INSECT PEST DIVERSITY ASSESSMENT FOR MANGO AND ITS MANAGEMENT PRACTICES USED BY THE FARMERS OF BAGHA AND CHARGHAT UPAZILA AT RAJSHAHI DISTRICT

MD. KHAIRUL ISLAM

DEPARTMENT OF ENTOMOLOGY

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

SHER-E-BANGLA NAGAR, DHAKA-1207

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BY

MD. KHAIRUL ISLAM

REGISTRATION NO.: 10-04070

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Approved by

……

(Professor Dr. Md. Abdul Latif)
Supervisor
Dept. of Entomology, SAU, Dhaka

……

(Professor Dr. Md. Mizanur Rahman)
Co-Supervisor
Dept. of Entomology, SAU, Dhaka

……

(Dr. Mohammed Sakhawat Hossain)
Chairman
Department of Entomology
Sher-e-Bangla Agricultural University, Dhaka

Department of Entomology
Sher-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh.

Memo No.: SAU/AEIS Date:

CERTIFICATE

This is to certify that the thesis entitled, **"INSECT PEST DIVERSITY ASSESSMENT FOR MANGO AND ITS MANAGEMENT PRACTICES USED BY THE FARMERS OF BAGHA AND CHARGHAT UPAZILA AT RAJSHAHI DISTRICT"** 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. Khairul Islam**, Registration No. 10-04070, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

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

Dated: December, 2015
Dhaka, Bangladesh

.....
(Professor Dr. Md. Abdul Latif)
Supervisor
Dept. of Entomology
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207.

Telephone: +88-02-9144270-8, Fax: +88-02-8155800, E-mail: mdalatif15@yahoo.com

DEDICATION

DEDICATED
TO
MY PARENTS

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LIST OF CONTENTS

CHAPTER	TITLE	PAGE
	ACKNOWLEDGEMENTS	v
	LIST OF CONTENTS	vi-viii
	LIST OF TABLES	ix-x
	LIST OF FIGURES	xi
	ABBREVIATION AND GLOSSARY	xii
	ABSTRACT	xiii
CHAPTER I	**INTRODUCTION**	**1-3**
CHAPTER II	**REVIEW OF LITERATURE**	**4-14**
2.1	Mango cultivars/varieties in different countries	4
2.2	Insect and mite pests of mango	6
2.3	Insect pest management practices of mango	10
2.4	Mango grower's demographic characteristics and its relationship	12
CHAPTER III	**MATERIALS AND METHODS**	**15**
3.1	Research Design	15
3.2	Locale of the study	15
3.3	Unit of analysis	18
3.3.1	Population and Sampling	18
3.3.2	Study Group (SG) Sampling	20
3.3.3	Field Level Officer (FLO) Selection	20
3.4	Distribution of Sample Size	20
3.5	Variables and their measurement techniques	22
3.5.1	Measurement of independent variables	22
3.5.2	Measurement of dependent variable	27
3.5.2.1	Insect pest diversity assessment for mango	28
3.5.2.2	Insect pest management practices	28
3.6	Insecticide usages by the mango growers	29

CHAPTER	TITLE	PAGE
3.7	Harmful effects of chemical insecticides usage	30
3.8	Assessment of ripening and harvesting time of mango	30
3.9	Usages of ripening chemicals	30
3.10	Usages of preservatives	30
3.11	Instrument for collection of data	30
3.12	Data collection	31
3.13	Compilation of data	35
3.14	Statistical analysis	35
CHAPTER IV	**RESULTS AND DISCUSSION**	
4.1	Selected characteristics of the mango growers	36
4.1.1	Gender	36
4.1.2	Age	37
4.1.3	Education	38
4.1.4	Agricultural farming experience	38
4.1.5	Mango cultivated land size	39
4.1.6	Number of mango trees	40
4.1.7	Annual income from mango cultivation	40
4.1.8	Experience in mango cultivation	41
4.1.9	Economic loss due to insect pest	41
4.1.10	Information received about insecticides usage	42
4.1.11	Insecticides source	43
4.1.12	Training exposure on mango cultivation	44
4.1.13	Organizational participation	45
4.2	Insect pest assessment for mango	46
4.2.1	Responses from mango growers on insect pest	46
4.2.1.1	Insect pest occurrence in mango orchard	46
4.2.1.2	Insect pest infestation status in mango orchard	46
4.2.1.3	Insect pest infestation severity in mango orchard	47
4.2.2	Response of field level officer on insect pest	48

CHAPTER	TITLE	PAGE
4.2.2.1	Insect pest occurrence in mango orchard	48
4.2.2.2	Insect pest infestation status in mango orchard	48
4.2.2.3	Insect pest infestation severity in mango orchard	49
4.2.3	Correlation between mango growers and field level officer's response on insect pest diversity	50
4.3	Insect pest management practices	50
4.3.1	Responses of mango growers on insect pest management practices	50
4.3.1.1	Cultural control	50
4.3.1.2	Mechanical control	51
4.3.1.3	Chemical control	52
4.3.2	Responses of field level officer on insect pest management practices	53
4.3.2.1	Cultural control	53
4.3.2.2	Mechanical control	53
4.3.2.3	Chemical control	54
4.3.3	Correlation between mango growers and field level officer's response on insect pest management practices	55
4.4	Insecticide usages by the mango growers	56
4.5	Harmful effects of chemical insecticides usage	57
4.6	Assessment of ripening and harvesting time of mango	59
4.7	Usages of ripening chemicals	59
4.8	Usages of preservatives	59
CHAPTER V	**SUMMARY AND CONCLUSION**	**60-62**
CHAPTER VI	**REFERENCES**	**63-66**
	APPENDIX-I	**67-72**
	APPENDIX-II	**73-75**

LIST OF TABLES

TABLE	TITLE	PAGE
1	List of mango cultivars in different countries	4
2	Insect and mite pests of mango, their identity, status and infestation severity	8
3	Population of the study area	14
4	Sample size of Study Group (SG) and Field Level Officers (FLO) Group	21
5	Distribution of the mango growers according to their age	37
6	Distribution of the mango growers according to their level of education	38
7	Distribution of the mango growers according to their experience in agricultural farming	39
8	Distribution of the mango growers according to their mango land size	39
9	Distribution of the respondents according to their mango trees	40
10	Distribution of the mango growers according to their annual family income from mango cultivation	40
11	Distribution of the mango growers according to their experience in mango cultivation	41
12	Distribution of the mango growers according to economic loss due to insect pest	42
13	Distribution of the mango growers according to information received about insecticides usage	43
14	Distribution of the mango growers according to information received about insecticides usage	44
15	Distribution of the mango growers according to their training exposure	45
16	Distribution of the mango growers according to their organizational participation	45
17	Response of the mango growers on insect pest occurrence in mango orchard	46
18	Response of the mango growers on insect pest infestation status in mango orchard	47

TABLE	TITLE	PAGE
19	Response of the mango growers on insect pest infestation severity in mango orchard	47
20	Response of the field level officers on insect pest occurrence in mango orchard	48
21	Response of the field level officers on insect pest infestation status in mango orchard	49
22	Response of the field level officers on insect pest infestation severity in mango orchard	49
23	Correlation matrix between mango growers and field level officer's response on insect pest diversity	50
24	Distribution of the mango growers according to insect pest management practices	52
25	Distribution of the mango growers according to insect pest management practices based on field level officers' response	55
26	Correlation matrix between mango growers and field level officer's response on insect pest management practices	55
27	Distribution of the mango growers according to insecticide usage	56
28	Distribution of the respondents according to harmful effects of chemical insecticides usage	58
29	Response of the mango growers and field level officers about the ripening -harvesting time of mango	59

LIST OF FIGURES

FIGURE	TITLE	PAGE
1	Map of Bangladesh showing the study area- Rajshahi District	16
2	Map of Rajshahi District showing the study area- Charghat and Bagha Upazila	17
3	Gender of the mango growers participated in the field survey	37
4	Response of the mango growers on information received about insecticides usages	42
5	Response of the mango growers on insecticides sources	44
6	Response of the mango growers on cultural control	51
7	Response of the mango growers on mechanical control	51
8	Response of the mango growers on chemical control	52
9	Response of the field level officers on cultural control of mango growers	53
10	Response of the field level officers on mechanical control of mango growers	54
11	Response of the field level officers on chemical control of mango growers	54
12	Response of the mango growers on harmful effects of chemical insecticides usage	57

ABBREVIATION AND GLOSSARY

Abbreviation	Acronyms
AEO	Agriculture Extension Officer
BBS	Bangladesh Bureau of Statistics
CC	Chemical Control
CG	Control Group
CP	Cultural Practices
DAE	Department of Agriculture Extension
et. al	All Others
FLO	Field Level Officer
MoA	Ministry of Agriculture
MP	Mechanical Practices
OP	Organizational Participation
p.	Page
SAAO	Sub Assistant Agriculture Officer
SG	Study Group
SPCBP	Strengthening Phytosanitary Capacity in Bangladesh Project
UAO	Upazila Agriculture Officer

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ABSTRACT

Information was collected from mango growers and DAE personnel of Bagha and Charghat Upazila during May-June, 2016 to assess the diversity of insect pests of mango and its management practices used by growers. Descriptive statistics, Pearson product moment correlation (r) were used for analysis. Six insect pests namely mango hopper, fruit fly, mealybug, leaf eating weevil, leaf gall and shoot gall were reported by the growers as well as DAE personnel. Most of the mango growers (96.4%) reported that they practiced field sanitation as cultural control method. 23.9% mango growers reported that they used pheromone trap against mango fruit fly. 95.4% mango growers reported that they used Imidacloprid followed by 92.3% used carbaryl. Majority mango growers used Admire (Imidacloprid) against mango hopper, Sevin (Carbaryl) for controlling fruit fly and mealybug, Dursban (Chlorpyrifos) for leaf gall treatment, Jubar (Lambdacyhalothrin) insecticide against leaf eating weevil, shoot gall as chemical control. 53.1% mango growers reported that they were faced the harmful effects of chemical insecticides like skin and eye irritation. All mango growers reported that they did not use any types of ripening chemicals or preservatives.

CHAPTER I

INTRODUCTION

Mango (*Mangifera indica* L.) a member of family Anacardiaceae is known as king of fruits for its sweetness, excellent flavor, delicious taste and high nutritive value (Litz 1997, Singh 1968). This important tropical fruit is being grown in more than 100 countries. It is also valuable ornamental and shade tree, which contributes to the protection of soil against erosion and different virtues. A number of insect pest are known to attack the mango trees, which have been studied in detail (Tandon and Verghese 1985, Herren 1981, Giani 1968, Sen 1955). The nymphs and female bugs suck sap from inflorescence, tender leaves, shoots and fruit peduncles. As a result, the affected inflorescences are shriveled and get dried. Severe infestation affects the fruit set and causes fruit drop. They secrete honey dew over, which sooty mould develops (Tandon and Lal 1978). Due to the growth of sooty mould on the leaves, photosynthetic activity is affected (Pruthi and Batra 1960). Karar *et al.* (2006) reported that mealybug (*Drosicha mangiferae* Green.) is the serious pest of mango crop in Pakistan and is growing threat to mango orchards.

Mango is now the most important fruit item by tonnage production and widely cultivated in all the districts of Bangladesh. Mango contributes 0.945 million MT from local production. The fruit has really of immense value in respect of money and prosperity. In Bangladesh, it is called as “King of the fruit”. Bangladesh is one of the major mango producing countries along with India, Pakistan, Mexico, Brazil, the Philippines, etc. (Alexander 1989). In Bangladesh, mango occupies about an area of 50,491 ha with a production of 945049 metric tons during 2011-12 according to FAOSTAT (2014). It is now in an increasing trend in area by 113.15% and in production by 106.28% in the year of 2011-12 compared to 2008-09 FAOSTAT (2014). Mango is the leading seasonal cash crop of the northwestern region of Bangladesh and dominates the economy in Rajshahi and Chapainawabganj districts.

About 492 insect species are known to infest mango and out of these approximately 45 percent reported from India and Bangladesh. Among these 45 percent, about a dozen are found more severe causing considerable loss to the fruit. Some of them are mango hopper, mango fruit fly, mango fruit weevil, mango defoliator, psyllid, mealybug etc. These insect pests cause a huge yield loss every year. To achieve good yields with top quality fruits, mango growers currently rely on regular insecticide (Malathion, Imidacloprid, Sevin, Pyrethrin, Cypermethrin, Spinosad, Lamdacyhalothrin etc.) applications. This leads to increase costs of production, the reduction of natural predators and parasitoids that help control the insect pests, increased pest resistance to insecticides, insecticide residues in the fruits and environmental pollution. Now-a-days the farmers are also practicing different cultural, biological and mechanical method to control insect pests. A large number of mango production is introduced in Bagha and Charghat upazila of Rajshahi. There is few information about insect pests and their management practices of mango at Bagha and Charghat upazila of Rajshahi.

Farmer's adopted different ways to control this pest, for example in Benin (West Africa), some farmers destroyed infected trees with mango mealybug to control the infestation (Willink and Moore, 1988), which is un-affordable solution. In general, the insecticides are considered to be the quick method for the control of insect pests but dependence on the insecticides has its own complications as WTO pointed out, phytosanitory standards, admissible limits of residues by World Health Organization and many management problems like development of pest resistance to insecticides, increased risk to humans, biodiversity and environment. This situation demanded some alternate measures to overcome these problems.

Rajshahi district is one of the major mango growing area in Bangladesh. High quality and different varieties of mango are abundant in Rajshahi. Around 1,81,107 metric ton mango produced in 16,961 ha land at every year in this district. Bagha and Charghat upazila of Rajshahi are focal point of mango production area. Around 87,058.5 metric ton mango produced in 12,446 ha

land at Bagha and Charghat upazila which occupied 48 percent of total mango production in Rajshahi district (MoA, 2016). Besides, Bagha and Charghat upazilas of Rajshahi are situated near the border of the India. Low quality insecticides entered in these areas in illegal ways which is also caused the harm of mango production. Appreciating and analyzing the aforesaid conditions the researcher has become interested in undertaking research work at these two upazilas.

Only a few researches have so far been conducted research on farmers' management practices against insect pest of mango in Bangladesh. Consequently, large amount of production is hampered and farmers face economic losses due to the insect pest attacks. The focal point of the research work was to explore the trends of insect pest diversity assessment and insect pest management practices for mango. This is why the following objectives were framed out in order to provide an appropriate track to the research work:

i. To identify the insect pest diversity for mango at Bagha and Charghat upazila;
ii. To know the insect pest management practices used by farmers for mango;
iii. To find out the insecticides used by the farmers for controlling major insect pests of mango;
iv. To know the ripening and harvesting time for mango at Bagha and Charghat upazila.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this chapter is to review the previous studies and opinions of experts and scientists having relevance to this investigation based on the major objectives of the study. Attempts have been made to review that finding of past researches having relevance to the present study. The researcher, therefore, made exhaustive effort to review the previous research works directly or indirectly related to the present study by different researcher in home and abroad.

2.1 Mango cultivars/varieties in different countries

Apart from numerous seedling varieties, more than a thousand vegetative propagated mango cultivars have been reported. Most of these have originated as chance seedlings selected earlier and further maintained asexually. Majority of these cultivars is of Indian origin and representation from other parts of the world is limited in number. In India, about 30 cultivars are being grown commercially. Majority of them have narrow adaptability and show ecogeographical preferences for growth and yield **(**Yadav and Rajan, 1993**).** However, the situation has been gradually changing in different regions of India. Traditional cultivars, specific to particular regions are being replaced by those assuring higher returns.

Table 1. List of mango cultivars in different countries

Country	Cultivars
Bangladesh	'Aswina', 'Fazli', 'Gopal Bhog', 'Himsagar','Khirsapati', 'Langra', 'Kishan Bhog', 'Kohinoor', 'Kua Pahari', 'Mohan Bhog'
Brazil	'Bourbon', 'Carlota', 'Coracao', 'Espada', 'Itamaraca', 'Maco', 'Magoada', 'Rosa', 'Tommy Atkins'
China	'Baiyu', 'Guixiang', 'Huangpi', 'Huangyu', 'Macheco', 'Sannian', 'Yuexi No. 1'

Country	Cultivars
Costa Rica	'Haden', 'Irwin', 'Keitt', 'Mora', 'Tommy Atkins'
Ecuador	'Haden', 'Keitt', 'Kent', 'Tommy Atkins'
Egypt	'Alphonso', 'Bullock's Heart', 'Hindi Be Sennara', 'Langra', 'Mabrouka', 'Pairie', 'Taimour', 'Zebda'
Guatemala	'Haden', 'Kent', 'Tommy Atkins'
Haiti	'Francine', 'Madame Francis'
India	'Alphonso', 'Banganapalli', 'Bombay', 'Bombay Green', 'Chausa', 'Dashehari', 'Fazli', 'Fernandian', 'Himsagar', 'Kesar', 'Kishen Bhog', 'Langra', 'Mallika', 'Mankurad, 'Mulgoa', 'Neelum', 'Pairi', 'Samar Behisht Chausa', 'Suvarnarekha', 'Totapuri', 'Vanraj', 'Zardalu', 'Amrapali', 'Bangalora', 'Gulabkhas'
Indonesia	'Arumanis', 'Dodol', 'Gedong', 'Golek', 'Madu', 'Manalagi', 'Cengkir', 'Wangi'
Israel	'Haden','Tommy Atkins','Keitt', 'Maya', 'Nimrod', 'Kent', 'Palmer'
Kenya	'Boubo','Ngowe','Batawi'
Malaysia	'Arumanis', 'Kuala Selangor 2', 'Golek', 'Apple Rumani', 'Malgoa', 'Apple Mango', 'Maha-65', 'Tok Boon'
Mali	'Amelie','Kent'
Mexico	'Haden', 'Irwin', 'Kent', 'Manila', 'Palmer', 'Sensation', 'Tommy Atkins', 'Van Dyke'
Myanmar	'Aug Din', 'Ma Chit Su', 'Sein Ta Lone', 'Shwe Hin Tha'
Pakistan	'Anwar Ratol', 'Baganapalli', 'Chausa', 'Dashehari', 'Gulab Khas', 'Langra', 'Siroli', 'Sindhri', 'Suvarnarekha', 'Zafran'
Peru	'Haden', 'Keitt', 'Kent', 'Tommy Atkins'
Philippines	'Carabao', 'Manila Super', 'Pico', 'Binoboy', 'Carabao', 'Dudul', 'Pahutan', 'Senora'
Singapore	'Apple Mango', 'Arumanis', 'Golek', 'Kaem Yao', 'Mangga Dadol'
South Africa	'Fascell', 'Haden', 'Keitt', 'Kent', 'Sensation', 'Tommy Atkins', 'Zill,
Sri Lanka	'Karutha Colomban, Willard, Vellai Colomban, Petti amba, Malwana amba, Parrot Mango and Peterpasand, Dapara, Hingurakgoda
Thailand	'Nam Doc Mai', 'Ngar Charn', 'Okrong', 'Rad', 'Choke Anand', 'Kao Keaw', 'Keow Savoey', 'Pimsenmum'
USA	'Keitt', 'Kent', 'Tommy Atkins'
Venezuela	'Haden' 'Keitt' 'Kent' 'Tommy Atkins
Vietnam	'Combodiana'

(Horticultureworld 2016)

2.2 Insect and mite pests of mango

The incidence and damage caused by mango insect pests have been presented below:

2.2.1 Incidence of insect and mite pests

The incidences of major insect pests of mango recorded were mango hopper (*Amritodus atkinsoni*, *Idioscopus clypealis*) and oriental fruit fly (*Bactrocera dorsalis* (Hendel))) in field condition. The important minor insect pests of mango were mango pulp weevil (*Sternochaetus frigidus*), mango mealybug (*Droshicha mangiferae* Green) recorded for the infestation in the field condition. Other minor insect pests were mango stone/seed weevil (*Sternochetus mangiferae* (Fabricius)), leaf cutting weevil (*Deporaus marginatus*), mango stem/trunk borer (*Batocera rubus* (Linnaeus), mango fruit fly (*Bactrocera tau*), guava fruit fly/peach fruit fly (*Bactrocera zonata* (Saunders)), mango leaf gall midge (*Procontarinia matteiana*), mango common scale (*Coccus mangiferae* (Green)), mango shoot gall psyllid (*Apsylla cistellata* (Cockerell), mango defoliator (*Cricula trifenestrata* (Helfer), mango fruit borer (*Citripestis eutraphera* Meyrick), mango leaf webber (*Orthaga exvinacea* Hampson), mango leafminer (*Acrocercops syngramma* Meyrick), mango leaf caterpillar (*Euthalia aconthea*), and pink gypsy moth (*Lymantria mathura* Moore) in field condition (Table 2). The mango eriophyid mite was also reported as the minor pest of mango in the field condition. But the incident of Mediterranean fruit fly (*Ceratitis capitata*), Queensland fruit fly (*Bacterocera troyni*) and Tapioca scale insect (*Aonidomytilus albus*) were not recorded in the field of mango growing areas of Bangladesh. (SPCBP 2015)

2.2.2 Damage potential of insect pests

Among these insect pests, mango hopper, oriental fruit fly and mango pulp weevil were more damaging than others. The adults and nymphs of mango hopper caused damage mango at its flower stage on inflorescence and fruits at pea size stage with medium to high infestation severity, if not controlled properly. Usually Bangladesh's farmers always used chemical insecticides and suppressed the infestation of mango hopper in every season; both adults and grubs of mango pulp weevil caused damage at fruiting stage of mango by feeding the internal pulp of mango with low to medium infestation severity. Besides, the oriental fruit fly (*Bactrocera dorsalis*) caused damage mango at fruiting stage by feeding the internal pulp by maggots with low to medium infestation severity. Other minor insect and mite pests damage mango with low infestation intensity. (SPCBP 2015)

2.2.3 Insect pests of mango, their identity, status and infestation severity

Mango plant suffers from a number of pests and diseases at all stages of development i.e. right from nursery stage to grown-up tree stage. Even fruits at pre-harvest stages are affected making them unsuitable for marketing and export (Fita 2014). Some of the mango pests as reported by different authors include; beetles, fruit flies, red banded thrips, mango tip borer, scales and seed weevil (Fita 2014, Nankinga *et. al* 2014, Barbara and Bradley 2012, Verghese 2000).

There are numerous species of mealybugs. The species prevalent in Pakistan is *Drosicha stebbingi* Green. Similarly, there are more than 4000 species of fruit flies distributed all over the world (Marsaro *et al.* 2013)

A number of insect pest are known to attack the mango trees, which have been studied in detail (Tandon and Verghese 1985, Herren 1981, Giani 1968, Sen 1955). The nymphs and female bugs suck sap from inflorescence, tender leaves, shoots and fruit peduncles. As a result, the affected inflorescences are

shriveled and get dried. Severe infestation affects the fruit set and causes fruit drop. They secrete honey dew over, which sooty mould develops (Tandon and Lal 1978). Due to the growth of sooty mould on the leaves, photosynthetic activity is affected (Pruthi and Batra 1960).

Bajwa and Gul (2000) reported that Paulownia spp attacked by mango mealybug. They managed this pest through destruction of eggs, banding of trees and application of insecticides together. More than 300 insect pests have been recorded to attack mango crop in different regions of world

Insect and mite pests of mango, their identity, status and infestation severity have been shown in the following Table 2.

Table 2. Insect and mite pests of mango, their identity, status and plant parts affected

Name of pest	Pest identity	Pest status	Stage and plant parts affected
Mango pulp weevil	*Sternochaetus frigidus* Order: Coleoptera Family: Curculionidae	Minor	Fruit, pulp
Mango stone/nut/ seed/weevil	*Sternochetus mangiferae* (Fab.) Order: Coleoptera Family: Curculionidae	Minor	Fruit, seed
Leaf cutting weevil	*Deporaus marginatus* Order: Coleoptera Family: Curculionidae	Minor	Young leaf
Mango stem/ trunk borer	*Batocera rubus* (Linnaeus) Order: Coleoptera Family: Cerambycidae	Minor	Tree trunk, stem
Oriental fruit fly	*Bactrocera dorsalis* (Hendel) Order: Diptera Family:Tephritidae	Major	Fruits
Cucurbit fruit fly	*Bactrocera cucurbitae* Order: Diptera Family:Tephritidae	Minor	Fruits

Name of pest	Pest identity	Pest status	Stage and plant parts affected
Mango eriophyid mite	*Aceria mangiferae* (Sayed) Order: Acarina Family: Eriophyidae	Minor	Leaves, fruits
Mango fruit fly	*Bactrocera tau* (Walker) Order: Diptera Family:Tephritidae	Minor	Fruits
Peach fruit fly/ Guava fruit fly	*Bactrocera zonata* (Saunders) Order: Diptera Family:Tephritidae	Minor	Fruits
Mango leaf gall midge	*Procontarinia matteiana* Order: Diptera Family: Cecidomyiidae	Minor	Leaves
Mango hopper (*Amritodus atkinsoni*)	*Idioscopus clypealis* Order: Homoptera Family: Cicadellidae	Major	Leaves, stems, flowers, fruits at pea size
Mango common scale insect	*Coccus mangiferae* (Green) Order: Homoptera Family: Coccidae	Minor	Leaves, twigs
Mango shoot gall psyllid	*Apsylla cistellata* (Buckton) Order: Homoptera Family: Coccidae	Minor	Shoot, twig
Mango mealybug	*Droshicha mangiferae* Green Order: Homoptera Family: Monophlebidae	Recorded in restricted areas of Bangladesh	Inflorescences, tender leaves, shoots & fruit peduncles
Mango defoliator	*Cricula trifenestrata* (Helfer) Order: Lepidoptera Family: Saturniidae	Minor	Leaves, twigs
Mango fruit borer	*Citripestis eutraphera* (Meyrick) Order: Lepidoptera Family: Pyralidae	Minor	Fruits
Mango leaf webber	*Orthaga exvinacea* (Hampson) Order: Lepidoptera Family: Pyralidae	Minor	Leaves, twigs

Name of pest	Pest identity	Pest status	Stage and plant parts affected
Mango leaf miner	*Acrocercops syngramma* (Meyrick) Order: Lepidoptera Family: Gracillariidae	Minor	Leaves, twigs
Mango leaf caterpillar	*Euthalia aconthea* Order: Lepidoptera Family: Gracillariidae	Minor	Leaves, twigs
Pink gypsy moth	*Lymantria mathura* (Moore) Order: Lepidoptera Family: Lymantriidae	Minor	Leaves, twigs

(SPCBP, 2015)

2.3 Insect pest management practices of mango

Ishaq *et al.* (2004) worked on the integrated management of mango mealybug and reported that this pest is difficult to control by water based insecticides.

Tandon and Verghese (1985) for the control of *Drosicha* spp. and *Rastrococcus iceryoides* are, exposure of eggs during summer, removal of weeds, conservation of natural enemies, application of alkathane bands and spray of neem seed extract 4% or garlic oil on trunk below band.

Atwal (1963) reported that the pest could be controlled by destroying eggs laid under the infested trees; nymphs could be prevented from crawling up the trees by applying 8 cm wide sticky bands with grease material or slippery bands with alkathene or plastic sheets around the

Jia *et al.* (2001) found significant reduction of mango mealybug through integration of dusting of 25% parathion in micro capsules form or 5% phoxim on the ground before the soil freezes in winter, painting mixture of 1 kg 40% omethoate +5 kg mineral oil and spraying 300 times solution of Bt or 2000 times solution of 20% fenpropathrin for the control of nymphs of mealybug.

Chemical control methods for mealybug and fruit fly have been inefficient (Yousuf and Ashraf 1987, Tandon and Lal 1980). There has been consistent interest to evolve cultural and biological control methods. Yousuf (1993) reported use of polyethylene bands for effective control of mealybug. Several predators of mango mealybug have been identified (Boavida *et al.* 1995; Bokonon and Neuenschwander 1995, Moore and Cross 1993, Syed *et al.* 1970). The fruit flies have been eliminated by the use of pheromone traps and other male annihilation methods (Ushio *et al.* 1982, Steiner *et al.* 1965, Steiner and Larches 1955,).

Vega-pina *et al*. (2000) found that Climatic factors (temperature, wind, rain, quality of air and solar light) and management practices (rootstocks, cultivars, plantation design, pruning, irrigation, application of growth regulators, fertilizers, and pests and disease control) affect the quality of mango fruits. The 45-day water stress fruits (45-fruits) were heavier than the 30-day water stress fruits (30-fruits). 45-Fruits exhibited a higher incidence and severity of internal darkening, were firmer, contained a higher content of titratable acidity, and fruit skins were redder than 30-fruits.

Stonehouse *et al.* (2002) found that the mean number of larvae per infested fruit was not constant, and was not significantly less variable than the infestation rate. In comparisons of bait application technique (BAT: 3 ml of 57% malathion + 30 ml commercial protein hydrolysate) with farmer controls, in melon, average season-end fruit infestation was 29% in unprotected fields and 5% in those protected by BAT; in guava infestation was 44% in unprotected orchards and 12% in orchards protected by BAT; in jujube, infestation was 16% in unprotected orchards and 4% in those protected by BAT.

2.4 Mango grower's demographic characteristics and its relationship

Islam *et al*. (2013) studied and found that most of the mango growers (91.43%) of the study area were middle to old aged category. Secondary and above secondary level of education jointly (66.66%) dominated mango cultivation. Almost half of the mango growers had medium size mango orchard. About 7.14 percent of the mango growers were small and 43.81 percent medium and only 19.05 percent of the mango growers possessed large category. Nearly half of the mango growers were medium group. The highest proportion (53.33%) of the mango growers had low knowledge while 42.86 percent had medium knowledge and 3.81 percent high knowledge on mango cultivation. A major portion (79.04%) of the mango growers had low organizational participation while 10.48 percent had medium participation and 10.48 percent had no participation. Most (91.43%) of the mango growers of the study area had low extension contact while 8.57 percent mango growers had medium extension contact. No mango grower was found having high extension contact. The 40 percent of the mango growers had low cosmopoliteness as compared to 31.43 percent having medium cosmopoliteness and 28.57 percent having high cosmopoliteness. The majority (57.14 percent) of the mango growers had low innovativeness and 42.86 percent had medium innovativeness scores. Most (88.57%) of the mango growers were facing high constraints in mango cultivation while 11.43% had medium constraints. No mango grower was found having low constraint. Among the selected characteristics of the mango growers: education, farm size, area under mango cultivation, family income, knowledge on mango cultivation, cosrnopoliteness, innovativeness and organizational participation had significant negative relationship with the constraints faced in mango cultivation.

Dutta (2013) reported that indigenous technical knowledge followed by farmers for the management of different pests at five villages in Lakhimpur district of Assam. Indigenous Technical Knowledge (ITK) is the accumulated skill, technology of a locality or a community and has been passed on from one

generation to another. There is a wide spread revival of studies on indigenous knowledge system with different synonyms namely local technical knowledge, traditional wisdom and informal research and development. The percentage of farmers practicing different ITKs ranged from 40% to 80%. All these practices are economical, eco-friendly and low cost involvement.

Gajendra *et al*. (2014) stated that 95.00% of mango growers had knowledge about use of grafted plants and use of picking poles for harvesting. Knowledge about use of chemical to reduce post-harvest losses was noticed with 36.30% of respondents. The advantage of washing of fruits was known to 60.56%. But a very less percentage of farmers (10.83%) were know the fact of chilling injury leads to reduction in fruit quality and method for increasing shelf life of fruits. Majority of mango growers (84.17%) had knowledge of susceptible variety (Alphanso) to spongy tissue. Higher number (52) of the respondents reported that they sell their produce immediately after the harvest whatever may be the price. Majority (85.00%) of the respondents market their produce to the commission agents.

Sujaivelu and Sabapathi (2014) analysed and studied various agricultural information needs of the farmers in processing and producing value added products in mango The results showed that the respondents wanted information in the descending order on the aspects like selection of mango varieties,/hybrids, plant protection measures, pruning in crop, manures and fertilizer management, post-harvest technology, preparation of main field, planting techniques, pretreatment of seedling, weed management, method of propagation, irrigation management, intercropping, recommended growth regulators to prevent flower and fruit drop, harvesting techniques and value addition in mango.

Tanwar *et al*. (2013) found that About 97.50 per cent mango orchardists have full adoption of square method of layout preparation for planting in orchard and there was no adoption of hexaconal, countur, triangular, and quinces method of

layout preparation for planting of mango in orchard. Maximum 57.50 per cent mango orchardists have full adoption of 10 m x 10 m planting distance. Most of the orchardists have full adoption of Dashehari, Langra and Chousa varieties for plantation in mango orchard. In fertilizers and manure application, most of the mango growers were have full adoption. Most of orchardists have partial adoption of ring and furrow method for irrigation, while 67.50 orchardists have full adoption of flood method for irrigation, there was 100 per cent full adoption in wettable sulpher, 97.50 per cent karathan and hexaconazal for disease control. Most of the orchardists have full adoption in Monocrtophos, Endosulphan and Imidacloprid for pest management.

Acema *et al*. (2016) showed that significant variation in perception of farmers on incidence, severity and yield loss due to various pests (fruit flies, seed borer, termites, scales and mealybugs) and, diseases (anthracnose, bacterial black spot, powdery mildew, algal leaf spot and sooty mould). Farmers' choice to take a particular management practice like pruning, spraying, manuring and mulching were influenced by age of mangoes, extension service, education level and sex. It was concluded that many pests and diseases of exotic mangoes existed in WNZ and sound scientific orchard management practices were still lacking among the mango growers. The study recommended awareness creation on various mango pests and diseases, and capacity enhancement of farmers and extension staff on scientific orchard management practices.

Vanmele *et al*. (2001) stated that damage caused by the seed-borer *Deanolis albizonalis* (Hampson) was often wrongly attributed to the fruit flies *Bactrocera dorsalis* Hendel. Nearly all farmers applied calendar sprays of insecticides (97%) and fungicides (79%) from pre-flowering until harvest, with on average 13.4 and 11.6 applications per year, respectively. Pyrethroids were most popular (57%), followed by organophosphates (25%) and carbamates (15%). Around 20% of the insecticides used belonged to WHO Toxicity Class I, while the rest nearly all belonged to Class II.

CHAPTER III

MATERIALS AND METHODS

Methodology plays an important role in a scientific research. To fulfill the objectives of the study, a researcher should be very careful while formulating methods and procedures in conducting the research. The methods and operational procedures followed in conducting the study were selection of study area, sampling procedures, instrumentation, categorization of variables, collection of data, measurement of the variables and statistical measurements. A chronological description of the methodology followed in conducting this research work has been presented in this chapter.

3.1 Research design

A research design is detailed plan of investigation. It is the blueprint of the detailed procedure of testing the hypothesis and analysis of the obtained data. The research design followed in this study was *ex-post facto,* because of uncontrollable and non-manipulating variables. This is absolute descriptive and diagnostic research design. A descriptive research design is used for fact findings with adequate interpretation. Diagnostic research design, on the other hand, is concerned with testing the hypothesis for specifying and interpreting the relationship of variables.

3.2 Study area

Rajshahi district consists of nine upazilas. The study was taken at Charghat and Bagha Upazila (Rajshahi District) where the large amount of areas are covered with mango production. According to DAE, the Charghat and Bagha Upazila are segmented of 19 and 14 blocks respectively (MoA, 2016). The present study was conducted at 10 blocks of each upazila based on the population size in the selected area accordingly purposively. The name of the blocks of Bagha Upazila where the study was conducted as Bagha Paourashova, Panch Para,

Sonadha, Bausha, Aarpara, Jhina, Arani Pauroshava, Digha, Monigram, Pakuria and the name of the blocks of Charghat Upazila where the study was conducted as Charghat Pauroshava, Barbaria, Pirojpur, Jhikra, Dharmahara, Shalua, Bankishor, Vialankshipur, Kalohati, Neempara. The Blocks' population had almost engaged in mango production. The total population of the study area is 17548. The map of the Rajshahi district has been presented in Figure 1 and the specific study locations of Charghat and Bagha upazilas of Rajshahi district have also been shown in Figure 2.

Figure 1. Map of Bangladesh showing the study area of Rajshahi district.

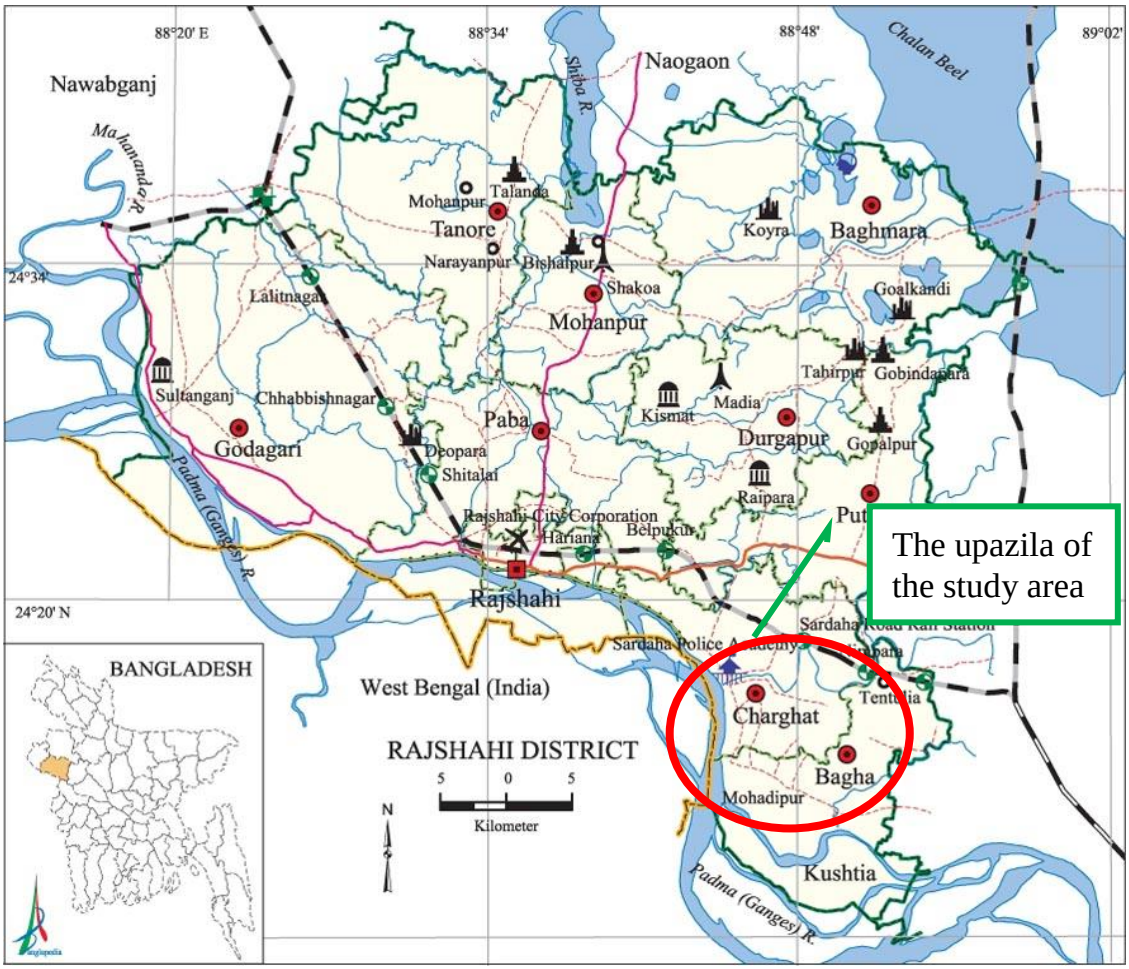

Figure 2. Map of Rajshahi district showing the study area of Charghat and Bagha upazila.

3.3 Unit of analysis

The unit of analysis of the study was the people who engaged mango production (farmers) and who provided the extension service to the mango growers (field officers).

3.3.1 Population and sampling

People who permanently reside in the selected blocks constituted the active population of this study. As all population of the study area could not possible to measure, head of the farm families of selected blocks of Charghat and Bagha Upazila (segmented by the Department of Agriculture Extension under the Ministry of Agriculture) of Rajshahi district were the population of the study. However, representative sample from the population were taken for collection of data following purposive sampling technique. One farmer (who operated farming activities of the family) from each farm family was considered as the respondent. Updated lists of all farm families of mango producers of the selected blocks were prepared with the help of SAAO and local leader (Matobbor). Farm families who engaged in mango production and who provided the extension service to the mango growers were considered as the study group. A purposive sampling procedure was followed to select one district from the all over Bangladesh, and a random sampling method was used to select the Upazila. Random sampling was also used to select the blocks of Charghat and Bagha Upazila as the study group. The total number of individuals under study was estimated 17548 in the study area which is shown in the following Table 3.

Table 3. Population of the study area

Name of District	Name of Upazila	Name of the Block	Population (Mango Cultivators)
Rajshahi	Charghat	Charghat Pauroshava	3496
		Barbaria	448
		Pirojpur	228
		Jhikra	307
		Dharmahara	456
		Shalua	412
		Bankishor	935
		Vialankshipur	1487
		Kalohati	542
		Neempara	396
	Bagha	Bagha Paourashova	1517
		Panch Para	443
		Sonadha	306
		Bausha	1478
		Aarpara	345
		Jhina	363
		Arani Pauroshava	1148
		Digha	436
		Monigram	1631
		Pakuria	1174
		Total	17548

3.3.2 Study Group (SG) Sampling

There are several methods for determining the sample size; here, I used Yamane's (1967) formula for study group:

$$n = \frac{z^2 P\,(1-P) N}{z^2 P\,(1-P) + N\,(e)^2}$$

Where,

n = Sample size;

N, Population size = 17548;

e, The level of precision = 7%;

z = the value of the standard normal variable given the chosen confidence level (e.g., z = 1.96 with a confidence level of 95 %) and

P, The proportion or degree of variability = 50%;

The sample size (n) is = 194

3.3.3 Field Level Officer (FLO) Selection

The respondents' size of the field level officers was 20 personnel which calculated as ten percent of the sampling population number. Sampling selected as 194 respondents who cultivated the mango.

3.4 Distribution of Sample Size

The total numbers of sample size under the study area were estimated 214 where the Study Group (SG) and Field Level Officers (FLO) group covered 194 and 20 respectively. The sample size is showing in the following Table 4.

Table 4. Sample Size of Study Group (SG) and Field Level Officers (FLO)

Name of District	Name of Upazila	Name of the Designation/ Block	Total Population	Sample Size of Farmers	Sample Size of Field Level Officer
Rajshahi	Charghat	UAO	-	-	01
		Charghat Pauroshava	3496	12	
		Barbaria	448	10	01
		Pirojpur	228	8	01
		Jhikra	307	8	01
		Dharmahara	456	10	01
		Shalua	412	9	01
		Bankishor	935	10	01
		Vialankshipur	1487	11	01
		Kalohati	542	10	01
		Neempara	396	8	01
	Bagha	UAO	-	-	01
		Bagha Paourashova	1517	11	
		Panch Para	443	9	01
		Sonadha	306	8	01
		Bausha	1478	11	01
		Aarpara	345	8	01
		Jhina	363	8	01
		Arani Pauroshava	1148	11	01
		Digha	436	9	01
		Monigram	1631	12	01
		Pakuria	1174	11	01
Total			17548	194	20

3.5 Variables and their measurement techniques

In a descriptive social research, selection and measurement of the variable is an important task. A variable is any characteristics which can assume varying or different values are successive individuals' cases (Ezekiel and Fox 1959). An organized research usually contains at least two identical elements i.e. independent and dependent variable. An independent variable is a factor which is manipulated by the researcher in his attempt to ascertain its relationship to an observed phenomenon. A dependent variable is a factor, which appears, disappears or varies as the experimenter introduces, removes or varies the independent variables (Townsend 1953). According to the relevance of the research area, the researcher selected 16 characteristics of the respondents as the independent variables (e.g. gender, age, education, agricultural farming experience, mango cultivated land size, number of mango trees, annual income from mango cultivation, experience in mango cultivation, economic loss due to insect pest, information received about insecticides usage, insecticides sources, training exposure on mango cultivation, organizational participation, harmful effects for chemical insecticides usages, usages of ripening chemicals, usages of preservatives). On the other hand, insect pests management practices was dependent variable consisted of two dimensions i.e. cultural and chemical management practices. Besides these, assessment of insect pest of mango and ripening, harvesting times of mango were also measured. The following sections contain procedures of measurement of dependent and independent variables of the study along with the assessment of insect pest of mango and ripening, harvesting times of mango.

3.5.1 Measurement of independent variables

The independent variables of the study were gender, age, education, agricultural farming experience, mango cultivated land size, number of mango trees, annual income from mango cultivation, experience in mango cultivation,

economic loss due to insect pest, information received about insecticides usage, insecticides sources, training exposure on mango cultivation, organizational participation, harmful effects for chemical insecticides usages, usages of ripening chemicals, usages of preservatives. The procedure followed in measuring the independent variables have been discussed in the subsequent sections.

3.5.1.1 Gender

Gender of the respondent was measured in terms of actual condition from their birth to the time of the interview, which was found on the basis of the response of the rural people. A score of one (1) was assigned for male and score two (2) was assigned for female. This variable appears in item number A.1. in the interview schedule as presented in APPENDIX-I.

3.5.1.2 Age

Age of the respondent was measured in terms of actual years from their birth to the time of the interview, which was found on the basis of the verbal response of the rural people. A score of one (1) was assigned for each year of one's age. This variable appears in item number A.2 in the interview schedule as presented in APPENDIX-I. Based on the available information cited by the respondents, they were classified into three categories according to the Ministry of Youth and Sports, Government of the Peoples Republic of Bangladesh.

Category	Years
Young age	≤ 35
Middle age	36 to 50
Old age	≥ 51

3.5.1.3 Education

Education was measured by assigning score against successful years of schooling by a respondent. One score was given for passing each level in an educational institution (Amin, 2004).

For example, if a respondent passed the final examination of class five or equivalent examination, his/her education score has given five (5). Each respondent of can't read & write has given a score of zero (0). A person not knowing reading or writing but being able to sign only has given a score of 0.5. If a farmer did not go to school but took non-formal education, his educational status was determined as the equivalent to a formal school student. This variable appears in item number A.3 in the interview schedule as presented in APPENDIX-I. Based on the available information cited by the respondents, they were classified into five categories.

Category	Education (Year of schooling)
Can't read & write	0
Can sign only	0.5
Primary education	1 to 5
Secondary education	6 to 10
Above secondary	> 10

3.5.1.4 Agricultural Farming Experience

Experience in agricultural farming of a respondent was measured on the basis of his/her duration of agricultural farming in terms of years. The experience of a respondent was measured by counting the period of time of agricultural farming. A score of one (1) was assigned for each year of agricultural farming. It was measured in complete years as reported by a respondent. Question regarding this variable appears in item number A.4 in the interview schedule as presented in Appendix-I.

3.5.1.5 Mango Cultivated Land Size

It refers to the area of land owned by a farmer on which mango growing activities are carried out. However, it was estimated in terms of hectare. Data obtained in response to questions under item number A.5 in the interview schedule (APPENDIX-I) formed the basis for determining mango cultivation area of the respondent.

3.5.1.6 Number of Mango Trees

The number of mango trees of a respondent was measured in terms of actual number. It was measured by counting the total number of trees what a respondent had. A score of one (1) was assigned for each tree. Question regarding this variable appears in item number A.6 in the interview schedule as presented in Appendix-I.

3.5.1.7 Annual Income from Mango Cultivation

The annual income from mango of a respondent is an important indicator of how much she can invest in his mango business. Annual income from mango was the income earned by the respondent from selling mango. Annual income from mango was measured in `thousand' Taka. The score 1(one) was assigned for each ‘000’ taka to compute the score of annual income from mango of the respondent. Questions regarding this variable appear in item number A.7 of the interview schedule.

3.5.1.8 Experience in Mango Cultivation

Experience in mango cultivation of a respondent was measured on the basis of his/her duration of mango cultivation in terms of years. The experience of a respondent was measured by counting the period of time of mango cultivation. A score of one (1) was assigned for each year of mango cultivation. It was measured in complete years as reported by a respondent. Question regarding

this variable appears in item number A.8 in the interview schedule as presented in Appendix-I.

3.5.1.9 Economic Loss due to Insect Pest

The economic loss for insect pests during mango cultivation of a respondent is an important indicator of how much she can loss in his mango business. Economic loss for insect pests during mango cultivation was the loss earned by the respondent due to the insect pests attack. Economic loss for insect pests during mango cultivation was measured in `thousand' Taka. The score 1(one) was assigned for each '000' taka to compute the score of Economic loss for insect pests during mango cultivation of the respondent. Questions regarding this variable appear in item number A.9 of the interview schedule.

3.5.1.10 Information received about insecticides usage

Information about insecticides usage of a respondent was determined by calculating the score where he got information. Data obtained in response to item number A.10 of the interview schedule as presented in Appendix-I.

3.5.1.11 Insecticides source

Insecticides source of a respondent was determined by calculating the score where he collected insecticides. Data obtained in response to item number A.11 of the interview schedule as presented in APPENDIX-I.

3.5.1.12 Training Exposure on Mango Cultivation

Training experience of a respondent was determined by the total number of day when he/she attended in different training programs in his/her life. A score of one (1) was assigned for each day of training attended. Data obtained in response to item number A.12 of the interview schedule as presented in APPENDIX-I. Scoring was done according to survey results and was categorized into 5 levels as no, low, medium and high. According to obtained survey data no, very low, low, medium and high training exposure were

classified into 0, 1–5, 6-12, and > 12 respectively where 0 indicating no training exposure and > 12 indicating higher training exposure.

3.5.1.13 Organizational Participation

Organizational participation of a respondent was computed on the basis of his/her participation in different organizations. This variable appears in item number A.13 in the interview schedule as presented in APPENDIX-I.
Scoring of the organizational participation was done using the following formula and in the following way-

OP = $P_{om} + P_{em} + P_{eo}$

Where, **OP =** Organizational participation score,

P_{om} = Participation as ordinary committee member,

P_{em} = Participation as executive committee member,

P_{eo} = Participation as executive committee officer (president/ sec).

Nature of participation	Score assigned
No participation	0
Participation as ordinary member	1
Participation as executive member	2
Participation as secretary/president	3

For example, if a respondent participated as an executive committee member of school committee, an ordinary member at NGO organized society and no participation in other organizations, that respondent would have a total score of three (3).

3.5.2 Measurement of dependent variable

Insect pest assessment for mango is one of the dependent variable. To reveal this insect pest assessment for mango, the researcher considered four (02) components: insect pest occurrence in mango orchard, insect pest infestation status in mango orchard, insect pest attack part in mango orchard and insect

pest infestation severity in mango orchard. All the major components were measured with the help of identified subcomponents. Each subcomponent was measured against the identified items, collected through the process of review of relevant literature, focused discussion with the officials, experts, experienced farmers.

3.5.2.1 Insect pest diversity assessment for mango

3.5.2.1.1 Insect pest occurrence in mango orchard

Insect pest occurrence in mango orchard was assessed by providing score. Score one was provided for yes and score zero was provided for no answer. Data obtained in response to item number B.1.1 of the interview schedule as presented in APPENDIX-I.

3.5.2.1.2 Insect pest infestation status in mango orchard

Insect pest infestation status in mango orchard was assessed by providing score. Score one was provided for minor answer and score two was provided for major answer. Data obtained in response to item number B.1.2 of the interview schedule as presented in APPENDIX-I.

3.5.2.1.3 Insect pest infestation severity in mango orchard

Insect pest attack part in mango orchard was assessed by providing score. Score one was provided for very low infestation severity. Data obtained in response to item number B.1.4 of the interview schedule as presented in APPENDIX-I.

3.5.3.2 Insect pest management practices

Insect pest management practices is the dependent variable. To reveal this management practices, the researcher considered two (02) components: cultural and chemical control. All the major components were measured with the help of identified subcomponents. Each subcomponent was measured against the

identified items, collected through the process of review of relevant literature, focused discussion with the officials, experts, experienced farmers.

Insect pest management practices (IPMP) was calculated by using the formula:

IPMP = CP + MP + CC

Where, IPMP = Insect pest management practices

CP = Cultural Practices

MP = Mechanical Practices

CC = Chemical Control

3.5.2.2.1 Cultural control

Cultural control of a respondent was determined by providing score. Score one was provided for very low practices. Data obtained in response to item number C.1.1 of the interview schedule as presented in APPENDIX-I.

3.5.2.2.2 Mechanical control

Mechanical control of a respondent was determined by providing score. Score one was provided for very low chemical use. Data obtained in response to item number C.1.2 of the interview schedule as presented in APPENDIX-I.

3.5.2.2.3 Chemical control

Chemical control of a respondent was determined by providing score. Score one was provided for very low chemical use. Data obtained in response to item number C.1.3 of the interview schedule as presented in APPENDIX-I.

3.6 Insecticide usages by the mango growers

What type insecticide usages by the mango growers was assessed by providing score. Score one was provided for yes and score zero was provided for no answer. Data obtained in response to item number D.1 of the interview schedule as presented in APPENDIX-I.

3.7 Harmful effects of chemical insecticides usage

Harmful effects of chemical insecticides usage referred to the harmful effects due to usages of chemical insecticides. It was expressed in score. In measuring this variable, a score of one was given for low effects. This variable appears in item number D.2 in the interview schedule as presented in APPENDIX-I.

3.8 Assessment of ripening and harvesting time of mango

Assessment of ripening and harvesting time of mango was determined by actual time of ripening and harvesting time. Data obtained in response to item number E.1 of the interview schedule as presented in APPENDIX-I.

3.9 Usages of ripening chemicals

Usages of ripening chemicals referred to the ripening chemicals which is used by the mango growers for ripening the mango. It was expressed in the score. In measuring this variable, a score of one was given for low effects. This variable appears in item number E.2 in the interview schedule as presented in APPENDIX-I.

3.10 Usages of preservatives

Usages of preservatives referred to the preservatives which is used by the mango growers to preserve the mango. It was expressed in the score. In measuring this variable, a score of one was given for low effects. This variable appears in item number E.3 in the interview schedule as presented in APPENDIX-I.

3.11 Instrument for collection of data

In order to collect reliable and valid information from the respondents, an interview schedule was prepared for collection of data from respondents keeping the objectives of the study in mind. The schedule was prepared in Bangla for a clear understanding to the respondents. The Bengali version of

interview schedule was used to collect data. The question and statements contained in the schedule were simple, direct and easily understandable by the respondents. Simple and direct question, different scales, closed and open form statements and questions were included in the interview schedule to obtain necessary information. The draft interview schedule was prepared in accordance with the objective of the study. The interview schedule was pre-tested with 10 respondents of the mango growers in the study area.

The draft interview schedule was pretested in actual field situation before finalizing it for collection of data. The pre-test was helpful to identify inappropriate questions and statements in the draft schedule. Necessary addition, alternation and adjustments were made in the schedule on the basis of the experience of the pretest. The interview schedule was then cyclostyled in its final form for the collection of data. The interview schedule was then printed in its final form. An English version of the interview schedule has been shown in APPENDIX-I.

3.12 Data collection

Data were collected personally through personal interview schedule from the sampled mango growers of the selected blocks. A rapport was established with the rural people so that they feel easy to answer the questions. A possible care was taken to establish rapport with the respondents so that they would not feel any indecision while starting the interview. Very good cooperation was obtained from the UAO (Plate 1 and Plate 4), field extension workers (Plate 3 and Plate 6) and growers (Plate 2 and Plate 5) of the study area. No serious difficulty was faced during the collection of data. Questions were asked in different ways so that the respondents could easily understand the questions. Whenever a respondent faced difficulty in understanding any questions, care was taken to explain the same clearly with a view to enabling him to answer it properly.

Plate 1. Data collection from UAO of Charghat Upazila

Plate 2. Data collection from farmer of Bagha Upazila

Plate 3. Data collection from SAAO of Bagha Upazila

Plate 4. Data collection from UAO of Bagha Upazila

Plate 5. Data collection from farmer at Charghat Upazila

Plate 6. Data collection from SAAO of Charghat Upazila

3.13 Compilation of data

After completion of field survey, data recorded in the interview schedules were coded, compiled, tabulated and analyzed in accordance with the objectives of the study. In this process, all the responses in the interview schedule were given numerically coded values. Local units were converted into standard units and qualitative data were converted into quantitative ones by means of suitable scoring whenever necessary. All the collected data were checked and cross-checked before transplanting to the master sheets. To facilitate tabulation, the collected data were properly coded and transferred from interview schedule to a master sheet. Tabulation and cross tabulation was done on the basis of categorization developed.

3.14 Statistical analysis

Data collected from the respondents were analyzed and interpreted in accordance with the objectives of the study. The analysis of data was performed using statistical treatment with SPSS (Statistical Package for Social Sciences) computer program, version 20. Statistical measures as a number, range, mean, standard deviation and person's product moment correlation (r) were used in describing the variables whenever applicable.

CHAPTER IV

RESULTS AND DISCUSSION

Information obtained from respondents by interview were measured, analyzed, tabulated and statistically treated according to the objectives of the study. This chapter has been discussed in five sections such as (i) selected characteristics of the mango growers (ii) insect pest diversity identification (iii) reorganization of insect pest management practices for mango (iv) identification of insecticide used by the farmers for controlling major insect pests of mango and (v) assessment of the ripening-harvesting time of different mango varieties.

4.1 Selected characteristics of the mango growers

Sixteen characteristics of the several types of mango growers were selected to describe and to find out the contribution to exercise management practices by mango growers. These selected characteristics were gender, age, education, agricultural farming experience, mango cultivated land size, number of mango trees, annual income from mango cultivation, experience in mango cultivation, economic loss due to insect pest, information received about insecticides usage, insecticides sources, training exposure on mango cultivation and organizational participation. The noticeable topographies of the sixteen characteristics of the mango growers, each of which constituted an independent variable. Insect pest diversity assessment were also done as independent variable.

4.1.1 Gender

The field survey was conducted among 194 mango growers in the selected areas of Charghat and Bagha Upazila. Among the mango growers most (96.4%) of them were male while only 4.6% mango growers participated in the study were female showing in the following Figure 3.

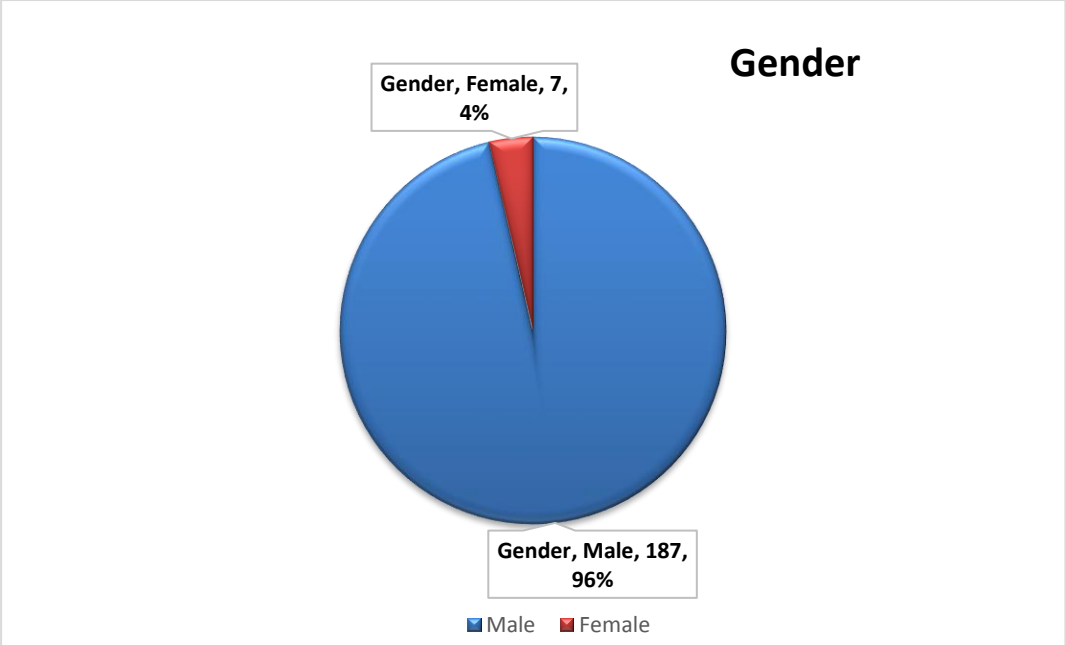

Figure 3. Gender of the mango growers participated in the field survey.

4.1.2 Age

The age of the mango growers ranged from 28 to 59 years with an average of 47.02 and standard deviation of 10.112. The respondents were classified into three categories on the basis of their age (Table 5) following Ministry of Youth and Sports, Government of the Peoples Republic of Bangladesh.

Table 5. Distribution of the mango growers according to their age

Category	Age range (yrs)	Observed range	Respondents		Mean age (yrs)	SD
			Number	Percent		
Young age	Up to 35	28 - 59	25	12.8	47.02	10.112
Middle age	36 - 50		127	65.5		
Old age	> 50		42	21.7		
Total	-		194	100.00		

Data showing that the highest value of proportion 65.5 percent of the mango growers were middle aged compared to 21.7 percent old and 12.8 percent being young aged.

4.1.3 Education

Respondents education were measured by following the procedure as discussed in Chapter 3. The education ranged from 0-16, with an average of 3.436 and standard deviation of 8.479. The respondents were classified into five categories on the basis of their education (Table 6) following Rashid (2014).

Table 6. Distribution of the mango growers according to their education

Category	Scoring	Respondents		Mean (score)	SD
		Number	Percent		
Can sign only	0.5	17	8.7	8.436	3.479
Primary education	1 – 5	39	20.1		
Secondary education	6 – 10	115	59.3		
Higher secondary or abv.	> 10	23	11.9		
Total	0 - 16	194	100.00		

It is determined from the Table 6 that 20.1 percent comprised primary education, 59.3 percent comprised of secondary education, no respondents were can't read or sign, 8.7 percent comprised of can sign only and 4.7 percent had above secondary education. Table 6 also shows that above 79.4 percent out of the selected respondents got primary to secondary level of education.

4.1.4 Agricultural farming experience

Experience in agricultural farming of the respondents was measured in terms of actual years of agricultural farming and in the present study that ranged from 7 to 35 with an average of 17.21 and standard deviation of 6.637. On the basis of experience in agricultural farming, the respondents were divided into three categories (Mean ± Standard Deviation) as shown in Table 7.

Table 7. Distribution of the mango growers according to their experience agricultural farming

Category	Scoring (yrs)	Observed range	Respondents		Mean (yrs)	SD
			Number	Percent		
Low	≤11	7 - 35	26	13.4	17.22	6.647
Medium	12 - 24		137	70.7		
High	> 24		31	15.9		
Total			194	100.00		

Table 7 shows that mango growers under medium experience category constitute the highest proportion (70.7%) compared to about same (15.9 %) low experience category and only 13.4 percent high experience category.

4.1.5 Mango cultivated land size

Mango cultivated land size varied from .1 to 1.56 ha with an average of .701 ha and standard deviation of .316. The respondents were classified into five categories on the basis of their farm size (Table 8) following DAE (Department of Agricultural Extension)

Table 8. Distribution of the mango growers according to their mango land size

Category	Score (ha)	Observed range	Respondents		Mean area(ha)	SD
			Number	Percent		
Landless	≤.02	.1 – 1.56	0	0	.703	.315
Marginal	.021 - .20		6	3.1		
Small	.21 - 1		156	80.4		
Medium	1 - 3		32	16.5		
Large	> 3		0	0		
Total			194	100.00		

Data in the Table 8 reveal that more than two-third (80.4 %) of the total respondent had small farm where, no respondents were landless, 16.5 percent mango growers had medium mango cultivated land size, 3.1 percent respondents were marginal and no respondents had large mango cultivated land.

4.1.6 Number of mango trees

The observed mango tree number of the mango growers ranged from 30 to 150 with a mean of 68.35 and standard deviation of 21.31. On the basis of their mango tree number, the respondents were classified into three categories (Mean ± Standard Deviation) as shown in Table 9.

Table 9. Distribution of the mango growers according to their mango trees

Category	Scoring (yrs)	Observed range	Respondents		Mean score(yrs)	SD
			Number	Percent		
Low	≤ 47	30 - 150	20	10.3	68.35	21.31
Medium	48 - 90		138	71.1		
High	> 90		36	18.6		
Total			194	194		

Table 9 shows that mango growers under small number of mango tree category constituted the lowest proportion (10.3 %) compared to 71.1% under highest category and 18.6 % under medium number category. Thus, majority (89.7%) of the mango growers had medium to large number of mango trees.

4.1.7. Annual income from mango cultivation

Annual income from mango cultivation of the respondents was measured in thousand taka' per year and in the present study that ranged from 40 to 180 with an average of 74.61 and standard deviation of 18.35. On the basis of annual family income from mango cultivation, the respondents were divided into three categories (Mean ± Standard Deviation) as shown in Table 10.

Table 10. Distribution of the mango growers according to their annual family income from mango cultivation

Category	Scoring ('000' Tk.)	Observed range ('000' Tk.)	Number of respondents		Mean ('000' Tk.)	SD
			Number	Percent		
Low	≤ 56	40-180	10	5.2	74.61	18.35
Medium	57-93		143	73.7		
High	> 93		41	21.1		
Total			194	100.00		

Data furnished in Table 10 reveal that above half (73.7%) of the respondents had medium annual income from mango cultivation while 5.2 percent and 21.1 percent of them had low and high annual income from mango cultivation respectively.

4.1.8 Experience in mango cultivation

Experience in mango cultivation of the respondents was measured in terms of actual years of mango cultivation and in the present study that ranged from 5 to 32 with an average of 15.37 and standard deviation of 5.26. On the basis of experience in mango cultivation, the respondents were divided into three categories (Mean ± Standard Deviation) as shown in Table 11.

Table 11. Distribution of the mango growers according to their experience in mango cultivation

Category	Scoring (yrs)	Observed range	Respondents		Mean score(yrs)	SD
			Number	Percent		
Low	≤10	5 - 32	7	3.6	15.37	5.26
Medium	11 - 20		164	84.5		
High	> 20		23	11.9		
Total			194	100		

Table 11 shows that mango growers under medium experience category constituted the highest proportion (84.5%) compared to low experience category (3.6%) and only 11.9 percent had high experience category.

4.1.9 Economic loss due to insect pest

Economic loss due to insect pest of the respondents was measured in `thousand taka' per year and in the present study that ranged from 5 to 16 with an average of 9.41 and standard deviation of 3.437. On the basis of economic loss due to insect pest, the respondents were divided into three categories (Mean ± Standard Deviation) as shown in Table 12.

Table 12. Distribution of the mango growers according to economic loss due to insect pest

Category	Scoring ('000' TK.)	Observed range ('000' TK.)	Number of respondents		Mean ('000' TK.)	SD
			Number	Percent		
Low	≤ 5	5-16	22	11.3	9.41	3.437
Medium	6-13		139	71.6		
High	> 13		33	17.1		
Total			194	100.00		

Data furnished in Table 12 reveal that above half (71.6%) of the respondents had medium economic loss due to insect pest while 11.3 percent and 17.1 percent of them had low and high economic loss due to insect pest respectively.

4.1.10 Information received about insecticides usage

According to the opinion expressed by the mango growers, out of 194, most (94.8%) of the mango growers (184) reported that they were received information about insecticides usage from representative of insecticide company which was followed by 91.7% from DAE officials as reported by 178 mango growers. Whereas, 10.8%, 8.2% and 3.1% mango growers reported that they received information about insecticides usage from neighbor, research organization and self respectively showing in the following Figure 4.

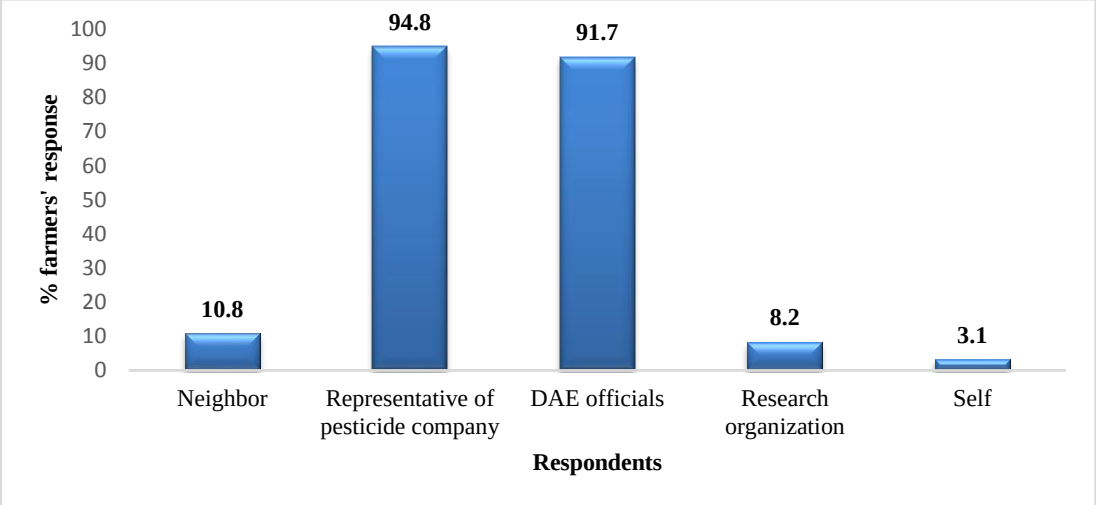

Figure 4. Response of the mango growers on information received about insecticides usages.

Based on the received information about insecticides usage of the respondents was measured in 'score' and in the present study that ranged from 3 to 11 with an average of 6.1 and standard deviation of 1.59. On the basis of information received about insecticides usage, the respondents were divided into three categories (Table 13).

Table 13. Distribution of the mango growers according to information received about insecticides usage

Category	Scoring (score)	Observed range (score)	Number of respondents		Mean (score)	SD
			Number	Percent		
Low	≤ 4	3-11	14	7.2	6.1	1.59
Medium	5-8		73	37.6		
High	> 8		107	55.2		
Total			194	100.00		

Data furnished in Table 13 reveal that above half (55.2%) of the mango growers had high level category of information received about insecticides usage while 7.2 percent and 37.6 percent of them had low and medium level information received about insecticides usage.

4.1.11 Insecticides source

According to the opinion expressed by the mango growers, out of 194, most (96.3%) of the mango growers (187) reported that they were collected insecticides from company agents which was followed by 72.6% of the mango growers reported that they were collected insecticides from insecticide retailer where as 23.7% collected from friends showing in the following Figure 5.

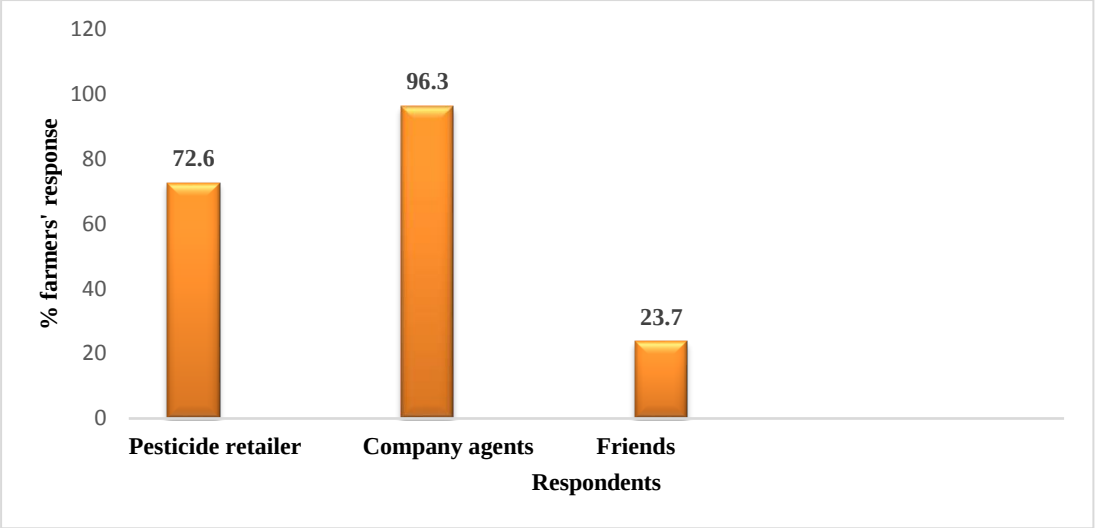

Figure 5. Response of the mango growers on insecticides sources.

Based on the insecticides source of the respondents were measured in `score' and in the present study that ranged from 2 to 9 with an average of 5.82 and standard deviation of 2.841. On the basis of insecticides source, the respondents were divided into three categories (Mean ± Standard Deviation) as shown in Table 14.

Table 14. Distribution of the mango growers according to insecticides source

Category	Scoring (score)	Observed range (score)	Number of respondents		Mean (score)	SD
			Number	Percent		
Low	≤ 3	2-9	14	7.2	5.82	2.841
Medium	4-6		59	38.2		
High	> 6		106	54.6		
Total			194	100.00		

Data furnished in Table 14 reveal that above half (54.6 %) of the respondents had high level category of insecticide source availability while 7.2% and 54.6% of them had low and medium level category of insecticide source availability.

4.1.12 Training exposure on mango cultivation

In this study, the researcher finds out some field level data and knowledge about training exposure of the mango growers. Their observed range about

training exposure was from 0 to 16 with a mean and standard deviation of 9.31 and 4.95 respectively. According to their length of training score, the respondents were classified into four categories. The distribution of the mango growers according to their training exposure has been presented in Table 15.

Table 15. Distribution of mango growers according to their training exposure

Category	Scoring	Observed range	Respondents		Mean (score)	SD
			Number	Percent		
No training	0	0 - 16	31	15.9	9.31	4.97
Low	1 - 5		58	29.8		
Medium	6 - 12		83	42.7		
High	> 12		22	11.6		
Total	0- > 12		194	100.00		

The table showed that the percentage of no training, low training, medium training and high training were 15.9%, 29.8%, 42.7% and 11.6% respectively. The researcher found that, there 15.9% of total mango growers had no any kind of training exposure, while 29.8% and 42.7% mango growers had low and medium training exposure respectively.

4.1.13 Organizational participation

The observed organizational participation scores of the mango growers ranged from 0 to 8 with an average of 2.40 and standard deviation of 1.94. Depending on the organizational participation scores, the mango growers were classified into three categories (Mean ± Standard Deviation) as shown in Table 16.

Table 16. Distribution of mango growers according to their organizational participation

Category	Scoring	Observed range	Respondents		Mean (score)	SD
			Number	Percent		
Low	2	0 - 8	56	28.8	2.40	.94
Medium	2-4		124	63.9		
High	> 4		14	7.3		
Total			107	100.00		

Data contained in Table 16 revealed that the highest proportion (63.9%) of the mango growers had medium organizational participation as compared to 28.8 percent had low and only 7.3 percent had high organizational participation. It reveals that the majority of the mango growers (92.7%) in the study area were in low to medium organizational participation category.

4.2 Insect pest assessment for mango

4.2.1 Responses from mango growers on insect pest

4.2.1.1 Insect pest occurrence in mango orchard

According to the opinion expressed by the mango growers, out of 194, all the mango growers (100%) reported that mango was infested in the orchard by mango hopper which was followed by fruit fly and leaf eating weevil as reported by 66.49% and 60.82% mango growers respectively. Whereas, 8.7%, 24.7%, and 13.9% mango growers reported that mango was infested in the orchard by leaf gall, mealybug, shoot gall respectively.

Table 17. Response of the mango growers on insect pest occurrence in mango orchard

Sl No.	Name of insect pests	Occurrence of insect pest	
		Frequency[N=194]	% response
01.	Mango hopper	**194**	100
02.	Fruit fly	**129**	66.4
03.	Leaf eating weevil	**118**	60.8
04.	Mealybug	17	8.7
05.	Leaf gall	48	24.7
06.	Shoot gall	27	13.9

4.2.1.2 Insect pest infestation status in mango orchard

According to the opinion expressed by the mango growers, out of 194, most (92.79%) of the mango growers reported that mango was infested in the orchard by mango hopper which was followed by fruit fly and leaf eating weevil insect reported by 76.43% and 71.34% mango growers respectively as

major insect. Whereas, mealybug, leaf gall, shoot gall infested in the orchard by 83.79%, 73.34%, 80.13% mango growers respectively as minor insect.

Table 18. Response of the mango growers on insect pest infestation status in mango orchard

Sl No.	Name of insect pests	Response on pest status (%)	
		Major	**Minor**
01.	Mango hopper	**92.79**	07.21
02.	Fruit fly	**76.43**	23.57
03.	Leaf eating weevil	**71.34**	28.66
04.	Mealybug	16.21	**83.79**
05.	Leaf gall	26.63	**73.34**
06.	Shoot gall	19.87	**80.13**

4.2.1.3 Insect pest infestation severity in mango orchard

According to the opinion expressed by the mango growers, out of 194, most (87.6%) of the mango growers reported that mango was infested in the orchard by mango hopper as high level which was followed by fruit fly and leaf eating weevil as reported by 68.51% and 53.19% mango growers respectively as high level. Whereas, 81.37%, 73.64%, 78.43% mango growers reported mealybug, leaf gall, shoot gall as the low-level infestation severity status respectively.

Table 19. Response of the mango growers on insect pest infestation severity in mango orchard

Sl No.	Name of insect pests	Response on infestation severity (%)				
		Not at all (0)	**Very low (1)**	**Low (2)**	**Medium (3)**	**High (4)**
01.	Mango hopper	-	-	-	12.4	87.6
02.	Fruit fly	-	-	14.13	17.36	68.51
03.	Leaf eating weevil	-		19.24	27.57	53.19
04.	Mealybug	-	1.22	81.37	17.41	-
05.	Leaf gall	-	7.35	73.64	19.01	-
06.	Shoot gall	-	5.61	78.43	15.96	-

4.2.2 Response of field level officer on insect pest

4.2.2.1 Insect pest occurrence in mango orchard

According to the opinion expressed by the field level officers, out of 20, all the field level officers (100%) reported that farmers' mango was infested in the orchard by mango hopper which was followed by fruit fly and leaf eating weevil as reported by 80% and 70% field level officers. Whereas, 30%, 35% and 45%, field level officers reported that farmers' mango was infested in the orchard by mealybug, leaf gall and shoot gall respectively.

Table 20. Response of the field level officers on insect pest occurrence in mango orchard

Sl. No.	Name of insect pests	Occurrence of insect pests	
		Frequency [N=20]	% response
01.	Mango hopper	**20**	100
02.	Fruit fly	**16**	80
03.	Leaf eating weevil	**17**	70
04.	Mealybug	6	30
05.	Leaf gall	7	35
06.	Shoot gall	9	45

4.2.2.2 Insect pest infestation status in mango orchard

According to the opinion expressed by the field level officers, out of 20, most (90%) of the field level officers reported that farmers' mango was infested in the orchard by mango hopper which was followed by fruit fly and leaf eating weevil insect reported by 75% and 70% field level officers as major insect. Whereas, mealybug, leaf eating weevil, leaf gall, shoot gall infested in the farmers' orchard by 85%, 75%, 80% field level officers' response respectively.

Table 21. Response of the field level officers on insect pest infestation status in mango orchard

Sl. No.	Name of insect pests	Response on pest status (%)	
		Major	Minor
01.	Mango hopper	**90**	10
02.	Fruit fly	**75**	25
03.	Leaf eating weevil	**70**	30
04.	Mealybug	15	**85**
05.	Leaf gall	25	**75**
06.	Shoot gall	20	**80**

4.2.2.3 Insect pest infestation severity in mango orchard

According to the opinion expressed by the field level officers, out of 20, most (87.6%) of the field level officers reported that farmers' mango was infested in the orchard by mango hopper as high level which was followed by fruit fly as reported by 68.51% field level officers as high level. Whereas, 81.37%, 76.23%, 73.64%, 81.43% field level officers reported mealybug, leaf eating weevil, leaf gall, shoot gall as the low-level infestation severity status at the farmers' orchard respectively.

Table 22. Response of the field level officers on insect pest infestation severity in mango orchard

Sl No.	Name of insect pests	Response on infestation severity (%)				
		Not at all (0)	Very low (1)	Low (2)	Medium (3)	High (4)
01.	Mango hopper	-	-	-	10	90
02.	Fruit fly	-	-	15	15	70
03.	Leaf eating weevil			15	20	65
04.	Mealybug	-	5	80	15	-
05.	Leaf gall	-	10	75	15	-
06.	Shoot gall	-	10	75	15	-

4.2.3 Correlation between mango growers and field level officer's response on insect pest diversity

In order to, find out the relation between mango growers and field level officer's response on insect pest, correlation analysis was used showing in the table 23.

Table 23. Correlation matrix between mango growers and field level officer's response on insect pest diversity

	X_1	X_2
X_1	1	
X_2	.976***	1

*** Significant at p<0.01

X_1 = Mango grower's response on insect pest;

X_2 = Field level officer's response on insect pest;

Form the correlation analysis it was found that there was a significant correlation between mango growers and field level officer's response on insect pest diversity.

4.3 Insect pest management practices

4.3.1 Responses of mango growers on insect pest management practices

4.3.1.1 Cultural control

According to the opinion expressed by the mango growers, out of 194, most (96.4%) of the mango growers (187) reported that they practiced field sanitation as cultural control which was followed by pruning, defoliation, thinning and topping as reported by 76.8% mango growers. Whereas, 53.1% mango growers reported that they practiced fertilization and manuring as cultural control showing in the following Figure 6.

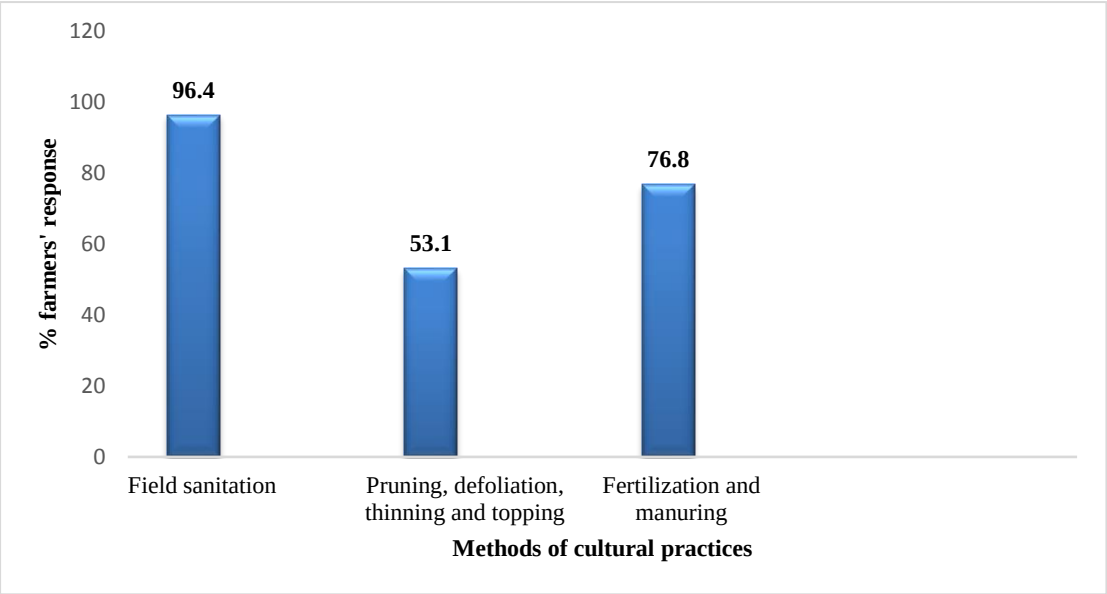

Figure 6. Response of the mango growers on cultural control.

4.3.1.2 Mechanical control

According to the opinion expressed by the mango growers, out of 194, most (23.9%) of the mango growers reported that they practiced pheromone trap as mechanical control where 6.7% mango growers practiced hand picking showing in the following Figure 7.

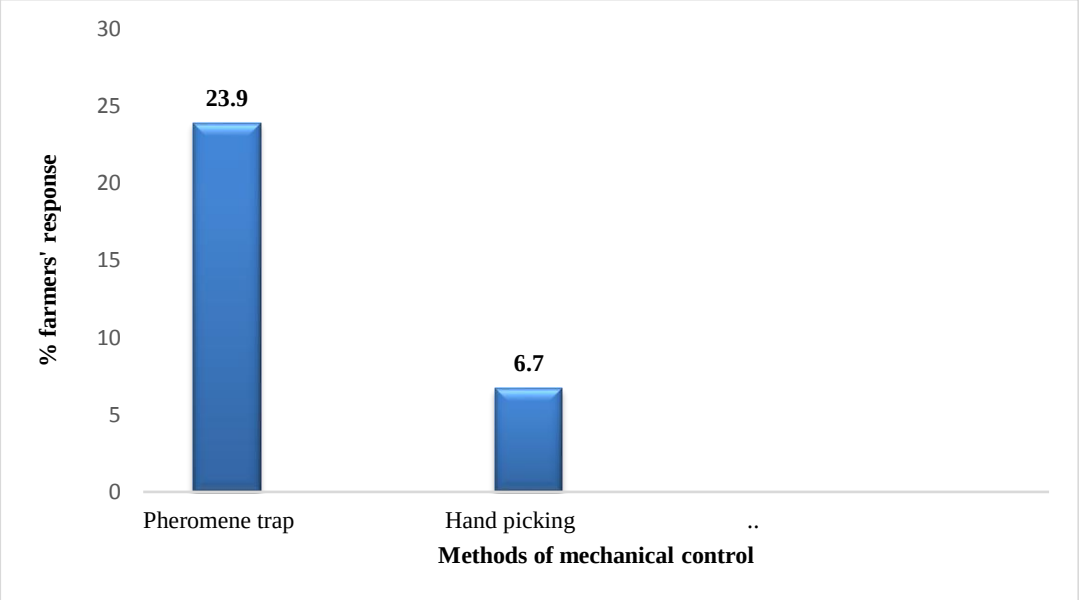

Figure 7. Response of the mango growers on mechanical control.

4.3.1.3 Chemical control

According to the opinion expressed by the mango growers, out of 194, most (95.4%) of the mango growers (185) reported that they used Imidacloprid as chemical control which was followed by Carbaryl as reported by 92.3 mango growers. Whereas, 58.3% and 47.9% mango growers reported that they used Chlorpyrifos and Lambdacyhalothrin respectively showing in the following Figure 8.

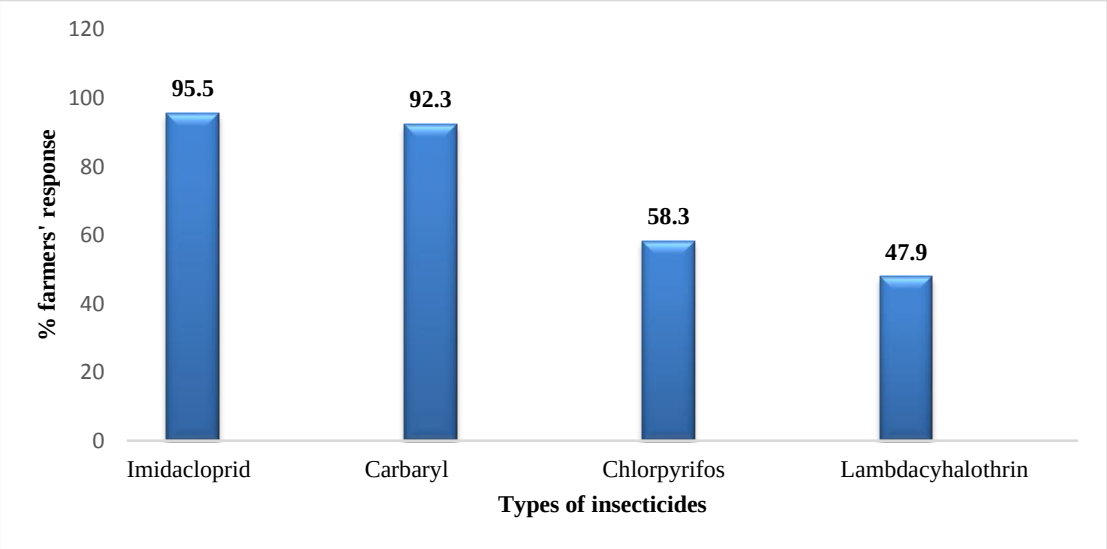

Figure 8. Response of the mango growers according to chemical control.

Based on the insect pest management practices of the mango growers was measured in `score' and in the present study that ranged from 9 to 34 with an average of 21.62 and standard deviation of 7.851. On the basis of insect pest management practices, the respondents were divided into three categories (Mean ± Standard Deviation) as shown in Table 24.

Table 24. Distribution of the mango growers according to insect pest management practices

Category	Scoring (score)	Observed range	Respondents		Mean (score)	SD
			Number	Percent		
Low	≤ 14	9-34	16	8.3	21.62	7.851
Medium	15-28		54	27.8		
High	> 28		124	63.91		
Total			194	100.00		

Data furnished in Table 24 reveal that above half (63.91%) of the mango growers had high level insect pest management practices for mango while 8.3 percent and 27.8 percent of them had low and medium level insect pest management practices

4.3.2 Responses of field level officer on insect pest management practices

4.3.2.1 Cultural control

According to the opinion expressed by the field level officer, out of 20, most (95%) of them reported that the mango growers practiced field sanitation as cultural control which was followed by pruning, defoliation, thinning and topping as reported by 75 percent. Whereas, 53.1% field level officer reported that the mango growers practiced fertilization and manuring as cultural control showing in the following Figure 9.

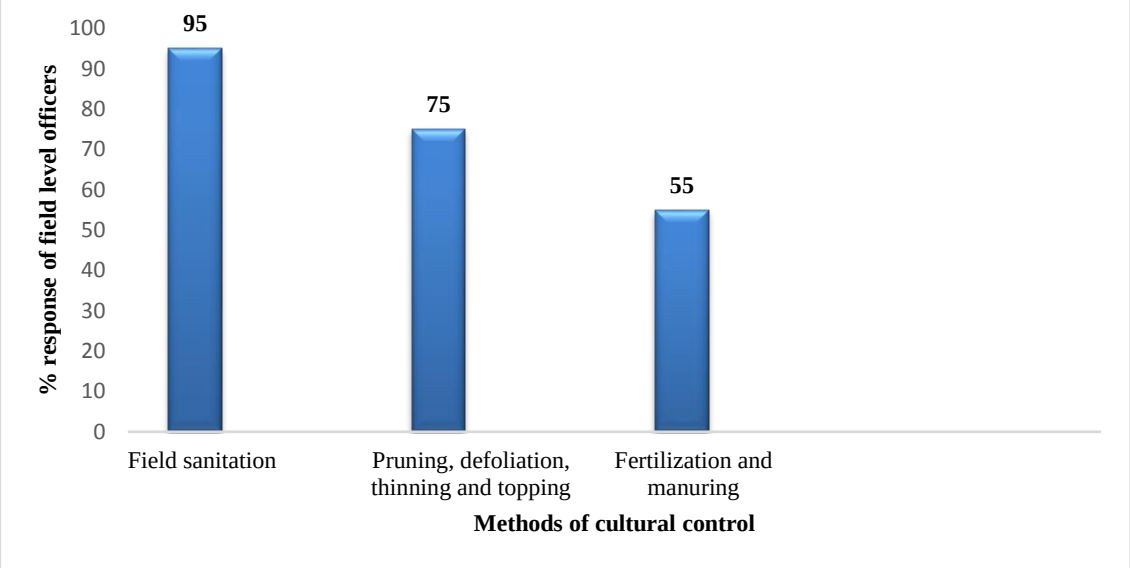

Figure 9. Response of the field level officers on cultural control of mango growers.

4.3.2.2 Mechanical control

According to the opinion expressed by the by the field level officer, out of 20, most (25%) of them reported that the mango growers practiced pheromone trap as mechanical control which was followed by hand picking as reported by 10% percent showing in the following Figure 10.

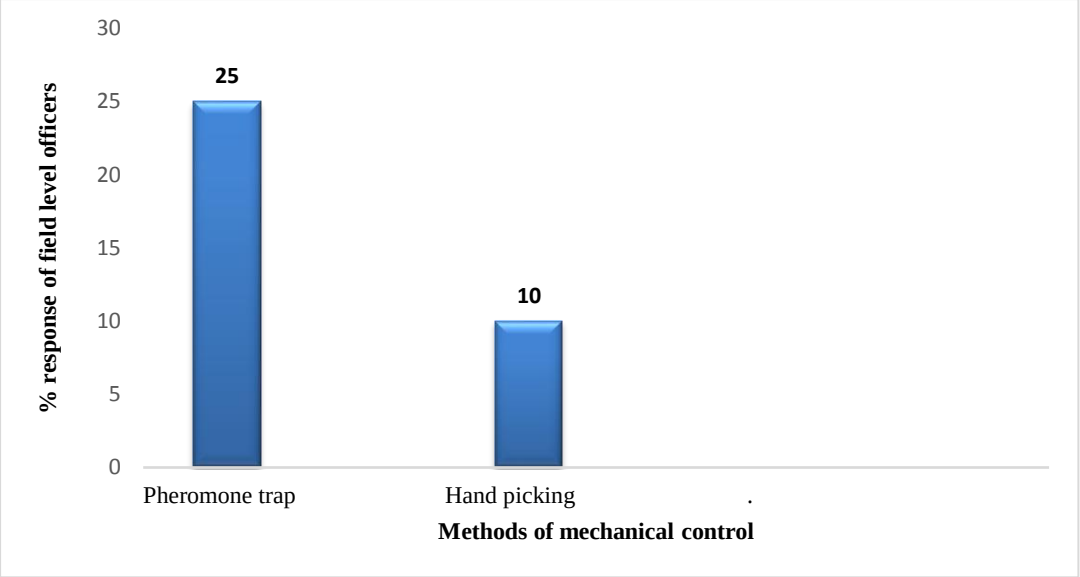

Figure 10. Response of the field level officer according to mechanical control of mango growers.

4.3.2.3 Chemical control

According to the opinion expressed by the field level officer, out of 20, most (95%) of the field level officers reported that the mango growers used Imidacloprid as chemical control which was followed by Carbaryl as reported by 90%. Whereas, 55% and 40% field level officers reported that the mango growers used Chlorpyrifos and Lambdacyhalothrin respectively showing in the following Figure 11.

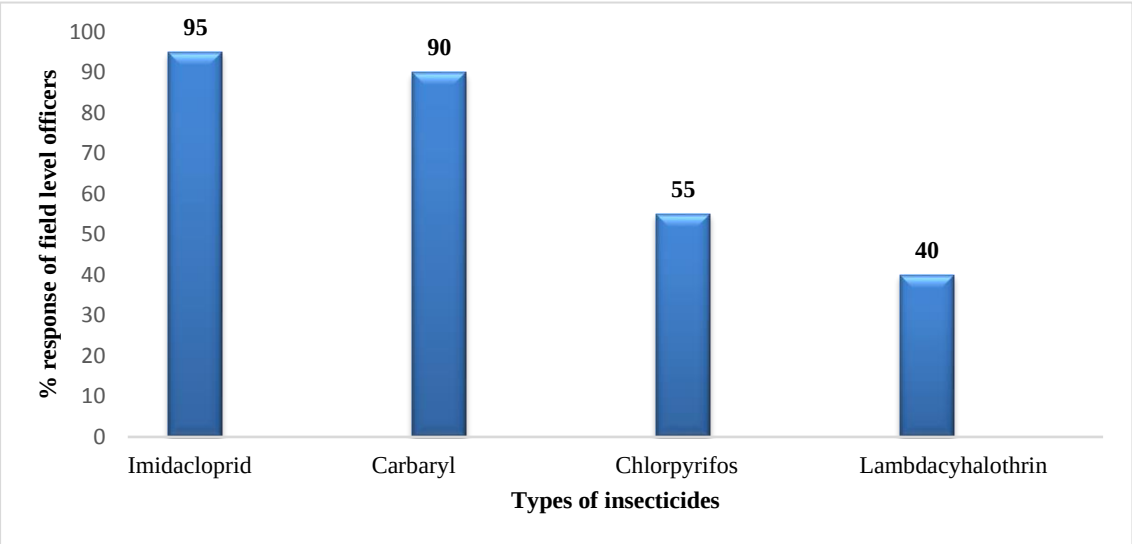

Figure 11. Response of the field level officer according to chemical control of mango growers.

Based on response of field level officer for the insect pest management practices by the mango growers was measured in `score' and in the present study that ranged from 8 to 32 with an average of 22.61 and standard deviation of 7.63. On the basis of the response of field level officer for the insect pest management practices by the mango growers, the mango growers were divided into three categories (Mean ± Standard Deviation) as shown in Table 25.

Table 25. Distribution of the mango growers according to insect pest management practices based on field level officers' response

Category	Scoring	Observed range (score)	Respondents		Mean (score)	SD
			Number	Percent		
Low	≤ 14	8-32	2	10	22.61	7.63
Medium	15-28		6	30		
High	> 28		12	60		
Total			20	100.00		

Data furnished in Table 25 reveal that above half (60%) of the mango growers had high level insect pest management practices for mango while 10 percent and 30 percent of them had low and medium level insect pest management practices based on field level officers' response.

4.3.3 Correlation between mango growers and field level officer's response on insect pest management practices

In order to, find out the relation between mango growers and field level officer's response on insect pest management practices, correlation analysis was used showing in the table 26.

Table 26. Correlation matrix between mango growers and field level officer's response on insect pest management practices

	X_1	X_2
X_1	1	
X_2	.783***	1

*** Significant at p<0.01

X_1 = Mango grower's response on insect pest management practices;

X_2 = Field level officer's response on insect pest management practices;

Form the correlation analysis it was found that there was a significant correlation between mango growers and field level officer's response on insect pest management practices.

4.4 Insecticide usages by the mango growers

According to the opinion expressed by the farmers, out of 194, most (45.52%) of the mango growers reported that they used admire which was followed by Imitaf (27.81%), Brider (16.13%), others (10.54%) of Imidacloprid insecticide as chemical control against mango hopper. For controlling fruit fly and mealybug, most (56.17%) of the farmers reported that they used Sevin which was followed by Sevin (19.61%), Coral (14.37%), others (9.85%) of Carbaryl insecticide. In case of leaf gall treatment, most (46.19%) of the mango growers reported that they used Dursban which was followed by Rexiban (24.72%), Pyriban (16.53%), others (12.56%) of Chlorpyrifos insecticide. Most (43.61%) of the mango growers reported that they used Jubar which was followed by Carate (26.79%), Fighter (18.47%), others (11.13%) of Lambdacyhalothrin insecticide as chemical control against leaf eating weevil, shoot gall showing in the following Table 27.

Table 27. Distribution of the mango growers according to insecticide usage

Sl No.	Pest Name	Common Name of Insecticide	Trade Name of Insecticide	Respondents' Percentage
01.	Mango Hopper	Imidacloprid	Admire	45.52
			Imitaf	27.81
			Brider	16.13
			Others	10.54
02.	Fruit fly, Mealybug	Carbaryl	Sevin	56.17
			Revin	19.61
			Coral	14.37
			Others	9.85

Sl No.	Pest Name	Common Name of Insecticide	Trade Name of Insecticide	Respondents' Percentage
03.	Leaf gall	Chlorpyrifos	Dursban	46.19
			Rexiban	24.72
			Pyriban	16.53
			Others	12.56
04.	Leaf eating weevil, shoot gall	Lambdacyhalothrin	Jubar	43.61
			Carate	26.79
			Fighter	18.47
			Others	11.13

4.5 Harmful effects of chemical insecticides usage

According to the opinion expressed by the mango growers, out of 194, most (53.1%) of the mango growers (103) reported that they were faced the harmful effects of chemical insecticides usage through nerve, skin and eye irritation and damage which was followed by dizziness as reported by 49.5% mango growers. Whereas, 43.2%, 18.1% and 14.4% mango growers reported that they were faced the harmful effects of chemical insecticides usage through headaches, nausea and fatigue respectively in the following Figure 12.

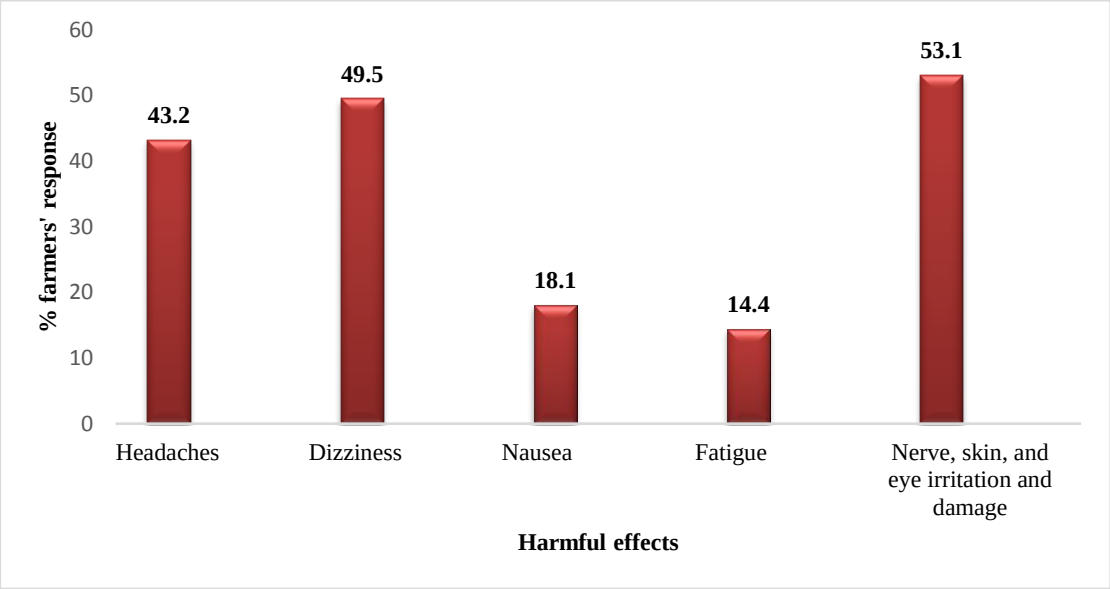

Figure 12. Response of the mango growers on harmful effects of chemical insecticides usage.

Based on the harmful effects of chemical insecticides usage of the respondents was measured in `score' and in the present study that ranged from 5 to 17 with an average of 9.42 and standard deviation of 3.73. On the basis of harmful effects of chemical insecticides usage, the respondents were divided into three categories (Mean ± Standard Deviation) as shown in Table 28.

Table 28. Distribution of the mango growers according to harmful effects of chemical insecticides usage

Category	Scoring (score)	Observed range (score)	Number of respondents		Mean	SD
			Number	Percent		
Low	≤ 5	5-17	59	30.4	9.62	3.841
Medium	6-13		94	48.5		
High	> 13		31	21.1		
Total			194	100.00		

Data furnished in Table 28 reveal that about half (48.5%) of the respondents had medium level at harmful effects of chemical insecticides usage while 30.4 percent and 21.1 percent of them had low and high level at harmful effects of chemical insecticides usage.

4.6 Assessment of ripening and harvesting time of mango

According to the opinion expressed by the mango growers and the field level officers, the ripening- harvesting time of different varieties are shown in the following Table 29.

Table 29. Response of the mango growers and field level officers about the ripening -harvesting time of mango

Sl No.	Name of mango varieties	Mango Growers	Field Level Officers
		Ripening- harvesting time	Ripening- harvesting time
01.	Langda	15 June - 20 June	18 June - 22 June
02.	Gopalbogh	25 May – 05 June	25 May - 30 May
03.	Himsagar	1 June - 10 June	1 June - 7 June
04.	Laksmanbhog	10 June - 15 June	7 June - 15 June
05.	Fazli	20 June - 30 June	25 June - 30 June
06.	Amropali	25 June – 30 June	22 June – 30 June
07.	Ashhwina	1 July – 7 July	1 July - 10 July

It was found almost same ripening-harvesting time of mango based on the response of the mango growers and field level officers.

4.7 Usages of ripening chemicals

According to the opinion expressed by the mango growers, the response on usages of ripening chemical were not found.

4.8 Usages of preservatives

According to the opinion expressed by the mango growers, the response on usages of preservatives were not found.

CHAPTER V

SUMMARY AND CONCLUSION

The study was conducted in the 20 blocks of Charghat and Bagha upazila under Rajshahi district where mango is produced on a large scale. Information were collected from 194 mango growers and 20 field level officers. Descriptive statistics, Pearson product moment correlation co-efficient, were used for analysis. It was used pre-designed and pretested questionnaire in order to assess insect pests of mango including its management practices for the insect pests in field. The findings of this study have been summarized below:

Two-third (80.4 %) mango growers had small farm where, no mango growers were landless, 16.5 percent mango growers had medium mango cultivated land size, 3.1 percent mango growers were marginal and no mango growers had large mango cultivated land.

71.6% mango growers had medium economic loss due to insect pest while 11.3 percent and 17.1 percent of them had low and high economic loss due to insect pest respectively.

94.8% mango growers reported that they were received information about insecticides usage from representative of insecticide company which was followed by 91.7% from DAE officials as reported by 178 mango growers. Whereas, 10.8%, 10.8% and 3.1% mango growers reported that they received information about insecticides usage from research organization, neighbor and self respectively.

96.3% mango growers reported that they were collected insecticides from company agents followed by 72.6% of the mango growers reported that they were collected insecticides from insecticide retailer where as 23.7% collected from friends.

53.1% mango growers reported that they were faced the harmful effects of chemical insecticides usage through nerve, skin and eye irritation and damage which was followed by dizziness as reported by 49.5% mango growers.

Whereas, 43.2%, 18.1% and 14.4% mango growers reported that they were faced the harmful effects of chemical insecticides usage through headaches, nausea and fatigue respectively.

All mango growers reported that mango was infested in the orchard by Mango hopper followed by fruit fly as reported by 59.7% mango growers. Whereas, 28.8%, 24.7%, 13.9%, and 8.7% mango growers reported that mango was infested in the orchard by leaf eating weevil, leaf gall, shoot gall, mealybug respectively.

92.79% mango growers reported that mango was infested in the orchard by Mango hopper as major insect followed by fruit fly insect reported by 76.43% mango growers. Whereas, Mealybug, leaf eating weevil, leaf gall, shoot gall infested in the orchard by 83.79%, 78.66%, 73.34%, 80.13% mango growers' response respectively.

87.6% mango growers reported that mango was infested in the orchard by Mango hopper as high level which was followed by fruit fly as reported by 68.51% farmers as high level. Whereas, 81.37%, 76.23%, 73.64%, 81.43% mango growers reported Mealybug, leaf eating weevil, leaf gall, shoot gall as the low-level infestation severity status respectively.

96.4% mango growers reported that they practiced field sanitation as cultural control followed by destroy all left-over seeds after harvest as reported by 76.8% mango growers.

91.6% mango growers reported that they practiced trap insects as mechanical control followed by hand picking as reported by 73.8% mango growers.

95.4% mango growers reported that they used Imidacloprid as chemical control followed by Carbaryl as reported by 92.3 percent mango growers.

63.91% mango growers had high level insect pest management practices for mango while 8.3 percent and 27.8 percent of them had low and high level insect pest management practices.

It was found that a significant correlation between mango growers and field level officer's response on insect pest diversity of mango and its management practices.

45.52% mango growers reported that they used admire followed by Imitap (27.81%), Brider (16.13%), others (10.54%) of Imidacloprid insecticide as chemical control against mango hopper.

For controlling fruit fly and mealybug, most (56.17%) of the mango growers reported that they used Sevin followed by Revin (19.61%), Coral (14.37%), others (9.85%) of Carbaryl insecticide.

In case of leaf gall treatment, 46.19% mango growers reported that they used Dursban followed by Rexiban (24.72%), Pyriban (16.53%), others (12.56%) of Chlorpyrifos insecticide.

43.61% mango growers reported that they used Jubar which was followed by Carate (26.79%), Fighter (18.47%), others (11.13%) of Lambdacyhalothrin insecticide as chemical control against leaf eating weevil, shoot gall.

It was also found almost same ripening-harvesting time of mango based on the response of the mango growers and field level officers.

From the research, six insect pests of mango namely mango hopper, fruit fly, mealybug, leaf eating weevil, leaf gall and shoot gall were reported. Majority mango growers used Admire (Imidacloprid) against mango hopper, Sevin (Carbaryl) for controlling fruit fly and mealybug, Dursban (Chlorpyrifos) for leaf gall, Jubar (Lambdacyhalothrin) insecticide against leaf eating weevil, shoot gall as chemical control.

CHAPTER VI

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APPENDIX-I

English Version of the Interview Schedule (STUDY GROUP)

Department of Entomology

Sher-e-Bangla Agricultural University, Dhaka-1207.

Interview schedule for data collection for the research on

"INSECT PEST DIVERSITY ASSESSMENT FOR MANGO AND ITS MANAGEMENT PRACTICES USED BY THE FARMERS OF BAGHA AND CHARGHAT UPAZILA AT RAJSHAHI DISTRICT"

(The interview schedule is entitled for a research study)

Serial No.	:		
Name of the respondent	:		
Village/ Block	:	Upazilla	: Charghat/Bagha
District	: Rajshahi	Occupation	: Farmer
Distance:	Timing:	Medium of communication:	

(Please answer the following questions. Secrecy will be strictly maintained.)

A.1 Gender

Please mention your gender? Give (√) tick to appropriate place/ fill in the blanks.

(a) Male …….

(b) Female …….

A.2 Age

How old are you? Age…….years

A.3 Education

Please mention your educational status-

(a) Can't read and write…….

(b) Can sign only……..…..

(c) Read up to class ……...

(d) Others (specify) …….….

A.4 Farming Experience

How many years have you been farming? ……years

A.5 Mango Cultivated Land Size

How many areas do you cultivate mango? .....centi-/acre/hectare

A.6 Number of Mango Trees

How many different mango trees are there on your land?

Sl No.	Name of mango varieties	No. of mango trees
01.	Langda	
02.	Gopalbogh	
03.	Himsagar	
04.	Khirsapat	
05.	Ashhwina	
06.	Khisanbogh	
07.	Laksmanbhog	
08.	Amropali	
09.	Bombai	
10.	Mohanbhog	
11.	Fazli	
12.	Others …….	
Total		

A.7 Annual Income from Mango Cultivation

How many credit do you earn from mango cultivation per year? ……. Tk.

A.8 Experience in Mango Cultivation

How many years have you been cultivating mango? ……years

A.9 Economic Loss due to Insect Pest

How many credit do your loss from insect pests of mango per year? …….Tk.

A.10 Information received about insecticides usage

Where do you get information about insecticides usage? Please mention the following status-

Sl. No.	Name of the source/s	Not at all (0)	Low (1)	Medium (2)	High (3)	Very high (4)
01.	Neighbor					
02.	Insecticide dealer					
03.	DAE officials					
04.	Research organization					
05.	Self					

A.11 Insecticides source

Where do you collect insecticides? Please mention the following status-

Sl. No.	Name of the source/s	Not at all (0)	Low (1)	Medium (2)	High (3)	Very high (4)
01.	Insecticide retailer					
02.	Company agents					
03.	Friends					

A.12 Training Exposure on Mango Cultivation

Please mention about your training exposure on mango cultivation

Sl. No.	Name of the training course	Organization	Days
01.			
02.			
03.			
04.			
05.			

A.13 Organizational Participation

Please express your state regarding the following statements

Sl. No.	Name of the organization	Nature of participation (years)			
		No participation(0)	Ordinary member(1)	Executive member(2)	President/ Secretary (3)
01.	Farmers' association				
02.	School Committee				
03.	Bazar Committee				
04.	Co-operative society				
05.	NGO organized society				

B.1 Insect pest diversity assessment for mango

B.1.1 Insect pest occurrence in mango orchard

Which insect pest does attack in your mango orchard?

Sl No.	Name of insect pests	Yes (1)	No (0)
01.	Mango hopper		
02.	Fruit fly		
03.	Mealybug		
04.	Leaf eating weevil		
05.	Leaf gall		
06.	Shoot gall		

B.1.2 Insect pest infestation status in mango orchard

What is the insect pest infestation status in your mango orchard?

Sl No.	Name of insect pests	Major (2)	Minor (1)
01.	Mango hopper		
02.	Fruit fly		
03.	Mealybug		
04.	Leaf eating weevil		
05.	Leaf gall		
06.	Shoot gall		

B.1.3 Insect pest infestation severity in mango orchard

What is the insect infestation severity in your mango orchard?

Sl No.	Name of insect pests	Not at all (0)	Very low (1)	Low (2)	Medium (3)	High (4)
01.	Mango hopper					
02.	Fruit fly					
03.	Mealybug					
04.	Leaf eating weevil					
05.	Leaf gall					
06.	Shoot gall					

C.1 INSECT PESTS MANAGEMENT PRACTICES

C.1.1 Cultural control

Sl. No.	Name of practices	Not at all (0)	Very low (1)	Low (2)	Medium (3)	High (4)
01.	Field sanitation					
02.	Fertilization and manuring					
03.	Pruning, defoliation, thinning and topping					

C.1.2 Mechanical control

Sl. No.	Name of practices	Not at all (0)	Very low (1)	Low (2)	Medium (3)	High (4)
01.	Pheromone trap					
02.	Hand picking					

C.1.3 Chemical control

Sl. No.	Name of chemicals	Not at all (0)	Very low (1)	Low (2)	Medium (3)	High (4)
01.	Imidacloprid					
02.	Carbaryl					
03.	Cypermethrin					
04.	Lambdacyhalothrin					

D.1 Insecticide usages by the mango growers

What type of insecticide do you use? Give (√) tick to appropriate place–

Sl No.	Name of the insecticide	Yes (1)	No (0)
01.			
02.			
03.			

D.2 Harmful effects of chemical insecticides usage

Do you feel the problems on insecticides usage in mango cultivation?

Sl. No.	Harmful effects	Not at all (0)	Low (1)	Medium (2)	High (3)	Very high (4)
01.	Headaches					
02.	Dizziness					
03.	Nausea					
04.	Fatigue					
05.	Nerve, skin, and eye irritation and damage					

E.1 Assessment of ripening and harvesting time of mango

Would you please mention the ripening and harvesting time of mango?

Sl No.	Name of mango varieties	Ripening time	Harvesting time
01.	Langda		
02.	Gopalbogh		
03.	Himsagar		
04.	Laksmanbhog		
05.	Fazli		
06.	Amropali		
07.	Ashhwina		

E.2 Usages of ripening chemicals

Do you use any ripening chemicals? Please mention the following status-

Sl. No.	Name of ripening chemicals	Not at all (0)	Low (1)	Medium (2)	High (3)	Very high (4)
01.	Ethylene					
02.	Calcium carbide					

E.3 Usages of preservatives

Do you use any preservatives? Please mention the following status-

Sl. No.	Name of preservatives	Not at all (0)	Low (1)	Medium (2)	High (3)	Very high (4)
01.	Formalin					
02.	Sodium Benzoate					
03.	Sulphur Dioxide					

Thanking you for your kind cooperation.

…….

Date: (Signature of the researcher)

APPENDIX-II

English Version of the Interview Schedule (FIELD LEVEL OFFICERS)

Department of Entomology

Sher-e-Bangla Agricultural University, Dhaka-1207.

Interview schedule for data collection for the research on

"INSECT PEST DIVERSITY ASSESSMENT FOR MANGO AND ITS MANAGEMENT USED PRACTICES BY THE FARMERS OF BAGHA AND CHARGHAT UPAZILA AT RAJSHAHI DISTRICT"

(The interview schedule is entitled for a research study)

Serial No. :

Name of the respondent :

Village/ Block : Upazilla : Charghat/Bagha

District : Rajshahi Occupation: UAO/SAAO

Distance: Timing: Medium of communication:

(Please answer the following questions. Secrecy will be strictly maintained.)

A.1 Insect pest assessment for mango

A.1.1 Insect pest occurrence in mango orchard

Which insect pest does attack at your Upazila/Block?

Sl No.	Name of insect pests	Yes (1)	No (0)
01.	Mango hopper		
02.	Fruit fly		
03.	Mealybug		
04.	Leaf eating weevil		
05.	Leaf gall		
06.	Shoot gall		

A.1.2 Insect pest infestation status in mango orchard

What is the insect pest infestation status at your Upazila/Block?

Sl No.	Name of insect pests	Major (1)	Minor (0)
01.	Mango hopper		
02.	Fruit fly		
03.	Mealybug		
04.	Leaf eating weevil		
05.	Leaf gall		
06.	Shoot gall		

A.1.3 Insect pest infestation severity in mango orchard

What is the insect infestation severity at your Upazila/Block?

Sl No.	Name of insect pests	Not at all (0)	Very low (1)	Low (2)	Medium (3)	High (4)
01.	Mango hopper					
02.	Fruit fly					
03.	Mealybug					
04.	Leaf eating weevil					
05.	Leaf gall					
06.	Shoot gall					

B.1 INSECT PESTS MANAGEMENT PRACTICES

B.1.1 Cultural control

Sl. No.	Name of practices	Not at all (0)	Very low (1)	Low (2)	Medium (3)	High (4)
01.	Field sanitation					
02.	Pruning, defoliation, thinning and topping					
03.	Fertilization and manuring					

B.1.2 Mechanical control

Sl. No.	Name of practices	Not at all (0)	Very low (1)	Low (2)	Medium (3)	High (4)
01.	Pheromone trap					
02.	Hand picking					

B.1.3 Chemical control

Sl. No.	Name of chemicals	Not at all (0)	Low (1)	Little (2)	Medium (3)	High (4)
01.	Imidacloprid					
02.	Carbaryl					
03.	Cypermethrin					
04.	Lambdacyhalothrin					

C.1 Assessment of ripening and harvesting time of mango

Would you please mention the ripening and harvesting time of mango at your Upazila/Block?

Sl No.	Name of mango varieties	Ripening time	Harvesting time
01.	Langda		
02.	Gopalbogh		
03.	Himsagar		
04.	Laksmanbhog		
05.	Fazli		
06.	Amropali		
07.	Ashhwina		

Thanking you for your kind cooperation.

……..……

Date: (Signature of the researcher)