SURVEY ON THE PRESENT MANAGEMENT PRACTICES OF GUAVA INSECT PESTS IN SOME SELECTED AREAS OF PIROJPUR DISTRICT

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SURVEY ON THE PRESENT MANAGEMENT PRACTICES OF GUAVA INSECT PESTS IN SOME SELECTED AREAS OF PIROJPUR DISTRICT

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CERTIFICATE

This is to certify that the thesis entitled **'Survey on the Present Management Practices of Guava Insect Pests in Some Selected Areas of Pirojpur District'** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of Master of Science in Entomology, embodies the result of a piece of *bonafide* research work carried out by Md. Saiful Islam, Registration number: 13-05758 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated: December, 2014
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DEDICATED
TO

MY BELOVED PARENTS

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SURVEY ON THE PRESENT MANAGEMENT PRACTICES OF GUAVA INSECT PESTS IN SOME SELECTED AREAS OF PIROJPUR DISTRICT

ABSTRACT

Thirty guava growers from Nesarabad upazila were purposively selected for conducting the survey on the present management practices adapted by growers against guava insect pests in major guava growing area of Bangladesh. Total of 30 guava growers were interviewed and made a clear observation during the period from 23 November 2014 to 14 May 2015. A well structured interview schedule was developed based on objectives of the study for collecting information. Survey findings revealed that white fly, fruit fly maggot, aphid and mealybug were the major insect pests in guava. In case of management practices, the highest plant infestation was recorded from GP_1 (63.33%), whereas the lowest plant infestation was observed from GP_5 and GP_4 (3.33%). The highest fruit infestation was recorded from GP_1 (56.67%), whereas the lowest fruit infestation was observed from GP_5 (3.33%). The highest benefit cost ratio (BCR) was recorded from GP_5 (3.08), while the lowest BCR was observed from GP_1 (2.37). For using different combination of insecticide, the highest plant infestation was recorded from IC_1 (50.00%), whereas the lowest from IC_5 (3.33%). The highest fruit infestation was recorded from IC_1 (43.33%), whereas the lowest fruit infestation was observed from IC_5 (3.33%). The highest BCR was recorded from IC_5 (3.42), whereas the lowest BCR was observed from IC_1 (2.50). Application of combined/integrated control tactics/measures were more effective for guava cultivation compared to single control measure.

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CHAPTER I

INTRODUCTION

Guava is important as well as popular fruit in Bangladesh. The most common and widely cultivated guava is *Psidium guajava* L., belongs to the family Myrtaceae, which contains about 150 species (Hossain *et al*., 2010). Guava was domesticated more than 2000 years ago (Cobley and Steele, 1976) but its domestication in the Indian sub-continent was around 17th Century (Hayes, 1974). It is mostly consumed as mature green or fresh ripens fruit. It is considered as a common man's fruit and called the "apple of the tropics" (Adsule and Kadam, 1995) and particularly rich in ascorbic acid (Menzel, 1985, Hossain *et al*., 2010). Guava produces high yield of good quality fruit in climates where there is a distinct winter season. Several edible species of the genus *Psidium* like *Psidium cattleianum* (strawberry guava), *P. guineense* (Brazillian guava), *P. araca* Raddi, *P. friedrichsthaliannum* (Ben.) Nied, (Costa Rican guava) and *P. britoa* acida Ben (Para guava) are grown in various parts of the world (Ahmad, 1986).

Guava is a nutritious food and a daily intake of only 20 g fresh guava fruit provide 40 mg vitamin C which is the requirement for an adult. Guava contains 82.5% water, 2.45% acid 4.45% reducing sugar, 9.73% total soluble solid, 0.48% ash and 260 mg vitamin C per 100 g of fruit (Faruq, 2007). Guava can be grown on a wide variety of soils from heavy clay to light sandy soil. It is tolerant to wet and saline conditions on good soil and with proper care the trees are highly productive (Aftab, 2009). Guava is a very productive and highly profitable fruit crop. It is chosen by fruit growers due to its wide adaptability and higher return per unit area (Khan, 1985). The guava varieties such as Kanchannagar, Mukundapuri, Swarupkati, Kashi etc. are successfully grown in almost all the districts of Bangladesh. In 1984 Bangladesh Agricultural Research Institute (BARI) released a Guava variety named "Kazipiara". The variety has potentiality in high yielding and year round bearing. With the release of Kazipiara a surprising increase in the Guava production occurred in Bangladesh (Rashid *et al*., 1987).

In recent years many insect pests have been reported to attack Guava in different region and period of growing season. The higher level of fruit fly damage that was severe in all selected sites tracked by mealy bugs, mites, stinkbug, red-banded thrips, guava moth, guava whitefly and scale in that order. Among the insect pests spiraling whitefly (*Aleurmlieus dispersus* Russel) has become a serious problem to Guava cultivation in Bangladesh, causing enormous damage to the plants and fruits. Severe infestation by white fly has been a great constraint for guava cultivation. In fact spiraling whitefly is a polyphagous pest and considered as the most economically damaging pests to other agricultural crops (Gerling, 1990). Indirectly the whitefly causes reduction of yield by transmitting viral pathogens and through secretion of wax and honeydew which reduces the photosynthetic area of the plant (Alam *et al*., 1998). Heavy colonization of whitefly may cause a serious indirect damage to the crop due to honeydew exertion on leaf or fruit surfaces which encourages growth of sooty mould by a black fungus and it turn affects the yield both in quantitative and qualitative terms (Byrnee *et al*., 1990; Kajita and Alam, 1996). They suspected that this pest species has been introduced in Bangladesh through immigration and through unchecked plant materials from others countries (Scanlan, 1995).

To control insect pests, use of chemicals is common phenomenon in Bangladesh, which causes hazards to health through residual effect of chemical insecticides. The application of insecticides has increased in recent years and the potential negative effects on human health and environment. Pesticides are developed and applied to destroy or suppress only the target organisms in agricultural crops, but they also affect non-target organisms which play an active roles as natural enemies. Repeated application of the pesticide ultimately reaches the soil, which in turn may interact with soil organisms and their metabolic activities. Dependence on chemical insecticides for controlling the insect pests has led to environmental and economic ill-heath both in physical and mental in addition to being ineffective as the pests have developed resistance. Plant derived insecticides have a wide range of mode of action such as feeding, deterrents, insecticides,

ovicidal and oviposition (Abdullah *et al*., 2011). Guava generally intake as green fruit and the consumers intake directly pesticides if the growers marketing their guava fruits immediately after applying insecticides the consumers intake pesticides directly. Chemical insecticides create natural imbalance through killing the beneficial insects. Moreover, sometimes it was for the chemicals do not control insect pests completely (Abdullah, 2005). On the other hand, the use of chemical insecticides creates different problems viz. health hazard, insecticide resistance, and adverse effect on environment. Moreover, the information on alternative methods of chemical insecticides has not been explored at farmers' level. It is necessary to point out the existing farmers practices on guava insect pests' management.

In view of these, sincere efforts were undertaken in this direction for evaluating the farmers' practices in managing insect pests for guava cultivation. Considering the above facts, the present research work has been undertaken in order to fulfilling the following objectives:

- To record the insect pest attacked in guava fruit and their population enumeration.
- To determine the extent of damage and economic losses by insect pests on yield.
- To find out the effective control measure adopted by the farmers against the insect pests of guava and their impacts on pest control measurers and economic return.

CHAPTER II

REVIEW OF LITERATURE

Guava (*Psidium guajava* Linn.*)* is an arborescent shrub or a small tree and is one of the popular fruits of Bangladesh. Guava plant is attacked by many insect pests. Among them whitefly and fruit fly are the most important and damaging pest. The present research work was aimed at studying the farmer practices in controlling the insect pests of guava insect and pests. The research work in these aspects so far done in Bangladesh and elsewhere is not adequate and conclusive. Nevertheless, some of the important and informative works and research findings related to the guava insect pests and control of insects and management of these insect pests by the guava growers so far been done at home and abroad have been reviewed in this chapter under the following headings:

2.1 Major insect pests in guava

2.1.1 White fly

The whiteflies cause damage to plant by three means, (i) large population of nymphs and adults suck sap directly from plant greatly reduce yield, (ii) heavy colonization of *B. tabaci* can cause serious damage to some crops due to honeydew excreted by all stages, particularly the late nymphal instars which encourages growth of “sooty mould” that affect yield both in quantity and quality and (iii) they reduce crop yield through transmission of viral diseases from crop to crop (Kajita and Alam, 1996).

The adult of whitefly is soft and pale yellow, change to white within few hours due to deposition of wax on the body and wings (Haider, 1996). Eggs are laid indiscriminately almost always on the under surface of the young leaves. The whitefly, *B. tabaci* is an important pest worldwide for many vegetable crops as well as tomato. The whiteflies are very small, fragile and active insects, jump from plant to plant with very slight disturbance and because of this there is great

difficulty in handling them during experimental work and as well as also management.

Brown and Bird (1992) have pointed out the increased prevalence as well as expanded distribution of whitefly borne viruses during the last decade and resulting devastating impact on crop growth and yield. Yield loss range from 20-100 per cent, depending on the crop, season, vector prevalence and other factors during the growing season.

The whitefly acts as a mechanical vector of many viral diseases for different crops (Butani and Jotwani, 1984). Young plant may even die in case of severe infestation. The pest is active during the dry season and its activity decreases with the on set of rains. As a result of their feeding the affected parts become yellowish, the leaves become wrinkle, and curl downwards and eventually fallen off. This happens mainly due to viral infection.

The adult whitefly is a tiny soft bodied and pale yellow, change to white within a few hours due to deposition of wax on the body and wings (Haider *et al*., 1996). Eggs are laid indiscriminately almost always on the under surface of the young leaves. Eggs are pear shaped and 0.2 mm long. One female can lay upto 136 eggs in its life time. The nymphs are pale, translucent white, oval, with convex dorsum and flat elongated ventral side. The whitefly adults and nymphs feed on the plant sap from the underside of the leaves. They secrete honeydew, which later helps the growth of sooty mould fungus thus reducing the photosynthetic area. The infested plants became weakened due to sucking of the plant sap from the leaves and also due to the reduction of photosynthesis of the infested plant parts. Young plant may even be killed in case of severe whitefly infestation (Srivastava and Singh, 1976). The infested plant parts become yellowish, the leaves become wrinkle, curl downwards and eventually they fallen off. This happens mainly due to viral infection where the whitefly acts as a mechanical vector of many viral diseases.

The systematic position of the pest is given below:

Phylum: Arthropoda

Class: Insecta

Sub-class: Pterygota

Division: Exopterygota

Order: Homoptera

Family: Aleyrodidae

Genus: *Aleurodicus*

Species: *Aleurodicus dispersus*

Biology and life history of whitefly

Scanlan (1995) has studied the biology and life history of the spiralling whitefly in Guava. The female lays eggs in white whorls of waxy secretion on the lower surface of the leaves. The tiny eggs are laid in spiral form and are hidden by the white waxy fluff in the lower surface of the leaves. The eggs are 0.5 mm in length and take about a week to hatch. The nymphal stage undergoes four instars and these instars are completed in about a month. Only the first instar nymph is capable of movement with three pairs of legs. The other nymphal instars are sessile. The last nymphal instar undergoes a pupal stage, which last about a week. Many long, delicate and filamentous strands of wax are seen to come out from the pupae and they are visible on the underside of infested leaves. Adult whitefly measures about 1.5 to 2.0 mm in length and two pairs of milky white wings with mealy white powdery wax covering. Salinas and Sumalde (1994) reported that the wooly whitely, *Aleurothrixus floccossus* (Maskell) passes through the egg stage and four nymphal instar before reaching the adult stage (Chong *et al*., 1991).

Seasonal abundance of whitefly

Rashid (1999) reported that a major peak period of whitefly infestation in December and January. In the month of September, adult whitefly start to lay on underside of top young leaves and then it started to increase. No infestation was found in the months from May to August.

Yee *et al*. (1997) has studied the whitefly *Bemisiu argentifolii* Bellows and Perring has been a major pest of crops in the South-Western United States since 1991. Populations of all stages of whitefly on alfalfa were low or non-existent from December to May and both sites. In the Imperial Valley, adult populations increased in June and peaked during September and decreased from October to November. In Yuma, adult populations peaked during August, and decreased late October to November. In the Imperial Valley, adult populations significantly higher in 1993 than in 1995, and in Yuma, adult populations were higher in 1993 than 1994.

Salinas and Sumalde (1994) reported that temperature, relative humidity, and the number of rainy days had a highly significant correlation with the adult population. A highly significant correlation was also noted between relative humidity and egg counts.

Highest population of the wooly whitefly was noted during the month of September, lowest during April, May and November. High temperature and rainfall appeared to have a disruptive effect on the population of the wooly whitetly (Salinas and Sumalde, 1994).

Whitefly population varies from season to season. It depends on temperature, rainfall, humidity, fog etc., Echeikraut and Cardona (1989) reported that dry conditions are more favorable for whitetly, *B tabuci* than those of high precipitation. Kuchanwar *el al*. (1989) studied the population dynamics of whitefly in citrus orchard and found three peaks in the emergence of nymphs in the first fortnight of July and last fortnight of December.

Southwood *et al*. (1997) reported that the population suffered very little from natural enemies in the field level but showed a slow rate of increase after disturbance. Horowitz (1986) found significant drop whitefly population level at heavy rainy condition. In a study in Sudan Kranz *et al*. (1977) found that increase in whitefly population in September and October and was directly correlated with the higher relative humidity (80-90%) and increasing temperature (36-38%).

Nature and extent of damage

Heavy colonization of whitefly can cause serious indirect damage due to honeydew excretion leaf or fruit surface which encourages growth of sooty moulds and in turn affects the yield both in quantitative and qualitative terms (Kajita and Alam, 1996; Basu, 1995). The infested plants are weakened h the sucking of plant sap from the leaves and due to the retardation of photosynthesis of the infested plant parts. Young plants even may he killed in case of severe whitely infestation (Perkins 1987; Scanlan, 1995).

Lloyd (1992) showed that these Homopteran insects damage crops by extracting large quantities of phloem sap, which may result in greater than 50% yield reductions. The long delicate filamentous waxy tissue from the nymphs and pupae of whitefly, Cf. disperses) on the underside of a Guava leaf results in the reduction of the photosynthetic area and ultimately reducing the yield because of the retardation of plant growth (Chong *et al*., 1991). Finally, a few species serve as vector of several economically important viral plant pathogens phloem sap (Muniyappa, 1980).

The whitely adults and nymphs feed on the plant sap from the underside of the leaves. They secrete honeydew, which later helps the growth of sooty mould fungus, *Capnodium citri* thus reducing the photosynthetic area. Butani (1979) found that whitely sucks cell sap from ventral leaf surface resulting in the drying up of the leaves and premature dropping of the leaves and there by devitalizing the trees to some extent.

2.1.2 Fruit fly

Guava is infested by a number of insect pests, which considered being the significant obstacles for its economic production. Fruit fly is the major pest responsible for considerable damage of guava.

Origin and Distribution

Fruit flies are distributed all over the world and infest a large number of host plants. The distribution of a particular species is limited perhaps due to physical, climatic and gross vegetational factors, but most likely due to host specificity. Such species may become widely distributed when their host plants are widespread, either naturally or cultivation by man (Kapoor, 1993). Two of the world's most damaging tephritids *Bactrocera* (*Dacus*) *dorsalis* and *Bactrocera* (*Dacus*) *cucurbitae*, are widely distributed in Malaysia and other South East Asian countries (Vijaysegaran, 1987). Gapud (1993) has cited references of five species of fruit fly in Bangladesh e.g., *Bactrocera brevistylus* (melon fruit fly), *Dacus* (Zeugo *Dacus*) *caudatus* (fruit fly) *D.* (*strumeta*) *cucurbitae* (melon fly), D. (Bractrocera) *dorsalis* Hendel (mango fruit fly) and D. (*Chacto Dacus*) *zonatus* (zonata fruit fly).

Fruit fly is considered to be the native of oriental, probably India and South East Asia and it was first discovered in the Yaeyama Island of Japan in 1919 (Anon., 1987). However, the fruit fly is widely distributed in India, Bangladesh, Pakistan, Myanmar, Nepal, Malaysia, Chin, Philippines, Formosa (Taiwan), Japan, Indonesia, East Africa, Australia and Hawaiian Island (Atwal 1993). It is also a serious pest in Mediterranean region (Andrewartha and Birch 1960).

Kapoor (1993) reviewed that fruit fly was originally reported from Hawaii and now widely distributed throughout the oriental region including China, Japan, much of the pacific region including New Guinea, Soloman and Bismark islands, Australia, Mauritius, East Africa, Kenya and Tanzania.

Host range of fruit fly

Many fruit fly species do serious damage to vegetables, oil-seeds, fruits and ornamental plants. Tomato, green pepper, papaya, cauliflower, mango, guava, citrus, pear, fig and peaches are also infested by fruit fly (Atwal, 1993).

Sixteen species of plants act as the host of fruit flies among which sweet gourd was the most preferred host of both *Bactrocera cucurbitae* and *Bactrocera tau*. Among flowers the rate of infestation was greater in sweet gourd but the intensity was higher in bottle gourd (Kabir *et al*., 1991).

Seasonal abundance

The population of fruit fly fluctuates throughout the year and the abundance of fruit fly population varies from month to month, season to season, even year to year depending upon various environmental factors. The fly has been observed to be active in the field almost throughout the year where the weather is equable.

Narayan and Batra (1960) reported that most of the fruit fly species are more or less active at temperatures ranging between 12ºC-15ºC and become inactive below 10ºC. They also observed that the incidence of fruit flies was the highest in February and the lowest in September.

The fruit fly population is generally low during dry weather and increases with adequate rainfall (Butani and Jotwani, 1984). The peak population of fruit fly in India is attained during July and August in rainy months and January and February in clod months. The adults of fly are the most active during July to August. Fruit fly populations were in general positively correlated with temperature and relative humidity.

Nature of damage

According to York (1992) observed the formation of brown resinous deposits on fruits as the symptom of infestation. The adult female lays eggs just below the epidermis or sometimes a little deeper in the pulp, and/or sometimes on young

leaves or stems of the host plants. After hatching, the larva feed into pulpy tissues and make tunnels in fruits causing direct damage.

According to Kapoor (1993), some flies make mines and a few form galls on different parts of the plants. The maggots bore and feed inside the fruits causing sunken discolored patches, distortion and open cracks. Affected fruits prematurely ripe or damage and drop from the plants. The cracks on fruits serve as the predisposing factor to cause pathogenic infection resulting in decomposition of fruits.

2.1.3 Aphids

There are six species of aphids that damage crops. These species include *Rhopalosiphum padi, Schizaphis graminurn, Sitobion avenae, Metopoliphiurn dirhodum, R. Maidis* and *Diuraphis noxia.* Two of those species commonly known as Russian Aphid (*Diuraphis noxia*) and Bird Cherry-Oat Aphid (*Rhopalosiphum padi*) are considered notorious for their direct and indirect losses.

Aphid is known to be a sporadic insect causing significant yield losses by spreading out from its origin. The centre of origin for aphid is considered to be the central Asian mountains of Caucasus and Tian Shan. The specie could now be found in South Africa, Western United States, Central and Southern Europe and Middle East. The economic impact of aphid include direct and indirect losses that have been estimated to be $893 million in Western United States during 1987 to 1993 (Morrison and Peairs, 1998) whereas 37% yield losses in winter have been reported in Canadian Prairies. Direct losses have also been assessed as an increased input cost due to insecticides and indirect losses include reduced yield due to aphid infestation.

Climatic conditions and temperature in particular, plays a significant role in population dynamics of the aphids. A warmer temperature can potentially accelerate the aphid’s growth both in terms of number and size, yet, the extreme temperatures can possibly reduce the survival and spread of Aphids. Aphid is

known to be present in its three different morphological types: immature wingless females, mature wingless females and mature winged females. Winged mature females or adults spread the population and infection to the surrounding host plants whereas the wingless types or apterous cause damage by curling and sucking the young leaves. Heavily infested plants may typically look prostrated and/or stunted with yellow or whitish streaks on leaves. These streaks, basically, are formed due to the saliva injected by the aphid (Morrison and Peairs, 1998). The most obvious symptoms due to heavy infestations can be reduced leaf area, loss in dry weight index, and poor cholorophyll concentration. Plant growth losses could be attributed mainly due to reduced photosynthetic activity to plants aphid infestation. The photochemical activities of the plants were reportedly inhibited by the aphid feeding from leaves and disruption in electron transport chain. Spikes can have bleached appearance with their awns tightly held in curled flag leaf. Yield losses can greatly vary due to infestation at different growth stages, duration of infestation and climatic conditions (wind patterns and temperature). A number of biotypes for aphid have been reported to be present throughout the cereal production areas of the world. These biotypes are classified due to significant genetic differences among them.

A number of strategies have been deployed to mitigate aphid. Among these strategies, the host plant resistance has been the most effective and economic method to induce antixenosis, antibiosis and/or tolerance against aphid. Its host plant resistance is well known to be qualitative in nature, and about nine resistance genes have been documented so far. A number of alternate methods to control this pest has been suggested and practiced that include cultural, biological and chemical control methods. Cultural control strategies involved eradication of volunteer and alternate host plants is generally recommended. Another strategy is grazing the volunteer plants which significantly reduce the aphid infestation (Walker and Peairs, 1998). Adjusting planting dates to de-synchronize the insect population dynamics and favourable environmental conditions of any particular area can also help to control aphid. The enhanced fertigation of infested field, and

biological control of aphid is also possible with 29 different species of insects and 6 fungus species, of the predator insects, 4 different species of wasps have become adopted to United States. Besides these cultural practices, chemical control method is also widely practiced with equivocal cost efficiency.

Life cycle

Most aphids reproduce a sexually throughout most or all of the year with adult females giving birth to live offspring often as many as 12 per day without mating. Young aphids are called nymphs. They molt, shedding their skin about four times before becoming adults. There is no pupal stage. Some species produce sexual forms that mate and produce eggs in fall or winter, providing a more hardy stage to survive harsh weather and the absence of foliage on deciduous plants. In some cases, aphids lay these eggs on an alternative host, usually a perennial plant, for winter survival. When the weather is warm, many species of aphids can develop from newborn nymph to reproducing adult in seven to eight days. Because each adult aphid can produce up to 80 offspring in a matter of a week, aphid populations can increase with great speed (Flint, 1998).

Nature of damage

Low to moderate numbers of leaf-feeding aphids aren't usually damaging in gardens or on trees. However, large populations can turn leaves yellow and stunt shoots; aphids can also produce large quantities of a sticky exudates known as honeydew, which often turns black with the growth of a sooty mold fungus. Some aphid species inject a toxin into plants, which causes leaves to curl and further distorts growth. A few species cause gall formations (Cannon, 2008).

Squash, cucumber, pumpkin, melon, bean, potato, lettuce, beet, chard, and bok choy are crops that often have aphid-transmitted viruses associated with them. The viruses mottle, yellow, or curl leaves and stunt plant growth. Although losses can be great, they are difficult to prevent by controlling aphids, because infection occurs even when aphid numbers are very low; it takes only a few minutes for the

aphid to transmit the virus, while it takes a much longer time to kill the aphid with an insecticide.

2.1.4 Mealybugs

Another major pest of guava plant is mealybug. Mealybugs (Homoptera: Pseudococcidae) are cottony in appearance, small oval, soft-bodied sucking insects. Adult mealybugs are found on leaves, stems and roots and are covered with white mealy wax, which makes them difficult to eradicate. They form colonies on stems and leaves developing into dense, waxy, white masses. They suck a large amount of sap from leaves and stems with the help of piercing/sucking mouth parts, depriving plants of essential nutrients. The excess sap is excreted as honeydew which attracts ants and develops sooty mould inhibiting the plant's ability to manufacture food. Mealybugs are white to pink in colour and measure 3-4 mm in length. Mealybugs eggs as well as crawlers are pink in colour. The crawlers measure 0.3 mm in length. Immature females and newly matured females are greyish-pink which are dusted with mealy white wax. Adult females are 2.5-4.0 mm long, soft-bodied, elongate oval and slightly flattened. Males have one pair of very simple wings, long antennae and white wax filaments projecting posteriorly with no mouthparts (Tanwar *et al*., 2007).

Mode of transport

Non-infected plants can be infected from infected plants as juvenile mealybugs can crawl from an infected plant to another plant. Small 'crawlers' are readily transported by wind, rain, birds, ants, clothing and vehicle and may settle in cracks and crevices, usually on new plants. The wax, which sticks to each egg, also facilitates passive transport by equipment's, animals or people. The female mealybug is not active and unable to fly. In fact, humans are great friends helping in transport of mealybugs. As the infested plant back the colonies of mealybugs migrate from shoot tips to twigs, branches and finally down the trunk. Long distance movement is most probable through carrying infested planting material and fresh fruit and vegetables across the country or even from one end of a farm

to the other. Ants, attracted by the honeydew, have been seen carrying mealybugs from plant to plant (Tanwar *et al*., 2007).

Nature of Damage

Infested growing points become stunted and swollen which may vary depending upon the susceptibility of each host species. Heavy clustering of mealybugs can be seen under leaf surface giving the appearance of a thick mat with waxy secretion. They excrete copious amount of honey dew that attracts ants and help in development of black sooty mould which inhibits the plants ability to manufacture food. Both nymphs and adults suck the sap from leaves causing withering and yellowing of leaves (Tanwar *et al*., 2007). Fruit may drop prematurely on crop plants. Heavy infestation can cause defoliation and even death of the plant. Mealybugs also affect the development of flowers and stems.

2.2 Management of guava insect pests

Insect pests are the most damaging factor of guava almost all over the world. Although there are various methods are available to combat this cost, there is not a single such method which has so far been successfully reduced the damage of guava insect pests. This perhaps, is mainly due to the polyphagous nature of most of the insect pests that helps their year round population build up. The available literatures on the measures for the controlling of these flies are discussed under the following sub-headings:

2.2.1 Cultural Control

Cultural methods of the pest control aim at reducing, insect population encouraging a healthy growth of plants or circumventing the attack by changing various agronomic practices (Chattopadhyay, 1991). The cultural practices used for controlling guava insect pests were described by the following headings.

Ploughing of soil

In the pupal stage of insect pest, it pupates in soil and also over winter in the soil. In the winter period, the soil n the field s turned over or given a light

ploughing; the pupae underneath are exposed to direct sunlight and killed. They also become a prey to the predators and parasitoids. A huge number of pupae are died due to mechanical injury during ploughing (Chattopadhyay, 1991; Nasiruddin and Karim, 1992; Kapoor, 1993).

Field Sanitation

The female insect pests lay lays eggs and the larvae hatch inside the fruit, it becomes essential to look for the available measures to reduce their damage on fruit and one of the safety measures for controlling insect pests is the field sanitation. Field sanitation is an essential prerequisite to reduce the insect population or defer the possibilities of the appearances of epiphytotics or epizootics (Reddy and Joshi, 1992).

According to Kapoor (1993), in this method of field sanitation, the infested fruits on the plant or fallen on the ground should be collected and buried deep into the soil or Cooked and fed to animals. Systematic picking and destruction of infested fruits in Proper manner to keep down the population is resorted to reduce the damages caused by fruit files infesting cucurbits, Guava, mango, peach etc. and many borers of plants (Chattopadhyay, 1991).

2.2.2 Mechanical Control

Mechanical destruction of non-economic and non-cultivated alternate wild host plants reduced the insect pest populations in guava, which survive at times of the year when their cultivated hosts are absent. Collection and destruction of infested fruits with the larvae inside helped population reduction of insect pests (Nasiruddin and Karim, 1992).

Bagging of Fruits

Sometimes each and every fruit is covered by a paper or cloth bag to block the contact of insect pests with the fruit thereby protecting from oviposition by the insect pest and it is quite useful when the insect pests are within the reach and the number of fruits to be covered arc less and it is a tedious task for big commercial

orchards Kapoor (1993). Bagging of the fruits against *Dacus* (*Bactrocera*) *cucurbitae* greatly promoted fruit quality and the yields and net income increased by 45 and 58% respectively in bitter gourd and 40 and 45% in sponge gourd. Covering of fruits by polythene bag is an effective method to control fruit fly in teasel gourd and the lowest fruit fly incidence in teasel gourd occurred in bagging. Fruits (4.2%) while the highest (39.35) was recorded in the fruits of control plot (Anon., 1988). Amin (1995) obtained significantly lowest fruit fly infestation (4.61%) in bagged cucumber compared to other chemical and botanical control measures.

Fruit Picking

Systematic picking and destruction of infested fruits in proper manner to keep down the population is resorted to reduce the damages caused by guava insect pests infesting cucurbits, guava, mango, peach etc. and many borers of plants (Chattopadhyay, 1991).

Wire Netting

Kapoor (1993) reviewed that fine wire netting may sometimes be used to cover small orchards. Though it is a costly method, but it can effectively reduce the insect pests infestation and protect the fruit from injury and deform, and also protects fruit crops against vertebrate pest.

2.2.3 Chemical control

A wide range of organophosphoras, carbamate and synthetic pyrethroids of various formulations have been used from time to time against fruit fly (Kapoor, 1993). Spraying of conventional insecticide is preferred in destroying adults before sexual maturity and oviposition. Kapoor (1993) reported that 0.05% Fenitrothion, 0.05% Malathion, 0.03% Dimethoate and 0.05% Fenthion have been used successfully in minimizing the damage to fruit and vegetables against fruit fly but the use of DDT or BHC is being discouraged now. Sprays with 0.03% Dimethoate and 0.035% Phesalone were very effective against the fruit fly. Fenthion, Dichlorovos, Phosnhamidon and Endosulfan are effectively used for the

control of melon fly. In field trials in Pakistan in 1985-86, the application of Cypermethrin 10 EC and Malathion 57 EC at 10 days intervals (4 sprays in total) significantly reduced the infestation of *Bactrocera cucurbitae* on Melon (4.8-7.9) compared with untreated control and Malathion was the most effective insecticide (Khan *et al.*, 1992).

Pawer *et al.* (1984) reported that 0.05% Monocrotophos was very effective in controlling *Bactrocera cucurbitae* in Guava. They also reported that Synthetic pyrethroids, Permethrin, Fenvelerate, Cypermethrin (ail at 100g a.i./ha) and Deltamethrin (at 15g a.i/ha) were very useful in controlling *Bactrocera cucurbitae*, in guava in South India. Kapoor (1993) listed about 22 references showing various insecticidal spray schedules for controlling for fruit flies on different plant hosts tried during 1968-1990.

Alam *et al*. (1998) reported control of the spiralling whitefly (*A. dicpersus*) of Guava with three insecticides. Among the three insecticide tested (Nuvacron 40 SL, Shobicron 425 EC and Chess 25 WP), the number of adults and nymphs of the whifetly survived per leaf were lowest in plants treated with Nuvacron 4 2.5 ml per liter of water and Shobicron (a 2.0 ml per liter of water compared with Chess and the untreated control after 96 hrs for nymphs and after 48 hrs of adults. After one month of spraying of insecticides were effective for adults, but the efficacy of Shobicron went down for nymphs. The percent reduction of adults over the untreated control was above 90% after 24 hrs, and those for nymphs were above 65% after 96 hrs application with Nuvacron and Shobicron. Kakakhel *et al*. (1997) showed that three insecticides at the recommended doses (Dimecron SCW 150, Karate 2.5 EC and Roxion 40 EC LC '50 ml/acre) significantly controlled whitefly and jassid population during 1992 and 1993 for seven days after spray as compared to check. Kabir *et al*. (1996) recommended the application of Fenon (Cypermethrin), Nogos (Dichlorvos) etc. at 23 to 26 days interval for the economic control of the betel blackfly, Aleurocauthus Ashby. Kabir *et al*. (1996) found Chess, Nogos and Fenom as affective on the reduction of black fly, *Aleurocanthus woglumiash* by after 7 days of application.

Many other insecticides are available to control aphids in the home garden and landscape, including foliar-applied formulations of malathion, permethrin, and acephate (nonfood crops only). While these materials may kill higher numbers of aphids than soaps and oils, their use should be limited, because they also kill the natural enemies that provide long-term control of aphids and other pests, and they are associated with bee kills and environmental problems. Repeated applications of these materials may also result in resistance to the material (Flint, 2004). Formulations combining insecticidal soaps and pyrethrins may provide slightly more knockdown than soaps alone yet have fewer negative impacts on natural enemies than malathion, permethrin, and acephate, because pyrethrins break down very quickly. Aphids are small, soft-bodied insects with long slender mouthparts that they use to pierce stems, leaves, and other tender plant parts and suck out fluids. Almost every plant has one or more aphid species that occasionally feed on it. Many aphid species are difficult to distinguish from one another; however, management of most aphid species is similar.

Any insecticide used against *M. hirsutus* should be carefully selected to avoid injury to its natural enemies. IPM using both coccinellid beetle predators and insecticides has been achieved on grapevine. Plant protection products are of limited effectiveness against mealybug because of its habit of hiding in crevices, and the waxy covering of its body. Most granular insecticides are ineffective therefore, systemic insecticides are used to control heavy infestations. Locate ant colonies and destroy them with drenching of chlorpyriphos 20 EC @ 2.5 ml/l or apply 5% malathion dust @ 25 kg/ha as the ants provide them protection from parasitoids and predators and also helps in spreading the crawlers to non-infested plants (Tanwar, 2007).

Bait spray

Protein hydrolysate insecticide formulations are now used against various dacine fruit fly species (Kapoor, 1993). New a day, different poison baits are used against various *Dacus* species which are 20 g Malathion 50% Or 50 ml of Diazinon plus 200 g of molasses in 2 liters of water kept in flat containers or

applying the bait Spray containing Malathion 0.05% plus 1% sugar/molasses or 0.025% of protein hydrolysate (20 ml of malathion 50Ec and 200g of sugar /molasses in 50 litres of water)or spraying plants with 500 g molasses plus 50 g Malathion in 50 liters of water or 0.025% Fenitrothion plus 0.5% percent molasses.

This is repeated at weekly intervals where the fruit fly infestation is serious (Kapoor, 1993). He reported that bait spray (1.0 g Dipterex 80SP and 100 g of molasses per liter of water) on snake gourd against fruit fly (*Bactrocera cucurbitae*) showed 8.50% infestation compared to 22.48% in control.

A field study was conducted to evaluate the efficacy of some baits against fruit fly in comparison with a standard insecticide and bait traps. The treatment comprised 25 g molasses + 2.5 ml Malathion, (Limithion 50 EC) and 2.5 litres water at a ratio of 1: 0.1: 100 satisfactorily reduced infestation and minimized the reduction in yield. According to Steiner *et al.* (1988) poisoned bait containing Malathion and protein hydrolysate gave better results in fruit fly management program in Hawaii.

2.2.4 Integrated Management of Guava pests

An attempt for developing IPM program or packages(s) related experiments are very few almost everywhere in the world. Uddin (1996) studied the comparative effectiveness of three IPM packages viz., the IPM package 1 consisting of barrier + yellow pan trap + bagging of fruits. IPM package 2 comprising Malathion spray (Hilthion 57 EC @ 2ml/liter of water) plus mechanical control and IPM package 3 containing bait spray (@ 25g of molasses, 2.5 ml of Hilthion 57EC and 2.5 liter of water). Plus treating soil with Diazinon 14G @ 2g/plot) in reducing the infestation level of fruit fly. Integrated control (pheromone traps, field sanitation, and insecticides used and bagging of individual fruits) is more effective in controlling insect pests in fruit (Jaiswal *et al.*, 1997).

CHAPTER III

MATERIALS AND METHODS

A sequential description of the methodologies followed in conducting this research work has been presented in this chapter.

3.1 Experimental site

In order to make an assessment of the current insect pest management and practices of guava production, this study was conducted in some selected areas of Nesarabad upazila under Pirojpur district of Barisal division. Pirojpur district is an important area of potentiality for guava production and that is why this district was purposively selected for the study. The study was conducted in Songgitkathi, Bastuvita, Atghar Kuriwana and Zindakathi villages of Nesarabad upazila under Pirojpur district. The experimental site was situated at 22.58^0 N latitude and 89.97^0 E longitudes with an elevation of 12 m from the mean sea level. The area represents the agro ecological zone of Low Ganges River Floodplain (AEZ 13).

3.2 Experimental period

Thirty guava growers were selected for conducting the study. In the Nesarabad Upazila there were a huge number of guava growers and most of them have a long history as a guava producers. As a part of survey, total of 30 guava growers were interviewed and make a clear observation during the period from 23 November 2014 to 14 May 2015.

3.3 Questionnaire

A well structured interview schedule was developed based on objectives of the study for collecting information with containing direct and simple questions in open form and close form. Appropriate scales were developed to measure variables.

The questionnaire was pre-tested with three guava growers in selected areas before finalized it for collection of data. Necessary corrections, additions,

alternations, rearrangements and adjustments were made in the interview schedule based on pretest experience. The questionnaire was then multiplied by printing in its final form. An English version of the interview schedule is presented into Appendix I.

3.4 Methods of survey

Thirty guava growers of different location were selected randomly for survey. Objective-oriented, structured questionnaires were used to identify socio-economic status of the guava growers, intensity of infestation in guava plants and fruits, major insect pests in guava and management practices that followed by the guava growers and use of different insecticides for managing these insect pests for guava cultivation were surveyed through a structured questionnaire.

The study was conducted with staying close contact with guava growers and visited with keen observation during the entire experimental period. A pre-tested survey instruments were used for the collection of data. Several factors were to find out the influence of management practices on guava production during the study period considered. Among grower characteristics, the specific variables included in the survey are: age, level of education, farm size, pest control training status, length of training experience and duration of involvement with guava cultivation.

Major insect pests of the guava were recorded through per the opinion and observation of the guava growers. The management procedures for controlling of these insect pests were identified with the opinion and observation in guava field. During the study period data recorded on different insecticides that were used by growers in controlling theses insect pests for guava cultivation, their cost as well as production and benefit cost ratio in guava cultivation.

3.5 Data processing, analysis and output generation

The data obtained for different characters were statistically analyzed to find out the significance of the different GPs and chemical insecticides combination (ICs) used by the respondents' guava growers infestation level, production cost, net return, benefit cost ratio and abundance of insect pest for different FPs and chemical insecticides combination (ICs) used. The mean values of all the characters were evaluated and analysis of variance was performing by the 'F' (variance ratio) test using MSTATC program. The significance of the difference among the different combinations of FPs and ICs for different characters was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The findings of the study were presented in accordance with the objectives of the study and possible interpretations have been provided with five heads in this chapter. The first head deals with the characteristics of the guava growers under different sub-heads. The second head deals with the insect pests infestation of guava field. The third head deals with the majors insect pests of guava field and chemical insecticides used for managing these insect pests by the guava growers. The fourth head deals with different field management practices for managing insect pests of guava and their impacts on their benefit cost ratio and pest abundance and the fifth head deals with the chemical insecticides used for managing guava insect pests and their impacts on production cost and benefit cost ratio and pest abundance in the guava field.

4.1 Characteristics of the guava growers

There are different interrelated characteristics of the guava growers that influence their knowledge on the insect pests management practices of guava cultivation. Therefore, it was hypothesized and interrelated with the characteristics of the guava growers under the study that have effect on the management of insect pests in guava cultivation. However, among characteristics of guava growers there were the most important six selected characteristics of the guava growers such as age, level of education, farm size, pest control training status, length of training experience and duration of involvement with guava cultivation were categories and presented below. Character wise summary of descriptive statistics of guava growers are presented in Table 1 to 6.

4.1.1 Age of the respondents

Age of the guava growers were classified into three categories as young, middle and old (Table 1). Among the respondent, the highest (66.67%) guava growers were middle aged, 23.33% were young and only 10.00% were in old aged.

Table 1. Distribution of the respondents guava growers according to their age

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Young aged (below 35 years)	7	23.33	35.06	7.30
Middle aged (35-50 years)	20	66.67		
Old aged (above 50 years)	3	10.00		
Total	30	100		

4.1.2 Education of the respondents

Level of education of the guava growers were classified into four categories as can sign only, primary education, secondary education and above secondary education (Table 2). Among the respondent, the highest (46.67%) guava growers have an education level at primary, 23.33% were illiterate, 20.00% in secondary level educated and only 10.00% in above secondary level educated.

Table 2. Distribution of the respondents guava growers according to their level of education

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Illiterate (0.5)	7	23.33	4.40	3.47
Primary education (1-5)	14	46.67		
Secondary education (6-10)	6	20.00		
Above secondary (above 10)	3	10.00		
Total	30	100		

4.1.3 Farm size of the respondents

Farm size of the guava growers were classified into four categories as marginal, small, medium and large (Table 3). Among the respondent, the highest (56.67%) guava growers were medium size farmers, followed by small size farmers (36.67%), whereas 3.33% guava growers were in marginal and large size farmers under the study.

Table 3. Distribution of the respondents guava growers according to their

farm size

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Marginal (upto 0.2 ha)	1	3.33	1.137	0.642
Small (0.201-1.0 ha)	11	36.67		
Medium (1.01 to 3.0 ha)	17	56.67		
Large (above 3.0 ha)	1	3.33		
Total	30	100		

4.1.4 Pest control training status

Pest control training status of the guava growers were classified into two categories as received pest control training and didn't received pest control training (Table 4). Among the respondent the highest (63.33%) guava growers didn't received any pest control training and 36.67% have received training on pest control or management.

Table 4. Distribution of the respondents guava growers according to their pest control training status

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Received pest control training	11	36.67	1.562	0.132
Didn't received pest control training	19	63.33		
Total	30	100		

4.1.5 Contact with extension agents

Contact with extension agents of the guava growers were classified into three categories as low, medium and high level contact with extension agents (Table 5). Among the respondent the highest (50.00%) guava growers have medium level contact with extension agents followed by low level contact (36.67%) and only 13.33% have high level contact with extension agents.

Table 5. Distribution of the respondents guava growers according to their contact with extension agents

Categories	Respondents	Mean	Standard

	Number	Percent		deviation
Low contact (upto 4)	11	36.67	6.562	0.603
Medium contact (5-9)	15	50.00		
High contact (10-13)	4	13.33		
Total	30	100		

4.1.6 Duration in guava cultivation

Duration of involvement in guava cultivation of the guava growers were classified into three categories as short term involvement, mid term involvement and long term involvement (Table 6). Among the respondent the highest (50.00%) guava growers have mid term involvement with guava cultivation, 30.00% have short term involvement and only 20.00% have involvement for long term in guava cultivation.

Table 6. Distribution of the respondents guava growers according to their duration of involvement in guava cultivation

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Short term involvement (below 5 years)	9	30.00	7.962	0.521
Mid term involvement (5-10 years)	15	50.00		
Long term involvement (above 10 years)	6	20.00		
Total	30	100		

4.2 Insect pests infestation of guava plant and fruits

Infestation of guava plant was assessed categories guava growers based on infestation level which were presented in Table 7. Among the guava growers the highest around 46.67% have low level infested plant in their guava filed saplings followed by 30.00% guava plant in mid infestation, whereas only 3.33% guava plants were belongs to severe and high level insect pests infestation followed by 6.67% in no infestation under the study area.

Table 7. Distribution of the respondents guava growers according to the level of infested plant and fruits in their guava field

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
No infestation (0% infested plant)	2	6.67	3.901	0.301
Low infestation (1-4% infested plant)	14	46.67		
Mild infestation (5-10% infested plant)	9	30.00		
Moderate infestation (11-30% infested plant)	3	10.00		
High infestation (31-50% infested plant)	1	3.33		
Severe infestation (above 50% infested plant)	1	3.33		
Total	30	100		

4.3 Majors insect pests of guava field and chemical insecticides used for managing the prevailing insect pests

Different insect pests were recorded from infested guava plant and the insect pests are white fly, aphid, fruit fly maggot and mealybug. Guava growers owners used different insecticides mainly confidor 70 WG, Actara 25 W, Sobicron 425 EC, Admire 20 SL, Ethion 46.5 EC, Ripcord etc. for controlling different insect pests of guava field as a sole or combination of different insecticides.

4.4 Different guava growers practices for managing insect pests and their impacts on infestation of guava plant and fruit

The guava growers practices (GPs) for the management of insect pests of guava as calculated and analyzed all of 30 sample guava growers altogether. Accordingly, the study reveals a total of 5 GPs for guava insect pest management, which may be designated as follows:

GP_1	Chemical control
GP_2	Chemical, Mechanical control
GP_3	Chemical, Mechanical, Cultural control
GP_4	Chemical, Mechanical, Field sanitation control
GP_5	Chemical, Mechanical, Cultural, Field sanitation control

4.4.1 Management practice of the growers of guava

Management practices of guava growers in controlling insect pests have been shown in Table 8. From the survey it was observed that, the guava growers (46.67%) practicing GP_1 followed by GP_2 (23.33%) and the lowest guava growers (6.67%) practicing GP_5 followed by GP_4 (10.00%) and GP_3 (13.33%) for the management of insect pests in guava field. The findings indicate that most of the growers used chemical control method which was still highly dominate in controlling insect pest in guava field. However, a number of guava growers followed practices like cultural practice, mechanical control and field sanitation. Among the guava growers many of them were found to depend solely on chemicals control.

Table 8. Guava growers practices for the management of insect pest and their effects on plant and fruit infestation

Practices	Practicing guava growers (%)	Plant infestation (%)	Fruit infestation (%)
GP_1	46.67 a	63.33 a	56.67 a
GP_2	23.33 b	20.00 b	23.33 b
GP_3	13.33 c	10.00 c	10.00 c
GP_4	10.00 c	3.33 d	6.67 d
GP_5	6.67 d	3.33 d	3.33 e
$LSD_{(0.05)}$	4.163	3.891	2.381

CV(%)	6.02	4.33	5.05

4.4.2 Plant infestation

For the management of guava insect pests, the highest plant infestation was recorded from GP_1 (63.33%) followed by GP_2 (20.00%) and GP_3 (10.00%), whereas the lowest plant infestation was observed from GP_5 and GP_4 (3.33%) under the study (Table 8).

4.4.3 Fruit infestation

For the management of guava insect pests, the highest fruit infestation was recorded from GP_1 (56.67%) followed by GP_2 (23.33%) and GP_3 (10.00%), whereas the lowest plant infestation was observed from GP_5 (3.33%) which was followed (6.67%) by GP_4 (Table 8).

Data revealed that combination of chemical, mechanical, cultural control and field sanitation practices was more effective than the sole one for management of guava insect pests and also reduction the infestation of plant and fruit infestation.

4.4.4 Production cost

From the Table 9 it was observed that, the highest production cost was recorded from GP_5 (BDT 60,145) followed by GP_4 (BDT 59,320) and GP_3 (BDT 58450), whereas the lowest production cost was observed from GP_1 (BDT 56,867) which was statistically similar with GP_2 (BDT 56,984).

Table 9. Guava growers' practices for insect pest management in guava field and their effects on production cost, net return and benefit cost ratio (BCR)

Practices	Production cost (BDT/ha)	Net return (BDT/ha)	BCR
GP_1	56867 d	134850 e	2.37 d
GP_2	56984 d	135740 d	2.38 d
GP_3	58450 c	151350 c	2.59 c
GP_4	59320 b	169460 b	2.86 b
GP_5	60145 a	185390 a	3.08 a
$LSD_{(0.05)}$	298.56	933.45	0.145
CV(%)	5.44	6.22	4.59

4.4.5 Net return

From the survey in case of the management of guava insect pests, the highest net return was recorded from GP_5 (BDT 185,390) followed by GP_4 (BDT 169,460) and GP_3 (BDT 151,350), whereas the lowest net return was observed from GP_1 (BDT 134,850) which was followed (BDT 135740) by GP_2 (Table 9). It was revealed that combination of chemical, mechanical, cultural control and field sanitation practices required the highest production cost than the sole one for management of guava insect pests.

4.4.6 Benefit cost ratio (BCR)

For the management of guava insect pests at the time of survey, the highest benefit cost ratio (BCR) was recorded from GP_5 (3.08) followed by GP_4 (2.86) and GP_3 (2.59), while the lowest BCR was observed from GP_1 (2.37) which was statistically similar (2.38) by GP_2 (Table 9). Data revealed that although combination of chemical, mechanical, cultural control and field sanitation practices was expensive than the others but from this combination the guava growers achieved maximum benefit in guava cultivation.

4.4.7 Number of insects/three twig of a plant (leaf and harvested fruit)

It was observed from the survey, for the management of guava insect pests, different number of white fly, fruit fly maggot, aphid and mealybug were recorded. Data reveled that the highest number of white fly was recorded from GP_1 (34.60) followed by GP_2 (32.20) and GP_3 (21.80), while the lowest white fly was observed from GP_5 (13.50) which was followed (18.20) by GP_4 (Table 10).

The highest number of fruit fly maggot and aphid were recorded from GP_1 (23.20 and 125.50, respectively) followed by GP_2 (18.50 and 88.40) and GP_3 (16.60 and 65.60), while the lowest fruit fly maggot and aphid was observed from GP_5 (8.20 and 21.50, respectively) which was followed (12.30 and 38.45) by GP_4 (Table 10).

Table 10. Guava growers practices for insect pests management and their effects on insect pests abundance in guava field

Practices	Number of insects/three twig of a plant (leaf and harvested fruit)			
	White fly	Fruit fly maggot	Aphid	Mealybug
GP_1	34.60 a	23.20 a	125.50 a	67.60 a
GP_2	32.20 b	18.50 b	88.40 b	56.30 b
GP_3	21.80 c	16.60 c	65.60 c	42.10 c
GP_4	18.20 d	12.30 d	38.45 d	28.00 d
GP_5	13.50 e	8.20 e	21.50 e	15.50 e
$LSD_{(0.05)}$	2.671	2.143	16.67	8.45
CV(%)	6.03	6.33	4.44	5.09

The highest number of mealybug was recorded from GP_1 (67.60) followed by GP_2 (56.30) and GP_3 (42.10), while the lowest mealybug was observed from GP_5 (15.50) which was followed (28.00) by GP_4 (Table 10).

4.5 Chemical insecticides used for managing insect pest in guava field and their impact on insect pest abundance

The insecticides combination (ICs) for guava field for managing insect pests as reported by the entire 30 guava growers together were primarily into different group. Accordingly, the study reveals a total of 5 ICs for guava insect pests management, which may be designated as follows:

IC_1	Ripcord
IC_2	Ethion 46.5 EC
IC_3	Sobicron 425 EC + Actara 25 WG
IC_4	Confidor 70 WG + Admire 20 SL
IC_5	Sobicron 425 EC + Confidor 70 WG + Admire 20 SL

4.5.1 Management practices of guava growers

The guava growers were using different combination of insecticide that have been shown in Table 11. Data revealed that, the guava growers practicing the highest (40.00%) for IC_1 followed by IC_2 (30.00%), IC_3 (16.67%), whereas the lowest guava growers (3.33%) practicing IC_5 followed by IC_4 (10.00%) for the

management of guava insect pests. The findings indicate that most of the guava growers used only one type of insecticides.

Table 11. Chemical insecticides used by the guava growers for the management of insect pest and their effects on plant and fruit infestation

Insecticide combinations (ICs)	Practicing guava growers (%)	Plant infestation (%)	Fruit infestation (%)
IC_1	40.00 a	50.00 a	43.33 a
IC_2	30.00 b	26.67 b	33.33 b
IC_3	16.67 c	13.33 c	13.33 c
IC_4	10.00 d	6.67 d	6.67 d
IC_5	3.33 e	3.33 d	3.33 d
$LSD_{(0.05)}$	5.091	3.781	4.091
CV(%)	6.11	5.80	7.01

4.5.2 Plant infestation

For the using of different combination of insecticide of guava insect pests, the highest plant infestation was recorded from IC_1 (50.00%) followed by IC_2 (26.67%) and IC_3 (13.33%), whereas the lowest from IC_5 (3.33%) followed by IC_4 (6.67%) under the study (Table 11). The findings indicate that combination of different types of systematic insecticides reduced the infestation in guava plant.

4.5.3 Fruit infestation

For the using of different combination of insecticide of guava insect pests, the highest fruit infestation was recorded from IC_1 (43.33%) followed by IC_2 (33.33%) and IC_3 (13.33%), whereas the lowest fruit infestation was observed from IC_5 (3.33%) followed by IC_4 (6.67%) under the study (Table 11).

4.5.4 Production cost

For the using of different combination of insecticide of guava insect pests, the highest production cost was recorded from IC_5 (BDT 72,650) followed by IC_4 (BDT 70,320) and IC_3 (BDT 68,450), while the lowest production cost was observed from IC_1 (BDT 62,250) followed by IC_2 (BDT 64,775) (Table 12).

Table 12. Chemical used by the guava growers for insect pest management in guava field and their effects on production cost, net return and benefit cost ratio (BCR)

Insecticide combinations (ICs)	Production cost (BDT)	Net return (BDT)	BCR
IC_1	62250 e	155450 e	2.50 d
IC_2	64775 d	175230 d	2.71 c
IC_3	68450 c	196450 c	2.87 c
IC_4	70320 b	221300 b	3.15 b
IC_5	72650 a	248320 a	3.42 a
$LSD_{(0.05)}$	693.23	8.09.22	0.169
CV(%)	4.55	6.16	4.98

4.5.5 Net return

For the using of different combination of insecticide of guava insect pests, the highest net return was recorded from IC_5 (BDT 248,320) followed by IC_4 (BDT 221,300) and IC_3 (BDT 196,450), whereas the lowest net return was observed from IC_1 (BDT 155,450) followed by IC_2 (BDT 175,230) under the study (Table 12). The findings indicate that combination of different types of insecticides give the highest net return for the guava growers.

4.5.6 Benefit cost ratio (BCR)

For the using of different combination of insecticide of guava insect pests, the highest BCR was recorded from IC_5 (3.42) followed by IC_4 (3.15) and IC_3 (2.87), whereas the lowest BCR was observed from IC_1 (2.50) followed by IC_2 (2.71) under the study (Table 12). The findings indicate that combination of different types of insecticides give the BCR also for the guava growers.

4.5.7 Number of insects/three twig of a plant (leaf and harvested fruit)

For the using of different combination of insecticide of guava insect pests, different number of white fly, fruit fly maggot, aphid and mealybug were recorded. Data reveled that the highest number of white fly was recorded from IC_1 (28.50) followed by IC_2 (23.10) and IC_3 (18.40), while the lowest white fly was observed from IC_5 (10.30) which was followed (14.60) by IC_4 (Table 13).

Table 13. Chemical used by the guava growers for insect pests management and their effects on insect pests abundance in guava field

Insecticide combinations (ICs)	Number of insects/three twig of a plant (leaf and harvested fruit)			
	White fly	Fruit fly maggot	Aphid	Mealybug
IC_1	28.50 a	18.50 a	34.80 a	45.30 a
IC_2	23.10 b	14.40 b	29.50 b	39.50 b
IC_3	18.40 c	12.50 c	23.40 c	31.20 c
IC_4	14.60 d	10.90 c	16.70 d	21.40 d
IC_5	10.30 e	6.10 d	11.50 e	15.30 e
$LSD_{(0.05)}$	3.671	2.476	4.321	5.091
CV(%)	5.55	5.90	4.29	4.57

The highest number of fruit fly maggot was recorded from IC_1 (18.50) followed by IC_2 (14.40) and IC_3 (12.50), while the lowest fruit fly maggot was observed from IC_5 (6.10) which was followed (10.90) by IC_4 (Table 13).

The highest number of aphid was recorded from IC_1 (34.80) followed by IC_2 (29.50) and IC_3 (23.40), while the lowest aphid was observed from IC_5 (11.50) which was followed (16.70) by IC_4 (Table 13).

The highest number of mealybug was recorded from IC_1 (45.30) followed by IC_2 (39.50) and IC_3 (31.20), while the lowest mealybug was observed from IC_5 (15.30) which was followed (21.40) by IC_4 (Table 13). Data revealed that combination of different insecticide was more effective than the others.

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APPENDICES

Appendix I. An Interview Schedule

DEPARTMENT OF ENTOMOLOGY
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA 1207

An interview schedule on
SURVEY ON THE PRESENT MANAGEMENT PRACTICES OF GUAVA INSECT PESTS IN SOME SELECTED AREAS OF PIROJPUR DISTRICT

Serial No. :----------

Name of the respondent : ----------

Mother/Father/Spouse Name : ----------

Village : ----------

Union : ----------

Upazila : ----------

District : ----------

Please answer the following questions. Provided information will be kept confidential and will be used only for research purpose.

1. Age

How old are you? …….. Years

2. Level of education

Mention your educational qualification (give tick mark against appropriate answer)

a) Do not know reading and writing……..( )

b) Can sign only …….. ( )

c) Read upto class …..……...

3. Farm size: Please give information on farm size regarding your depending on the utilization of land

Sl. No.	Type of land use	Land area	
		Local unit	Hectare
1.	Homestead area (including pond, garden etc.)		
2.	Land under own cultivation		
3.	Land given to others on borga		
4.	Land taken as borga from others		
5.	Land taken as lease		
Total			

4. Pest control training status

Mention your pest control training status (give tick mark against appropriate answer)

a) Received pest control training …….... ( )

b) Didn't received pest control training…….. ( )

5. Contact with extension agent: Please indicate your extent of contact with the following agent

Sl. No.	**Extension agent**	**Extent of contact**				
		Regularly	**Often**	**Occasionally**	**Rarely**	**Not at all**
1.	Upazilla Agriculture Officer (UAO)	More than 6 times/year	5-6 times/ year	3-4 times/ yea	1-2 times/ year	0 time/ year
2	Agricultural Extension Officer (AEO)	More than 6 times/year	5-6 times/ year	3-4 times/ year	1 time/ month	0 time/ month
3	Assistant Agricultural Extension Officer (AAEO)	More than 6 times/year	5-6 times/ year	3-4 times/ year	1-2 times/ year	0 time/ year
4.	Sub Assistant Argil. Officer (SAAO)	More than 3 times/month	3times/ month	2 times/ month	1 time/ month	0 time/ month
6.	Field worker of NGOs	More than 3 times/month	3times/ month	2 times/ month	1 time/ month	0 time/ month
7.	Dealer of Agril. Commodities	More than 3 times/month	3times/ month	2 times/ month	1 time/ month	0 time/ month
8.	Progressive farmers	More than 3 times/month	3times/ month	2 times/ month	1 time/ month	0 time/ month
9	Neighbors	More than 6 times/month	5-6 times/ month	3-4 times / month	1-2 times/ month	0 time/ month

6. Duration of guava cultivation

a) Please mention the duration of your involvement in guava cultivation?

……..…….. Years

7. Please mention the infestation levels of your guava field

Categories	Number of insects/three twig of a plant (leaf and harvested fruit)
No infestation (0% infested plant)	
Low infestation (1-4% infested plant)	
Mild infestation (5-10% infested plant)	
Moderate infestation (11-30% infested plant)	
High infestation (31-50% infested plant)	
Severe infestation (above 50% infested plant)	

8. Please answer the following questions

Insect pest management practices that you followed	Impact of these management practices				
	Plant infestation (%)	Fruit infestation (%)	Production cost (BDT/ha)	Net return (BDT/ha)	Benefit cost ratio (BCR)

9. Please answer the following questions

Insect pest management practices that you followed	Number of insect pests for these management practices				
	White fly	Fruit fly	Aphid	Mealybug	Others

10. Please answer the following questions

Use of chemical insecticides	Impact of the use of the chemical insecticides				
	Plant infestation (%)	Fruit infestation (%)	Production cost (BDT/ha)	Net return (BDT/ha)	Benefit cost ratio (BCR)

11. Please answer the following questions

Insect pest management practices that you followed	Number of insect pests for the use of the chemical insecticides				
	White fly	Fruit fly	Aphid	Mealybug	Others

Thank you for giving your valuable time.

Date: **Signature of the Interviewer**

CHAPTER V

SUMMARY AND CONCLUSION

Thirty guava growers from Nesarabad Upazila were purposively selected for conducting the survey on the present management practices of guava insect pests in major guava growing area of Bangladesh. A total of 30 guava growers were interviewed and make a clear observation during the period from 23 November 2014 to 14 May 2015. A well structured questionnaire was developed based on objectives of the study for collecting information. Among guava grower characteristics, the specific variables included in the survey are: age, level of education, farm size, pest control training status, length of training experience and duration of involvement with guava cultivation. Major insect pests of the guava were recorded as per the opinion and observation of the guava growers. The management procedures for controlling of these insect pests were identified with the opinion and observation in guava field. During the study period data on different management practices and pesticides used by the guava in controlling theses insect pests their cost and production and benefit cost ratio in guava cultivation were recorded.

In socio-economic characteristics, among the respondent, the highest (66.67%) guava growers were middle aged, and only 10.00% were in old aged. The highest (46.67%) guava growers have an education level at primary, and only 10.00% in above secondary level educated. The highest (56.67%) guava growers were medium size farmers, whereas 3.33% guava growers were in marginal and large size farmers. Among the respondent the highest (63.33%) guava growers received pest control training and 36.67% have not received any training on pest control or management. The highest (50.00%) guava growers have medium level contact with extension agents and only 13.33% have high level contact with extension agent. The highest (50.00%) guava growers have mid term involvement with

guava cultivation, and only 20.00% have involvement for long term in guava cultivation.

Among the guava growers the highest around 46.67% have low level infested plant in their guava filed and high level insect pest infestation followed by 6.67% in no infestation under the study area. Different insects were recorded from infested guava plant and the species are white fly, fruit fly maggot, aphid and mealy bug. Guava growers owners used different insecticides mainly confidor 70 WG, Actara 25 W, Sobicron 425 EC, Admire 20 SL, Ethion 46.5 EC, Ripcord etc. for controlling different insect pest in guava field as a sole or combination of different insecticides.

In case of management practices, the highest guava growers (46.67%) practicing GP_1 followed by GP_2 (23.33%) and the lowest guava growers (6.67%) practicing GP_5 followed by GP_4 (10.00%) and GP_3 (13.33%) for the management of insect pests in guava field. For the management of guava insect pests, the highest plant infestation was recorded from GP_1 (63.33%), whereas the lowest plant infestation was observed from GP_5 and GP_4 (3.33%). The highest fruit infestation was recorded from GP_1 (56.67%), whereas the lowest plant infestation was observed from GP_5 (3.33%). The highest production cost was recorded from GP_5 (BDT 60,145), whereas the lowest production cost was observed from GP_1 (BDT 56,867). The highest net return was recorded from GP_5 (BDT 185,390), whereas the lowest net return was observed from GP_1 (BDT 134,850). The highest benefit cost ratio (BCR) was recorded from GP_5 (3.08), while the lowest BCR was observed from GP_1 (2.37). The highest number of white fly maggot was recorded from GP_1 (34.60), while the lowest white fly maggot was observed from GP_5 (13.50). The highest number of fruit fly was recorded from GP_1 (23.20), while the lowest fruit fly was observed from GP_5 (8.20). The highest number of aphid was recorded from GP_1 (125.50), while the lowest aphid was observed from GP_5 (21.50). The highest number of mealybug was recorded from GP_1 (67.60), while the lowest mealybug was observed from GP_5 (15.50).

For using different combination of insecticide, the guava growers practicing the highest (40.00%) for IC_1, whereas the lowest guava growers (3.33%) practicing IC_5. The highest plant infestation was recorded from IC_1 (50.00%), whereas the lowest from IC_5 (3.33%). The highest fruit infestation was recorded from IC_1 (43.33%), whereas the lowest fruit infestation was observed from IC_5 (3.33%). The highest production cost was recorded from IC_5 (BDT 72,650), while the lowest production cost was observed from IC_1 (BDT 62,250). The highest net return was recorded from IC_5 (BDT 248,320), whereas the lowest net return was observed from IC_1 (BDT 155,450). The highest BCR was recorded from IC_5 (3.42), whereas the lowest BCR was observed from IC_1 (2.50). For the using of different combination of insecticide of guava insect pests, different number of white fly, fruit fly maggot, aphid and mealybug were recorded. The highest number of white fly was recorded from IC_1 (28.50), while the lowest white fly was observed from IC_5 (10.30). The highest number of fruit fly maggot was recorded from IC_1 (18.50), while the lowest fruit fly maggot was observed from IC_5 (6.10). The highest number of aphid was recorded from IC_1 (34.80), while the lowest aphid was observed from IC_5 (11.50). The highest number of mealybug was recorded from IC_1 (45.30), while the lowest mealybug was observed from IC_5 (15.30).

Conclusion:

From the observed findings it may be concluded that:

- Combined/integrated application of Chemical, Mechanical, Cultural control and Field sanitation was more effective for controlling insect pests as well as higher benefit for guava cultivation;
- Alternative application of pesticides was more effective in controlling guava insect pests in different location of Pirojpur district.

Recommendation:

Based on the findings it may be recommended that:

- For highest benefit from guava cultivation IPM practices would be more effective in controlling insect pests of guava and also attaining highest benefit in guava cultivation;
- Combination of insecticides with other control methods would be more effective and economic.
- For final recommendation more guava growers need to be included in the survey system in different part of the guava growing areas of Bangladesh.