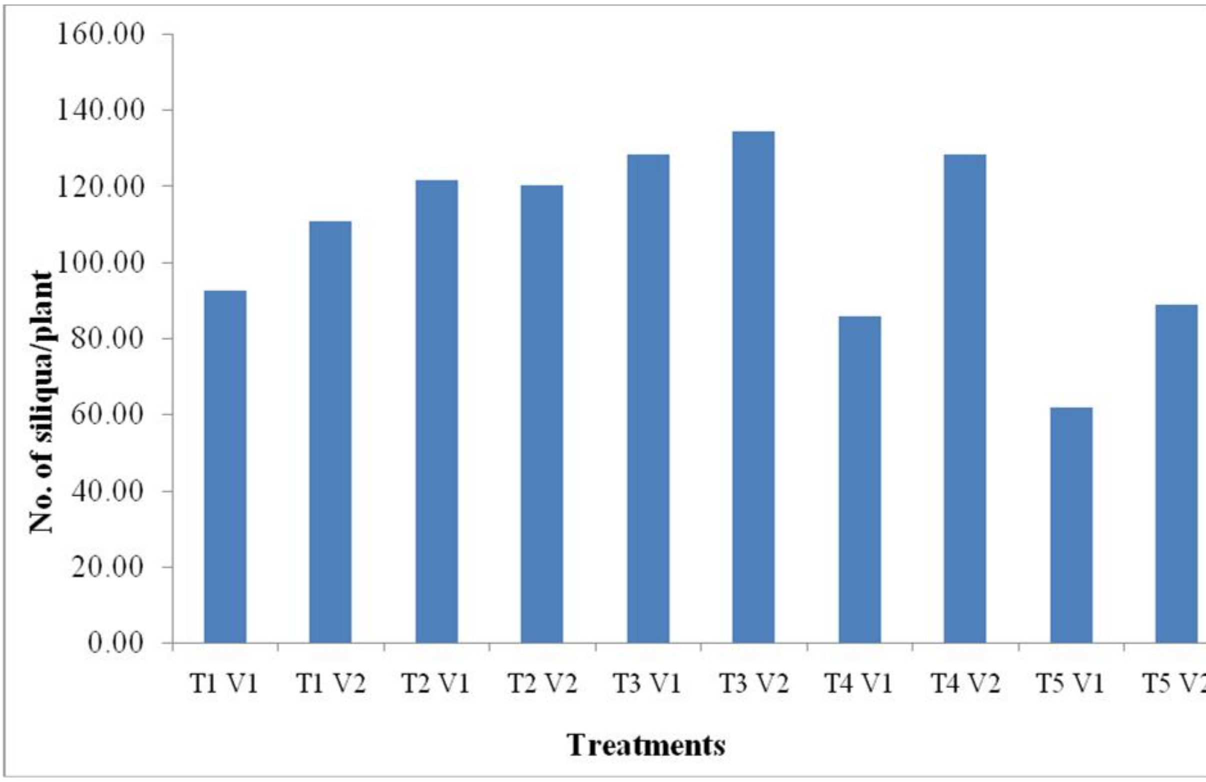

Figure2: Interaction effect ofinsecticides and mustard varieties on number of siliqua /plant

[T_1V_1 = Dursban + BARI sorisha-9, T_1V_2 = Dursban + BARI sorisha-11, T_2V_1 = Malathion + BARI sorisha-9, T_2V_2 = Malathion + BARI sorisha-11, T_3V_1 = Sumi-Alpha + BARI sorisha-9, T_3V_2 = Sumi-Alpha + BARI sorisha-11, T_4V_1 = Sevin + BARI sorisha-9, T_4V_2 = Sevin + BARI sorisha-11, T_5V_1 = Control + BARI sorisha-9, T_5V_2 = Control + BARI sorisha-11]

4.7.4 Siliqua length (cm)

Figure3: shows that siliqua length varied from 4.39 to 6.03 cm. However the longest siliqua length (6.03 cm) was obtained from T_2V_1 combination which was statistically non-significant with T_3V_2combination. T_3V_1 combination was statistically non-significant with T_4V_1 and T_1V_1 combination but significantly different with T_2V_1 and T_3V_2 combination. T_5V_2, T_2V_2, T_4V_2. T_5V_1 and T_1V_2 were not significantly different with each other but significantly different with rest of the combinations. All the treated plants increased siliqua length over the control.

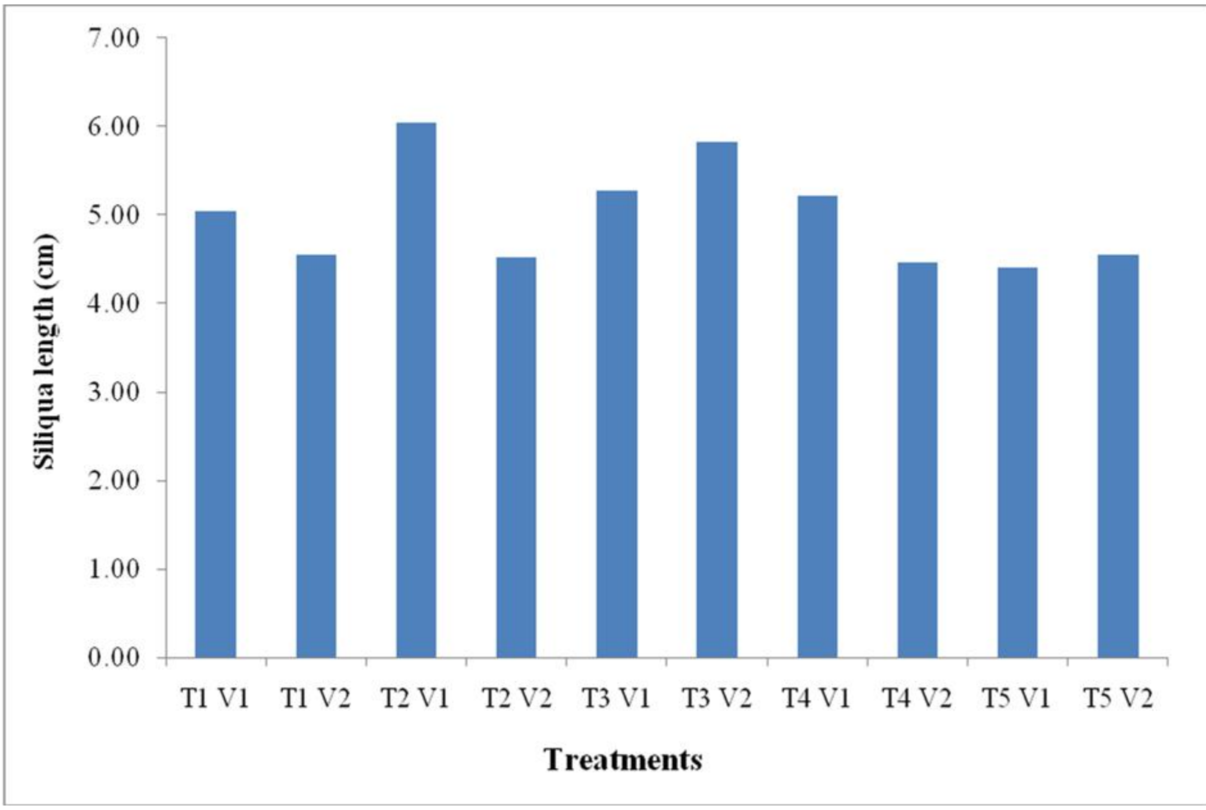

Figure3: Interaction effect ofinsecticides and mustard varieties on Siliqua length (cm)

[T_1V_1 = Dursban + BARI sorisha-9, T_1V_2 = Dursban + BARI sorisha-11, T_2V_1 = Malathion + BARI sorisha-9, T_2V_2 = Malathion + BARI sorisha-11, T_3V_1 = Sumi-Alpha + BARI sorisha-9, T_3V_2 = Sumi-Alpha + BARI sorisha-11, T_4V_1 = Sevin + BARI sorisha-9, T_4V_2 = Sevin + BARI sorisha-11, T_5V_1 = Control + BARI sorisha-9, T_5V_2 = Control + BARI sorisha-11]

4.7.5 Number of seeds per siliqua

The variation due to insecticides and varieties was significant for the number of seeds per siliqua. Figure 4: showed the number of seeds per siliqua ranged from 12.84 to 21.70. The highest number of seeds per pod (21.70) was produced by the T_3V_2 combination which was significantly different with T_4V_1 combination. T_1V_1 and T_2V_1 were statistically non-significant with T_5V1 and T_4V_1 combination. T_4V_2 and T_3V_1 were statistically non-significant with T_2V_2 and T_5V_1 combination. T_1V_2 was statistically non-significant with T_5V_2. The lowest value was obtained from T_5V_2 combination

Hossain (1993) stated that number of seeds per pod were increased significantly by the application of insecticides. All the insecticides were significantly higher than the control treatment. Among the insecticides the Sumi-Alpha was produced highest number of seeds per pod.

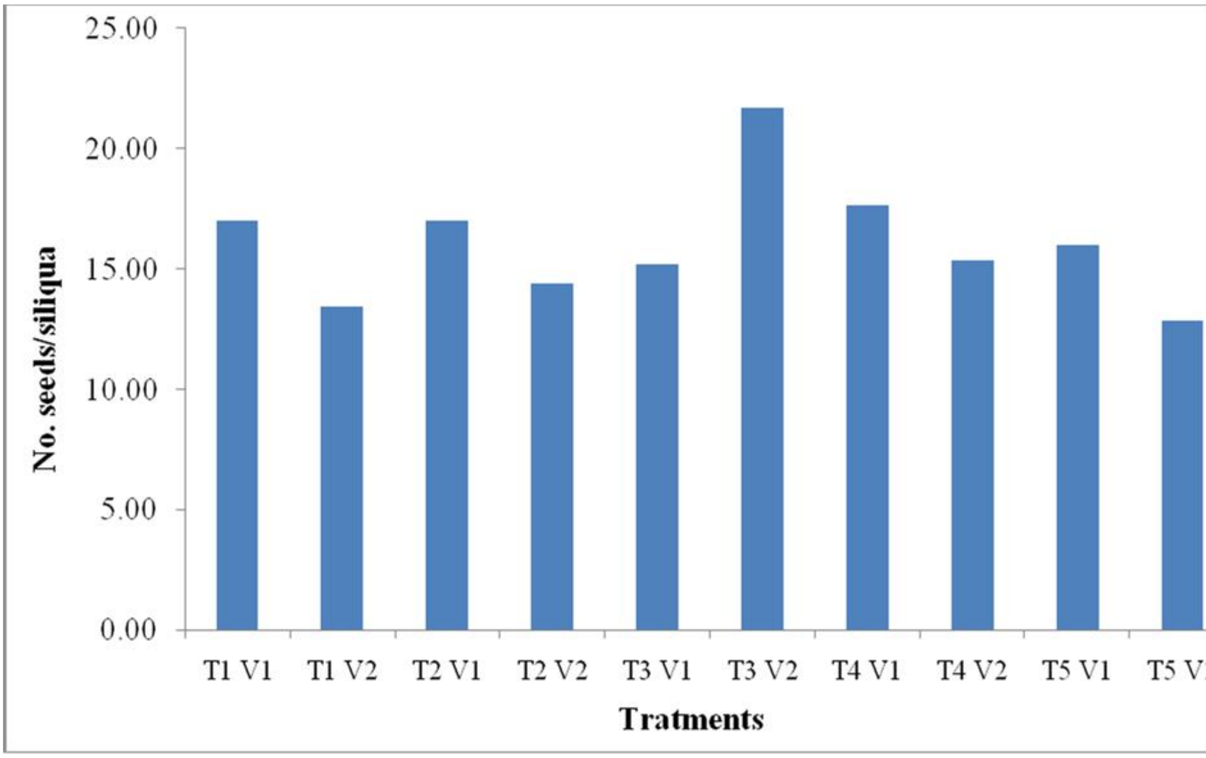

Figure4: Interaction effect of insecticides and mustard varieties on seeds/siliqua

[T_1V_1 = Dursban + BARI sorisha-9, T_1V_2 = Dursban + BARI sorisha-11, T_2V_1 = Malathion + BARI sorisha-9, T_2V_2 = Malathion + BARI sorisha-11, T_3V_1 = Sumi-Alpha + BARI sorisha-9, T_3V_2 = Sumi-Alpha + BARI sorisha-11, T_4V_1 = Sevin + BARI sorisha-9, T_4V_2 = Sevin + BARI sorisha-11, T_5V_1 = Control + BARI sorisha-9, T_5V_2 = Control + BARI sorisha-11]

Unfilled siliqua/ plant

The highest number of unfilled siliqua (8.9) was found in the combination T_5V_1 which is statistically non-significant with T_5V_2 combination. T_1V_2 combination was significantly different with T_5V_2 combination. T_2V_1 was not significantly different with T_3V_2 and T_2V_1 combination but significantly different with T_1V_2 combination. T_4V_2 was statistically non-significant with T_4V_1 and T_1V_1 combination but significantly different with T_2V_1 combination. The lowest number of unfilled siliqua was obtained from T_3V_2 combination which was significantly different with all the combinations. So, T_3V_2 combination is the best for getting maximum yield.

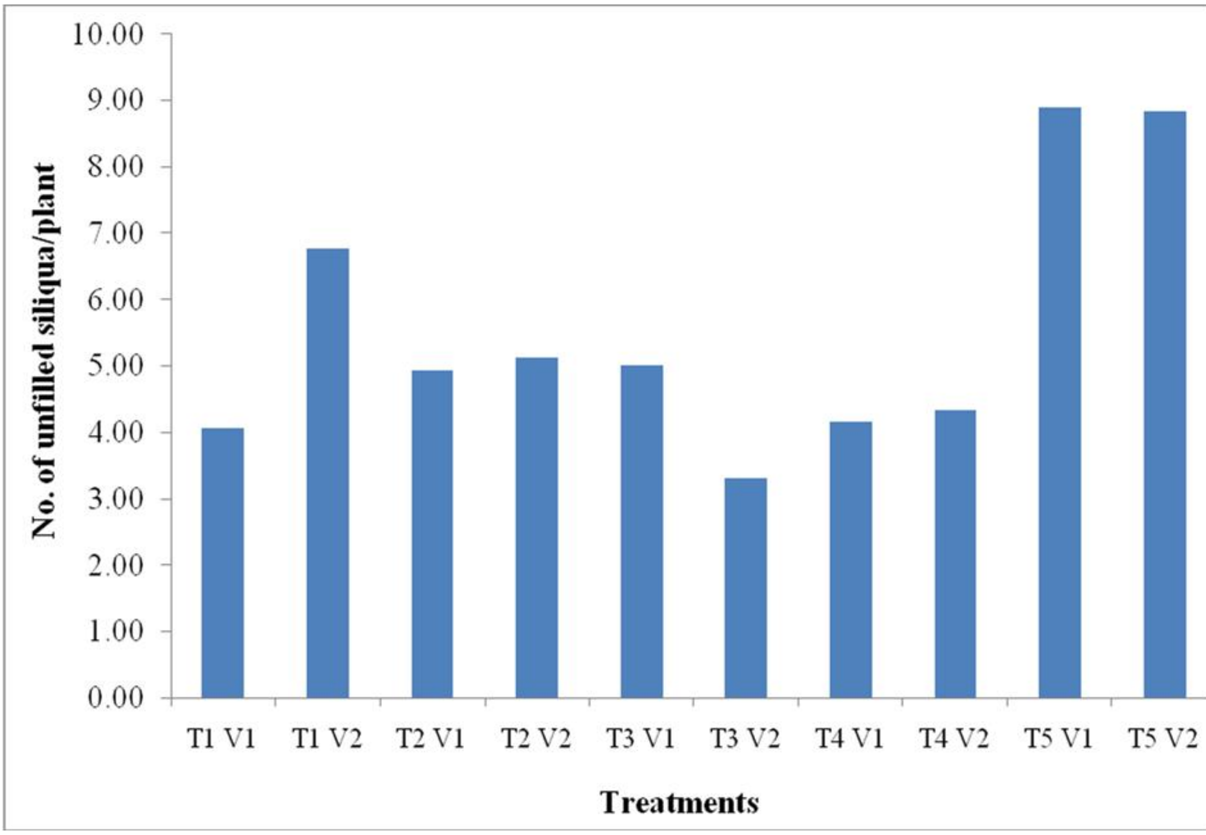

Figure5: Interaction effect ofinsecticides and mustard varieties on number of unfilled siliqua/plant

[T_1V_1 = Dursban + BARI sorisha-9, T_1V_2 = Dursban + BARI sorisha-11, T_2V_1 = Malathion + BARI sorisha-9, T_2V_2 = Malathion + BARI sorisha-11, T_3V_1 = Sumi-Alpha + BARI sorisha-9, T_3V_2 = Sumi-Alpha + BARI sorisha-11, T_4V_1 = Sevin + BARI sorisha-9, T_4V_2 = Sevin + BARI sorisha-11, T_5V_1 = Control + BARI sorisha-9, T_5V_2 = Control + BARI sorisha-11]

4.7.6 Thousand seed weight

Figure 06: shows that the highest 1000- seed weight (3.17 g) was obtained under the combination of T_3V_2 which was statistically similar to T_1V_2 combination. T_2V_2 combination was significantly different from T_3V_2 and T_1V_2 combination. T_3V_1 combination was statistically non-significant with T_2V_1 but significantly different with T_2V_2 combination. T_4V_2 combination was not significantly different with T_2V_1 combination. T_1V_1 and T_5V_2 were not significantly different with each other but significantly different with T_4V_1 combination. The lowest value was obtained from T_5V_1 combination which is statistically similar to T_4V_1 combination but significantly different with rest of the combinations. So T_3V_2 combination would be followed to get maximum results.

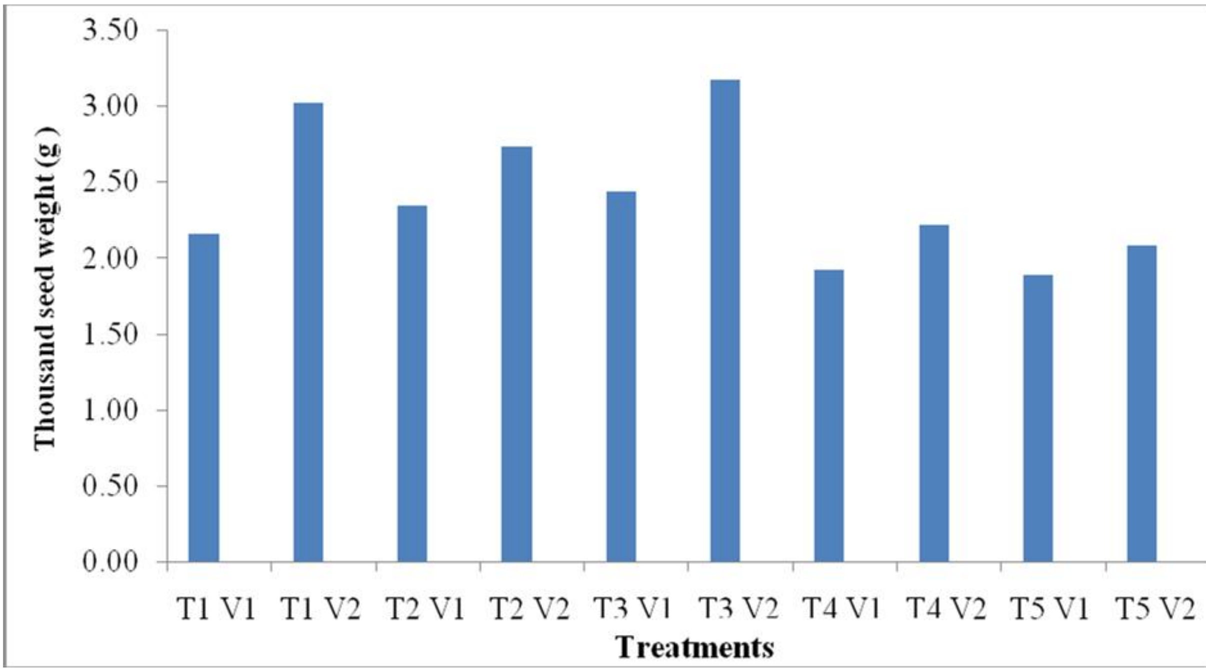

Figure 6: Interaction effect of insecticides and mustard varieties on thousand seed weight(g)

[T_1V_1 = Dursban + BARI sorisha-9, T_1V_2 = Dursban + BARI sorisha-11, T_2V_1 = Malathion + BARI sorisha-9, T_2V_2 = Malathion + BARI sorisha-11, T_3V_1 = Sumi-Alpha + BARI sorisha-9, T_3V_2 = Sumi-Alpha + BARI sorisha-11, T_4V_1 = Sevin + BARI sorisha-9, T_4V_2 = Sevin + BARI sorisha-11, T_5V_1 = Control + BARI sorisha-9, T_5V_2 = Control + BARI sorisha-11]

4.7 Yield

It was evident from analysis of variance that insecticides had a significant effect on seed yield of mustard. Seed yield varied from 1146.66 kg to 430 kg/ ha due to the application of different insecticides and varietal factor. T_3V_2 combination was statistically significant with T_3V_1. T_1V_1 and $T_5V_1$was statistically non-significant but significantly different with other treatments. The lowest result was found in T_5V_2 combination which was significantly different with all other combinations. So treatment three and variety two shows better result and their combination showed maximum result. That’s why T_3V_2 combinations would be preferred for getting maximum yield of mustard. All the treated plants showed significant increase of seed yield over the control treatment except T_5V_1. The application of Sumi-Alpha was the best in performance. The above result lead to a decision that Sumi-Alpha is appropriate for the control of mustard aphid.

Hossain (1993) stated that seed yield was increase significantly with the application of different insecticides in the field condition. Considering the seed yields. Ahmed and Miah (1989) reported that pyrithroid group insecticide cypermethrin was the most effective treatment for the control of mustard aphid. From the above discussion, if was evident that all the crop characters such as plant height, number of branches per plant, pod length, number of seed per pod, weight of 1000 seeds and seed yield were significantly increased over the control with the application of insecticides. Number of` pods per plant were not significantly different with the application of insecticides. To obtain maximum seed yield per unit area it appears that number of plants per unit area is one of the most important factor. Increase in seed yield due to application of insecticides was mainly due to improvement in yield component such as number of pods per plant, pod length, number of seeds per pod and weight of 1000 seeds. Overall growth in insecticides were treated plant might he high due to the control of mustard aphid which led to the plants a healthy growth over control treatment.

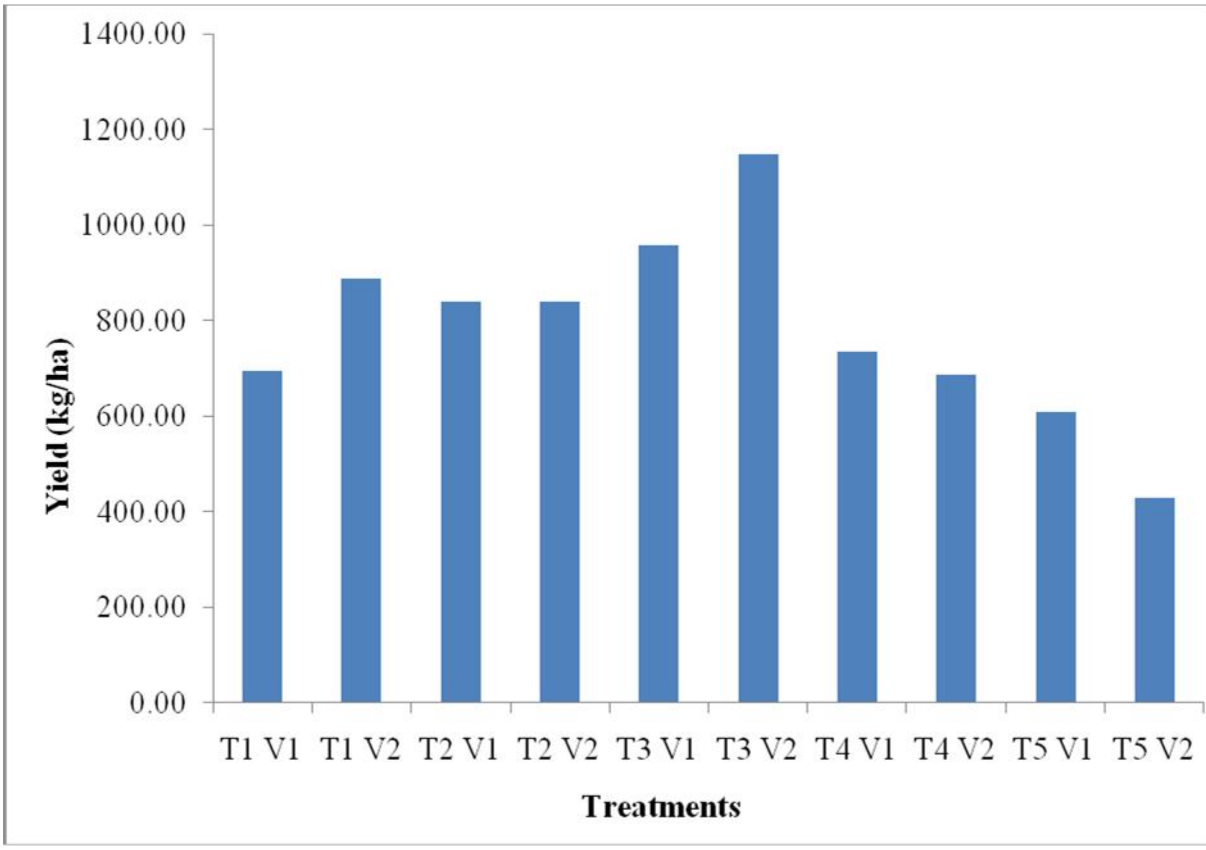

Figure 7: Interaction effect ofinsecticides and mustard varieties on yield (kg/ha)

[T_1V_1 = Dursban + BARI sorisha-9, T_1V_2 = Dursban + BARI sorisha-11, T_2V_1 = Malathion + BARI sorisha-9, T_2V_2 = Malathion + BARI sorisha-11, T_3V_1 = Sumi-Alpha + BARI sorisha-9, T_3V_2 = Sumi-Alpha + BARI sorisha-11, T_4V_1 = Sevin + BARI sorisha-9, T_4V_2 = Sevin + BARI sorisha-11, T_5V_1 = Control + BARI sorisha-9, T_5V_2 = Control + BARI sorisha-11]

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at Sher-e-Bangla Agricultural university farm , Dhaka in the rabi season during the period from November 2012 to February 2013 with a view to evaluate the effectiveness of insecticides in controlling mustard aphid and compare two varieties of mustard (BARI sarisha-9 and BARI sarisha-11).

The experiment was laid out in randomized complete block design with insecticides such as Dursban 25EC, Malathion 57EC, Sumi-Alpha 5EC and Sevin 85 SP in the unit plots, respectively replicated three times. The plot size was 2.5m × 2m. The land was prepared finally by ploughing with the country plough followed by laddering to level the soil. Urea, TSP, MP and Boric acid as the source of Nitrogen (N), Phosphorus (P_2O_5), Potassium (K_2O) and Boron (B) fertilizers were applied @ Urea 50 kg/ha, TSP 85 kg/ha, MP 40 kg/ha and Boric acid 10 kg/ha. The seeds of mustard were sown in different plots of the experimental field on 24 November 2012. Intercultural operations like thinning, weeding and mulching were done as and when necessary for proper growth and development of the crop. The experimental plots were treated with insecticides as per experimental requirements. Data were analyzed statistically using the “Analysis of Variance” technique and mean differences were adjusted by LSD.

Percent reduction of aphid infested plant was significantly different and affected by both spaying of insecticides at different dates of sampling. All the combinations were found to be effective. Among the combination T_3V_2 was the most effective in controlling mustard aphid (71.67, 81.30 and 76.00%) at 1DAT, 4DAT and 7DAT respectively after first spray and (74.33, 86.67.00 and 78.33%) reduction of aphid population at 1DAT, 4DAT and 7DAT respectively after second spray. On the other hand $T_5V_1$was less effective in most of the cases to mustard aphid. Insecticides had a significant effect on most of the crop characters. The seed yield of all the combinations were significantly better than control.

CONCLUSION

So, it can be concluded that Sumi-Alpha is the most effective insecticide for controlling mustard aphid *L. erysimi*. Sevin was less effective in controlling mustard aphid. BARI sorisha-11 was better than BARI sharisha-9. Another important thing is T_3V_2(Sumi-Alpha and BARI sorisha-11) combinations performance werebetter than all other combinations. However, more studies are necessary to confirm the findings.

Considering the findings of the study the following recommendations can be drawn:

1. The T_3V_2(Sumi-Alpha @ 1.0ml/L of water + BARI shorisha-11) may be suggested for control of Mustard aphid and better yield.
2. Further study can be conducted with different doses of other insecticides.

Further intensive studies based on different insecticides and varieties combination practice should be done.

CHAPTER VI
REFERENCES

Abbott's, W.S. (1925). A method of computing the effectiveness of insecticides.*J.Econ. Entomol*.**18**: 265-267.

Aggarwal, B.K., Das, S. and Senchowghuri, M. (1988). Biology and food relation of *Micraspis disprder* and *aphidophagous coccinellid* in India.*J.Aphidol*.**2**(1-2): 7-17.

Aggarwal, N., Rohilla, H.R. and Singh, H. (1996).Effect of mustard aphid *Lipahis erysimi*(Kalt.) infestation on the yield contributing trait of some rapeseed mustard genotypes.*Annual Agril. Res*. **17**(1): 18-21.

Ahmad, M. and Miah, R.U. (1989). Screening of insecticides for the control of mustard aphid *L*. pseudobrassicae Dav. *Indian J. Entomol*.**51**(4): 366-368.

Ahmed, A. and Mannan, M. A. (1977).Studies on the comparative effectiveness of Malathion 57 EC at three different dosages on mustard aphid.*Bangladesh J.Agril. Res*.**1**(2): 67-68.

Ahmed, M.U., Ahmed, A. and Mannan, M.A. (1977).Studies on the comparativeeffectiveness of organophosphorus insecticides for control of mustard aphid in Bangladesh.*Bangladesh J. Agril. Res*. **11**(2): 16-19.

Alam, M.Z., Ahmed, A. and Siddique, A. (1964A). Control of winter aphid in EastPakistan.Abstract of the research paper, Divi.Entomol.p. 37.

Amjad, M. and Peters, D.C. (1972). Survival, development and reproduction of turnip aphid on oil seed *Brassica*. *J. Econ. Entomol*.**85**(5): 2005- 2007.

Anand, R.K. (1983). Predation of *Coccinella septempunctata* L. and *Menochilus sexmaculatus*Fab.on five species of aphids. *Proanikee*.**4**: 234-237.

Arora, K.S., Sanini, L.M., Sandbu, R.S. and Mahendera, A.S. (1969).Effect of insecticides on yield and quality in Indian mustard, *Brassica juncea* L. *Indian J. Agril. Sci*. **39**(5): 444-447. 48

Atwal, A.S.(1976). Pest of oilseed crops. Agricultural pests of India and South- East Asia,Kalyani Publishers. p. 520.

Awasthi, C.J. (1993). Incidence of mustard aphid (*Lipaphis erysimi* Kalt.) in arid zone.*Uttar Pradesh J. Zool*. **13**(1): 31-32.

Bakhetia, D.R.C. and Sidhu, R.S. (1983).Differential response of *Brassica*species/varieties to the aphid, *Lipaphis erysimi* (Kalt.).*J. Res. Punjab. Agric. Univ*. **10**: 272-279.

Bakhetia, D.R.C. and Sidhu, R.S. (1980).Taxonomic status of mustard aphid, *Lipaphis erysimi*Kalt. (Homoptera: Aphididae). *J. Ent. Res*. **4**(1): 105-106.

Bakhetia, D.R.C. (1983). Losses in rapseed/mustard due to *Lipaphis erysimi* (Kalt.) inIndia: A literature study proc. 6th Intern. Rape seed conf. Paris. May 16-20: 1142-1147.

Bakhetia, D.R.C. and Sekhon, B.S. (1984). A review of research work on insect pest of rapseed-mustard in India. A paper presented at the all India annual rabi oilseeds workshop of rapseed-mustard, safflower and linseed, held at Sukhadia Univ. Agril. Res. Sta. Duragapura, Rajasthan, August 6-10, 1084. p. 5

Bakhetia, D.R.C. (1986). Pest management in rapeseed and mustard.*Pesticides* **20**: 32-38.

Baral, K., Dasgupta, B., Ghosh, R.K. and Chattergee, B.N. (1986).Chemical control of mustard aphid, *L. erysimi* Kalt.*Pesticides*.**20**(6): 13-14.

BARC (Bangladesh Agricultural Research Council); (1997). Fertilizer recommendation guide, Pub. BARC, New Airport Road, Farmgate, Dhaka. p. 14-123.

BBS (Bangladesh Bureau of Statistics); (2005).The Year Book of Agricultural Statistics of Bangladesh. Stat. Div. Minis. Planning Govt. Peoples Repub. Bangladesh, Dhaka.p. 419. 49.

Begum, S. (1993-94). Assessment of losses due to aphid infestation at different cropgrowth stages at Joydebpur..Annual Research Report.Entomol. Div. BARI, Jodebpur, Gazipur.p. 30-31.

Begum, S. (1994-1995). Population activities of mustard aphids in relation to differentsowing time.Annual Research Report.Entomol. Div. BARI, Jodebpur, Gazipur. P. 33-34.

Bishnol, O.P., Singh, H. and Singh, R. (1992).Incidence and multiplication of mustardaphid (*Lipaphis erysimi*) in relation to meterological variables.*Indian J. Agri. Sci*. **62**(10): 710-712.

Biswas, G.C. and Das, G.P. (2000). Population dynamics of mustard aphid, *Lipaphis erysimi*(Kalt) (*Homoptera: Aphididae*). *Bangladesh J. Entomol*.**10**: (1-2); 15-22.

Blackman, R.L. and Eastop, V.F. (1984). Aphids on world's crop: An Identification andInformation Guide. John Wiley and Sons: Chichester, New York, Brisbane, Toronto, Singapore. p . 466.

Chanal, B.S. and Sukhija, H.S. (1969).Spraying in mustard progve.Punjab Agric. Univ. **5**(3):14.

Chowdhury, R. and Roy, C.S. (1975).Evaluation and economics of some insecticides for the control of mustard aphid, *L. erysimi* Kalt.on rabi *B. juncea*. *India J. Entomol*.**37**(3): 264-68.

Das, G.P and Islam, M.A. (1986).Seasonal activity of late mustard aphid (*Lipaphis erysimi*Kalt.)*Bangladesh J. Agric*. **11**(1): 56-61.

Davis, J. J. (1914). New or little – Known species of Aphididae. *Can. Entomol*. **46**(7):26-236.

Dhingra, S. (1991).Periodic checking to detect development of resistance in mustard aphid, *L. erysimi* Kalt. To recommended insecticides used for more than two decades. *J. Entomol. Res*. **15**(2): 88-92. 50

Dobrovliansky, V.V. (1916). A list of aphids found on cultivated plants in theGovernment of Khrkov. Bull, Psta Agric, Kharkov. p. 6.

Fletcher, T.B. (1914). Some South Indian insects and other animals of importance.Madras. Printed by the Suptd. Govt,Press p. 29l.

Gazi, M., Hossain, A., Islam, Z.M. Hossain, M.A. and Khaliquzzaman, M. (2001).Effect of some insecticides on mustard aphid, *L. erysimi* Kalt.in the field and net house conditions. *Online J. Biol. Sci*. **1**(11): 1031-1033.

Gomez, K.A and Gomez., A A. (1984). Statistical Procedure of Agricultural Research2nd Edn.John Wiley and Sons.New York, Chichester, Bristone, Toronto, Singapore.p. 680.

Hamid.S. and Ahmed S. (1980). Biological assessment of three different insecticides Against *L. erysimi* Kalt.On winter oilseed crops in Proc. 1st Paki.Congr.of Zool. p .283-290.

Haque, M.E. and Miah, M.A (1979). Observation on the control of mustards aphid withSumisidin 20 EC, Lannate 9 Sp and Initoria 50 WP *Bangladesh J. Agric.* **4**(2): 175-177.

Hossain, G.M.A. (1993). Effect of insecticides on growth, yield and chemicalcomposition of mustard. M.S.(Ag) thesis Dept. of Agril. Chemistry.Bangladesh Agril.Univ. Mymensingh.p. 99.

Husain, M. and Begum, N. (1984).Evaluation of *Brassica* germplasm for their reaction to aphids.*Bangladesh J. Agric*. **9**(4): 31-34.

Islam, N, Bhuiyan., M.I.M, Begum, A. and Karim, M.A. (1990). Field evaluation of foliar insecticides for the control of the mustard aphid.*L.erysimi*.*Bangladesh J. Zool.* **18**(2): 185-188. 51.

Jarvis.J.L.,(1970). Relative injury of some cruciferous, oil seeds by the turnip aphid. *J.Econ.Entomol*.**63**(5): 149-152.

Jagan Mohan, N. K.J. and Kumar. N. K. (1981). Chemical control of mustard aphid,*erysimi*Kalt and leaf webber, *Crocidolomia binotalis* Zell on Cabbage.*Pesticides*.**15**(2): 29-32.

Jadhav.S.N. and Singh, N.P. (1990). Save mustard crop from insect Pests in India, **40**(6): 19.

Kabir, K.H. and Rouf, F.M.A. (1993-94). Field screening of mustard varieties/linesagainst aphids at Jessore. Annul Research Report. Entomol. Divi.,BARl, Joydebpur, Gazipur. p. 35-38.

Kabir, S.M.H. and Khan, A.H. (1980).The nature of infestation of *Lipaphis erysimi* andits effects on the growth and yield of mustard, Proc. of the 4th and 5th Bangladesh Sci. Conf. p. 8.

Kanchan, B., Hadubandhu, S, Bral and Sethi.H.(2001). Persistence and economics ofsome insecticides for the control of mustard aphid.*L. erysimi* on rape seed.*Interacademicia*.***5***(4): 486-493.

Kher, S. and Rataul, H.S. (1992).Screening of some Brassica species and their strainsfor resistance to mustard aphid, based on aphid infestation index.*Indian J. Entomol*.***54***(3): 255-261.

Kalra, V.K. (1988). Population dynamics of various predators associated with mustard aphid, *L. erysimi* Kalt. *J. Bio. Control*.**2**(2): 77-79.

Khurana, A.D. (1986). A review mustard aphid, *Lipaphis erysimi* (Kalt.) a serious insect pest of rapeseed and mustard in India.*Pesticides*.**20**(5): 62-66.

Kumar, S., Krishna, M., Tripathi, R.A., Singh, S.V. and Mohan, K. (1996).Comparativeefficacy and economics of some insecticides against the mustard aphid, L. erysimi Kalt.on mustard. Annual Plant Protect. Sci. 4(2): 160-164.

Lai, O.P. (1969). Field studies for varietal resistance in rape and mustard aphid *Lipaphiserysimi* Kalt.*Zeitschrift fur Angewandte Entomologie.* **64**: 394-400.

Mahal, M.S., Sing. R and Balraj Singh, B. (1990). Interaction between two aphid specieson rays, *Brassica juncea* Cross. *J. Insect Sci.* **3**(1): 90-101.

Mandal, S.M.A., Misra, B. K and Patra, A.K. (1994). Yield loss in rapessed and mustard due to aphid infestation in respect of different varieties and dates of sowing. *Orissa J. Agril.Res*. **7**: 58-62.

Mondal, N., Alam, M.S. Hasan, F. and Das, D.C. (1992).Effect on food and larval development period of *Lipaphis erysimi* and *Aphis Ciricola*.*Bangladesh J. Zool*. **20**(2): 297-300.

Paul, S.K. and Ghosh, M.R. (1987). Influence of time of sowing on incidence of pestcomplex of Indian mustard. *J. Oilseeds Res*. **4**(2): 154-61.

Prasad.S.K. and Phadke.K.G. (1986). Variability in the incidence of mustard aphid, *Lipaphis ervsimi* (Kalt.) on different varieties/species of rapeseed and mustard crop.*Indian J. Entomol*.**48**(2): 222-225.

Sachan, J.N. and Bansal.O.P (1975). Influence of different host plants on the biologyofmustard aphid, *Lipaphis erysimi* Kalt. *Indian J. Entomol*.**37**(4): 420-424.

Sidhu, H.S. Singh.S. (1964). Biology of the mustard aphid - *Lipaphis erysimi* (Kaltenbach) in the Punjab.*Indian Oilseeds J*. **8**(4): 348-359.

Singh, S.R., Narain, A. Srivastava K.P. and Siddiqui J.A. (1965).Fecundity of mustard aphid of different rapes and mustard species.*Indian Oilseeds J*. **9**(3): 215-219. 53.

Nasir, A.B., Javed, H., Aslam, M, and Khan, A.A. (1988). Influence of abiotic factors onthepopulation of mustard aphid, *Lipaphis erysimi* Kalt. Sarhad.*J. Agril.* **14**(5): 453-455.

Nasiruddin, M. and Islam, M.A. (1079), Verania discolor Fab (Coleoptera:Coccinellidae) an effective predator on different species of aphids.*Bangladesh J. Zool*. **7**(1): 69-71.

Nirmala, D., Indra, D., Desh, R., Devi, N., Dogra, I. and Raj, D. (2001).Comparativefield efficacy of insecticides against mustard aphid.*L. errysimi* on rapeseed crop in mid hill zone of Himachal.

Prasad, S.K. and Pradhan, S. (1971). Distribution and sampling of mustard aphid, *Lipaphiserysimi* (Davis).*Indian J. Entomol*.**33**(3): 260-271.

Rajagopal, S. and Kareen, A. (1984).Studies on the toxic effect of some insecticides onparasites and predator, *M. sexmacuiltus* of chilies aphid, *M. Persicae. Pranikee*.**4**: 308-315.

Ramkishore and Phadke, K.G. (1988a). Distribution of aphid, *Lipaphis erysimi* on mustard crop.*J.Aphidol*.**2**(10): 72-75.

Rana, J.S. and Kakkor, J. (2000). Biological studies on 7-spot ladybird beetle, *Coccinellaseptempunctata*al. with cereal aphid *Sitobion avenae* . F .as prey. *Cereal Res.Commu*.**28**(4): 449-454.

Rohilla, H.R., Singh, H., Kalra, V.K. and Kharub, S.S. (1987). Losses caused bymustard aphid *L. erysimi* (Kalt.) in different Brassica genotypes. 7th Intl. Rapeseed Cong., Poznan, 11-14.

Rouf, F.M.A and Kabir, K.H. (1994-95). Assessment of losses due to aphid infestationat different growth stages of mustard. Annual Research Report.Entomol. Div BARI, Joydebpur,Gazipur. p. 29-33. 54

Saini, M.L. and Chhabra, K.S. (1966).Control of mustard aphid *Lipaphis erysimi* (kalt.)bysystemic insecticides.*Plant Protect. Bull*. **19**(2): 4-8.

Samdur, M.Y., Gulati, S.C., Manivel, P. and Ramna, R. (1997).Effect of environmentalfactors on mustard aphid (*Lipaphis erysimi* Kalt) infestation in different germplasm of Indian mustard, *Brassica juncea* (L).*J. Oilseeds*. *Res.* **14**(2): 278-283.

Shahjahan, M. (1994).Field and Laboratary evaluation of some *Brassica* germplasms forresistance to aphid. M.S. Thesis, Dept. Entomol. Bangladesh Agricultural University, Mymensingh. p. 89.

Sharma, K.C. and Khatri, N.K. (1979).Studies on biology and control of the mustardaphid (*Lipaphis erysimi* Kalt.) on mustard at Khumattar.*Nepalese J. Agric*. **14**: 63-71.

Sidhu, H.S. and Singh, S. (1964). Control schedule of mustard aphid in panjab. *Indian Oil Seed J.* **8**(3): 237- 238.

Singh, V.S., Yadav. R.P. and Singh, H. (1994).Post-embryonic development, survival rate and predation potential of *C. septempunctata* L. in relation to the mustard Aphid, *L. erysimi*. L. *Entomol. Res,* **18**(1): 5-10.

Sinha, R.P. Razdani, S.S. and Kumari, K. (1998).Studies on the biology of mustardaphid (*Lipaphis erysimi* Kolt.)Aphididac : Homoptera. *J. Appl. Biol*. **8**(1): 131-137.

Sinha, R.P., Kiran, K., Singh, S.N. and Cumary, K. (2001), Relative efficacy andpersistence of toxicity of insecticides against mustard aphid.*Indian J. Entomol*.**63**(2): 186-191 55.

Sonkar, U.B. and Desai, B.B. (1999). Effect of sowing dates on the incidence of mustardAphid, *Lipaphis erysimi* kalt.on mustard production. *Indian J. Entomol*:**6**(1): 41-44.

Srivastava, A.S and Srivatawz, J. L. (1970).Insecticides for control of mustard aphids.Intl.Pest Control. **12**(2): 27.

Srivastava A, Singh, H. and Thakur, H.L. (1996). Assessment of avoidable yield losscaused by green peach aphid, *Myzus persicae* Sulzer and mustard aphid, *L. Erysimi* (Kalt.) in *Brassica. Indian J. Plant Protect*. **24**(1-2): 115-116.

Thomas, J and Phadke, K.G. (1993). Residual toxicity and persistence of Chlopyrifos,Quinalphos and Oxydemeton methyl to aphid, *L. erysimi* Kalt.*Indian J. Entomol.***55**(3): 275- 280.

Thomas, J. and Phadke, K.G. (1996).The relative toxicity of Chlorpyrifos, Quinalphosand Oxydemeton methyl to aphid, *Lipaphis erysimi* and its predator *C. septempunctata* L. On rapeseed crop.*Indian J. Entomol*.**57**(3): 249-253.

Tripathi, N.L.M., Sachan, G.C., Verma, S.K. and pathak, P.K. (1985).Relative efficacy of some synthetic pyrethroids and other insecticides against *L. erysimi* Kalt.*Pesticides.***19**(12): 26-36.

Tripathi, N.L.M., Sachan, G.C., Verma, S. K. (1988a). Laboratory evaluation of somesynthetic pyrethroids And other insecticides against *Lipaphis erysimi* kalt. I*ndian J. plant Protect.* **16**(1):53-55.

Tripathi, N.L.M., Sochan, G.C. Verma, S. K. (1988b). Relative toxicity and safety tosome insecticides *Coccinela septempunctata*.*Indian J. Plant. Protect.* **16**(1): 87-88.

UNDP and FAO, (1998). Land Resources Appraisal of Bangladesh for Agricultural Development Report No.2. Agro-ecological regions of Bangladesh.FAO. Rome. p. 212-221. 56

Upadhyay, S. and agrawal, R.K. (1993a).Efficacy of different insecticides on incidenceof mustard aphid L. Erysimi on Indian mustard (Brassicae juncea) and its economic importance.Indian J. Agril. Sci. 63(8): 522-525.

Upadhyay, S. and agrawal, R. K. (1993b).persistent toxicity of some insecticides against *L. erysimi* Kalt.on mustard. *Indian J. Plant.Portect.***21**(1): 104-105.

Vekaria, M. V. and Patel, G. M. 1998.Studies on the number of genarations of mustard aphid, *Lipaphis erysimi* (Kalt.) under laboratory conditions.*Pest Manage.Econ. Zool*. **6**(2): 163-165.

Vekaria, M.V. and Patel, G.M. (1999). Biology of mustard aphid *L. erysimi* in northGujrat.*Indian J. Entomol*.**61**(3): 261-264.

Yadav, P.R., Yadav L.S. and Dashad.S.S.(1988). Comparative efficacy of someinsecticides against the Aphid, *Lipaphis erysimi* Kalt.on Cabbage Crop.*Indian J.Entomol*.**50**(1): 61-68.

Zaman, M. (1990a).Evaluation of foliar insecticides against the mustard aphid on rape inPeshwar, Pakisthan.*Indian J. Enomol*.**52**(4): 565-569.

Zaman, M. (1990b).Evaluation of emulcifiable concentrate insecticides against mustard aphid on rape. *Sorhad J. Agric*. **6**(4): 399-402.