HOST PREFERRENCE AND CHEMICAL CONTROL OF MANGO MEALYBUG (*DROSICHA MANGIFERAE* GREEN)

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JUNE, 2011

HOST PREFERRENCE AND CHEMICAL CONTROL OF MANGO MEALYBUG (*DROSICHA MANGIFERAE* GREEN)

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

MASTER OF SCIENCE
IN
ENTOMOLOGY
SEMESTER: JANUARY-JUNE, 2011

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This is to certify that thesis entitled, **"HOST PREFERRENCE AND CHEMICAL CONTROL OF MANGO MEALYBUG (*DROSICHA MANGIFERAE* GREEN)"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN ENTOMOLOGY,** embodies the results of a piece of bona fide research work carried out by **Md. Bablur Rahman**, **Registration No. 09-03729** under my supervision and guidance. No part of the thesis has been submitted to any where for any degree or diploma.

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

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Dated: June, 2011
Place: Dhaka, Bangladesh

ACKNOWLEDGEMENTS

All praises and thanks are due to the supreme ruler of the universe, the almighty Allah for His grace bestowed upon the author for accomplishment of this research study.

The author expresses the deepest sense of respect and heartiest gratitude to his respectable supervisor Prof. Dr. Md. Abdul Latif, Department of Entomology, Sher-e-Bangla Agricultural University for his efficient and scholastic guidance, constructive criticism, valuable suggestions and immense help to carry out the research work toward successful completion and preparation of the thesis by necessary corrections and modification through reviewing the text.

He wishes to express his sincere appreciation and heartfelt gratitude to his co-supervisor Prof. Dr. Mohammed Ali, Department of Entomology, Sher-e-Bangla Agricultural University, for his valuable suggestions, constant cooperation, inspiration and sincere advice to improve the quality of the thesis.

Cordial thanks to Prof. Dr. Md. Razzab Ali, Chairman, Department of Entomology and all respected teachers of the Department of Entomology, Sher-e-Bangla Agricultural University for their help and co-operation during the study and research.

He is grateful to all those people who made a contribution to this research work although it is not possible to mention all by their names.

Last but not the least, the author expresses his immense indebtedness and the deepest senses of gratitude to his beloved parents and younger sister who sacrificed all their happiness during the whole study period. The author is grateful to all the respondents in the study area for their cooperation and help in accomplishing the objectives of this research work. Finally, he wishes to extend his heartfelt thanks and gratitude to all of his relatives for their inspiration, blessing and encouragement that opened the gate of his higher study.

The author

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ABSTRACT

The experiment was conducted at Entomology laboratory and Sher-e-Bangla Agricultural University campus Dhaka during the period from from March, 2011 to May, 2012 to study host preference and chemical control of mango mealybug. Six chemical insecticides viz. Lamdacyhalothrin (Fiter 2.5EC), Chlorpyrifos (Dursban 20EC), Cypermethrin (Ripcord 10EC), Imidacloprid (Bamper 200SL), Dimethoate (Dimetheon 40 EC), Thiamethoxam (Aktara 25WG) were tested field recommended dose on different stages of mealybug. In field, the experiment was laid out in randomized complete block design (RCBD) and in laboratory it was set in completely randomized design (CRD) with three replications. The major hosts of mealybug are mango, jackfruit, banana, redgram, papaya, cotton, mulberry, guava, tomato, turkey, berry, brinjal, teak, berry, chilli, marigold etc. Major parts of the plant in where infestation occurs were inflorescence, succulent leaf, lower surface of leaf mid rib, petiole, leaf bud etc. Maximum infestation occurs in mango, jackfruit, banana and papaya with 100 percent infestation rate followed by brinjal, strawberry, chilli and marigold. Immature stages of the plant are more susceptible. The highest mortality (100%) was found in thiamethoxam treated insect of 1st instar of mango mealybug in both field and laboratory condition. In 2nd and 3rd instars nymph, chlorpyrifos was most effective. In adult stage, it is more difficult to control mealy bug by chemical treatment. In field condition 53.33% mortality was found in chlorpyriphos and 46.67% in lambdacyhalothrin treatment in laboratory experiment.

CONTENTS

CONTENTS (Contd.)

LIST OF TABLES

LIST OF PLATES

LIST OF APPENDICES

ABBREVIATIONS

%	: Percentage
μM	: Micro mol
^{0}C	: Degree Celcius
BARI	: Bangladesh Agricultural Research Institute
BBS	: Bangladesh Bureau of Statistics
BRRI	: Rice Research Institute Bangladesh
CRD	: Completely Randomized Design
cv.	: Cultivar
DMRT	: Duncans Multiple Range Test
e.g.	: Exempli gratia (by way of example)
et al	: And others
FAO	: Food and Agriculture Organization
Fig.	: Figure
g	: Gram
GA_3	: Gibberellic acid
HCL	: Hydrochlori acid
$HgCl_2$	: Mercuric Chloide

i.e.	: ed est (means That is)
IRRI	: International Rice research Institute
mgL^{-1}	: Milligram per litre
pH	: Negative logarithm of hydrogen ion
spp	: Species (plural number)
var.	: Variety
Viz.	: Namely

CHAPTER I

INTRODUCTION

Mango (*Mangfera indica* Green) a member of the family Anacardiaceae, is considered as the most popular fruit in tropical and subtropical regions particularly in India and Bangladesh because of its excellent flavor, attractive fragrance, and beautiful shades of colour, delicious taste and healthful value. Mango is commercially important fruit in Bangladesh and is called as the "king of fruits". It has been cultivated in this sub continent from 4000 years ago (Candole, 1984). Mango is originated in the Indian sub-continent during the Prehistoric time (Vavilov, 1926; Mukherjee, 1998).

Mango is now recognized as one of the popular and delicious fruits in the world. It has medium calorific and high nutritional values. It supplies ample amount of carotene (precursors of vit-A) to the human nutrition (Singh, 1968). Among all major fruits, mango is second only to 'Bael' in containing niacin and has more thiamine (vitamin B1) and riboflavin (vitamin B2) than most other fruits. Both unripe and ripe mangoes are a good source of Vitamin C. Mango provides a lot of energy with as much as 74 Kcal per 100 gram edible portion which nearly equals the energy values of boiled rice of similar quantity by weight. In mineral contents, mango holds an average position among fruits. In containing iron, unripe mango has the first and ripe fruit, about the 16th position, among all major fruits. (Gopalan *et al*., 1971). Mango has a large number of, medicinal uses, in addition to its great popularity as fresh fruit. It is also used in many dried and processed forms. The timber is considered valuable fuel-wood, being light in weight and burning easily. The timber of the old tree is useful in making packing boxes, cheap doors, windows and in the making of plywood.

Mango is grown over wide geographical areas particularly Egypt, Australia, India, Pakistan, the USA (Florida and Hawaii), Venezuela, Mexico, Philippines, Thailand, Burma, Niger, Nigeria, Zaire, Madagascar, Maturities, Cuba, Brazil and the West Indies island (Islam *et al*, 1995). Mango ranks third among the tropical fruits grown, in the world with a total production of 28848 thousand metric tons (FAO, 2002). India is the largest producer of mangoes in the world, producing over 65% of total world production

(Patil-'and Path, 1994). Due to certain limitation of soil and climatic condition, the mango grows better in some selective areas of Bangladesh. The leading mango growing districts are Rajshahi, Dinajpur, Rangpur, Kustia and Jessore (North western districts). Mango ranks first in terms of area among the fruits and in production it stands third only next to banana and jackfruit. It occupies an area of about 25,000 hectares of land from where 622 thousand metric tons of mango are produced annually with an average of 24 t/ha (BBS, 2006) which is much lower compared to that of neighboring countries.

A large number of insects, mites and other vertebrate pests cause a considerable damage to mango trees as well as fruits (Tandon *et. al*, 1985). There have been over 175 species of insects damaging mango trees (Nayar *et. al*, 1976). Litz, (l997) reported that nearly 260 species of insects and mites that have been recorded as pests of mango, 87 are fruit feeders, 127 are foliage feeders, 36 feed on the inflorescence, 33 inhabits buds and 25 feed on branches and the trunk. Insect pests play a significant role for the low yield and poor quality of fruits in Bangladesh. These pests attack mango plants from nursery stage up to maturity. There are about 30 insect species of insect pests which have been reported as pests of mango in Bangladesh. However, there are many other species which are yet to be identified insect pests causing recognizable damage to both trees and fruits of mango in Bangladesh (Hossain, 1989).

Mango mealybug *Drosicha mangiferae* Green is one of the most damaging insect pests of mango. All producers had some knowledge of the mango mealy bug. The name was given varied from insect to disease or both. One of the best definitions recorded for the pest was “A white worm with black powder, producing honey-like oil”. All producers declared the mango mealy bug a pest and 97% answered that it decreased fruit production. In 68% of all cases, the incidence of the pest was considered higher in the dry season than in the rainy season. Premature flower and fruit drop, probably due to fruit flies and Lepidopteran species and not further addressed in the present surveys, were mentioned by 30%.

Of all producers, 46% tried chemical control of the mango mealy bug. Even when most effective chemicals were used, treatments were stopped after a short time due to the high cost of the pesticides and the adapted sprayers. Outbreaks invariably resumed again.

The mango mealy bug secrets honeydew and soon after infestation, the mango leaves are covered with a black sooty mould. This mould, considered by some producers as a separate disease, reduces photosynthesis and thereby fruit production. It also attracts numerous flies and other insects, virtually preventing social activities under the infested trees. Without treatment, the trees are no longer useful and need to be cut. The successful biological control of mango mealy bug, therefore, has had a clear impact on fruit production, on nutrition and health, and on social activities. The most important impact of the pest is on fruit production. The economic value of the abated loss is calculated in the next section, but a decrease in fruit production also has an immediate effect on energy intake, especially by the rural population. Indirect effects on general health can also be expected due to a decrease in Vitamin A intake, as well as from a decreased availability of traditional medicine derived from the mango tree. The black sooty mould on leaves makes all plant material unsuitable for medicinal purposes.

The present research work was:

i) To study the host diversification;

ii) To study the effect of some chemical insecticides against mango mealybug;

iii) To identify the susceptible stage to control of mango mealybug.

CHAPTER II

REVIEW OF LITERATURE

Several studies on chemical control of mango pests have been carried out by eminent researchers in well known universities and agricultural research institutes in Indian subcontinent and elsewhere in the world. Usually it is in the region of the world where originate the invasive pests that the appropriate exotic natural enemies capable of putting them back into control in the newly infested region are found. This review is an overview of the literature on mango pests which focuses on the studies on chemical control of the mango mealybug especially report on the project that was implemented in Bangladesh and had achieved a good degree of success in the eighties. The review highlights what need to be done to widen or extend this project into a Regional Chemical control Program.

2.1 Mango

Mango, *Mangifera indica* L, a member of the family Anacardiaceae, is one of the most important nutritionally rich in carbohydrates and vitamins and foreign exchange earning fruit crop of Pakistan. Nature has endowed Pakistan with wide range of agro-climatic conditions, which permit quality production of both tropical and temperate fruits. The climate of Pakistan is favorable to all types of fruits. Mango is the second major fruit crop of Pakistan after citrus. Pakistan is standing at 5th place in world's total mango production (FAO, 2001; Minfal, 2002). The output during the current year (2010) has substantially decreased to 9- 10 tons per hectare. It is about 50% of the potential yield, which is 20 tones per hectare (Shabid, 2006), that shows a significant difference between average and potential yields. The main reason for the yield reduction is the pest pressure and diseases attacking the mango orchards. Mango is an ancient fruit of Indian origin, is of great importance to millions throughout the tropics (Singh, 1968; de Laroussilhe, 1980; Litz, 1997).

It is sold on local markets in Africa and constitutes an important source of energy and nutrients (Vitamins A, C, and D, amino acids, carbohydrates, fatty acids, minerals, organic acids, proteins). Mango is also a valuable ornamental and shade tree and contributes to the protection of soil against erosion. Different medicinal virtues are known (D'Almeida, 1995).

In Benin, a survey among mango producers over a large area estimated that the chemical control program allowed interviewed farmers to gain on average US$ 328 annually. This amounted, when extrapolated to all farmers of Benin, to an estimated net yearly gain of $US 50 million for the whole country (Bokonon-Ganta *et al*, (2001). The authors of this study concluded that the added value of the chemical control is estimated at $US 531 million over 20 years. These benefits are based on the total cost of chemical control of mango mealybug estimated at $US 3.66 million and which includes costs in other African countries involved in the program and the cost of importing the natural enemy from India. The figures translate in a benefit-cost ratio of 145:1 in favour of benefits for Benin alone.

In Côte d'Ivoire Hala *et al.* (2004) reported that *R. invadens* appeared in 1989 at the eastern border of the country and became in less than four years a major constraint to fruit production nation-wide. By 1996 the mango mealybug had reached the northern region, the main area for export mango production. It was evaluated that 53% of mango yield losses occurred as the result of *R. invadens* in festations in Korogho-Lataha research station. Yield losses even reached 100% in some farms and farmers responded most often by cutting down and destroying all the trees in the infested orchards. On the average, the infestation rates reached 82, 36 and 11% respectively in the cities, villages and orchards.

2.2 Mango pests

A number of insect pests are known to attack the mango trees, which have been studied in detail (Sen, 1955; Giani, 1968; Herren, 1981; Tandon and Verghese, 1985). Some of these are certainly responsible for causing considerable damage and become a limiting factor in many mango-growing areas. To effectively monitor a mango orchard for insect pest outbreaks, growers must be first aware of the types of insect pests they are likely to encounter and should conduct the surveys on a regular basis. (Patriquin *et. al*, 1995).

According to Bokonon-Ganta *et al.* (2001) and several others entomologists and actors from the production and processing chains in the countries we surveyed, until recently, damages by pests and diseases on mango in Africa in general, and in West Africa in particular were of minor economic importance. It is only in the eighties that a mealybug later identified as *Rastrococcus invadens* Williams (Homoptera: Pseudococcidae) and a fruit fly identified as *Bactrocera invadens* were reported causing serious damage to various fruit trees, especially mango, in Benin, Togo and Ghana (Agounkè *et al.,* 1988, Vayssières, 2005).

2.3 Mango mealybug *Drosicha mangiferae*

The main problem, mentioned by mango producers throughout the survey, was the infestation of mango trees by the mango mealybug. All producers had some knowledge of the mango mealybug. The names given varied from insect to disease or both. One of the best definitions recorded for the pest was "A white worm with black powder, producing honey-like oil". All producers declared the mango mealybug a pest and 97% answered that it decreased fruit production. In 68% of all cases, the incidence of the pest was considered higher in the dry season than in the rainy season

*R. invadens*is a native pest from Southeast Asia. It was introduced into western Africa through plant materials (Tobih *et al*, 2002). It is a pest of more than 21 economically important plant species, but mango is its major host plant. The pest has been reported causing 80% of mango yield losses in Ghana (Entomological society of Nigeria, 1991), 53% to 100% reduction of total production in Côte d'Ivoire (Hala *et al,* 2004), significant reduction in weight and size of fresh mango fruit in Nigeria, Togo and Benin (Ivbijaro and Udensi, 1988; Ivbijaro *et al*, 1991; Tobih *et al*, 2002). The insect affects the morphology and physiology of infested trees causing delays in flowering, fall of floral spikes and leaves and slowing the emission of new branches.

Estimates by producers confirmed the negative impact of the pest on plant production and the positive impact of the introduced natural enemy. Production did not immediately return to pre-infestation levels, probably due to the effect of the residual sooty mould on trees following the releases of *G. tebygi*. A similar impact of the introduced natural enemy had been assessed in Togo based on estimation of the production of a limited number of trees grown from the main seedling nurseries (Vögele *et al.,* 1991). An increase beyond the original mango production is attributed to the fact that during the last 10 years many new mango orchards had been established and were coming into production. To what extent the second parasitoid, *A. mangicola*, which was established later (Neuenschwander *et al.,* 1994; Neuenschwander, 1996), contributed to the decline of the mealybug populations and increased mango production remains unknown.

3.4 Hosts of mango mealybug

Atwal, (1976) found that the major host of mealy bug were papaya, redgram silk, cotton, papaya cotton, shoe flower, jatropha, tapioca, mulberry, guava, tomato, turkey berry, brinjal, teak, country mallow, latjira, wild mustard, spider wort, chandvel, garden sprug, hazardani, dronapushpi, tulasi, congress grass, ghamra, pig weed. He also stated that nymph was highly mobile and in succulent small plant.

The pest has recently moved into the mango production areas of Burkina Faso in the provinces of Comoé, Léraba and Kénédougou (Otoidobiga, personal communication), in Western Mali in the region of Sikasso (SidikiTraoré, personal communication), and in Guinea where it is causing alarming losses to mango production. Not only has the pest disrupted the production of mango and of many other fruits and ornamental trees, but it is also a nuisance by causing accumulation of excreted honey dew that results in the formation of sooty mould which in turn arrests normal growth, photosynthesis, flowering and fruiting of the attacked plants (Pitan *et al,* 2000). As a consequence, growers are even deprived from enjoying the shade of attacked trees.

In Guinea *R. invadens* was first observed in 2000 and later confirmed by IITA. Initially localized in one region, the pest rapidly infested the entire country. According to the scientific community and the majors groups of actors in the mango value chain, the bug infestations are causing serious damages to mango production in Guinea. Over the last few years, the infestations have had a negative economic impact on producers and traders of this commodity. Although the rates of infestations are most important in urban areas than in orchards, the economic and social strain on farmers seem to be greater given the importance of the revenue of mango production, trade and consumption on farmers' income and welfare. Indeed mango production plays a fundamental role in procuring extra income to farmers in rural areas all over Guinea.

Mango mealybug, *D. mangiferae* Green, is one of the most serious insect pests of mango in Pakistan due to its polyphagous nature (Green, 1908). It lays egg in loose soil within radius of 2-3 meter around the infested trees. Hatching of the eggs starts with rise in temperature and the nymphs crawl to the succulent shoots and base of fruiting parts (Birat, 1964; Atwal, 1976). The nymphs and female bugs suck sap from inflorescence, tender leaves, shoots and fruit peduncle. As a result, the affected inflorescences are shriveled and get dried. Rigorous infestation affects the fruit set and causes fruit drop. They exude honey dew over the leaves, on which sooty mould is developed (Tandon and Lal, 1978).

Until recently, damage by insect pests and diseases on mango in Africa was insignificant. In 1986, however, a mealybug, later described as *Rastrococcus invadens* Williams (Homoptera: Pseudococcidae) of South East Asian origin (Williams, 1986), was reported to cause serious damage to various fruit trees, especially mango, in Benin, Ghana and Togo (Agounkè *et al.*, 1988).

2.5 Control of *Drosicha mangiferae*

Karar *et al*. (2009) worked on comperative effectiveness of old and new insecticides for the Control of Mango Mealybug (Drosicha mangiferae green) in Mango and found that the maximum mortality of 1st instar mango mealybug was observed in those treatments, where Mospilan were applied with 80, 85 and 91% after 24, 72 and 168 h of spray. However, in case of 2nd and 3rd instar, Decis and Curacron gave maximum mortality 71 and 70, 24 h after spray. After 72 and 168 h Mospilan proved best with 78 and 81% mortality. Supracide the most effective insecticides for the control of adult female at all the post treatment intervals i.e. 60, 72 and 73% mortality under field conditions.

The most common method used by local farmers to control *R. Invadens* is cutting down infested trees (Agricola *et al.*, 1989). Investigations by National Research Services (NRS) have yielded little alternative control approaches to mitigate the threat caused by *R. invadens*. In Burkina Faso, Côte d'Ivoire and Mali, chemical control has been experimented but the technology has been poorly adopted by farmers because of little efficiency and fears that the use of insecticides will erase the organic nature of mango production of the region and expose mango export to pesticide Maximum Residue Limit restrictions in force in the European Union markets where most of the exported production is sold.

Mango mealybug is difficult to control by insecticides and the use of chemicals has been inefficient (Yousuf and Ashraf, 1987; Khan and Ahsan, 2008). The sticky bands along with burning and burying treatments significantly reduced the frequency of infestation of mango mealybug by 0.00-15.79%. Burlap bands reduced population of mango mealybug nymphs by 78.98%. Stem injection can achieve a very high level of mortality of sucking insects (98%). The mortality rates achieved with insecticide sprays were up to 55% (lshaq *et al.,* 2004).

Syed *et al*.(2012) were studied on Toxicity of Some Insecticides to Control Mango Mealybug showed that Mango mealybug, *Drosicha mangiferae*, is one of the most serious insect pests of mango because it reduces the plant vigor by sucking the sap from inflorescence, tender leaves, shoots and fruit peduncles. To control this pest, insecticides of different groups were evaluated in both the laboratory and field conditions. In laboratory conditions profenofos showed maximum percent mortality of 93.3% and 86.67% of the 1st and 2nd instar mango mealybug. While triazophos proved to be an effective insecticide for the control of the 4th instar by showing 64.0 and 100% mortality in leaf dip method and foliar application. Out of seven insecticidal band applications tested in the field conditions, the combination of cotton + buprofezin proved effective by manifesting 99.l0% control of mango mealybug. The present study has shown that the insecticides tested, especially profenofos, methomyl and triazophos, and cotton + buprofezin band application provided effective control of the mango mealybug. The control of this insect pest throughout the orchards predominantly depends on judicious use of chemicals like profenofos, triazophos, methoniyl, acetamiprid, buprofezin and deltamethrin, for the development of an integrated pest management strategy.

Abbas *et el.* (2009) said that the maximum mortality of second and third nymphal instar was recorded to be 71% with Decis spray followed by Curacron (70%) mortality of second and third nymphal instars of mango mealybug. Mospilan was found to be the next effective treatment with 65% mortality of the pest followed by Karate and Lorsban (63 & 62% mortality). The later mentioned treatments also showed non-significant difference with Confidor and Supracide showed 58 and 60% mortality of the pest, respectively. No significant difference existed between Talstar and Hostathion application (51 & 47% mortality, respectively). Starter was the least effective with 27% mortality of second and third nymphal instars of mango mealybug. Similarly the application of Ripcord also showed no promising results (with 38% mortality of the pest). Results showed that Supracide was the most effective causing the greatest mortality (78%) after 72 h of all insecticides tested. Decis was the most effective resulting in 74% mortality of the pest. The mortality of all other treatments was Curacron > Supracide > Lorsban > Karate = Confidor > Hostathion > Talstar > Ripcord > and Starter with 73, 70, 66, 65, 64, 58, 56, 43, and 29%, respectively.

The few studies that have been published so far on the socio-economic impact of chemical control in Africa indicate a very high return to the investment. A first study on the chemical control of the cassava mealybug by Norgaard (1988) consisted of asimple benefit–cost analysis for the "reasonable, leastfavorable" case. Chemical control was shown to behighly cost effective, with a benefit–cost ratio of 149:1, but the lack of data did not allow for deeper analysis.Several years later, a new study on the same project, using detailed regional data over a longer period of time, resulted in a remarkably similar figure of 199:1(Zeddies *et al.,* 2000). Preliminary results of on-goingstudies on the water hyacinth and the cassava greenmite also indicate high returns to investment (IITA,Plant Health Management Division, unpublished data). An recent economic study of the chemical control of the spiny black fly on an estate in Swaziland found a benefit–cost ration of 2.8, over only one season (Van Den Berg *et al.,* 2000).
Lack of official statistics about mango production in Benin, complications arising from alternate bearing of mango trees, and the widely observe dun necessary tree felling following the attack by the mango mealybug complicated the economic analysis.The study documents the impact of mango mealybug and its chemical control by measuring mango yields and prices, before and after the establishment of the natural enemies, and by registering the perceptions of producers concerning the evolution of mango production from the beginning of the invasion until 10 yearslater. Calculated benefits are then

compared with the cost of the chemical control programme.The importance of mango cultivation in Benin was shown in these surveys through the various usesmade of the tree and its fruits. In India, mango is alsoimportant in various ceremonial functions (Singh, 1968); but this aspect was not recorded in the presentsurvey.

In the present analysis, the previously quantified impact of the pest and the resultant sooty mould on plant growth (Bokonon-Ganta and Neuenschwander, 1995) was extended to include fruit production and revenue for the farmer. The overall failure of various individual control measures undertaken by producers resulted in a general panic. Because a perennial plant providing shade and fruits was threatened, the whole community, including decision-makers in towns, became concerned. The capability of the introduced natural enemy, *G.tebygi* to reduce populations of *R. invadens* was well recognized by the producers. Most attributed the observed improvement to the success of chemical control, and only 15% of the producers attributed the improvement in fruit production primarily to weather factors, thus, confirming previous survey data (Bokonon-Ganta and Neuenschwander, 1995). Similar observations on the awareness amongst the local population of the value and practice of chemical control of *R. invadens* had been made by Vögele *et al.* (1991) in Togo. By contrast, in a study on the impact of chemical control against the cassava mealybug, *Phenacoccus manihoti* Matile-Ferrero (Homoptera: Pseudococcidae), the majority of farmers recognized improvement, but attributed it to weather (Neuenschwander *et al.*, 1989).

CHAPTER III

MATERIALS AND METHODS

The research work was conducted to search the host and evaluate the efficacy of some chemical insecticide on mango mealybug *Drosicha mangiferae* Green.

3.1. Location and time

The present research was conducted at Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during the period of March, 20011 to May, 2012. The experimental area is located at 23.74^0 N latitude and 90.35^0 E longitudes with an elevation of 8.2 m from the sea level.

3.2 Climate and weather

The experimental area is situated in the sub-tropical climatic zone and characterized by heavy rainfall during the months of January to May (Kharif Season) and scanty rainfall during the rest period of the year (Biswas, 1987). The Rabi season (October to March) is characterized by comparatively low temperature and plenty of sunshine from November to February. The detailed meteorological data in respect of temperature, relative humidity and total rainfall recorded by the Weather Station of Bangladesh, Sher-e-Bangla Nagar, Dhaka during the period of study have been presented in Appendix II.

3.3 Host preference.

Mango maelybug is polyphagous insect. Host was observed in of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka of Bangladesh. The major host of this area are mango, jackfruit, banana, red gram, papaya, cotton, flower mulberry, guava, tomato, turkey berry, brinjal, Teak, berry, chilli, marigold etc. Major parts of the plant in where infestation occurs are inflorescence, succulent leaf, lower surface of leaf mid rib, petiole, and apex of plant, leaf etc.

3.4 Test insect

Mango maelybugs, *Drosicha mangiferae* Green. (Homoptera: Monophlebidae), was chosen as test insect in this experiment.

3.5 Systematic position

Phyllum: Arthropoda
Class: Insecta
Sub-Class: Pterygota
Division: Endopterygota
Order: Homoptera
Family: Monophlebidae
Genus: *Drosicha*
Species: *Drosicha mangiferae* Green.

3.6 Treatments

Six insecticides were used in the experiment. The common name, trade name and dose of insecticides are given below:

Common Name	Trade name	Dose
Lamdacyhalothrin	Fiter 2.5EC	1.0 ml/L
Chlorpyrifos	Dursban 20EC	2.0 ml/L
Cypermethrin	Ripcord 10EC	1.0 ml/L
Imidacloprid	Bamper 200SL	0.5 ml/L
Dimethoate	Dimetheon 40EC	2.0 ml/L
Thiamethoxam	Aktara 25WG	0.5 g/L

Only water was applied in control treatments.

3.7 Effect of different insecticides against different stages of mealybug

Six chemical insecticides under different chemical groups were tested against different stages of mango mealybug in laboratory and field. The test procedures are given below:

3.7.1 Test of insecticides against 1st and 2nd instar nymph

To examine the toxicity of six insecticides viz, Lamdacyhalothrin (Fiter 2.5EC), Chlorpyrifos (Dursban 20EC), Cypermethrin (Ripcord 10EC), Imidacloprid (Bamper 200SL), Dimethoate (Dimetheon 40EC), Thiamethoxam (Aktara 25WG) exact amount was measured and diluted in1 liter of water for the control of mango mealybug under laboratory as well as under field conditions against the 1st and 2nd instar nymph of *D. mangiferae*, leaf dip bioassay method was used. Insecticidal solution (500m1) of each insecticide was prepared at their field recommended doses (Table 1). Fresh mango leaves equal to the size of Petri dish (5cm) were dipped into the insecticide solution for about 1 min and then air dried at room temperature. After drying, these treated leaves were placed in the Petri dishes containing moistened filter paper to avoid desiccation of the leaves. Thereafter ten active crawlers of the 1st and 2nd instar were placed in the Petri dishes containing treated leaves with the help of fine camel hair brush. Each Petri dish was then placed under controlled conditions (25 ± 2°C, 60± 5 % RH). Experiment was laid under Randomized Block Design (RBD) with seven treatments including control while all the treatments were replicated thrice. Mortality data was taken up to three days of post treatment.

3.7.2 Test of insecticides against adult mealybug

In order to determine toxicity of insecticides at their recommended field doses viz., Lamdacyhalothrin (Fiter 2.5EC), Chlorpyrifos (Dursban 20EC), Cypermethrin (Ripcord 10EC), Imidacloprid (Bamper 200SL), Dimethoate (Dimetheon 40 EC), Thiamethoxam (Aktara 25WG) against the adult mango mealybug, two methods were applied i.e. leaf dip method and foliar method.

3.8 Leaf dip method

For the leaf dip bioassay, leaves were cut as the size of Petri dish. These leaves were dipped in insecticide solution containing 100 ml water + insecticide. There were three replications in each treatment and seventh treatment was labeled as control, in which leaf discs were dipped in tap water only. In each replication three, 4th instars maelybug were placed. The data was recorded up to 3 days after insecticidal treatment.

3.9 Foliar method

Hand sprayer was used in this method. The insecticide solutions were prepared in the Hand sprayer. Under spraying method, two different solutions were made i.e., one containing 500 ml water + insecticide. These solutions were then sprayed (one time) on dorsal side of maelybug. Fresh mango leaves were provided to the treated maelybugs. There were three replications in each treatment. One treatment was of control in which maelybugs were sprayed with tap water only. In each replication three adult maelybugs were placed. The data was recorded up to three days.

3.10 Effect of different insecticidal bands against mango maelybug under field conditions

Insecticides with liquid and granular formulations viz., Lamdacyhalothrin (Fiter 2.5EC), Chlorpyrifos (Dursban 20EC), Cypermethrin (Ripcord 10EC), Imidacloprid (Bamper 200SL), Dimethoate (Dimetheon 40 EC), Thiamethoxam (Aktara 25WG) were used for band trial against the l’ instar mango maelybug for their susceptibility against insecticides at their recommended field doses. The insecticide bands (2 inch diameter) were applied 3 feet above ground level around the trunks. The band was made in the way that first, the trunk (two inches width) was covered with moist soil and then, insecticide was gently applied on the moist soil.

3.11 Data collection

Data was recorded after every days by adopting the following procedure: A square of 6 x 6 inches dimension above and below the band was made with the help of a pointed needle to record the number of maelybugs present in that marked square only.

Percentage control of first instar mango maelybug was calculated by the following formula:

$$\text{Mortality}(\%) = \frac{\text{No. of insect pests in treatments - No. of insect pests in control}}{\text{No. of insect pests in control}} \times 100$$

3.12 Statistical analysis of experimental data

The data obtained from experiment on various parameters were statistically analyzed in MSTAT-C computer program. The mean values for all the parameters were calculate and the analysis of variance for the characters was accomplished by Duncan’s Multiple Range Test

(DMRT) and the significance of difference between pair of means was tested by the Least Significant Differences (LSD) test at 5 % levels of probability.

CHAPTER IV

RESULTS AND DISCUSSION

The results generated out of the experiments on the host preference and chemical control of mango mealybug (*Drosicha mangiferae* Green) are presented under different subheadings. The results have been interpreted, elaborated and discussed in the light of relevant available research report.

4.1.1 Host Plants

Mango mealy bug is a polyphagous insect and attacks many host plants. Heavy infestation of mango mealy bug has been noticed on wide range of cultivated crops and weed hosts belonging to different families of plant kingdom. The Table 1 shows the list of recorded hosts of mango mealy bug.

Table 1. Hosts of mango mealy bug at Sher-e-Bangla Agricultural University campus

Common name	Botanical name	Family
Mango	*Mangifera indica* L.	Anacardiaceae
Jackfruit	*Artocarpus heterophylus* Lam.	Moraceae
Banana	*Musa ×paradisiacal* L.	Musaceae
Redgram	*Cajanus cajan* L.	Leguminaceae
Papaya	*Carica papaya* L.	Caricaceae
Silk cotton	*Ceiba pentandra* (L.) Gaertn.	Malvaceae
Cotton	*Gossypium hirsutum* L.	Malvaceae
Mulberry	*Morus alba* L.	Moraceae
Guava	*Psidium guajava* L.	Myrtaceae
Tomato	*Lycopersicon esculentum* Mill.	Solanaceae
Turkey berry	*Solanaum torvum* Sw.	Solanaceae
Brinjal	*Solanum melongena* L.	Solanaceae
Berry	*Canthium inerme* (L.f.) Kuntze	Rubiaceae
Strawberry	*Fragaria* × *ananassa* Duchesne	Rosaceae
Brinjal	*Solanum melongena* L.	Solanaceae

Chili	*Capsicum frutescens* L.	Solanaceae
Marigold	*Tagetes patula* L.	Compositae

4.1.2 Infestation intensity of mango mealybug

Table 2. Shows that maximum infestation occurred in mango, jackfruit, banana and papaya with 100 percent infestation followed by brinjal, strawberry, chilli and marigold with 80.65, 76.32, 65.25 and 35.29 percent of infestation, respectively. In case of leaf infestation, maximum infestation (64.29%) occurred in marigold followed by banana, chilli, papaya, bginjal, mango, strawberry and jackfruit with 62.50, 47.06, 47.06, 35.39, 25.00, 23.07 and 10.00 percent infestation, respectively. Considering the number of insect per leaf, the highest number of mealybug (40.00 cm^2) was found in strawberry followed by 37.00, 25.00, 14.00, 12.00, 8.00, 7.00 and 3.00 in brinjal, mango, banana, jackfruit, chili, papaya and marigold, respectively. In case of inflorescence infestation, the highest number (84.00 cm^{-2}) of mealybug was recorded from banana followed by papaya, brinjal, jackfruit, strawberry, mango, chilli and marigold where the number of insect was 37.00, 25.00, 14.00, 12.00, 8.00, 7.00 and 3.00 per cm^{-2}. In most of the plants the insect confined its infestation on inflorescence, succulent leaf, petiole and apical leaf bud. The results support the findings of Atwal (2007) who reported that major host of mealy bug were papaya, redgram silk, cotton, papaya cotton, shoe flower, jatropha, tapioca, mulberry, guava, tomato, turkey berry, brinjal, teak, country mallow, latjira, wild mustard, spider wort, chandvel, garden sprug, hazardani, dronapushpi, tulasi, congress grass, ghamra, pig weed. He also stated that nymph was highly mobile and infested succulent part of the plant.

Table 2. Infestation intensity of mango mealybug on some cultivated hosts

Name of hosts	% plant infestation	% leaf infestation	No. of insect in infested area of leaf (cm^{-2})	No. of insect in infested inflorescence (cm^{-2})	Infested part of the plant
Mango	100.00	25.00	25.0	35.0	Inflorescence, succulent leaf
Jackfruit	100.00	10.00	12.0	40.0	Inflorescence
Banana	100.00	62.50	14.0	84.0	Lower surface

					of mid rib
Straw berry	76.32	23.07	40.0	40.0	Petiole, leaf bud
Brinjal	80.65	35.39	37.0	62.0	Petiole, leaf bud, fruit
Chili	65.25	47.06	8.0	9.0	Petiole, leaf bud
Papaya	100.00	47.06	7.0	80.0	Leaf, leaf bud
Marigold	35.29	64.29	3.0	8.0	Leaf, leaf bud

Infested host.

Plate 1: Infested pumkin stem

Plate 2: Infested hedge plant

Plate 3: Infested chilli

Plate 4: Infested strawberry

Plate 5: Infested tulshi plant

Plate 6: Infested marrigold plant

Plate 7: Infested papaya plant

Plate 8: Infested papaya leaf

Plate 9: Infested brinjal

Plate 10: Infested brinjal plant

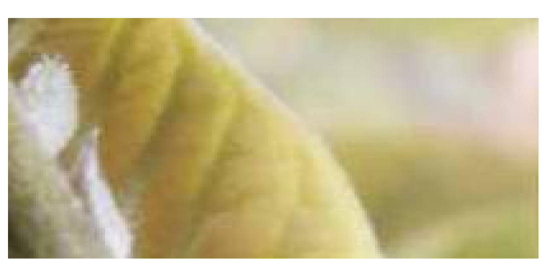

Plate 11: Infested mango inflorescence **Plate 12:** Infested mango leaf

Plate 13: Infested jackfruit inflorescence **Plate 14:** Infested jackfruit inflorescence

Plate 15: Dead mealy bug

Plate 16: Infested jackfruit inflorescence

4.2 Effect of chemical insecticides against different stages of mango mealybug

The results on the effect of six chemical insecticides viz., lamdacyhalothrin, chlorpyrifos, cypermethrin, imidacloprid, dimethoate, and thiamethoxam against different stages of mango mealybug at laboratory and filed condition are discussed below under the following subheadings.

4.2.1.1 Effect on 1st instar nymph of mango mealybug in field.

The results on the effectiveness of six chemical insecticides against 1st instar nymph of mango mealybug in filed condition have been shown in Table 3. The data reveal that the highest nymphal mortality (94.44%) was observed under imidacloprid after 24 hours of insecticide application followed by 92.22% and 91.11% in lambdacyhalothrin and thiamethoxam, respectively having no significant difference among them. However, significant difference was found with other insecticides. The lowest mortality was observed in dimethoate which was statistically similar with chlorpyriphos and cypermethrin. After 48 hours of insecticide application, the highest nymphal mortality (100%) was found in lambdacyhalothrin treatment. After 72 hours of insecticide application, lambdacyhalothrin, imidacloprid and thiamethoxam were found to be the most effective insecticide resulted in maximum mortality (100.00%) of the pest and differed significantly from that other treatments. Cypermethrin, chlorpyriphos and dimethoate showed statistically similar response with 98.89, 97.89 and 97.89 percent mortality of first instar nymph of mango mealy bug, respectively. This result supports the findings of Syed *et al.* (2012) but Karar *et al*. (2009) reported that mospilan is most effective in field condition.

Table 3. Effectiveness of chemical insecticides against 1st instar nymph of mango mealybug in field

Name of insecticides	Percent nymphal mortality after spray		
	24 h	**48 h**	**72 h**
Lambdacyhalothrin	92.22 a	100.00 a	100.0 a
Chlorpyriphos	81.11 b	90.00 c	97.89 a
Cypermethrin	81.11 b	90.00 c	98.89 a
Imidacloprid	94.44 a	97.78 ab	100.00 a
Dimetheoate	80.00 b	91.11 bc	97.89 a
Thiamethoxam	91.11 a	96.67 abc	100.00 a
LSD	**7.239**	**6.939**	**2.564**
CV	**4.59**	**4.05**	**1.42**

In a column means having different letter(s) are different at 5% level of significant by Duncan's Multiple Range Test (DMRT).

4.2.1.2 Effect of insecticides on 1st instar nymph of mango mealybug in laboratory

The data pertaining to the mortality percentage of first instar nymph of mango mealybug at 12 hours of post treatment interval are shown in (Table 4). The results reveal significant differences among the treatments. Lambdacyhalothrin, and thiamethoxam were found to be the most effective and resulted in maximum mortality (100.00%) of the pest follwed by dimetheoate which caused 96.67% mortality of the 1st instar nymph. Chlorpyriphos and imidacloprid gave 73.33 and 63.33 percent mortality of the pest. Cypermethrin was found to be the least effective insecticide for the control of first instar of mango mealy bug resulted with 53.33% mortality and also differed significantly from all other treatments. After 24 hours, lambdacyhalothrin, thamethoxam and dimethoate were found to be the most effective and resulted in maximum mortality (100.00%) of the pest followed by 86.67 and 86.67% mortality of the pest in those treatments where chlorpyriphos and imidacloprid were sprayed. Cypermethrin was found to be the least effective insecticide for the control of first inster of mango mealy bug resulted with 63.33 percent mortality and also differed significantly from those of observed in all other treatments. After 36 hours, Lambdacyhalothrin, thiamethoxam, dimetheon, Chlorpyriphos and Imidacloprid were found to be the most effective and resulted in maximum mortality (100.00%) of the pest. Cypermethrin was found to be the least effective insecticide for the control of 1st instar of mango mealybug resulted with 93.33% mortality and no significant difference was observed in all other treatments. The result support the findings of Karar *et al.* (2009) and Syed *et al*.(2012) found that profenofos showed maximum percent mortality (93.3% and 86.67%, respectively) of the 1st and 2nd instar mango mealybug.

Table 4. Effectiveness of chemical insecticides against 1st instar nymph of mango mealybug in lab.

Name of insecticides	**Percent nymphal mortality after spray**		
	12h	**24 h**	**36 h**
Lambdacyhalothrin	100 a	100 a	100.0 a
Chlorpyriphos	73.33 b	86.67 a	100.0 a
Cypermethrin	53.33 c	63.33 b	93.33 a
Imidacloprid	63.33 bc	86.67 a	100 .0 a
Dimetheoate	96.67 a	100 a	100.0 a
Thiamethoxam	100 a	100 a	100.0 a
LSD	**18.09**	**15.10**	
CV	**12.26**	**9.28**	**4.77**

In a column means having different letter(s) are different at 5% level of significant by Duncan's Multiple Range Test (DMRT)

4.2.2.1 Effect on 2nd instar nymph of mango mealybug in field

The results on the effectiveness of six chemical insecticides against 2nd instar nymph of mango mealybug in filed condition have been shown in Table 5. After 24 hours of spray, the maximum mortality (61.67%) of the pest was observed in chlorpyriphos having significant difference with other insecticides. The nymphal mortality was 53.33, 48.33 and 46.67%, respectively in those treatments where thiamethoxam, imidacloprid and lambdacyhalothrin were sprayed, respectively. Dimetheoate and cypermethrin show significant difference each other. After 48 hours, the highest mortality (73.33%) of the pest was recorded in chlorpyriphos followed by imidacloprid (66.67%) and cypermethrin (60.00%) having no significant difference. There were significant difference in lambdacyhalothrin and thiamethoxam (97.78 and 96.67%) in terms of mortality of second instar nymphs of mango mealybug 48 hours after spray. The lowest mortality (33.33%) observed in the trees where dimetheoate was sprayed. Similarly significant differences were found between treatments means, regarding mortality of second instar nymphs of mango mealy bug after 72 hours of spraying. The highest mortality was found in chlorpyriphos (85.00%) followed by imidacloprid (80.00%). There were no significant difference between cypermethrin (78.33%) and thiamethoxam (73.33) in terms of nymphal mortality. The lowest mortality percentage was found between Lambdacyhalothrin anddimetheon (66.67 and 66.67%) which highly significant difference with others. Karar *et al.* (2009) and Syed *et al*. (2012) found that profenofos and decis showed maximum percent mortality of the 1st and 2nd instar nymph of mango mealybug.

Table 5. Effectiveness of chemical insecticides against 2nd instar nymph of mango mealybug in field

Name of insecticides	**Percent nymphal mortality after spray**		
	24 h	**48 h**	**72 h**
Lambdacyhalothrin	46.67 c	60.00 bc	66.67 d
Chlorpyriphos	61.67 a	73.33 a	85.00 a
Cypermethrin	45.00 c	65.00 b	78.33 bc
Imidacloprid	48.33 bc	66.67 ab	80.00 ab
Dimetheoate	33.33 d	50.00 d	61.67 d
Thiamethoxam	53.33 b	56.67 cd	73.33 c
LSD	**6.140**	**6.980**	**5.988**
CV	**7.02**	**6.19**	**4.44**

In a column means having different letter(s) are different at 5% level of significant by Duncan's Multiple Range Test (DMRT)

4.2.2.2 Effect on 2nd instar nymph of mango mealybug in laboratory

The data pertaining to the mortality percentage of second instar of mango mealy bug at 24 hours of post treatment interval are shown in Table 6. The results reveal significant differences among treatments. Dimetheon was found to be the most effective and resulted in maximum mortality (70.00%) of the followed by 66.67 and 60.00%, respectively in those treatments where imidacloprid and thiamethoxam were sprayed. There is no significant difference between chlorpyriphos and cypermethrin with 50.00% mortality of the nymph. Lambdacyhalothrin was found to be the least effective insecticide for the control of second instar of mango mealybug resulted with 36.67% percent mortality and also differed significantly from those of observed in all other treatments. After 48 hours, imidacloprid was found to be the most effective and resulted in maximum mortality (83.33%) of the pest followed by 80.00, 76.67 and 76.67%, respectively in those treatments where thiamethoxam, dimetheoate and cypermethrin were sprayed with no significant difference among them. Lambdacyhalothrin was found to be the least effective insecticide for the control of second instar of mango mealy bug resulted with 70.00% mortality and also differed significantly from those of observed in all other treatments. After 72 hours, imidacloprid was found to be the most effective and resulted in maximum mortality of the pest (93.33%) followed by dimetheoate, cypermethrin and thiamethoxam, respectively which gave 90.00, 86.67 and 86.67% nymphal mortality. Chlorpyriphos and lambdacyhalothrin were found to be the least effective insecticide for the control of 2nd instar of mango mealybug resulted with 83.33 and 83.33% mortality and no significant difference with all other treatments. The result support the findings of Karar *et al.*(2009), Abbas *et al.* and Syed *et al*. (2012) found that profenofos showed maximum percent mortality of the 2nd instar mango mealybug.

Table 6. Effectiveness of chemical insecticides against 2st instar nymph of mango mealybug in laboratory

Name of insecticides	Percent nymphal mortality after spray		
	24 h	**48 h**	**72 h**
Lambdacyhalothrin	36.67 c	70.00 c	83.33 a
Chlorpyriphos	50.00 bc	73.33 bc	83.33 a

Cypermethrin	50.00bc	76.67 abc	86.67 a
Imidacloprid	66.67 a	83.33 a	93.33 a
Dimetheoate	70.00 a	76.67 abc	90.00 a
Thiamethoxam	60.00 ab	80.00 ab	86.67 a
LSD	**14.73**	**8.79**	**9.18**
CV	**14.57**	**6.30**	**5.08**

In a column means having different letter(s) are different at 5% level of significant by Duncan's Multiple Range Test (DMRT)

4.2.3.1 Effect on 3rd instar nymph of mango mealybug in field

The data regarding percent mortality of third instar nymphs of mango mealy bug 24 hours after spray are given in (Table 7). The maximum mortality of the pest was observed in the treatments where Imidacloprid was applied with 46.67 percent mortality of the pest. Others show significant difference with each other followed by 37.78, 33.33, 31.11 and 31.11 percent mortality in those treatments where thiamethoxam, dimetheoate, chlorpyriphos and cypermethrin were sprayed, respectively. Lambdacyhalothrin (24.44) showed significant difference with other in terms of 3rd instar nymphal mortality of mealybug. After 48 hours, the highest mortality (57.78%) of the pest was recorded in those trees where chlorpyriphos applied followed by 51.11% in dimetheoate. There were no significant difference among chlorpyriphos, thiamethoxam and cypermethrin (48.89, 46.67 and 44.44%, respectively) in terms of mortality of 3rd instar nymph. The lowest mortality (35.55%) of the pest was observed in the trees where dimetheoate was sprayed. Significant differences were found between treatments means, regarding mortality of third instar nymphs of mango mealy bug 72 hours after spray. The highest mortality percentage was found in imidacloprid (66.57%) followed by thiamethoxam (60.00%) and dimetheoate (57.78%). Lambdacyhalothrin and chlorpyriphos gave 55.56% percent mortality of the 3rd instar nymnph. The lowest mortality percentage was found cypermethrin (53.33%) which highly significant difference with others. The result agree with reports of Agricola *et al*. (1989) who observed that chlorpyriphos and methomyl manifested good control against the Comstock mealy bug, *Pseudococcus comstocki* (Kuwana) in both the laboratory and field conditions.

Table 7. Effectiveness of chemical insecticides against 3rd instar nymph of mango mealybug in field

Name of insecticides	Percent nymphal mortality after spray		
	24 h	**48 h**	**72 h**

Lambdacyhalothrin	24.44 d	35.55 c	55.56 cd
Chlorpyriphos	31.11 c	48.89 b	55.56 cd
Cypermethrin	31.11 c	44.44 b	53.33 d
Imidacloprid	46.67 a	57.78 a	66.66 a
Dimetheoate	33.33 bc	51.11 ab	57.78 bc
Thiamethoxam	37.78 b	46.67 b	60.00 b
LSD	**5.797**	**7.405**	**2.529**
CV	**9.35**	**8.59**	**2.39**

In a column means having different letter(s) are different at 5% level of significant by Duncan's Multiple Range Test (DMRT)

4.2.3.2 Effect on 3rd instar nymph of mango mealybug in laboratory

The data regarding percent mortality of third instar nymph of mango mealy bug 24 hours after spray are given in (Table 8). The maximum mortality (80.00%) of the pest was observed in the treatments where dimetheoate and thiamethoxam were applied. Lambdacyhalothrin (63.33%) shows significant difference with dimetheoate and thiamethoxam but little significant difference with cypermethrin (60.00%) and chlorpyriphos (56.67%). The lowest mortality (53.33%) of the pest was observed percent in the trees where imidacloprid was sprayed. After 48 hours, the highest mortality of the pest was recorded to be 90.00 and 90.00 percent in those trees where dimetheoate and thiamethoxam applied followed by lambdacyhalothrin (80.00%). There was no significant difference between cypermethrin and chlorpyriphos (73.33 and 70.00%, respectively) of third instar nymphs of mango mealybug after 48 hours of spray. The lowest mortality (66.67%) of the pest was observed in the trees where imidacloprid was sprayed. The result support the findings of Karar *et al.* (2009) and Abbas *et al.*2009) found that Curacron (70%) is the most effective. According to Agricola *et al*. (1989) chlorpyriphos and methomyl manifested good control against the Comstock mealy bug, *Pseudococcus comstocki* (Kuwana) in both the laboratory and field conditions.

Table 8. Effectiveness of chemical insecticides against 3rdinstar nymph of mango mealybug in laboratory

Name of insecticides	Percent nymphal mortality after spray	
	24 h	**48 h**
Lambdacyhalothrin	63.33 b	80.00 b

Chlorpyriphos	56.67 bc	70.00 cd
Cypermethrin	60.00 bc	73.33 c
Imidacloprid	53.33 c	66.67 d
Dimetheoate	80.00 a	90.00 a
Thiamethoxam	80.00 a	90.00 a
LSD	**7.97**	**5.753**
CV	**6.63**	**4.04**

In a column means having different letter(s) are different at 5% level of significant by Duncan's Multiple Range Test (DMRT)

4.2.4.1 Effect on adult female mango mealybug

The data pertaining to the mortality percentage of adult females of mango mealy bug at 24 hours of post treatment interval are shown in (Table 9). The results reveal highly significant differences among treatments. Chlorpyriphos was found to be the most effective and resulted in maximum mortality (53.33%) of the pest followed by 36.67, 30.00 and 26.67%, respectively in those treatments where dimetheoate, lambdacyhalothrin and thiamethoxam, respectively were sprayed. Cypermethrin showed 23.33% mortality of the pest shows significant variation with each other. Imidacloprid was found to be the least effective insecticide for the control of adult female of mango mealy bug resulted in 20.00% mortality and also differed significantly from those of observed in all other treatments. After 48 hours, the results reveal highly significant differences among treatments. Chlorpyriphos was found to be the most effective and resulted in maximum mortality of the pest (63.33%) followed by 60.00, 50.00 and 43.33%, respectively in those treatments where dimetheoate, thiamethoxam and lambdacyhalothrin respectively were sprayed. Imidacloprid and Cypermethrin were found to be the least effective insecticide for the control of adult female of mango mealy bug resulted in 36.67 and 36.67 percent mortality and also differed significantly from those of observed in all other treatments. After 72 hours, Chlorpyriphos was found to be the most effective and resulted in maximum mortality (73.33%) of the pest followed by 70.00, 60.00 and 50.00%, respectively in those treatments where dimetheoate, thiamethoxam and lambdacyhalothrin were sprayed. Imidacloprid showed 46.67% mortality of the pest having significant variation with others. Cypermethrin was found to be the least effective insecticide for the control of adult female of mango mealybug resulted in 40.00% mortality and also differed significantly from those of observed in all other treatments. This result supports the findings of Karar *et al.* (2009) and Abbas *et al.* (2009). Yousuf and Ashraf (1987) and Khan and Ahsan (2008) found that the sticky bands along with burning and burying treatments significantly reduced the frequency of infestation of mango mealybug by 0.00-15.79%. Burlap bands reduced population of mango mealybug nymphs by 78.98%. lshaq *et al*. (2004) found that Stem injection can achieve a very high level of mortality of sucking insects (98%). The mortality rates achieved with insecticide sprays were up to 55%. Syed *et al*. (2012) found that cotton + buprofezin proved effective by manifesting 99.l0% control of mango mealybug

Table 9. Effectiveness of chemical insecticides against adult female mango mealybug in field

Name of insecticides	Percent adult mortality after spray		
	24 h	**48 h**	**72 h**
Lambdacyhalothrin	30.00 c	43.33 c	50.00 d
Chlorpyriphos	53.33 a	63.33 a	73.33 a
Cypermethrin	23.33 de	36.67 d	40.00 f
Imidacloprid	20.00 e	36.67 d	46.67 e
Dimetheoate	36.67 b	60.00 a	70.00 b
Thiamethoxam	26.67 cd	50.00 b	60.00 c
LSD	**4.394**	**4.697**	**2.877**
CV	**7.63**	**5.34**	**2.79**

In a column means having different letter(s) are different at 5% level of significant by Duncan's Multiple Range Test (DMRT)

4.2.4.2 Effect on adult female mango mealybug in laboratory

The mortality percentage of adult females of mango mealy bug at 72 hours of treatment interval is shown in (Table 10). The results reveal highly significant differences among treatments. Lambdacyhalothrin was found to be the most effective and resulted in maximum mortality (46.67%) of the adult insect followed by 26.67, 26.67 and 23.33%, respectively in those treatments where chlorpyriphos, imidacloprid and cypermethrin were sprayed. Dimetheoate showed 6.63% mortality of the pest having significant variation with other. Thiamethoxam was found to be the least effective insecticide for the control of adult female of mango mealy bug resulted in 00.00 percent mortality. Karar *et al.* (2009) and Abbas *et al.*(2009) told that supracide was the most effective insecticides for the control of adult female. Syed *et al*. (2012) found that triazophos proved to be an effective insecticide for the control of the adult by showing 64.0 and 100% mortality in leaf dip method and foliar application. He also found that profenofos, methomyl and triazophos application provided effective control of the mango mealybug.

Table 10. Effectiveness of chemical insecticides against adult mango mealybug in laboratory

Name of insecticides	Percent adult mortality after 72 hrs of spraying
Lambdacyhalothrin	46.67 a
Chlorpyriphos	26.67 b
Cypermethrin	23.33 b
Imidacloprid	26.67 b
Dimetheoate	6.67 c
Thiamethoxam	0.00c
LSD	**9.965**
CV	**2.5**

In a column means having different letter(s) are different at 5% level of significant by Duncan's Multiple Range Test (DMRT)

CHAPTER V

SUMMARY AND CONCLUSION

The present study was conducted at the Entomology laboratory and field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from March, 20011 to May, 2012 to know host preference and chemical control of mango mealybug.

Mango mealybug is a polyphagous insect which attacked mango, jackfruit, banana, redgram, papaya, cotton, mulberry, guava, tomato, turkey, berry, brinjal, berry, chilli, marigold etc. Major infested parts of the plants are inflorescence, succulent leaf, and lower surface of mid rib, petiole and apex of plant, leaf etc. Maximum infestation occurs in mango, jackfruit, banana and papaya with 100 percent infestation rate.

Six chemical insecticides viz. Lamdacyhalothrin, Chlorpyriphos, Cypermethrin, Imidacloprid, Dimethoate and Thiamethoxam were tested against different stages of mango mealybug in Entomology laboratory and field.

In field experiment, three sprays were given in first instars of larvae of seven, fifteen and twenty two days old of mango mealybugs. In each case data were taken after 24, 48 and 72 hours interval respectively. The highest mortality percentage (94.44%) of 1st instar nymph of mango mealybug was observed in imidacloprid, after 48 hours lamdacyhalothrin (100%) and 72 hours lamdacyhalothrin, imidacloprid and thiamethoxam (100 % respectively). In 16-18 days old, maximum mortality was found in thiamethoxam (86.67-94.45%).In 23-25 days old, maximum mortality was found in dimethoate and chlorpyriphos (70.00-87.78%). In 2nd inster nymph, maximum mortality was found in chlorpyriphos (61.67-85.00%). In 3rd inster nymph, maximum mortality was found in chlorpyriphos and bumper (46.47-66.57%). The highest mortality of adult female after 24 hours of spray of mango mealybug was observed in chlorpyriphos (53.33-73.33%).

In laboratory experiment, one spray was given in 1st, 2nd, 3rd instars of larvae and adult female of mango mealybugs. In 1st instars of larvae, data were taken after 12, 24 and 36 hours interval respectively. The highest mortality of 1st instar nymph of mango mealybugs was observed in lamdacyhalothrin, thiamethoxam, dimethoate, chlorpyriphos and imidacloprid with 100% respectively. In 2nd instars nymph, data were taken after 24, 48 and 72hours interval respectively. The highest mortality was observed in imidacloprid and dimethoate (70.00-93.33%). In 3rd instars of larvae, data were taken after 24, and 48hours interval respectively. The highest mortality percentage (80.00) of 3rd instar nymph after 24 hours of spray of mango mealybugs was observed in dimethoate and thiamethoxam. The highest mortality percentage (90.00) of 3rd instar nymph after 48 hours of spray of mango mealybugs was observed in dimethoate and thiamethoxam. In adult female, data were taken after 72 hours. The highest mortality percentage (46.67) of adult female mealybug was observed in lamdacyhalothrin.

From the above results, it could be concluded that 1st instar nymph was more vulnerable to insecticides and no insecticides was effective against adult mealybug. The order of susceptibility of the different stages of mealy bug was 1st instar nymph> 2nd instar nymph> 3rd instar nymph> adult. Imidacloprid and thiamethoxam were the most effective insecticide against 1st instar nymph, chlorpyriphos and imidacloprid were the most effective insecticide against 2nd instar nymph and in 3rd inster nymph, maximum mortality was found in chlorpyriphos and bumper and chlorpyriphos and lamdacyhalothrin were the most effective insecticide against adult female.

However, the following recommendations may be suggested:

1. Further study may be needed to find out the appropriate dose of thiamethoxam and chlorpyriphos to control the mango mealybug.
2. More chemicals and botanical extracts should be included for future study as sole or different combination to make sure the better performance of chlorpyriphos 40EC.

CHAPTER VI

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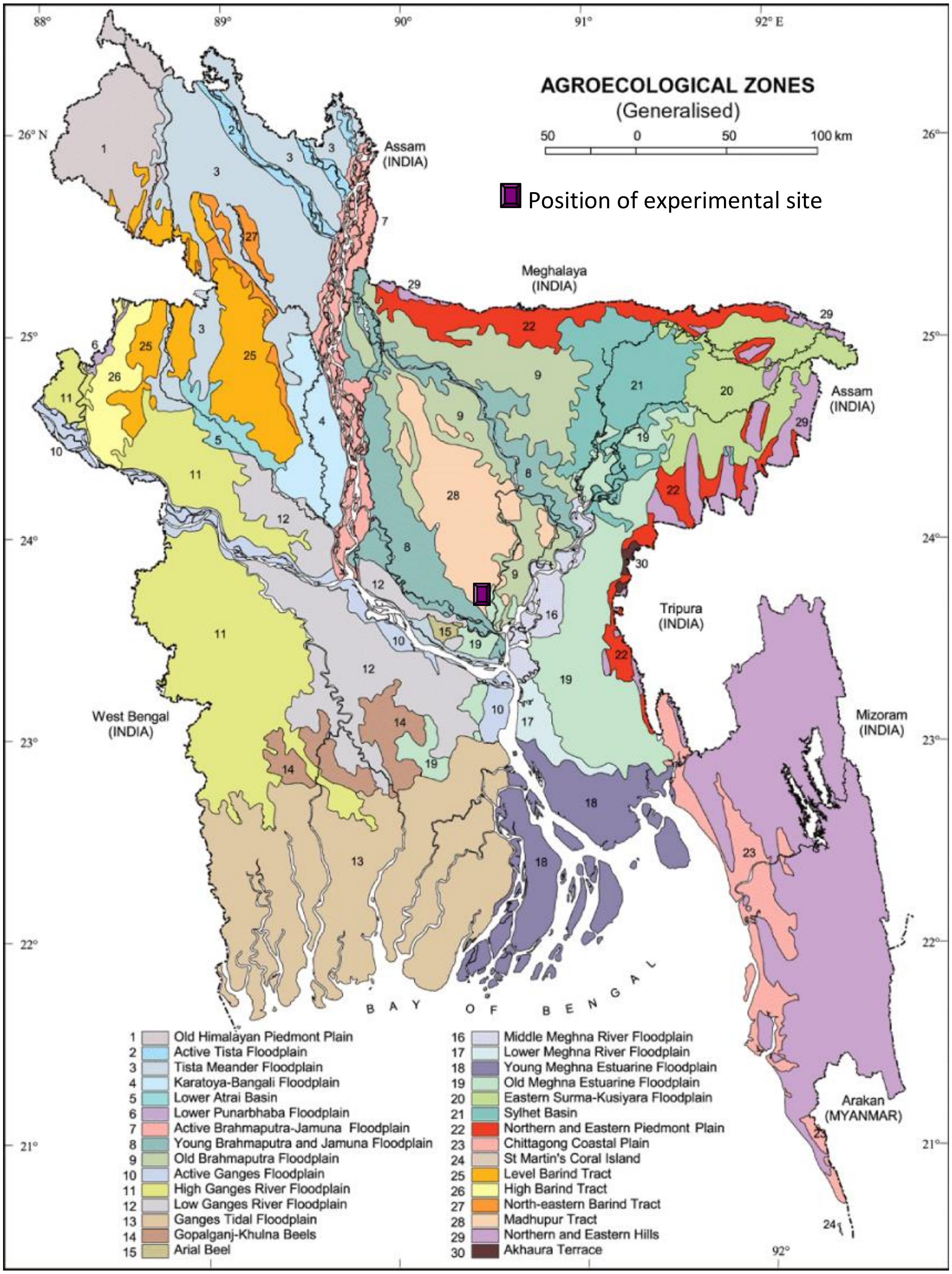
APPENDICES

Appendix I. Map showing the experimental site under study



Appendix II. Weather data, 2011, Dhaka

Month	Average RH (%)	Average Temperature (˚C)	Total Rainfall (mm)	Average Sunshine hours
May	81	32.9	340.4	4.7
June	84	31.9	1721	3.3
July	80	31.1	1295	4.9
August	80	31.4	1191	3.0
September	78	31.5	805	5.2
October	77	29.5	172.3	5.7

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1207.