

**DISTRIBUTION AND ABUNDANCE OF MANGO MEALYBUG IN  
BANGLADESH**

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**DISTRIBUTION AND ABUNDANCE OF MANGO MEALYBUG IN  
BANGLADESH**

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### CERTIFICATE

This is to certify that thesis entitled, “**DISTRIBUTION AND ABUNDANCE OF MANGO MEALYBUG IN BANGLADESH**” 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 result of a piece of bona fide research work carried out by **Md. Nahian Hossain, Registration No. 10-03919** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

**Dated: June, 2016**  
**Dhaka, Bangladesh**

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*DEDICATED TO*

*MY*

*BELOVED PARENTS*

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**The Author**

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## **ABSTRACT**

The present study was conducted in all over Bangladesh during the period from November, 2015 to May, 2016 to know distribution, host preference, damage severity, percent of infestation, infested plant part and percent of plant part infestation and damage severity of mango mealybug. Survey was done at 26 districts and 87 upazilla in Bangladesh. Mango mealybug was recorded from 17 upazilla out of 87 upazilla in Bangladesh. Jackfruit was common host at all locations followed by mango. Among all the host plant Mango and Jackfruit are most preferable for mango mealybug. Comparatively higher infestation occurred on fruit of jackfruit (about 86.72%) compared to inflorescence (about 73%) and branch (about 78.3%). In, case of mango, more infestation occurred on inflorescences (about 84.38%) than branch and fruit. High severity was observed on fruit of jackfruit (about 86.72%) and inflorescence (about 84.38%) of mango in most of locations.

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## LIST OF ACRONYMS

AEZ = Agro-Ecological zone

*et al.* = And other

Kg = Kilogram

SAU = Sher-e-Bangla Agricultural University

Sl. =Serial

No. = Number

Max =Maximum

Min = Minimum

% = Percentage

# CHAPTER I

## INTRODUCTION

Mango (*Mangifera indica* L.) is the member of family Anacardiaceae. It is regarded and appreciated for its strong aroma, delicious taste and high nutritive value (Litz 1997, Singh 1968). This tropical fruit mango is being grown in more than 100 countries (Sauco 1997). Apart from that, it is also valuable ornamental and shade tree with medicinal virtues (Almeida D,1995). Mango (*Mangifera indica* L) the king of all fruits is cultivated in about 750000 hectares of land in Indian subcontinent. Annually, about 12.5 million tones of mangoes from an area of 2021 thousand hectares of mango orchard were harvested in Indian subcontinent (Sekhar *et al.*,2013). In Bangladesh, about 101811 Mt. ton Mangoes From an area of 61997 acres of mango orchard was harvested (BBS,2015). It is sold on local markets in Bangladesh 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 tree and contributes to the protection of soil against erosion (Almeida D,1995). Insect pests have been regarded as an important constrain to garden fruits throughout the centuries (Hill,2008). A number of insect pest are known to attack the mango trees, which have economic importance ( Tandon *et al.*,1985, Herren 1981, Giani 1968).

Insect pests are the major threat to underscore the mango production accounting for huge seasonal loss (Ishaq *et al.*,2004). Grossly 400 insects and non insect pests have been recorded from Indian subcontinents that have pest property. However, out of that thirty are obnoxious and serious pests to mango orchard (Kapadia, 2003). Application of newer brands of insecticides though in practice in large scale but very often is less prudent to check the pest hazards (Ishaq *et al.*,2004). Several insects attack mango from nursery stage to fruit maturity. Among all of the mango insect pests, mealy bug, *Droschia mangiferae* (G.) is one of the notorious and destructive pests rendering huge scale of fruit loss (Karar *et al.*,2006). Bhagat (2004) had mentioned that though this insect is mainly a pest of mango tree, however, in the areas of heavy populations, it has the tendency to attack a variety of other fruit trees like peach (*Prunus persica*), plum (*P. domestica*), papaya (*Carica papaya*) and all citrus species. Karar (2009) had opined that mealy bug preferred mango varieties differentially. Mango mealybug became a serious pest of mango and citrus in West Africa which reduced mango fruit 50-90% and pest caused serious nuisance (Moore 2004). *D. mangiferae* is considered to be prime destructive mealy bugs species of mangoes in subcontinent of South East Asia. *D. mangiferae* is the serious, dilapidating, polyphagus, dimorphic and notorious pest of mango orchards in Indian sub-continent (Rao *et al.*,2006). In consideration to tree/fruit injury, it ranked 2nd after leaf hopper. Extent of loss may extend up to 50% in some occasional cases (Atwal,1976).

Mealybug is a polyphagous pest which was reported to cause serious damage to various fruit trees particularly mango (Akinlosotu *et al.*,1994). The major host plants are mango (*Mangifera indica*), citrus (*Citrus spp.*), frangipani (*Plumeria rubra*) and fig (*Ficus spp.*) (Ivbijaro *et al.*,1992). Mealybugs are sucking insects, soft bodied, oval shape and cottony in appearance, which are found to attack on leaves, stems, roots and fruits which are covered like whitish powder. They suck a large amount of sap from all parts of the tree. They are found in moist warm climate and also act as a vector for several plant diseases. They attach themselves to the plant and secrete a powdery wax layer used for protection while they suck the plant juices. Some species of mealybug lay their eggs in the same waxy layer used for protection in the quantities of 50-100; other species are born directly from the female. Juvenile mealybugs can crawl from an infested plant to non-infested plant. The other mode of transfer is the small ‘crawlers’ are transferred by wind, rains, birds, ants, clothing and vehicles and settled on new plants. The wax which sticks to each egg also facilitates passive transport by equipments, animals or people. The female mealy bug is unable to fly and not active. In fact, humans are great friends helping in transport of mealy bug. As the infested plant back the colonies of mealy bugs migrate from shoot tips to twigs, branches and finally down the trunk. Ants attracted by the honeydew, have been seen carrying mealybugs from plant to plant. Severe infestation affects the growing fruits resulting in fruit drop. Both the quality and the quantity of the food are greatly

affected due to this infestation (Herren,1981). Damage to plants is principally manifested due to the unremitting sucking of 'cell sap' from tender leaves, stem and inflorescence and even from the growing fruits. The nymphs and females of this bug suck sap from inflorescence, tender leaves, shoots and fruit peduncles. Affected panicles shrive and become dried. Infested plants are affected by the sooty mould (Tandon and Lal1978). Severe infestation often leads to fruit drops or makes the fruit unfit for marketing (Karar *et al.*,2013). In general, *D. mangiferae* is found to infest almost all mango cultivars resulting severe fruit necrosis. Due to the growth of sooty mould on the leaves, photosynthetic activity is affected (Pruthi *et al.* 1960). Further the sooty mould of *D. mangiferae* provides an effective medium for rapid growth of black and sooty fungi which decolorizes the fruit and makes it unacceptable to consume (CABI,2005). The response of insects to the climatic conditions is very imperative to predict possible geographic range of a species and to develop.

### **Objectives**

Considering the above facts the research work was designed with the following objectives -

- ⇒ To know distribution and abundance of mango mealybug in Bangladesh
- ⇒ To record host plants, infested plant parts, percent of infestation and damage severity of mango mealybug on different host plants.

## CHAPTER II

### REVIEW OF LITERATURE

This review is an overview of the literature on mango pests which focuses on the mango mealybug and its distribution and abundance. Literatures cited below under the following headings and sub-headings reveal some information about the present study.

#### **Mango pests**

A number of insect pests are known to attack the mango trees, which have been studied in detail (Giani 1968, Herren 1981, Sen & Prasad 1956, 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.*,1995 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 (Vayssieres 2005, Agounke *et al.*, 1988).

Babu, 1998 recorded 18 species of insects at various stages of mango crop in an overlapping manner from August 1998 to July 1999 and August 1999 to July 2000 in Chittoor and Cuddapah regions of Andhra Pradesh, India, wherein they identified *Amritodus atkinsoni*, *Idioscopus* spp, *Procontarinia matteiana*, *Orthaga exvinacea*, *Sternochetus mangiferae* and *Bactrocera* spp. attaining major status or in a severe form whereas, three species, *Apoderus tranquebaricus*, *Coptosoma varigatum* and *Dasychira mendose* were recorded as stray pests. The remaining ten insect species appeared as minor pests without causing any severe and perceptible economic damage to the crop.

The mango seed could be used as a potential source for functional food ingredients, natural antioxidants, antimicrobial compounds, cosmetic and activated carbon. In addition to that, it could be further processed into therapeutic functional food products. This suggests that the mango seeds should be further utilized rather than just discarded as a waste. (Kittiphoom 2012).

### **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. invadensis* 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.*, 2006), significant reduction in weight and size of fresh mango fruit in Nigeria, Togo and Benin (Ivbijaro and Udensi 1988, Ivbijaro *et al.*, 1991 and 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 (Vogele *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.

Mealybugs feed by inserting their stylets through the plant tissue to suck up sap from either phloem or mesophyll, or both. Males terminate their feeding towards the end of the second nymphal stage. Generally, stylet penetration is accomplished by secretion of solidified saliva that forms a sheath around the stylets. Similarly to other members of the suborder Sternorrhyncha, which includes scale insects, aphids, psyllids and whiteflies, mealybugs consume a diet containing mainly carbohydrates but also limited amounts of free amino acids and other nitrogen compounds (Franco *et al.*.2000, Gullan and Martin 2003, Silva and Mexia 1999, Tonkyn and Whitcomb 1987).

Thus, except for sucrose hydrolysis, food digestion is hardly necessary. However, organic compounds in phloem sap need to be concentrated before they can be absorbed, and this occurs in the filter chamber, a specialized component of the

digestive system, which enables the direct passage of water from the anterior midgut to the Malpighian tubules, thereby concentrating food in the midgut (Terra and Ferreira,2003).

The residue of ingested phloem sap, after digestion and assimilation in the insect gut, is released from the anus as a sugar-rich material, the honeydew. Up to 90% of the ingested sugars may be egested in this way (Mittler and Douglas,2003).

Mealybugs developed several different defense mechanisms. Many of the species tend to establish themselves in protected sites, such as cracks and crevices in bark, leaf axils, root crowns, nodes of grass stems, under fruit sepals and within fruit navels, between touching fruits or fruits and leaves, and in tunnels bored by insect larvae in roots and stems (Franco *et al.*,2000, Kosztarab and Kozar.,1988).

This cryptic behavior of mealybugs may originate a spatial refuge from natural enemies and harsh environmental conditions. This type of plant colonization makes mealybugs practically invisible during the latent population phase. However, during outbreaks the population explodes from the refuge and becomes conspicuous (Berlinger and Golberg,1978, Gutierrez *et al.*,2008).

The waxy secretion is the most common conspicuous trait of the mealybug family. It is a complex system that serves different functions, and which is produced by

the epidermal wax glands and transported to the body surface via ducts, pores, and secretory setae of various types (Foldi 1983, Gullan and Kosztarab, 1997).

Zada *et al.* (2009) found that the main components of the wax of five mealybug species (*P. citri*, *P. ficus*, *P. vovae*, *P. cryptus*, and *N. viridis*) were trialkylglycerols and wax esters. The wax cover is believed to prevent water loss. The hydrophobic property of the wax enables the mealybugs to escape drowning or becoming swamped by water in their typical cryptic sites.

The ovisac, which is also a wax secretion, is considered to be an adaptation that protects the offspring from both wet and dry conditions, and that may also provide an attachment to the host plant. Tubular ducts and multilocular disc pores, respectively, produce long hollow and shorter curled filaments, which make up the ovisac and the male cocoon (Cox and Pearce 1983, Foldi 1983).

The white wax of mealybugs is strongly light reflective, and may reduce desiccation in some cases; the wax also serves to cover the honeydew droplets and to protect the mealybugs from contamination by their own honeydew and defensive exudates (Gullan and Kosztarab 1997).

The wax cover and the secretion process are involved in mealybug defense against natural enemies. It is hypothesized that the rarity of infestation by pathogens and nematodes is related to the wax shield. Stuart *et al.* (1997) found varied

susceptibility of *Dysmicoccus vaccinii* Miller and Polavarapu to several nematode species; they showed that removal of the waxy coating from the mealybug did not influence their susceptibility to *Heterorhabditis bacteriophora* Poinar. The lateral wax protrusions protect the mealybugs from predators and facilitate spacing of individuals within the colony.

The nymphs and adult females of most mealybugs possess two pairs of dorsal ostioles, located between the head and prothorax and on the sixth abdominal segment, that discharge a globule of liquid when the insect is disturbed. This waxy liquid solidifies quickly on contact with air and is believed to have a defensive function (Eisner and Silberglied 1988, Gullan and Kosztarab 1997).

It was found, for example, that this discharge negatively affect *Symphorobius fallax* Navas (Neuroptera, Hemerobiidae) larvae (Gillani and Copland 1999), green lacewings (Neuroptera, Chrysopidae), and the parasitoid *Leptomastidea abnormis* (Girault) (Hymenoptera, Encyrtidae) (Franco 1999).

Ostiolar secretions may have different functions in other mealybug species, for example, the highly developed condition of the dorsal ostioles in obligate ant-attended mealybugs suggests that the released fluid may attract the ants (Gullan and Kosztarab 1997).

Nagrare (2014) revealed five mealybug species belonging to the Pseudococcidae and Monophlebidae families of Hemiptera order infesting cotton in India other than predominant mealybug species *Phenacoccus solenopsis* (Tinsley) and *Paracoccus marginatus* (Williams and Granara de Willink). These mealybug species were spherical mealybug *Nipaecoccus viridis* (Newstead), striped mealybug *Ferrisia virgata* (Cockerell), pink hibiscus mealybug *Maconellicoccus hirsutus* (Green), mango mealybug *Rastrococcus iceryoides* (Green) (Pseudococcidae) and ber (*Zizyphus*) mealybug *Perissopneumon tamarindus* from Monophlebidae (Green).

### **Seasonal abundance of mango mealybug**

Adult males and newly emerged first-instar nymphs, or crawlers, of most mealybug species display dispersal actively. Other nymphal stages and adult females may also move limited distances (Kosztarab and Kozar 1988) but, similarly to most scale insects, crawlers are the mealybugs' main dispersal agents. There is evidence that this developmental stage of scale insects is dispersed passively by the wind, and may be carried for distances of a few meters to several kilometers, or even more, from the natal plant–host, although mortality is very high (Gullan and Kosztarab 1997).

In contrast, Williams and Granara de Willink (1992) reported that mealybugs were believed to be distributed by air currents over only short distances. As well as

wind, water, bed-soil, humans, and domestic and wild animals may aid the passive dispersal of mealybugs (Kosztarab and Kozar,1988).

Among arthropods, ants have also been reported to disperse some mealybug species (Gullan and Kosztarab 1997, Malsch *et al.* 2001 and Ranjan 2006).

Nevertheless, if conditions are favorable, crawlers usually settle on the natal host plant, often close to their mother, which leads to an aggregative distribution (Gullan and Kosztarab 1997; Nestel *et al.*,1995). Many species of mealybugs have been widely distributed by commercial traffic, mostly carried on imported plant material (Williams and Granara de Willink 1992).

Because of their cryptic habits and small size, mealybugs are difficult to detect at borders during quarantine inspections, especially if their population density on plants is low (Gullan and Martin,2003).

Shito *et al.*, (2012) reported that eggs of mulberry mealybug are pink, minute, and contained in an egg sack of white wax. Newly hatched nymphs are called "crawlers" since the nymphal stage is wingless.

Mani and Thontadarya (1988) showed that the maximum temperature tested had a positive correlation and relative humidity had negative correlation with mealybug populations. Higher temperatures shortened the incubation period; a 5°C



depression in temperature increased the life cycle duration twofold (Babu and Azam 1987).

Pitan *et al.*,(2000) discussed in his research paper that clear that there were reductions in the population levels of mango mealybug *Rastrococcus invadens* after the introduction *Gyranusoidea tebygi* in Nigeria. Similar reports have been made by Agricola *et al.* (1989), Agounke and Fischer (1993), Bokonon-Ganta and Neuenschwander (1995), Matokot *et al.* (1992) in their various studies.

The mealybug was located in the Paraguay River basin in the Santa Cruz de la Sierra is of eastern Bolivia. Mealybug populations were extremely low in all areas but there was a period of increase from August to December. Eighteen species of natural enemies were found attacking *P. manihoti*: the most abundant and also most important were a solitary, internal parasitoid, *Epidinocarsis lopezi* (DeSantis) (Hymenoptera: Encyrtidae), *Hyperaspisnotata* Mulsant and *Diomus* spp. (Coleoptera: Coccinellidae), and *Ocyptamus* spp. (Diptera: Syrphidae). Collections of a closely related mealybug, *Phenacoccus herreni* Cox & Williams yielded two additional encyrtid parasitoids, *Epidinocarsis diversicornis* (Howard) and *Aenasius* sp. nr *vexans* Kerrich, but they did not survive on *P. manihoti*. Four parasitoids (*E. lopezi*, *E. diversicornis*, *Parapyrus manihoti* Noyes and *Allotropia* sp.) and four predators (*H. notata*, *Diomus* sp., *Symphorobius maculipennis* Kimmins, and *Exochomus* sp.) were sent for quarantine. Natural enemy species

were forwarded to the International Institute of Tropical Agriculture at Ibadan, Nigeria for mass rearing and subsequent release (Lohr, 1990).

This experiment showed that after Survey for mealy bugs, natural enemies and ants were conducted in abandoned pineapple fields on the Hawaiian islands of Oahu and Maui. Whole plant samples were taken, and mealy bugs and ants found were identified. Mealy bug-infested plant parts were isolated and held until natural enemies emerged from parasitized host material. Its densities ranged from a mean of 23 to 157 mealy bugs per plant, while in areas with mixed populations of this mealy bug and *Dysmicoccus neobrevipes* Beardsley, densities ranged from a mean of 23 to 118 mealy bugs per plant. Ants were present at all sample sites and on all dates. *Pheidole mega cephalo* (F.) was the most common ant species found. *Anagyrus ananatis* Gahan was the most common parasitoid. It attacked only *D. brevipipes*, the dominant mealy bug in the pineapple fields surveyed. Percent parasitisation of *D. brevipipes* by *A. ananatis* in the presence of ants ranged from 0.3 to 9.9%. Percent parasitization of *D. brevipipes* and *D. neobrevipes* per plant by *Euryrhopalus propinquus* Kerrich ranged from 0.05 to 2.2%. Mean densities of the predators *Lobodiplosis pseudococci* (Felt), *Nephus bilucernarius* Mulsant and *Sticholotis ruficeps* Weise ranged from 0.05 to 5.75, 0.1 to 1.8, and 0.05 to 0.2 individuals per plant, respectively (Hector *et al.* 1999).

### **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 Kéné Dougou (Otoïdobia, personal communication), in Western Mali in the region of Sikasso (Sidiki Traoré, 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).

Kashid (2010) mentioned in his work that Sindhudurg district is highly favorable for growing a large number of fruits like mango, cashew nut, areca nuts etc. Fruits and vegetable in the study region play an important role in view of their export potentials as well as domestic requirement and employment generation.

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 major 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 and 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 (Agounke *et al.*, 1988).

Mealybugs feed on a variety of herbaceous and woody plants, including the angiosperm, gymnosperm and fern families. However, most of the species with known hosts develop on herbaceous plants, especially grasses (*Poaceae*) and composites (*Asteraceae*) (Ben-Dov 2006, Kosztarab and Kozar 1988).

As expected, information on the host ranges of mealybugs is mainly derived from observations of species of economic importance. Most species are oligophagous or stenophagous (or monophagous) while others are polyphagous (Ben-Dov 2006, Kosztarab and Kozar 1988).

It was found that more than 1300 mealybugs and their natural enemies were collected from six crops (apples, pears, nashi, citrus, persimmon and grapes). *Pseudococcus longispinus* and *P. calceolariae* were the commonest species in all crops, these three species accounted for more than 99% of all mealybugs collected. Mealybugs were attacked by 14 species of natural enemy. *Parectromoides varipes* was newly identified as a primary parasitoid of mealy bugs, and males of this

species and *Gyranusoidea advena*, previously unknown, were found. Both species, together with *Tetracnemoidea sydneyensis*, *T. peregrina* and *T. brevicornis*, and *Coccophagus gurneyi* (Aphelinidae) and two species of Ophelosia (Pteromalidae) were widespread throughout the surveyed regions. Common predators included *Cryptolaemus montrouzieri* (Col: Coccinellidae), *Cryptoscenea australiensis* (Neuroptera: Coniopterygidae) and *Diadiplosis koebelei* (Dipt: Cecidomyiidae). Five species of ants were recorded tending mealy bugs, but none is known to be disruptive to mealy bug natural enemies. Data for biological control of mealybug pests in horticultural crops concluded that *Pseudaphycus maculipennis* (Hym: Encyrtidae) should be introduced against *P. affinis*. The activity of existing species should be encouraged in future integrated pest management (IPM) programmes, by, for example, distributing *A. fusciventris* around the country and commercializing the mass rearing and release of *C. montrouzieri* (Charles *et al.*, 2006).

## CHAPTER III

### MATERIALS AND METHODS

The present research work on distribution and abundance of mango mealybug, its host plants, infested plant parts and damage severity was carried out throughout Bangladesh except Dhaka district. The materials and methods followed are described here as

#### Duration of the study

The field survey on mango mealybug distribution at 26 districts was conducted during November, 2015 to May, 2016.

#### Study area

Field survey was conducted at 87 upazilla under 26 major mango growing districts of Bangladesh to collect the information on distribution, host plant and infestation level on various hosts of mango mealybug. The list of upazilla and districts are shown in Table 1.

**Table 1. List of districts and Upazilla surveyed for mango mealybug**

Sl. No.	Name of District under study	Name of Upazilla under study
01.	Chuadanga	1.Chuadanga Sadar
		2.Alamdanga
		3.Dhamurhuda
		4.Jibannagar
02.	Meherpur	5.Meherpur Sadar
		6.Gangni
		7.Mujibnagar
03.	Jhenaidah	8.Jhenaidah Sadar
		9.Kouthadpur

		10.Moheshpur
		11.Harinakundu
		12.Kaligang
04.	Jessore	13.Jessore Sadar
		14.Chougacha
		15.Sarsha
		16.Jhikorgasa
05.	Dinajpur	17.Dinajpur Sadar
		18.Birol
		19.Fulbari
		20.Birampur
		21.Hakimpur
06.	Thakurgaon	22.Sadar
		23.Baliadangi
		24.Pirgang
07.	Panchagar	25.Sadar
		26.Autowary
		27.Boda
08.	Bogra	28.Sadar
		29.Sanatala
		30.Sibgang
		31.Sajahanpur
		32.Gabtali
09.	Mymensingh	33.Sadar
		34.Dhobaura
		35.Haluaghat
		36.Fulbari
		37.Muktagacha
10.	Jamalpur	38.Sadar
		39.Melandha
		40.Boxiganj
		41.Islampur
11.	Sherpur	42.Sadar
		43.Nakla
		44.Nalitabari



		45.Jhenaigathi
12.	Gazipur	46.Sadar
		47.Kapashia
13.	Tangail	48.Sadar
		49.Bhuapur
		50.Dhonbari
		51.Sofipur
14.	Jaypurhat	52.Jaypurhat Sadar
		53.Kalay
		54.Akkelpur
15.	Natore	55.Sadar
		56.Singra
16.	Lalmonirhat	57.Sadar
		58.Hatibandha
17.	Kustia	59.Kustia Sadar
		60.Kumarkhali
		61.Mirpur
18.	Manikganj	62.Sadar
		63.Singayer
19.	Khulna	64.Khulna sadar
		65.Dumuria
		66.Koyra
20.	Bandarban	67.Bandarban Sadar
		68.Ruma
		69.Thanchi
21.	Cox's Bazar	70.Cox's Bazar sadar
		71.Teknaf
		72.Ramu
22.	Comilla	73.Comilla Sadar
		74.Chouddagram
		75.Burichong
		76.Brahmanpara
23.	Sylhet	77.Sylhet Sadar
		78.Zakiganj
		79.Jaintapur
24.	Shatkhira	80.Kaliganj

		81.Debhata
		82.Shatkhira sadar
25.	Feni	83.Fulgazi
		84.Sagalnayha
26.	Brahmanbaria	85.Brahmanbaria Sadar
		86.Akhaura
		87.Kasba

### Field survey

The field survey was conducted to find out the distribution, host plants and infestation level on different hosts of mango mealybug in Bangladesh. Visited the DD office of each district and information was collected about mango mealybug. Based on this information respective upazilas were visited and information was collected from Upazilla Agricultural Officer (UAO). Based on UAO information the respective location was visited to observe the mealybug status. Different host plants were observed visually in each location. Infested and healthy host plants were observed visually and recorded. Then branches an infested plant were observed from an infested plant; healthy and infested branch were observed visually. Leaves, inflorescence and fruits of an infested branch were observed and recorded. Number of mealybug from an infested parts was counted. Severity was classified as low (<30%), medium (30<60%) and high (70%<).



**Plate 1.** Farmers Interview



**Plate 2.** Interview of DAE personnel



**Plate 3.** Adult female mealybug



**Plate 4.** Adult male mealybug



**Plate 5.** Infested branch of jackfruit



**Plate 6.** Infested inflorescence of jackfruit



**Plate 7.** Infested inflorescence of litchi



**Plate 8.** Infested leaves of litchi



**Plate 9.** Infested plant parts of Guava



**Plate 10.** Infested plant parts of cotton



**Plate 11.** Infested of Ata



**Plate 12.** Infested of Coconut plant





Plate 13. Some of my surveyed places

## CHAPTER IV

### RESULTS AND DISCUSSION

The results on distribution of mango mealybug in Bangladesh, host plants and infestation levels on different hosts have been presented and discussed with possible interpretations under the following heading and subheadings.

#### 1. Distribution of Mango Mealybug in Bangladesh

The distribution of mango mealybug at different locations in Bangladesh is shown in Table 2. With their host plant.

**Table 2. Visiting District, found mealybug Upazilla, Host plant**

Sl. No.	Name of districts where mealybug found	Name of Upazilla where mealybug found	Host Plant
01.	Chuadanga	Jibannagar	Jackfruit, Mango
02.	Jhenaidah	Moheshpur	Malta
03.	Jessore	Sharsha	Guava, Jackfruit
04.	Dinajpur	Sadar	Jackfruit, Mango, Litchi, Pomegranate, Mahogany, Coconut, Ata, Sweet gourd
		Birol	
		Birampur	
		Fulbari	
05.	Thakurgaon	Hakimpur	Mango, Jackfruit, Guava, Custard apple
		Sadar	
06.	Panchagar	Baliadangi	Mango, Jackfruit, Lemon
		Autowary	
07.	Jamalpur	Boda	Mango, Jackfruit
		Sadar	
08.	Gazipur	Baxigonj	Mango, Jackfruit
		Sadar	
09.	Tangail	Dhanbari	Mango, Jackfruit
10.	Lalmonirhat	Hatibandha	Mango, Jackfruit

## **2. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Jibonnagar, Chuadanga**

Four host plants were recorded with variable levels of infestation and severity at JibanNagar Upazilla. The recorded host plants were mango, jackfruit, guava, litchi. Host was jackfruit (80.00% plant infestation) mango (72.22%) plant infestation, Low level of infestation was occurred in Litchi (29.75% infestation), guava (infestation 40.00%).

Mealybug sucks the cell sap from different parts of the host plant such as leaf, branch, stem, inflorescence, fruit etc. In mango, maximum infestation occurred in Inflorescence (18.61 %) and minimum infestation were occurred in branch (13.92%) but highest number of mealybug 109.6 was recorded from one Fruit and severity was high. In jackfruit maximum infestation (34.04%) occurred on leaves having 109.06 insects/fruit with high severity and minimum infestation was observed from inflorescence (6.33%). On the other hand Guava (40%) Infestation, its stem was 24.5% infested and 16.73 insects per branch. In litchi infestation of inflorescence was 14.5%, fruits infestation was 12.6% and branch was 10.5%. Number of insects each fruit was high (68.1), inflorescence (27.58) and branch was (22.2).

The order of infestation in different plant parts of mango was inflorescence (18.61%) > fruit (14.41%) > branch (13.92%) that was 109.6 > 80.87 > 66.47 in case of number insect per fruit, inflorescence and branch respectively.

The order of infestation in different plant parts of jackfruit was leaves (34.04%) > fruit (14.04%) > inflorescence (6.33%) that was 109.6 > 64.27 > 52.2 in case of number insect per fruit, inflorescence and leaves respectively.

The order of infestation in different plant parts of litchi was inflorescence (14.5%) > fruit (12.6%) > branch (10.5%) that was 68.1 > 27.58 > 22.2 in case of number insect per fruit, inflorescence and branch respectively.

**Table 3. Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at JibonNagar, Chuadanga**

Sl. No.	Host plant	No. of plant observed	Percent of plant infestation	Infested Plant Part	Percent of plant part infestation	No. of Insect/plant part	severity
01.	Mango	101.0	72.94	Inflorescence	18.61±6.19	80.87±14.81	High
				Fruit	14.41±5.1	109.6±22.36	High
				Branch	13.92±3.71	66.47±14.36	Medium
02.	Jackfruit	150.0	80.0	Leaf	34.04±4.24	52.2±10.33	Medium
				Inflorescence	6.33±3.14	64.27±8.91	Medium
				Fruit	14.04±5.19	109.6±19.38	High
03.	Guava	80.0	40.0	Stem	24.5±4.95	16.73±5.93	Low
04.	Litchi	160.0	29.75	Inflorescence	14.5±2.12	27.58±7.49	Low
				Fruit	12.6±1.41	68.1±14.34	Medium
				Branch	10.5±3.54	22.2±4.51	Low

### **3. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Mohespur, Jhenaidha**

One host plant were recorded with variable levels of infestation and severity at Moheshpur upazilla. Host was Malta (60.00% plant infestation). Mealybug sucks



the cell sap from different parts of the host plant such as leaf, stem etc. It's stem was 34% infested and 25.2 insects per stem and leaf was 18.61% infested, 80.87 insects per leaf. Severity of leaves was high and setm was medium.

The order of infestation in different plant parts of malta was stem (34%) > leaf (18.61%) that was 80.87 > 25.2 in case of number insect per leaf and stem respectively.

**Table 4. Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Moheshpur, Jhenaidha**

Sl. No.	Host plant	No. of plant observed	Percent of plant infestation	Infested Plant Part	Percent of plant part infestation	No. of Insect/plant part	severity
01.	Malta	86	60	Leaf	18.61±6.19	80.87±14.81	High
				Stem	34±4.23	25.2±10.30	Medium

**4. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Sarsha, Jessore**

Two host plants were recorded with variable levels of infestation and severity at Sarsha upazilla. The recorded host plants were jackfruit, guava. In jackfruit, maximum infestation was occurred in fruit (34.57%) and minimum infestation was occurred in leaf (6.67%) but highest number of mealybug 87.73 was recorded from one Inflorescence and severity was high. On the other hand, guava's infestation was recorded 54.33%, stem infestation was 34.57% and highest number of mealybug 49 was recorder from one stem. Severity of guava was

medium. In, jackfruit severity of inflorescence and fruit was high and leaves was medium.

The order of infestation in different plant parts of jackfruit was fruit (34.57%) > inflorescence (14.33%) > leaf (6.67%) that was 87.73 > 49.5 > 42.53 in case of number insect per inflorescence, fruit, and leaf respectively.

**Table 5. Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Sarsha, Jessore**

Sl. No.	Host plants	No. of plant observed	Percent of plant infestation	Infested plant part	Percent plant part infestation	No. of Insect/plant part	Severity
01.	Guava	78	54.33	Stem	34.57±6.37	49.0±8.98	Medium
02.	Jackfruit	145	87.89	Leaf	6.67±2.52	42.53±13.10	Medium
				Inflorescence	14.33±3.51	87.73±16.96	High
				Fruit	34.57±6.37	49.5±7.08	High

### **5. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Dinajpur Sadar**

Mealybug was recorded from eight host plants at Dinajpur sadar upazilla with different levels of infestation and severity. Jackfruit, mango, guava and litchi, pomegranate, Custard apple, Mahogany and Cotton plant were the host plants in this area. Percent plant infestation was maximum (100.0%) in jackfruit, Litchi was 70%, Mango was 97.81%, Pomegranate was 53%, Ata was 94.66%, Mahogany was 36%, Cotton was 66.67% and minimum was guava(28.57%).

In jackfruit, maximum infestation was occurred in branch (18.53%) and minimum infestation was occurred in fruit (8%) but highest number of mealybug 49.3 was

recorded from one branch and severity was medium. Mango's highest infestation occurred in branch (18.53%), minimum in inflorescence (8.25%) but highest number of mealybug observed from a fruit that 71.2.

Litchi was infested 70%, which highest infested part was inflorescence about 15.6% and highest number was recorder from one inflorescence it was 26.87, severity is low. Ata's highest infestation part was fruit recorded 22.53% and leaf was 8.01% but highest number of mealybug was found on a fruit, it was 82.3 which show high severity. Guava's infestation maximum on stem which was recorded 15.5% and highest number of mealybug was recorder from a stem it was 13.2 which means severity was low. Pomegranate is a fruit, like others fruit plants it was also infested, it's infested plant parts were inflorescence and leaf, but maximum infested part was inflorescence (34.57%) and leaf was 12.3% and highest number of mealybug recorder from one inflorescence about 49 which severity was medium.

Mahogany and Cotton plants was not fruit plants, but it also infested. Each type of plant's stems were infested. Mahogany stem showed 14.3% infestation and cotton was 116.5%. Infestation of cotton was recorded as high severity.

The order of infestation in different plant parts of jackfruit was branch (18.53%) > inflorescence (15.5%) > fruit (8%) that was 49.3 > 26.87 > 13.33 in case of number insect per branch, inflorescence and fruit respectively.

The order of infestation in different plant parts of mango was fruit (20.5%) > branch (18.53%) > inflorescence (8.25%) that was 71.2 > 54.96 > 37.7 in case of number insect per fruit, branch and inflorescence respectively.

The order of infestation in different plant parts of pomegranate was inflorescence (34.57%) > leaf (12.3%) that was 49.0 > 10.3 in case of number insect per inflorescence and leaf respectively.

The order of infestation in different plant parts of ata was fruit (22.53%) > leaf (8.01%) that was 82.3 > 13.02 in case of number insect per fruit and leaf respectively.

**Table 6. Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Dinajpur Sadar**

Sl. No.	Host plant	No. of plant observed	Percent of plant infestation	Infested plant part	Percent of plant part infestation	No. of Insect/plant part	severity
01.	Jackfruit	176	100	Branch	18.53±5.80	49.3±11.43	Medium
				Inflorescence	15.5±3.54	26.87±8.09	Medium
				Fruit	8±1.41	13.33±4.06	Low
02.	Guava	63	28.57	Stem	15.5±2.12	13.2±4.63	Low
03.	Litchi	210	70	Inflorescence	15.6±3.54	26.87±8.09	Low
04.	Mango	350	97.81	Fruit	20.5±3.70	71.2±13.22	High
				Branch	18.53±4.08	54.96±12.4	High
				Inflorescence	8.25±2.63	37.7±6.42	Medium
05.	Pomegranate	35	53	Inflorescence	34.57±6.37	49.0±8.98	Medium
				Leaf	12.3±1.12	10.3±1.56	Low
06.	Custard apple	100	94.66	Fruit	22.53±9.80	82.3±13.49	High
				Leaf	8.01±2.41	13.02±3.47	Low
07.	Mahogany	137	36	Stem	14.3±1.12	15.3±2.56	Low
08.	Cotton	43	66.67	Stem	116.5±6.36	44.54±16.1	High

## **6. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Birampur, Dinajpur**

In Birampur upazilla, four plants were found as mango mealybug host. They were Jackfruit, Litchi, mango and guava. Their infestation rate was respectively 93.8%, 53.75%, 88% and 38%. Jackfruit and mango infestation rate was high.

In jackfruit, it was recorder that it's branch, inflorescence and fruit were infested. The rate of infestation of branch was 18.3%, inflorescence was 8.53% and fruit was 28.3%. Here, maximum fruit was infested. But highest number of insects was recorded from a branch and it was 69.3% with high severity.

The order of infestation in different plant parts of jackfruit was fruit (28.3%) > branch (18.3%) > inflorescence (8.53%) that was 69.3 > 54 > 37.71 in case of number insect per branch, fruit and inflorescence respectively.

The order of infestation in different plant parts of litchi was leaf (26.8%) > inflorescence (14.3%) that was 27.8 > 11.3 in case of number insect per inflorescence and leaf respectively.

The order of infestation in different plant parts of mango was inflorescence (27.8%) > branch (19.2%) > fruit (16.42%) that was 90 > 89 > 76 in case of number insect per inflorescence, fruit and branch respectively.

**Table 7 . Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Birampur, Dinajpur**

Sl. No.	Host plant	No. of plant observed	Percent of plant infestation	Infested Plant Part	Percent of plant part infestation	No. of Insect/plant part	severity
01.	Jackfruit	104	93.8	Branch	18.3±4.56	69.3±14.22	High
				Inflorescence	8.53±2.63	37.71±6.42	Medium
				Fruit	28.3±12.3	54±2.83	High
02.	Litchi	217	53.75	Inflorescence	14.3±3.01	27.8±8.9	Medium
				Leaf	26.8±11.3	11.3±1.56	Low
03.	Mango	350	88	Fruit	16.42±4.19	89±11.23	High
				Branch	19.2±1.03	76±7.87	High
				Inflorescence	27.8±3.18	90±3.21	High
04.	Guava	75	38	Stem	22.5±4.19	17.1±2.19	Low

**7. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Birol, Dinajpur**

In Birol upazilla three host plants found they were mango, jackfruit, litchi. Their infestation rate was mango (85.6%), jackfruit (94.25%), litchi (61.75%). Infested plant parts were inflorescence, fruit and branch.

In case of mango, infested plant parts recorder inflorescence (11.2%), fruit(19.2%) and branch (31.43%).But highest number of mealybug found on one branch it was about 70.01.Maximum infestation rate was recorded from branch, severity was high in branch. In jackfruit, infested plant parts were branch, inflorescence and fruit, maximum infestation rate was recorded from inflorescence

rate was 21.4% and minimum was from fruit it was 8.3%.But highest number of mealybug found from one inflorescence it was 89.4, severity was high.

Litchi was infested by mealybug 61.75%. Infested plant parts were inflorescence and branch, their rate was 11.9% and 9.91%. Highest number of mealybug found from one inflorescence it was 51.01, severity is medium in inflorescence.

The order of infestation in different plant parts of mango was branch (31.43%) > fruit (19.2%) > inflorescence (11.2%) that was 70.01 > 63 > 41.3 in case of number insect per branch, inflorescence and fruit respectively. The order of infestation in different plant parts of jackfruit was inflorescence (21.4%) > branch (11.2%) > fruit (8.3) that was 89.4 > 72.1 > 70.09 in case of number insect per inflorescence, fruit and branch respectively.

The order of infestation in different plant parts of litchi was inflorescence (11.9%) > branch (9.91%) that was 51.01 > 20.1 in case of number insect per inflorescence and branch respectively.

**Table 8. Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Birol, Dinajpur**

Sl. No.	Host plant	No. of plant observed	Percent of plant infestation	Infested Plant Part	Percent of plant part infestation	No. of Insect/plant part	severity
01.	Mango	359	85.6	Inflorescence	11.2±1.23	63±8.9	Medium
				Fruit	19.2±7.72	41.3±2.23	Medium
				Branch	31.43±4.29	70.01±8.24	High
02.	Jackfruit	109	94.25	Branch	11.2±1.23	70.09±2.49	High
				Inflorescence	21.4±1.42	89.4±9.11	High
				Fruit	8.3±1.19	72.1±3.49	Medium
03.	Litchi	576	61.75	Inflorescence	11.9±2.1	51.01±2.1	Medium
				Branch	9.91±1.19	20.1±7.39	Low

**8. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Fulbari, Dinajpur**

Only Jackfruit found as host of Mango mealybug, plant infestation percent was 93.25% of this upazilla. Infested plant parts was branch (11.4%), inflorescence (21.4%) and fruit (5.9%) also. Highest number of Mealybug was found from one inflorescence about 70.09 and minimum from one fruit about 61.4. But inflorescence infestation severity was high.

The order of infestation in different plant parts of jackfruit was inflorescence (21.4%) > branch (11.4%) > fruit (5.9%) that was 70.09 > 68.09 > 61.4 in case of number insect per inflorescence, branch and fruit respectively.

**Table 9. Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Fulbari, Dinajpur**

Sl. No.	Host plant	No. of plant observed	Percent of plant infestation	Infested Plant Part	Percent of plant part infestation	No .of Insect/part	severity
01.	Jackfruit	63	93.25	Branch	11.4±3.23	68.09±4.39	Medium
				Inflorescence	21.4±4.9	70.09±2.3	High
				Fruit	5.9±1.3	61.4±1.3	Medium

**9. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Hakimpur, Dinajpur**

There were three host plant found in hakimpur upazilla. Mango, jackfruit and mahogany and their infestation rate were 84%, 97% and 32%. Infestation plant part was inflorescence, fruit, branch and leaf.



Mango's infested plant part was inflorescence (19.2%), fruit (24.2%) and branch (30.4%). Maximum rate was recorded from branch and minimum from inflorescence. But highest number of mealybug found from one inflorescence it was about 64, severity of inflorescence was high severity of infestation of mealy in fruit was medium and in branch was low.

In jackfruit's infested plant parts were branch, inflorescence and fruit. Infestation rate of inflorescence was 8.25%, branch was 18.53%, fruit was 20.53%. Maximum infestation rate recorded from one fruit and highest number of mealybug was found from one fruit, it was 71.21. Severity of inflorescence and branch was medium, fruit infestation severity was high.

Third host plant was mahogany, its infested plant parts were branch and leaf. Percent of infestation both of them were 8.3% and 9.11%. Highest number of mealybug recorded from one branch it was 24.8. severity of branch was medium and leaf was low.

The order of infestation in different plant parts of jackfruit was branch (30.4%) > fruit (24.2%) > inflorescence (19.2%) that was 64 > 41.3 > 11.8 in case of number insect per inflorescence, fruit and branch respectively.

The order of infestation in different plant parts of jackfruit was fruit (20.53%) > branch (18.53%) > inflorescence (8.25%) that was 71.21 > 54.9 > 37.71 in case of number insect per fruit, branch and inflorescence respectively.

The order of infestation in different plant parts of mahogany was leaf (9.11%) > branch (8.3%) that was 54.9 > 15.2 in case of number insect per branch and leaf respectively.

**Table 10. Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Hakimpur, Dinajpur**

Sl No.	Host plant	No. of plant observed	Percent of plant infestation	Infested Plant Part	Percent of plant part infestation	No. of Insect/part	Severity
01.	Mango	67	84	Inflorescence	19.2±2.48	64±2.23	High
				Fruit	24.2±7.79	41.3±2.83	Medium
				Branch	30.4±4.29	11.8±1.19	Low
02.	Jackfruit	43	97	Branch	18.53±4.08	54.9±12.63	Medium
				Inflorescence	8.25±2.63	37.71±6.42	Medium
				Fruit	20.53±3.70	71.21±13.22	High
03.	Mahogany	30	32	Branch	8.3±2.19	24.8±1.23	Medium
				Leaf	9.11±1.23	15.2±4.19	Low

**10. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Gazipur Sadar**

In Gazipur Sadar, only mango was act as host plant. Here plants infestation rate was 82%.Only inflorescence and stem were infested and percent both of them was 18.61% and 13.92%.Highest number of mealy was recorded from one inflorescence and it was 80.87 .There severity was high both infested plant parts.

The order of infestation in different plant parts of mango was inflorescence (18.61%) > stem (13.92%) that was 80.87 > 76.47 in case of number insect per inflorescence and stem respectively.

**Table 11. Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Gazipur Sadar**

Sl. No.	Host plant	No. of plant observed	Percent of plant infestation	Infested Plant Part	Percent of plant part infestation	No. of Insect/plant part	Severity
01.	Mango	123	82	Inflorescence	18.61±6.19	80.87±14.81	High
				Stem	13.92±3.71	76.47±14.36	High

**11. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Dhanbari, Tangail**

Only jackfruit was found as host plant in Dhanbari upazilla, Tangail. Here, plants infested rate was 92%, where infested plant parts were inflorescence, fruit and stem. Maximum infestation was stem, it's about 18.54% and minimum was recorded from inflorescence about 5.32%.

Highest number of mealybug found from one fruit, it's 102.3. Here, fruit infestation severity was high others were medium.

The order of infestation in different plant parts of jackfruit was stem (18.54%) > fruit (14.52%) > inflorescence (5.32%) that was 102.3 > 65.27 > 49.8 in case of number insect per fruit, inflorescence and stem respectively.

**Table 12. Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Dhanbari, Tangail**

Sl. No.	Host plant	No. of plant observed	Percent of infestation	Infested Plant Part	Percent of plant part infestation	No. of Insect/part	Severity
01.	Jack fruit	48	92	Inflorescence	5.32±2.14	65.27±7.97	High
				Fruit	14.52±5.16	102.3±22.36	High
				Stem	18.54±5.80	49.8±10.42	High

**12. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Hatibandha , Lalmonirhat**

One host plant was found in Hatibandha. Infestation of mango was 87%, infested plant part was inflorescence. Percent of infestation was 34.57% and highest number of mealybug was recorded from one inflorescence 49. Severity of infestation was high.

**Table 13. Host plant, percent of plant infestation, infested plant part, percent of plant part infestation and severity of infestation at Hatibandha, Lalmonirhat**

Sl. No.	Host plant	No. of plant observed	Percent infestation	Infested plant part	Percent inflorescence infestation	No. of insect/ inflorescence	Severity
01.	Mango	112	87	Inflorescence	34.57±6.37	49.0±8.98	High

**13. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Jamalpur Sadar**

In Jamalpur Sadar upazilla, only jackfruit plant was found to attack by mango mealybug. The plant infestation rate was 90% and infested plant parts were

inflorescence, fruit and branch. Maximum infestation was found in branch (18.53%) and minimum was in inflorescence (6.33%) that was 14.41% for fruit (Table 14). The highest number of mealybug (109.6/fruit) was recorded from single fruit. Severity of infestation was found as high for branch and fruit and medium for inflorescence. The order of infestation in different plant parts was branch (18.53%) > fruit (14.41%) > inflorescence (6.33%) that was 109.60 > 64.27 > 49.30 in case of number insect per fruit, inflorescence and branch respectively.

**Table 14. Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Jamalpur Sadar**

Sl. No.	Host plant	No. of plant observed	Percent of plant infestation	Infested plant parts	Percent plant part infestation	No. of insect/ plant parts	Severity
01.	Jack fruit	64	90.0	Inflorescence	6.33±3.14	64.27 ± 8.91	Medium
				Fruit	14.41±5.16	109.6 ± 22.36	High
				Branch	18.53±5.80	49.3±11.43	High

**14. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Baxiganj, Jamalpur**

Jackfruit was found as host plant in Baxiganj upazilla. It's infestation rate was 87%. Infestation plant part was were inflorescence, fruit and branch. Maximum percent of infestation was found in inflorescence (34.57%) and minimum was in fruit (14%). Highest number of mealy bug was recorded from one fruit about 93.93% .

Severity of infestation of inflorescence and fruit was high, but branch was medium.

The order of infestation in different plant parts of jackfruit was inflorescence (34.57%) > branch (18.53%) > fruit (14%) that was 93.93 > 49.3 > 49.0 in case per fruit, branch and inflorescence respectively.

**Table 15. Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Boxiganj, Jamalpur**

Sl. No.	Host plant	No. of plant observed	Percent of infestation	Infested Plant Part	Percent of plant part infestation	No. of insect/plant part	severity
01.	Jackfruit	37	87	Inflorescence	34.57±6.37	49.0±8.98	High
				Fruit	14±5.13	93.93±14.61	High
				Branch	18.53±5.80	49.3±11.43	Medium

**15. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Baliadangi, Thakurga**

Three host plants were found in Baliadangi upazilla. Mango, jackfruit and custard apple were host plant and their infestation rate was 82.25%, 81% and 32%. In mango infested plant parts were inflorescence, fruit and branch. Maximum rate of infestation was recorded from fruit (37.42%) and minimum from branch (9.67%) inflorescence show 28% infestation. Highest number of mealybug bearing part was one inflorescence and it was 70.34. Severity of inflorescence and fruit was high.

Jackfruit's infested plant part was inflorescence and fruit. Infestation rate of inflorescence was 5.95% and fruit was 18.7%. The highest number of mealybug recorded from one fruit 101.33. Severity of infestation of fruit was high.

On the other hand, custard apple infested plant part was fruit. Rate of infestation was 9.57% and severity was low.

The order of infestation in different plant parts of mango was fruit (37.42%) > inflorescence (28%) > branch (9.67%) that was 70.34 > 51.73 > 39.76 in case of number insect per inflorescence, branch and fruit respectively.

The order of infestation in different plant parts of jackfruit was fruit (18.7%) > inflorescence (5.95%) that was 101.33 > 48.5 in case of number insects per fruit and inflorescence respectively.

**Table 16. Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Baliadangi, Thakurga**

Sl No.	Host plant	No. of plant observed	Percent of infestation	Infested Plant Part	Percent of plant part infestation	No. of Insect/plant part	severity
01.	Mango	84	82.25	Inflorescence	28±7.33	70.34±16.98	High
				Fruit	37.42±9.31	39.76±10.59	High
				Branch	9.67±3.28	51.73±42.74	Medium
02.	Jackfruit	72	81	Inflorescence	5.95±2.42	48.5±10.07	Medium
				Fruit	18.7±4.09	101.33±27.95	High
03.	Custard Apple	34	32	Fruit	9.57±2.12	14.73±7.82	Low

## **16. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Thakurgaon Sadar**

There two host plants were found in Thakurga sadar upazilla. Mango and jackfruit was infested by mealybug and infestation rate was 30.76% and 100%.

In, mango infestation plant parts were inflorescence and branch. Maximum rate of infestation was in inflorescence (12%) and minimum was branch (9.5%). Highest number of mealybug was recorded from one inflorescence it was 32.87. Severity of infestation of inflorescence was medium and branch was low.

In, jackfruit infested plant parts was inflorescence, fruit and branch. Maximum infestation rate was recorded from branch (19.5%) and minimum was inflorescence (7.5%). But highest number of mealybug was found in one fruit 88.8 and it's infestation rate was 17.83%. So severity of infestation of fruit was high.

The order of infestation in different plant parts of mango was fruit (19.9%) > inflorescence (12.0%) > branch (9.5%) that was 39.76 > 32.87 > 19.9 in case of number insects per fruit, inflorescence and branch.

The order of infestation in different plant parts of jackfruit was branch (19.5%) > fruit (17.83%) > inflorescence (7.5%) that was 88.8 > 22.27 > 21.93 in case of number insect per fruit, inflorescence and branch respectively.



**Table 17. Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Thakurgaon Sadar**

Sl. No.	Host plant	No. of plant observed	Percent of infestation	Infested Plant Part	Percent of plant part infestation	No. of Insect/plant part	severity
01.	Mango	36	30.76	Inflorescence	12.0±2.58	32.87±6.61	Medium
				Fruit	19.9±4.43	39.76±10.59	Medium
				Branch	9.5±3.10	19.9±4.43	Low
02.	Jackfruit	79	100	Inflorescence	7.5±3.21	22.27±7.57	Medium
				Fruit	17.83±6.49	88.8±16.62	High
				Branch	19.5±4.81	21.93±4.67	Medium

**17. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Autowary , Panchagar**

Two host plants found in Autowary upazilla. Mango and cotton are host of mealybug, their infestation rate was 80% and 66%.

In mango, inflorescence, fruit and stem were infested by mealybug. Maximum infestation rate was recorded from fruit (37.42%) and minimum from stem (9.67%) but highest number of mealybug was found from one inflorescence and it was 70.33. Severity of infestation was high both of inflorescence and fruit, stem was medium in severity.

Cotton was another host plant, it was infested plant part was canopy, infestation rate was 116.5% and highest number of mealybug recorded from on canopy about 44.53. Severity was high.

The order of infestation in different plant parts was fruit (37.42%) > inflorescence (28%) > branch (9.67%) that was 70.33 > 51.73 > 37.67 in case of number insect per inflorescence, branch and fruit respectively.

**Table 18 . Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Autowary, Panchagar**

Sl No.	Host plant	No. of plant observed	Percent of infestation	Infested Plant Part	Percent of plant part infestation	No. of Insect/part	severity
01.	Mango	54	80	Inflorescence	28±17.33	70.33±17.94	High
				Fruit	37.42±9.31	37.67±10.59	High
				Branch	9.67±3.28	51.73±4.74	Medium
02.	Cotton	23	66	Canopy	116.5±6.36	44.53±16.11	High

**18. Distribution, host plant, infestation, number of insect and severity of mango mealybug in Boda, Panchagar**

In Boda upazilla three host plants were recorded as host plant of mealy bug. They were jackfruit, mango and sweet gourd. Jackfruit's infestation rate was 100%, it's infested plants parts were inflorescence, fruit and branch. Maximum infestation rate of jackfruit recorded from branch it was about 19.5% and minimum from inflorescence it was 8.5%. But highest number of mealybug found from one infested fruit it was 88.8. Severity of fruit was high, inflorescence and branch was low.

Mango infestation rate was 80%. It's infestation plant parts was inflorescence, fruit and branch. Maximum infestation rate was recorded from branch (27.1%) and minimum from inflorescence (5.95%), but highest number of mealybug found

from one infested fruit and it was 103.3. Here, severity of infested plant parts of fruit and branch was high and inflorescence was medium. Another host plant sweet gourd, it was infestation rate was 10%. Infested plant part was stem Severity was low.

The order of infestation in different plant parts of jackfruit was branch (19.5%) > fruit (17.8%) > inflorescence (8.5%) that was 88.8 > 22.27 > 21.93 in case of number insect per fruit, inflorescence and branch respectively.

The order of infestation in different plant parts of mango was branch (27.1%) > fruit (18.7%) > inflorescence (5.95%) that was 103.3 > 89.3 > 49.5 in case of number insect per fruit, branch and inflorescence respectively.

**Table 19. Host plants, percent of infestation, infested plant part, percent of plant part infestation and severity of mealybug at Boda, Panchagar**

Sl No.	Host plant	No. of plant observed	Percent of infestation	Infested Plant Part	Percent of plant part infestation	No. of Insect/part	severity
01.	Jackfruit	47	100	Inflorescence	8.5±3.21	22.27±7.57	Low
				Fruit	17.8±6.49	88.8±16.62	High
				Branch	19.5±4.81	21.93±4.67	Low
02.	Mango	61	80	Inflorescence	5.95±2.42	49.5±10.07	Medium
				Fruit	18.7±4.09	103.3±27.24	High
				Branch	27.1±11.09	89.3±21.25	High
03.	Sweet gourd	45	10	Stem	8.5±1.54	23.8±14.23	Low

## **CHAPTER V**

### **SUMMARY AND CONCLUSION**

#### **SUMMARY**

The study was conducted in all over Bangladesh during the period from November, 2015 to May, 2016 to know distribution, host preference, damage severity of mango mealybug.

Field survey was done at 87 upazilla of 26 districts in Bangladesh. Upazilla Agricultural Officer (UAO) of each Upazilla in Bangladesh was visited and asked about mango mealybug status. Based on UAO information the respective locations were visited to observe the mealybug status.

Mango mealybug was recorded from 17 upazilla namely Jibannagar (Chuadanga), Moheshpur (Jhenaidha), Sarsha (Jessore), Dinajpur sadar, Birampur, Birol, Fulbari, Hakimpur (Dinajpur), Gazipur sadar (Gazipur), Dhanbari (Tangail), Hatibandha (Lalmonirhat), Jamalpur sadar, Boxiganj (Jamalpur), Thakurgaon sadar, Baliadangi (Thakurgaon), Autowary, Boda (Panchagar) .

Mealybugs are sucking insects, soft bodied, oval shape and cottony in appearances which are found to attack on leaves, stems roots and fruits which are covered like whitish powder. They suck a large amount of sap from all parts of the tree. Mango mealybug is polyphagous insect which attacked mango, jackfruit, cotton, guava, mahogany, sweet gourd, custard apple, litchi, malta. Infested plant parts were mainly inflorescence, fruit and branch.

From recorded data we observed that, in Jiban Nagar upazilla only high severity was observed in mango and others plant those were medium and low. In Moheshpur upazilla only host plant was malta and it's leaves infestation is high. In Sarsha upazilla guava and jackfruit were infested but severity in jackfruit was high. In Dinajpur sadar upazilla infestation occurred on mango, jackfruit, custard apple were mostly infested and severity most all of them were high. From the recorded data we observed, in Birampur upazilla host plants were Jackfruit, Mango, Litchi, Guava but severe infestation occurred in mango. In, Birol upazilla collected data show that only jackfruit infestation was high. In Fulbari upazilla, only host plant was jackfruit, there mango mealybug was newly insects. In Hakimpur upazilla new host plant we found and it was mahogany, infestation severity was medium. In, Gazipur sadar upazilla only host plant was mango and infestation severity was high.

## **CONCLUSION**

Based on the study following conclusion are drawn:

Among all the host plant Mango and Jackfruit are most preferable for mango mealybug. Comparatively higher infestation occurred on fruit of jackfruit compared to inflorescence and branch. In, case of mango, more infestation occurred on inflorescences than branch and fruit. High severity was observed on fruit of jackfruit and inflorescence of mango in most of locations.

## CHAPTER VI

### REFERENCES

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