

**“Study of aphid on mustard, *Lipaphis
erysimi* (Kalt) at Norther Madhya Pradesh”**



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ENTOMOLOGY BY

AZHAR UDDIN

Department of Entomology

Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya

College of Agriculture, Gwalior (M.P.)

2021

CERTIFICATE - I

*This is to certify that the thesis entitled, “Study of aphid on mustard, **Lipaphis erysimi (Kalt) at Northern Madhya Pradesh**” submitted in partial fulfillment of the requirements for the Degree of **MASTER OF SCIENCE in Agriculture Entomology of Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior**, is a record of the bona-fide research work carried out by **Mr. AZHAR UDDIN** under my guidance and supervision. The subject of the thesis has been approved by the student’s Advisory Committee and the Director of Instruction.*

No part of the thesis has been submitted for any other degree or diploma or has been published. All the assistance and help received during the course of this investigations has been acknowledged by the scholar.

Place: (Dr. Pradyumn Singh)
Date: Chairman of the Advisory Committee

MEMBER OF STUDENT’S ADVISORY COMMITTEE

Chairman	(Dr. Pradyumn Singh)
Member	(Dr. N.S. Bhadauria)
Member	(Dr. V.B. Singh)
Member	(Dr. J.C. Gupta)

CERTIFICATE – II



Aadhar Card No. – 8573 8607 3519

I.D. No. - 19111902

*This is to certify that thesis the entitled “**Study of aphid on mustard, Lipaphis erysimi (Kalt) at Northern Madhya Pradesh**” submitted by **Mr. AZHAR UDDIN** to the **Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior** in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in AGRICULTURE** in the department of **Entomology**, College of Agriculture, Gwalior has been accepted after evaluation by the External Examiner and approved by the Student’s Advisory Committee after an oral examination of the same.*

Place:

(Dr. Pradyumn Singh)

Date:

Chairman of the Advisory Committee

MEMBERS OF STUDENT’S ADVISORY COMMITTEE

Chairman (Dr .Pradyumn Singh)

Member (Dr. N.S. Bhadauria)

Member (Dr. V.B. Singh)

Member (Dr. J.C. Gupta)

Head of the Department

Dean of the College

Director Instruction

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(Azhar Uddin)

Contents

Number	Title	Page range
I	Introduction	1-3
II	Reviews of Literatures	4-11
III	Materials and Methods	12-15
IV	Results	16-21
V	Discussion	22-23
VI	Summary, Conclusion and Suggestions for further work	24-25
	Bibliography	26-29
	Appendices	<i>i-iii</i>
	Vita	

List of Tables

Table No.	Title	Pages
3.1	Insecticides treatments detail	13
3.2	Bio pesticides treatments details	14
3.3	Skeleton of ANOVA	15
4.1	Tolerant host genotypes against mustard aphid.	17
4.2	Effect of newer insecticide against mustard aphid.	19
4.3	Most effective bio pesticide against mustard aphid.	21

List of Abbreviations and Symbols

Symbol	Abbreviation	Stand for
@		At the rate of
%		Per cent
±		Plus or minus
°C		Degree centigrade
	CV	Coefficient of variation
	CD	Critical difference
	d.f.	Degrees of freedom
	<i>et al.</i>	Co- workers
	Fig.	Figure
	RH	Relative Humidity
	NS	Non-significant
	spp.	species
	viz.	For instance
	i.e.	That is
	etc.	X sectra
	kg.	kilogram
	gm	gram
	cm	centimeter
	mg	Milligram
	hrs.	hours
	q	quintal
	r	Correlation coefficient
	<i>viz.,</i>	Namely

Chapter – I

Introduction

Mustard is the members of Cruciferaceae or Brassicaceae family. Species of mustard is cultivated all over the world as oilseed crops or as vegetables and fodder crops. It contains about three thousand five hundred species and three hundred fifty genera (Warwick *et al.*, 2000). Eight different species of rapeseed-mustard are known and in an around 53 countries they are being cultivated, spreading all over the globe. The eight species which are known- Indian mustard, brown sarson and yellow sarson, toria, karanrai, gobhisarson, taramira and black mustard

Mustard seed is the second largest produced oilseed in the world with an area of 37.0 mha, with the production of 63.09 mt and the productivity of 18.50 q/ ha. In India, it had the area of 6.3 million hectare with production of 7.37 mt and productivity of 11.90 q/ ha. Around 7.4 mt of rapeseed-mustard produced by India next to China *i.e.* 11-12 mt. Among the entire oilseed crops producing states in India and in U.P the area of rapeseed mustard during the year 2013-14 was recorded 4.70 mha with production 2.5 mt and productivity of 890 kg/ ha (Anonymous, 2014).

Species of mustard are good source of oil, and it contains about 32- 42 % of oil, oil and seed of mustard are used to make pickles, vegetables etc and also the oil is used to make soap and other cosmetic items, afterremoval of oil from the seed, the remnant (cake) is used as feed for cattle's. The oil extracted from the seed of mustard have many medicinal values, mustard oil contain mono-unsaturated and polyunsaturated fat which is used to cure heart diseases, it contains anti-bacterial and antifungal property, contains vitamin E which is good for skin, also contains antioxidants which protect our body from many disease. The dependency of incidence and multiplication of insect pests on mustard crop majorly based on ecological factors. So they require prerequisite application of insecticides at appropriate stage to minimize the effect in mustard oil. This pest is more abundant from Dec to March as it infests mustard crop as well as various cruciferous vegetables and oilseeds also affected by this crop. The cloudy and cold weather (20°C or below), with high relative humidity (70-75%) are very

favorable conditions for the multiplication of this pest. The pest of mustard also vary due to the variety of crop, agro technological practices and environmental factors which directly or indirectly affects the yield. However, it causes the yield losses up to 54.2% (Bakhetia and Sekhon, 1989).

Mustard plants are infested at all the stages by mustard aphid. The cell sap from leaves, flower buds, flowers, twigs and pod of the mustard plants sucked by both the nymph and adults

The sticky good amount of honey dew is secreted by them, which responsible for the growth of shooty mold fungus, and the fungus makes the pods and leaves dirty black (Awasthi, 2002). During the period of infestation of mustard aphid on mustard plants pod and leaves become curled while the young infested pods fail to mature and plants mostly fail to develop and results in stunted growth, wither flowers and hindered pod formation (Morzia and Huq, 1991). Sometimes the severe infestation of this pest can cause complete loss yield of the oilseed, and mustard plants sometimes fails to bear siliqua or grow with very poor pods (Das and Islam, 1986).

Rapeseed-mustard contributes 28.6% in the total oilseeds production among the seven edible oilseeds cultivated in India, and thus ranks second after groundnut sharing 27.8% in the India's oilseed economy (Shekhawat *et al.*, 2012). During 2015-16 in India, rapeseed and mustard were grown over an area of 5.75 m/ ha with production of 6.80 m.t and productivity of 1183 kg/ ha respectively (Anonymous, 2017). With an area of 0.53 m. ha, production of 0.90 m.t and productivity of 1721 Kg/ ha (2015-2016) Haryana is the third most important rapeseed–mustard producing state in the country which is highest in the country (Anonymous, 2017).

Aphid suck sap from the host-plant through the help of phloem sieve element, styles, the needle-like piercing sucking mouthparts, and infested plants eventually become stunted and distorted. Wilting, yellowing, and stunting of plants are included with the major infestation symptoms (Khan *et al.*, 2015). The avoidable yield losses of mustard, affected to aphid infestation in the tune of 20 to 50%, and it could be extended up to 78% (Prasad and Phadke, 1983).

The present study was conducted to find out the relative effectiveness of insecticides to control the mustard aphid population.

Objectives-

- 1) To find out tolerant host genotypes against mustard aphid.
- 2) To find out the most effective newer insecticide against mustard aphid.
- 3) To find out the most effective biopesticide against mustard aphid.

Chapter – II

Reviews of Literature

The work done on insect pest of mustard, *Lipaphis erysimi* (Kalt.) at Northern Madhya Pradesh related to present investigation is reviewed herewith.

Varietal resistance.

Vekaria and Patel (2000) studied the relative resistance of promising brassica and allied genotypes against mustard aphid, *L. erysimi*. They observed that none of the genotype was found immune, however, five mustard genotypes, viz., GSL-1 (*B. napus*), PC-5 (*B. carinata*), T-27 (*Eruca sativa*), local genotype (*B. tourenfortij*) and T-6342 were found resistant. Further genotypes belonging to *B. campestris* group were found to be more susceptible to aphid than that of *B. juncea*.

Takar *et al.*, (2003) tested 20 varieties/entries of mustard against aphid, *L. erysimi*. Based on aphid population, the varieties/entries, viz., T-59, Bio- 902 and, PCR-7 and DLM-29 were found highly resistant (below 70.45 aphid/ plant); Kranti, Pusa Bold, Rohini, VSL-5, BIO-772, DLM-58, Brani, RH-8113, Pusa Basant, DLM-80 and DLM-68 were found moderately resistant (between 70.45 to 116.51 aphids/plant) and DLM-75, M-21, AG-5, DLRA-343 and Pusa Lord were found least resistant, having more than 116.51 aphids per plant.

Bhat *et al.*, (2004) screened mustard cultivars viz., KS-101, KS-102, KS-103, KS-104, KBS-1, BSH-1, DBS-5, KOS-1 and YSK-151 for resistance to aphid, *L. erysimi* and revealed that all the cultivars were not infested at pre-bloom stage. The maximum aphid infestation of 20.96 and 100.66 aphid/plant were recorded at bloom and post-bloom stages, respectively on yellow sarson (*Brassica campestris* var. *sarson*) cv. YSK-151, and the lowest infestation was on KS-104 and BSH-1 (8.77 and 46.18 aphids/ plant). Cultivars KS-104 and KS-101 were relatively resistant to aphid infestation while, the remaining cultivars were categorized as moderately susceptible and DBS-5 was the only late flowering cultivar.

Patel, S.R. (2004) observed that the critical period of mustard exposure to aphids was found to be the 3rd week after aphid appearance when the crop was in flowering stage and hence the control measures have to be initiated before flowering. There was not much difference in natural aphid population/plant in the crop sown up to end of November while the aphid population increased suddenly in December sown crop.

Rangrez *et al.*, (2004) conducted a field trial for screening mustard cultivars, viz., KS-101, KS-102, KS-103, KS-104, KOS-1, BS-1, BS-2, BSH1, DBS-5 and YSK-151 against aphid, *L. erysimi*. The results revealed that none of the varieties studied were infested with the aphid at pre-bloom stage of the crop. During the post-bloom stage of the crop the maximum aphid population (97.3/ plant) was recorded on yellow sarson variety YSK-151 followed by BSH-1, BS-1, KS-103, BS-2, KS-102, DBS-5, KOS-1, KOS-101 in descending order of population. Minimum mean aphid population (30.6/ plant) was recorded on KS-104.

Jat *et al.*, (2007) conducted an experiment on screening of different mustard varieties for resistance against aphid, *L. erysimi*. The minimum aphid population (16 aphid/ plant) was observed on variety T-59, while maximum (56 aphid/ plant) was on RZM-1359. The varieties T-59 and Bio-902 could be categorized as least preferred, varieties Tm-4, PCR-7, RH-30, RH-781 and PBR-91 as moderately preferred and GM-2, JM-1 and RZM-1359 as highly preferred varieties. The aphid population had negative correlation with plant growth as well as seed characters viz., plant height, siliqua per plant, seeds per siliqua. Biochemical characters viz., total phenols was negatively correlated and free amino acids was positively correlated with aphid population.

Pawar *et al.*, (2009) screened 20 genotypes of mustard against aphid, *L. erysimi*. The genotype SKM-0401 was the least susceptible with 1.47 aphid index per plant followed by SKM-0518, SKM-0445, SKM-0301 and SKM-0533 with 1.52, 1.53, 1.57 and 1.60 aphid index per plant, respectively. The genotype SKM-0531 was found most susceptible (4.54 aphid index/plant) followed by GM-1, SKM-0529, GM-2, GM-3, SKM-0507 and SKM 0109, which

recorded 4.52, 4.40, 4.37, 4.29, 4.22 and 4.11 aphid index per plant, respectively.

Khedkar *et al.*, (2011) screened 17 genotypes of mustard against *L.erysimi*. The lowest aphid index (1.18) was recorded in variety GM-2 with highest test weight (6.08 g) but was at par with PCR-7 (5.90 g) followed by Vaibhav. The highest seed yield (10.54 q/ha) was recorded from the variety GM-2 which was at par with GM-1, GM-3, Vardan, Pusa Jay Laxmi, RH-30 Pusa Jagnath, Vaibhav, Pusa Jay Kisan and Pusa Bahar (10.50 to 8.95 q / ha).

Singh (2013) screened 20 varieties of mustard against aphid, *L. erysimi* out of which none was found completely free from aphid infestation. Variety, T-6342 was found resistant while, RH-819, Pusa Bahar, Bio-902, Sanjucta and Asech were found highly susceptible.

Shah *et al.*, (2015) observed that antixenosis test, 'G9' (16.9) and 'G29' (5.7) proved to be highly susceptible, while 'G28' highly resistant (3.8) (1.7) in terms of mean number of aphids per flower and mean number of aphids per pod, respectively. 'G9' proved to be highly susceptible (21.4) while 'G28' proved to be highly resistant (5.5) out of eight tested genotypes in meannumber of total aphids per accession. In aphid multiplication test, genotype 'G9' produced maximum number of offspring (93.8) while 'G7' produced minimum number of aphids (61.2) as compared to other tested genotypes.

Gautam *et al.*, (2019) reported that the mustard crop is more vulnerable to a wide variety of insect pests from sowing till harvest than other oil seed crops. The invasion by insect pests are one of the important factors responsible for low yield such as; mustard aphid, *L. erysimi* (Kalt), cabbage aphid, *B. brassica* (L), mustard sawfly, *A. proxima* (Klug), cabbage butterfly, *P. brassicae* (Linn), painted bug, *B. picta* (K), mustard leaf eater, *S. litura* (F), leaf miner, *Ch. Horticola* (Goureau) thrips, *T. tabaci* and whitefly, *B. tabaci* (Gennadius). Among them, *L. erysimi* (Kalt), (Aphididae: Homoptera) is the most devastating pest in India and is distributed in many other countries also found most preferred crop to sucking complex and six varieties of mustard.

Sreedhar *et al.*, (2019) given that at 70 DAS the genotypes NPJ 194 was least preferred by aphid with an average population of 8.67 (1.0 All) per 10 cm top central shoot while DRMR-15-14 encountered with 51 aphid population (3.0 All) per 10 cm top central shoot.

Bio-efficacy of insecticides against aphid.

Dikshit and Prasad, (2001) evaluated bioefficacy of imidacloprid against mustard aphid, *L. erysimi*, applied as seed treatment (Gacho 70ws, 5 and 10 g a.i. /kg seed) and foliar spray (Confidor 200 SL, 20 and 40 g a.i. /ha) at 50 percent pod formation stage on mustard, *Brassica compristris* (*Brassica juncea*), in the separate experiments conducted during winter (November to February) in New Delhi, India. Imidacloprid controlled the aphid population when used as seed treatment and foliar spray. The lower doses (seed treatment at 5 g a.i./ kg and foliar spray at 20 g a.i./kg) proved sufficient to optimize the yield of mustard crop. The mustard seed and soil at harvest did not contain imidacloprid residues.

Gour and Pareek, (2003) tested the efficacy of nine insecticides against mustard aphid, *L. erysimi*. The treatment of dimethoate (0.03%) proved most effective followed by dimethoate (0.015%), imidacloprid (0.05%), acephate (0.05%) and cypermethrin (0.002%). Neem extract (0.2%) was found least effective in reducing aphid population followed by neem extract (0.4%), cartap hydrochloride (0.04%) and ethofenprox (0.002%), whereas, endosulfan (0.02 and 0.035%), acephate (0.025%), malathion (0.025 and 0.05%), cypermethrin (0.001%), ethofenprox (0.004%) and cartap hydrochloride (0.08%) existed in moderate group of efficacy. The maximum yield of mustard seeds was obtained in dimethoate (0.03%) followed by imidacloprid (0.05%), dimethoate (0.015%) and acephate (0.05%), whereas, minimum yield was obtained in the treatment of cartap hydrochloride (0.04%). The highest benefit: cost ratio (20.0) was computed in the treatment of dimethoate (0.03%) and lowest (0.3) in imidacloprid (0.025%).

Rohilla *et al.*, (2004) evaluated the bio-efficacy of ten insecticides against mustard aphid, *L. erysimi* and revealed imidacloprid 17.8 SL

(0.178%), thiomethoxam 25 WG (50 g a.i./ ha), oxydemeton methyl 25 EC (0.025%) and monocrotophos 36 EC (0.03%) were most effective.

Bhattacharya and Dhar, (2008) evaluated the efficacy of different insecticides (oxydemeton methyl, dimethoate, endosulfan, imidacloprid and thiomethoxam) against *L. erysimi* on mustard. Imidacloprid 17.8 SL (0.002%) showed the best knock-down effect and highest persistency. Imidacloprid, when applied thrice at vegetative, flowering and pod initiation stages, reduced up to 98.30 percent aphid population with highest seed yield (13.92 q/ ha) and benefit :cost ratio (2.12 : 1).

Dhaka *et al.*, (2009) tested the efficacy of new insecticides against mustard aphid, *L. erysimi*. They proved acetamiprid 20 SP (125 g/ ha.) most effective followed by acephate, thiamethoxam, imidacloprid, profenofos, dimethoate and oxydemeton methyl for the management of aphids. Thiamethoxam was found as the safer insecticide to the coccinellid.

Bhargava, (2010) evaluated the bioefficacy of newer insecticides *viz.*, imidacloprid 200 SL, thiomethoxam 25 WG, quinalphos 25 EC, dimethoate 25 EC, oxydemeton-methyl 25 EC, acetamiprid 20 SP, imidacloprid 70 WS, thiomethoxam 70 WS, against foliage feeding barley aphid, *Rhopalosiphum maidis* (Fitch.). He found that all the treatments reduced the aphid population significantly and increased the grain yield as compared to untreated check. The cent percent reduction in aphid population was observed in the treatment of imidacloprid 70 WS and stood at par with thiomethoxam 70 WS, applied as seed treatment at one day of spray or 65 days after sowing. Further, the minimum aphid population was also recorded after 15 days of spray in both the treatments with maximum grain yield.

Patil *et al.*, (2010) evaluated the efficacy and economics of newer insecticides and seed treatment against foliage feeding wheat aphid, four insecticides *viz.*, Imidacloprid 17.8 SL, Thiomethoxam 25 WS, Quinalphos 25 EC and Oxydemeton methyl 25 EC applied through spray and two *viz.*, Imidocloprid 70 WS and Thiomethoxam 70 WS through seed treatment. Imidacloprid 17.8 SL @ 20 g.a./ha proved to be significantly most effective followed by thiamethoxam 25 WS @ 12.5 g.a./ha, imidacloprid 70 WS @ 0.35

g.a./kg of seed, thiomethoxam 70 WS @ 0.35 g.a./kg of seed, oxydemeton methyl 25 EC @ 12.5 g.a.i./ha and quinolphos 25 EC @ 125 g.a.i./ha against the control of foliage feeding wheat aphids. The treatment with imidacloprid 17.8 SL @ 20 g.a.i/ha (51.86 g /ha) recorded significantly highest yield, over rest of the treatments and untreated control (39.53 g/ ha). The highest additional income (Rs. 13,738/ha) net profit (Rs. 13,140.00/ha) and benefit cost ratio (2.48) were observed in the treatment with imidacloprid 17.8 SL @ 20 g.a.i/ha.

Mandal *et al.*, (2012) tested the efficacy of different Insecticides against *L. erysimi* on rapeseed and reported chlorpyrifos (93.50%) most effective treatment followed by chlorpyrifos+cypermethrin (92.76%), thiomethoxam (90.70%) and imidacloprid (90.46%) and dichlorvos (82.81%) showed least effective. The highest seed yield was recorded from chlorpyrifos+cypermethrin (18.45 q/ ha) treated plots followed by thiomethoxam (17.86 q/ ha), chlorpyrifos (17.50 q/ ha) and imidacloprid (16.75 q/ ha) and lowest in dichlorvos (16.50 q/ ha). Incremental cost benefit ratio indicated that highest return was obtained from imidacloprid (1:16.12) followed by lambda-cyhalothrin (1:15.68).

Kumar *et al.*, (2013) tested the bio efficacy of some newer insecticides with conventional insecticides for the control of mustard aphid, *L. erysimi* and their effect on coccinellid population in rapeseed mustard. The maximum control of aphid was obtained with the application of thiamethoxam 25% WDG @100 g/ ha followed by imidacloprid 17.8% SL @ 150 ml/ ha. Conventional insecticides were found less effective than newer insecticides for controlling mustard aphid.

Mishra and Yadav (2013) evaluated the efficacy and economics of different insecticides against mustard aphid and revealed that increase in seed yield due to application of imidacloprid and methamexaon was 6.14 and 3.14 q/ ha with insecticidal efficacy of 39.87 and 29.31 percent, respectively over control. Highest cost: benefit ratio 1.92 and 1.87 was also incurred with application of imidacloprid during first and second year respectively.

Kumar and Kumar, (2016) were reported that the treatments of Dimethoate 30 EC followed by spraying of Malathion 50 EC and Neem oil (0.5%) were found more effective for control of *Lipaphis erysimi* (Kalt), respectively. Whereas, the descending order of treatments were Neem oil > NSKE>Tobacco Leaf extract > *Bacillus thuringiensis* > *Beauveria bassiana* > *Metarhizium anisopliae*. The least effective treatment was *Verticillium lecanii*. Maximum infestation was recorded in control.

Dharavath *et al.*, (2017) given that the Acephate 50 WG at 700 gm/ha T₃ (D3C3) was found to be most effective pesticide to control the mustard aphid population followed by Acetamiprid 20% SP at 100 gm/ha and Imidacloprid 200 SC at 300 ml/ha is moderately effective. Application of pesticide significantly controlled the aphid population which suggested that acephate 50 WG at 700 gm/ha could restrain the aphid infestation in mustard.

Sahu *et al.*, (2018) was observed highest reduction of aphid population in spray of neem oil (32.5%) followed by Monocrotophos (36.5%), *Beauveria bassiana*(37.5%), Dimethoate (40.0%), Extract of Lantana camera (42.5%). The mustard production was found highest yield, Dimethoate (93g), followed by Monocrotophos (86g), *Lantana camera* (53g) and neem oil (53g), *Beauveria bassiana* (52.5g) as compared to the control one (50.5g).

Yadav *et al.*, (2018) reported that all the treatments gave significantly higher yield (10.20-13.00 q/ ha) over control (9.67 q/ ha). The effect of treatment on seed yield was found higher yield (13.00q/ ha) in Emamectin Benzoate @ 0.005%. As compare to other tested treatments. The result showed that all the chemicals had better yield in comparison to botanicals. Among botanicals Nimbecidine @ 0.45% gave highest yield which over at par with other botanicals except castor oil. The Effectiveness of treatments was determined based on the population of mustard aphid was recorded one day before spray as pre-treatment observation, while post treatment observations were taken at 3, 7 and 10 days after spray. Among all insecticides in which Emamectin benzoate @ 50g a.i./ha. were found more effective due to minimum insect-pest infestation and resulted significantly more yield over control.

Bio-efficacy of Bio-pesticides against aphid.

Kumar and Kumar, (2016) were reported that the treatments of Dimethoate 30 EC followed by spraying of Malathion 50 EC and Neem oil (0.5%) were found more effective for control of *Lipaphis erysimi* (Kalt), respectively. Whereas, the descending order of treatments were Neem oil > NSKE > Tobacco Leaf extract > *Bacillus thuringiensis* > *Beauveria bassiana* > *Metarhizium anisopliae*. The least effective treatment was *Verticillium lecanii*. Maximum infestation was recorded in control.

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Sharma and Sharma, (2017) evaluated six biopesticides *viz.*, melia (Melia 10 EC), eupatorium (Eupatorium 10 EC), melia-SFE (Melia-SFE 5 EC), eupatorium-SFE (Eupatorium-SFE 5 EC), azadirachtin (Neem Baan 1500 ppm), spinosad (Success 2.5% SC) and one synthetic insecticide malathion (Milthion 50 EC) against mustard aphid, *Lipaphis erysimi* (Kaltenbach) and leaf miner, *Chromatomyia horticola* in brown sarson is reported. On the basis of reduction in insect population over control on 7th day after spray, the order of efficacy against *L. erysimi* was malathion>azadirachtin = melia>melia-SFE = eupatorium > eupatorium-SFE >spinosad and against *C. horticola*, spinosad>melia = melia-SFE = malathion>azadirachtin = eupatorium = eupatorium-SFE. Malathion, azadirachtin and melia treatments resulted in significantly higher yield as compared to untreated check.

Shinde *et al.*, (2021) studied the efficacy of biopesticides against mustard aphid in mustard crop. The efficacy of bio pesticides *viz.*, *Beauveria bassiana*, *Verticillium lecanii*, azadirachtin and a standard insecticide check, dimethoate was studied against mustard aphid, *Lipaphis erysimi*. The reduction of aphid after the application of all biopesticides and dimethoate was observed significantly superior over control at all the interval of

observation. However, all the bio pesticidal treatments singly and in their combination were at par with the standard check insecticide dimethoate in terms of mean aphid population after the application of three sprays. Therefore, they recommend the use of biopesticides *Beauveria bassiana*, *Verticillium lecanii* and azadirachtin individually or in their combination as an eco-friendly and cost-effective alternative for the management of mustard aphid, *Lipaphis erysimi* (Kalt.).

Chapter- III

Materials and Methods

The present studies on, “**Study of aphid on mustard, *Lipaphis erysimi* (Kalt) at Northern Madhya Pradesh**” were conducted during the *Rabi* season 2020-21 in the experimental field of Zonal Agricultural Research Station (ZARS), Morena. The experimental area is having uniform topography, gentle slope and adequate drainage.

Location and climate:

Morena is situated in Chambal region at the latitude of 26°5' North and longitude 78°0' East with an altitude of 177.0 meters from mean sea level, in Madhya Pradesh. This Region comes under semi-arid sub-tropical climate with extreme weather condition having hot and dry summer and cold winter. Generally monsoon sets in during the last week of June.

Annual rainfall ranges from 600 to 700 mm, most of which falls during last June to the middle of September. In this area winter rains are occasional and uncertain. The maximum temperature goes up to 47°C during summer and minimum as low at 5°C during winter.

Experiment no.1: To find out tolerant host genotypes against mustard aphid.

Methodology:

Design	:	RBD
No. of replications	:	3
No. of Genotype	:	10
Total no. of plots	:	30
Plot size	:	3.0 m x 0.60 m (two row plot)
Distance between Rep.	:	2.10 m
Fertilizer dose (N:P:K)	:	80:40:20 Kg / ha

Field experiment will be conducted for find out relative resistance/tolerance among the mustard varieties/genotypes against aphid.

Observation will be recorded to count number of aphid on 10 cm top twig of 5 randomly selected plant from each plot at pre flowering and pod development.

Experiment No.2: To find out the most effective newer insecticide against mustard aphid.

Experimental details:

1. Crop : Mustard
2. Variety : RH-725
3. Season. : Rabi 2020-21
4. Designs : RBD
5. Treatments 07
6. Replications : 03 (Three)
7. Total number of plots 21
8. Gross area of plot size : 3.0 x 4.2 m
9. Spacing (R-R x P-P) : 30 x10 cm
10. Plot to plot distance : 1 m
11. Distance between replication : 2 m
12. Recommended dose of fertilizer(N:P:K) : 80:40:20 Kg / hac

Table 3.1: Insecticides treatments details:-

Tr.N o.	Pesticides	Dose.
T ₁	Imidacloprid(17.8 SL)	0.25 ml/ ltr
T ₂	Thiamethoxam (25 WG)	0.25 gm/ ltr
T ₃	Acetamaprid(20 SP)	0.1 gm/ ltr
T ₄	Dimethoate(30 EC)	1.0 ml/ ltr
T ₅	Clothianidine (50 WGD)	0.12 gm/ ltr
T ₆	Difenthiuron (50 WP)	0.4 gm/ ltr
T ₇	Control	

Observations to be recorded:

Observations to be recorded on affected aphids in pre and post treatments. Pre-treatment observations will be recorded at 24 hrs. Before spray, and post treatment observations will be recorded at 3,5 and 7 days after spraying.

Experiment No.3:To find out the most effective biopesticide against mustard aphid.

Experimental details:

1. Crop : **Mustard**
2. Variety : RH-725
3. Season. : Rabi 2020-21
4. Designs : RBD
5. Treatments : 7
6. Replications : 3 (Three)
7. Total number of plots : 21
8. Gross area of plot size : 3 m x 4.20 m
9. Spacing (R-R x P-P) : 30 cm x 10 cm
10. Plot to plot distance : 1 m
11. Distance between replication : 2 m
12. Recommended dose
of fertilizer (N: P: K kg/ha) : 80:40:20 Kg / hac

Table 3.2: Bio pesticides treatments details:-

Tr. No.	Bio-pesticides	Dose
T ₁	Azadirachtin (300 ppm)	5 ml/ ltr
T ₂	Azadirachtin + <i>Beauveria bassiana</i>	5 ml + 2 gm/ ltr
T ₃	Azadirachtin + <i>Verticillium lecanii</i>	5 ml + 2 gm/ ltr
T ₄	<i>Beauveria bassiana</i>	2 gm/ ltr
T ₅	<i>Verticillium lecanii</i>	2 gm/ ltr
T ₆	Dimethoate (30 EC)	1 ml/ ltr
T ₇	Control	

Observation to be recorded:

Observations to be recorded on affected aphids in pre and post-treatments. Pre-treatment observations will be recorded at 24 hrs. Before spray and post-treatment observations will be recorded at 3,5 and 7 days after spraying.

Statistical analysis:

The data were subjected to statistical analysis after transformation. The count data were transformed to \sqrt{x} values, while percentages were transformed to \sqrt{x} whose values ranges from 0 to 30 and 70 to 100 and into angular whose values ranges from 0 to 100. The skeleton of analysis of variance is given below.

Table 3.3: Skeleton of ANOVA

Source of variation	D.F	S.S	M.S.S	F cal	F tab
Replication	(r-1)	SSR	MSR	MSR/MSE	
Treatments	(t-1)	SSTr	MSTr	MStr/MSE	
Error	(r-1)(t-1)	SSE	MSE		
Total	(rt-1)				

r - Number of replications

t - Number of treatments

The 'F' test was used for testing the significant effect of various treatments.

$$SE(m) = \sqrt{\frac{MSE}{r}}$$

Where,

'r' is the number of replications.

$$CD = SE(m) \times \pm \sqrt{2} \times t \text{ value at 5\% level of significance for error d.f.}$$

Chapter – IV

Result

The study of aphid on mustard, *Lipaphis erysimi* (Kalt) at Northern Madhya Pradesh was carried out on RVSKVV, Zonal Agricultural Research Station, Morena, Madhya Pradesh during Rabi 2020-21, and the results obtained are presented here under.

To find out tolerant host genotypes against mustard aphid.

10 genotypes of mustard were screened aphid, *L. erysimi* during Rabi, 2020-21. In the present finding infestation of the aphid was recorded in different stages of plant growth table 4.1 .The data on present findings revealed that aphid infestation during pod and flowering stages ranged from 7.97- 30.13 aphid/ plant. The minimum aphid population was recorded in genotype PT-2015-8 (7.97 aphid/ plant) which was found superior over rest of the genotypes followed by JT-14-5 (9.57 aphid/ plant), BAUT-08-08 (14.1 aphid/ plant), TKM-20-2 (16.3 aphid/ plant) this genotypes was found resistive and maximum aphid population was recorded in PT-2018-09 (30.13 aphid/ plant) followed by PT-303 (29.23 aphid/ plant), RTM-19-17 (22.00 aphid/ plant), CG toria-3 (20.77 aphid/ plant) and CG toria-4 (18.43 aphid/ plant) and this host genotypes are resulted susceptible.

Table 4.1: Tolerant host genotypes against mustard aphid.

Genotypes	Flowering	Pod	Mean
ORT-2019-01	11.53 (3.47)	22.27 (4.77)	16.9 (4.17)
RTM-19-17	15.6 (4.01)	28.4 (5.38)	22 (4.74)
CG toria-4	15.07 (3.95)	21.8 (4.72)	18.43 (4.35)
PT-2018-09	21.73 (4.72)	38.53 (6.25)	30.13 (5.53)
TKM-20-2	12.73 (3.64)	19.87 (4.51)	16.3 (4.1)
PT-303	24.4 (4.99)	34.07 (5.88)	29.23 (5.45)
BAUT-08-08	12.8 (3.65)	15.4 (3.99)	14.1 (3.82)
JT-14-5	7.93 (2.9)	11.2 (3.42)	9.57 (3.17)
CG toria-3	23 (4.85)	18.53 (4.36)	20.77 (4.61)
PT-2015-8	6.47 (2.64)	9.47 (3.16)	7.97 (2.91)
SEm (±)	0.713	0.817	
CD (P=0.05)	NS	NS	

Figures in parentheses are Square root transformed values.

To find out the most effective newer insecticide against mustard aphid.

The most effective newer insecticides against aphid on mustard crop in the field was evaluated during *Rabi*, 2020-21, the insecticide which are sprayed are Imidacloprid (17.8 SL), Thiamethoxam (25 WG), Acetamiprid (20 SP), Dimethoate (30 EC), Clothianidine (50 WGD) and Difenthiuron (50 WP), and on the basis of reduction in aphid population at different intervals after applications the newer insecticide are evaluated. The results are presented in table 4.2.

Pretreatment observations recorded one day before first application indicates that the aphid population ranges 43.87-59.13 aphid/ plant, and further data recorded on 3rd, 5th, 7th days after first spraying.

Aphid population three day after spray-

After all the spray all the treatment were proved significantly superior over untreated control. Three day after application of insecticides, minimum aphid population *i.e.* 22.2 aphid per plant was recorded in the treatment T₅ which is sprayed with Clothianidine (50 WGD), followed by treatment T₁ sprayed with Imidacloprid (17.8 SL) and treatment T₂ spray of Thiamethoxam (25 WG) which resulted in the aphid population 25.93 aphid per plant each, whereas maximum aphid population *i.e.* 36.47 and 30.8 aphid per plant were recorded in treatment T₄ and T₃ sprayed with Dimethoate (30 EC) and Acetamiprid (20 SP), respectively.

Aphid population five day after spray

Five days after insecticidal spray, all the treatments were found significantly superior over untreated control. The minimum aphid population of 1.13 aphid per plant was recorded in the treatment T₃ (Acetamiprid 20 SP) followed by T₂ (Thiamethoxam 25 WG) which exhibited 1.33 aphid per plant. The next effective treatments were T₅ (Clothianidine 50 WGD), T₁ (Imidacloprid 17.8 SL) and T₆ (Difenthiuron 50 WP) which have 1.53, 1.6 and 1.67 aphid per plant, respectively. The maximum aphid population was recorded in T₄ Dimethoate 30 EC which have 1.8 aphid/ plant.

Aphid population seven day after spray

Seven days after insecticidal spray the minimum aphid population *i.e.* 0.73 aphid per plant was recorded in treatment T₅ (Clothianidine 50WGD) followed by T₃ sprayed with Acetamiprid 20SP and T₂ sprayed with Thiamethoxam 25 WG.

Table 4.2 : Effect of newer insecticide against mustard aphid.

Tr. No.	Pesticides	DBS	3 DAS	5 DAS	7 DAS	MEAN
T ₁	Imidacloprid 17.8 SL	50.33 (7.13)	25.93 (5.14)	1.6 (1.45)	1.67 (1.47)	19.88 (4.51)
T ₂	Thiamethoxam (25 WG)	52.53 (7.28)	25.93 (5.14)	1.33 (1.35)	0.73 (1.11)	20.13 (4.54)
T ₃	Acetamiprid(20 SP)	47.33 (6.92)	30.8 (5.59)	1.13 (1.28)	0.73 (1.11)	20.00 (4.53)
T ₄	Dimethoate(30 EC)	55.27 (7.47)	36.47 (6.08)	1.8 (1.52)	0.87 (1.17)	23.6 (4.91)
T ₅	Clothianidine (50 WGD)	43.87 (6.66)	22.2 (4.76)	1.53 (1.43)	0.73 (1.11)	17.08 (4.19)
T ₆	Difenthiuron (50 WP)	53.07 (7.32)	28.33 (5.37)	1.67 (1.47)	0.87 (1.17)	20.98 (4.64)
T ₇	Control	59.13 (7.72)	55.73 (7.5)	14.67 (3.89)	17.73 (4.27)	36.82 (6.11)
SEm (±)		0.862	0.517	0.394	0.198	
CD (P=0.05)		NS	1.789	1.363	0.687	

DBS= Day before spray, DAS= Day after spray, Figures in parentheses are Square root transformed values.

To find out the most effective bio-pesticide against mustard aphid.

The most effective newer bio-pesticide against aphid on mustard crop in the field was evaluated during *Rabi*, 2020-21, the bio-pesticide which are sprayed are Azadirachtin(300 ppm), Azadirachtin + *Beauveria bassiana*, Azadirachtin + *Verticillium lecanii*, *Beauveria bassiana*, *Verticillium lecanii* and Dimethoate (30 EC) and on the basis of reduction in aphid population at different intervals after applications the bio-pesticides are evaluated. The results are presented in table 4.3

Pre-treatment observations recorded one day before first application indicates that the aphid population ranges 95.93-190.93 aphid/ plant, and further data recorded on 3rd, 5th and 7th days after first spraying.

Aphid population three day after spray-

After all the bio-pesticide spray all the treatment were proved significantly superior over untreated control. Three day after application of bio-pesticide, minimum aphid population 39.07 aphid per plant was recorded in the treatment T₃ which is sprayed with Azadirachtin+ *Verticillium lecanii*,

followed by treatment T₄ sprayed with *Beauveria bassiana* and treatment T₂ sprayed with Azadirachtin + *Beauveria bassiana* which resulted in the aphid population 46.47 and 46.8 aphid per plant, respectively whereas maximum aphid population *i.e.* 64.07 and 61.13 aphid per plant were recorded in treatment T₆ and T₅ sprayed with Dimethoate(30 EC) and *Verticillium lecanii* respectively.

Aphid population five day after spray

Five days after spray, there was a significant loss of aphids were seen as compared to third day, minimum aphid population *i.e.* 2.73 aphid per plant were recorded in treatment T₂ sprayed with Azadirachtin + *Beauveria bassiana* which was at par with treatment T₆ and T₄ sprayed with Dimethoate (30 EC) and *Beauveria bassiana* with aphid population 3.07 and 3.53 aphid per plant respectively.

Aphid population seven day after spray-

After all the bio-pesticide spray all the treatment were proved significantly superior over untreated control. Seven day after application of bio-pesticide, minimum aphid population *i.e.* 1.4 and 1.47 aphid per plant was recorded in the treatment T₄ and T₁ which is sprayed with *Beauveria bassiana* and Azadirachtin (300 ppm), respectively, followed by treatment T₂ sprayed with Azadirachtin + *Beauveria bassiana* and treatment T₅ sprayed *Verticillium lecanii* which resulted in the aphid population 1.67 aphid per plant each.

Table 4.3: Most effective biopesticide against mustard aphid.

Tr. No.	Bio-pesticides	DBS	3 DAS	5 DAS	7 DAS	MEAN
T ₁	Azadirachtin (300 ppm)	95.93 (9.82)	52.13 (7.25)	4.2 (2.17)	1.47 (1.4)	38.43 (6.24)
T ₂	Azadirachtin + <i>Beauveria bassiana</i>	113.07 (10.66)	46.8 (6.88)	2.73 (1.8)	1.67 (1.47)	41.07 (6.45)
T ₃	Azadirachtin + <i>Verticillium lecanii</i>	155.53 (12.49)	39.07 (6.29)	4.00 (2.12)	1.67 (1.47)	50.07 (7.11)
T ₄	<i>Beauveria bassiana</i>	177.73 (13.35)	46.47 (6.85)	3.53 (2.01)	1.4 (1.38)	57.28 (7.6)
T ₅	<i>Verticillium lecanii</i>	132.6 (11.54)	61.13 (7.85)	4.07 (2.14)	1.67 (1.47)	49.87 (7.1)
T ₆	Dimethoate (30 EC)	190.93 (13.84)	64.07 (8.04)	3.07 (1.89)	1.8 (1.52)	64.97 (8.09)
T ₇	Control	109.2 (10.47)	48 (6.96)	30.8 (5.59)	18.6 (4.37)	51.65 (7.22)
SEm (±)		1.064	0.509	0.160	0.151	
CD (P=0.05)		NS	NS	0.556	0.523	

DBS= Day before spray, DAS= Day after spray, Figures in parentheses are Square root transformed values.

Chapter- V

Discussion

The results on the investigation “**Study of aphid on mustard, *Lipaphis erysimi* (Kalt) at Northern Madhya Pradesh**” during *Rabi* 2020-21 have been presented in preceding chapter. The findings of investigations have been discussed in the light of previously available information and important conclusions have been drawn.

5.1. To find out tolerant host genotypes against mustard aphid.

Ten genotypes of mustard were screened aphid, *L. erysimi* during *Rabi*, 2020-21. The minimum aphid population was recorded in genotype PT- 2015-8 (7.97 aphid/plant) which was found superior over rest of the genotypes followed by JT-14-5 (9.57 aphid/plant), BAUT-08-08 (14.1 aphid/plant), TKM-20-2 (16.3 aphid/plant) this genotypes was found resistive and maximum aphid population was recorded in PT-2018-09 (30.13aphid/plant) followed by PT-303 (29.23 aphid/ plant), RTM-19-17 (22.00 aphid/ plant), CG toria-3 (20.77 aphid/ plant) and CG toria-4 (18.43 aphid/ plant) and this host genotypes are resulted susceptible. Similarly Sreedhar *et al.*,(2019) found NPJ 194 as the tolerant genotype against aphid with an average population of 8.67 while 20 varieties of mustard were screened by Singh (2013) and he found T-6342 as a resistant variety and Pusa Bahar, RH-819, Sanjucta Bio-902, and Asech as highly susceptible against aphid.

4.2. To find out the most effective newer insecticide against mustard aphid.

The treatment T₅ (sprayed with Clothianidine 50 WGD) followed by T₁ (sprayed with imidacloprid 17.8 SL alone) and T₃ (sprayed with Acetamiprid 20 SP) were found to be most effective in reducing the aphid population on mustard crop. Dikshit and Prasad (2001) and Patil *et al.*,(2010) also reported that imidacloprid controls the aphid population when used as foliar spray similarly Rohilla *et al.*,(2004) reported imidacloprid 17.8 SL (0.178%), thiomethoxam 25 WG (50 g a.i./ ha as a most effective insecticide, whereas Gour and Pareek (2003) tested the efficacy of nine insecticides against mustard aphid, *L. erysimi* and found dimethoate (0.03%) and imidacloprid

(0.05%) as most effective insecticide. The results are also corroborate with Bhattacharya and Dhar (2008) and Mishra and Yadav (2013) they reported imidacloprid 17.8 SL most effective than other insecticides against mustard aphid. The effectiveness of acetamiprid 20 SP, imidacloprid and dimethoate against mustard aphid was also reported by Dhaka *et al.*,(2009).

3. Bio-efficacy of bio pesticide against aphid, *L. erysimi*.

The treatment T₁ (sprayed with Azadirachtin (300 ppm)), followed by T₂ (sprayed with Azadirachtin + *Beauveria bassiana*) and T₅ (sprayed with *Verticillium lecanii*) were found to be most effective biopesticide in reducing the aphid population on mustard crop. Kumar and Kumar (2016) found neem oil and *Beauveria bassiana* as most effective biopesticide whereas *Verticillium lecanii* as a least effective insecticide. Sahu *et al.*, (2018a) observed highest reduction of aphid population in spray of neem oil (32.5%) followed by Monocrotophos (36.5%) and *Beauveria bassiana*(37.5%) similarly Shinde *et al.*,(2021) studied the efficacy of biopesticides and found all biopesticides and dimethoate significantly superior over control at all the interval of observation against mustard aphid in mustard crop and recommended the use of biopesticides *Beauveria bassiana*, *Verticillium lecanii* and azadirachtin individually or in their combination as an eco-friendly and cost-effective alternative for the management of mustard aphid.

Chapter- VI

Summary, Conclusion and Suggestions for further work

SUMMARY

The study of aphid on mustard, *Lipaphis erysimi* (Kalt) with the objectives to find out tolerant host genotypes against mustard aphid and to find out the most effective newer insecticide and effective bio-pesticide against mustard aphid have been summarized in this chapter.

10 genotypes of mustard were screened aphid, *L. erysimi* during *Rabi*, 2020-21 and infestation of aphid was recorded in different stages of plant growth, PT-2015-8 genotype found superior over rest of genotypes with 7.97 aphid/plant followed by JT-14-5 (9.57 aphid/plant), BAUT-08-08 (14.1 aphid/plant), TKM-20-2 (16.3 aphid/plant) and hence this genotypes were found to be tolerant host genotypes against mustard aphid whereas maximum aphid population was recorded in PT-2018-19 (30.13 aphid/ plant) followed by PT-303 (29.23 aphid/ plant), RTM-19-17 (22.00 aphid/ plant), CG toria-3 (20.77 aphid/ plant) and CG toria-4 (18.43 aphid/ plant) and this host genotypes are resulted susceptible. The insecticide which are sprayed are Imidacloprid(17.8 SL), Thiamethoxam (25 WG), Acetamiprid(20 SP), Dimethoate(30 EC), Clothianidine (50 WGD) and Difenthiuron (50 WP) and Pretreatment observations recorded one day before first application indicates that the aphid population ranges 43.87-59.13 aphid/ plant, and further data recorded on 3rd, 5th, 7th days after first spraying. All the treatments were found significantly superior over untreated control. The treatment T₅ (sprayed with Clothianidine (50 WGD)) followed by T₁ (sprayed with imidacloprid 17.8 SL alone) and T₃ (sprayed with Acetamiprid(20 SP)) were found to be most effective in reducing the aphid population on mustard crop. The bio-pesticide which are sprayed are Azadirachtin (300 ppm), Azadirachtin + *Beauveria bassiana*, Azadirachtin + *Verticillium lecanii*, and Dimethoate (30 EC) and the reduction in aphid population at different intervals after applications the bio- pesticides are evaluated. Pretreatment observations recorded one day before first application indicates that the aphid population ranges 95.93-190.93

aphid/ plant, and further data recorded on 3rd, 5th and 7th days after first spraying. The treatment T₁ (sprayed with Azadirachtin (300 ppm)), followed by T₂ (sprayed with Azadirachtin + *Beauveria bassiana*) and T₅ (sprayed with *Verticillium lecanii*) were found to be most effective biopesticide in reducing the aphid population on mustard crop whereas treatment T₆ and T₄ sprayed with Dimethoate (30 EC) and *Beauveria bassiana* are found to be least effective biopesticide against mustard aphid.

CONCLUSION

- From the results it is concluded that genotype PT-2015-8 followed by JT-14-5, BAUT-08-08 and TKM-20-2 found resistive where as PT-2018-09, PT-303, RTM-19-17, CG toria-3, and CG toria-4 found susceptible.
- Clothianidine (50 WGD) followed Imidacloprid (17.8 SL), Acetamaprid (20 SP) and Thiamethoxam (25 WG) are proved to be most effective newer insecticide against mustard aphid.
- Azadirachtin (300 ppm) followed by Azadirachtin + *Beauveria bassiana* and *Verticillium lecanii* are found to be most effective biopesticide against mustard aphid.

SUGGESTIONS FOR FURTHER WORK

- ❖ Observations on seasonal incidence of aphid may be recorded throughout the year in the field of mustard.
- ❖ Genotype studies may be undertaken more critically taking into consideration the morphological and biochemical component of the plant and yield.
- ❖ Further evaluation of this insecticides and bio-pesticides should be done to check the efficacy of newer insecticides against pest complex of mustard.

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APPENDICES

Pre flowering stage

Sources of variation	d.f	S.S.	M.S.S.	F-cal.	F-tab.
Treatments	9	17.91871	1.990967	1.3044	2.456281
Replication	2	17.60555	8.802774	5.767214	
Error	18	27.47426	1.526348		
Total	29	62.99852			
CD	2.281937	Sem	0.71329		

Pod development stage

Sources of variation	d.f	S.S.	M.S.S.	F-cal.	F-tab.
Treatments	9	21.10342	2.344825	1.169926	2.456281
Replication	2	22.75041	11.3752	5.675539	
Error	18	36.07652	2.004251		
Total	29	79.93035			
CD	2.614887	Sem	0.817364		

PESTICIDE

Sources of variation	d.f	S.S.	M.S.S.	F-cal.	F-tab.
Treatments	6	3.019369	0.503228	0.225652	2.996
Replication	2	3.540856	1.770428	0.793877	
Error	12	26.76123	2.230102		
Total	20	33.32145			
CD	2.98245	Sem	0.862188		

Sources of variation	d.f	S.S.	M.S.S.	F-cal.	F-tab.
Treatments	6	15.5869	2.597816	3.236089	2.996
Replication	2	2.310658	1.155329	1.439188	
Error	12	9.63317	0.802764		
Total	20	27.53073			
CD	1.789389	Sem	0.517		

Sources of variation	d.f	S.S.	M.S.S.	F-cal.	F-tab.
Treatments	6	12.96416	2.160694	4.635048	2.996
Replication	2	0.602031	0.301016	0.645728	
Error	12	5.593971	0.466164		
Total	20	19.16016			
CD	1.363579	Sem	0.394		

Sources of variation	d.f	S.S.	M.S.S.	F-cal.	F-tab.
Treatments	6	24.69402	4.11567	34.74733	2.996
Replication	2	0.232248	0.116124	0.980397	
Error	12	1.421348	0.118446		
Total	20	26.34762			
CD	0.687338	Sem	0.1987		

BIO -PESTICIDE

Sources of variation	d.f	S.S.	M.S.S.	F-cal.	F-tab.
Treatments	6	41.43279	6.905465	2.031036	2.996
Replication	2	42.86474	21.43237	6.303692	
Error	12	40.79965	3.399971		
Total	20	125.0972			
CD	3.682548	Sem	1.064577		

Sources of variation	d.f	S.S.	M.S.S.	F-cal.	F-tab.
Treatments	6	6.261766	1.043628	1.341286	2.996
Replication	2	4.813804	2.406902	3.093386	
Error	12	9.33696	0.77808		
Total	20	20.41253			
CD	1.761664	Sem	0.509274		

Sources of variation	d.f	S.S.	M.S.S.	F-cal.	F-tab.
Treatments	6	33.34614	5.55769	71.59616	2.996
Replication	2	0.22165	0.110825	1.427686	
Error	12	0.931506	0.077626		
Total	20	34.49929			
CD	0.556433	Sem	0.160858		

Sources of variation	d.f	S.S.	M.S.S.	F-cal.	F-tab.
Treatments	6	22.13501	3.689168	53.70992	2.996
Replication	2	0.182043	0.091022	1.325166	
Error	12	0.824243	0.068687		
Total	20	23.14129			
CD	0.523417	Sem	0.151313		

Study of aphid on mustard, *Lipaphis erysimi* (Kalt) at Northern Madhya Pradesh

Dr. Pradyumn Singh,
Scientist at
Zonal Agricultural
Research Station, Morena (M.P.)

Mr. Azhar Uddin,
M.Sc. Scholar

THESIS ABSTRACT

Present study was carried out at RVSKVV, Zonal Agricultural Research Station, Morena, Madhya Pradesh during Rabi 2020-21. 10 genotypes of mustard were screened against aphid, *L. Erysimi* during the season to evaluate the tolerant hostgenotypes, most effective newer insecticide and biopesticides. PT-2015-8 genotype found superior over rest of genotypes with 7.97 aphid/plant followed by JT-14-5 (9.57 aphid/plant), BAUT-08-08 (14.1 aphid/plant) and found to be tolerant host genotypes against mustard aphid whereas maximum aphid population was recorded in PT-2018-19 (30.13 aphid/ plant) followed by PT-303 (29.23 aphid/ plant), RTM-19-17 (22.00 aphid/ plant) and CG toria-3 (20.77 aphid/ plant) so this genotypes resulted as susceptible. The insecticide which are sprayed are Imidacloprid(17.8 SL), Thiamethoxam (25 WG), Acetamiprid(20 SP), Dimethoate(30 EC), Clothianidine (50 WGD) and Difenthiuron (50 WP). The treatment T₅ (sprayed with Clothianidine (50 WGD)) followed by T₁ (sprayed with imidacloprid 17.8 SL alone) and T₃ (sprayed with Acetamiprid(20 SP)) were found to be most effective in reducing the aphid population on mustard crop. The bio-pesticide which are sprayed are Azadirachtin (300 ppm), Azadirachtin + *Beauveria bassiana*, Azadirachtin + *Verticillium lecanii*, and Dimethoate (30 EC) and the reduction in aphid population at different intervals after applications of the bio-pesticides are evaluated. The treatment T₁ (sprayed with Azadirachtin (300 ppm)), followed by T₂ (sprayed with Azadirachtin + *Beauveria bassiana*) and T₅ (sprayed with *Verticillium lecanii*) were found to be most effective biopesticide in reducing the aphid population on mustard crop whereas treatment T₆ and T₄ sprayed with Dimethoate (30 EC) and *Beauveria bassiana* are found to be least effective bio- pesticide against mustard aphid.

THESIS ABSTRACT

1. Title of the thesis : **Study of aphid on mustard, *Lipaphis erysimi* (Kalt) at Northern Madhya Pradesh**
2. Name of the Scholar : **Mr. Azhar Uddin**
3. Postal Address : Village- Ikoda, Teh.- Kurwai, Dist- Vidisha, Pin code- 464224 (M.P.)
4. Advisor : **Dr. Pradyumn Singh**
5. Official Address : Department of Entomology,
College of Agriculture, Gwalior (M.P.)
6. Degree awarded : **master of science in Agriculture**
7. Year of award of degree : 2020-2021
8. Major subject : **ENTOMOLOGY**
9. Total number of pages in the thesis : 30
10. Number of words in the abstract : 261

Signature

Pradyumn Singh
Advisor

Signature

Dr. U.C. Singh
Head of the Department

Signature Dr.

Mr. Azhar Uddin
Student

VITA

The author of this thesis is Mr. Azhar Uddin s/o Sahab Uddin born on 10th Dec 1995 at Ikoda, Vidisha, (Madhya Pradesh). He passed his high school education in 2011 from N.M.H.S. School, Kurwai, Vidisha, Madhya Pradesh (MP Board) with 60.00%. He passed his senior secondary examination in 2013 from N.M.H.S. School, Kurwai, Vidisha, Madhya Pradesh (MP Board) with 71.80%. He completed his graduation in B.Sc. Agriculture from College of Agriculture, Ganj Basoda, Jawahar Lal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh in the year 2019 and achieved OGPA of 7.18/ 10. After completion of graduation, he was admitted in College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh for M.Sc. (Ag.) Entomology in the year 2019. He did research on the topic "Study of aphid on mustard, *Lipaphis erysimi* (Kalt) at Northern Madhya Pradesh"

Date:

Place: Gwalior

Azhar Uddin