SURVEY AND DOCUMENTATION OF INSECT PESTS COMPLEX OF CUCURBIT VEGETABLES IN SELECTED AREA AND FARMER'S MANAGEMENT PRACTICES

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JUNE, 2016

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REGISTRATION NO. : 10-04029

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

MASTER OF SCIENCE (MS)

IN

ENTOMOLOGY

SEMESTER: JANUARY-JUNE, 2015

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CERTIFICATE

This is to certify that the thesis entitled '**SURVEY AND DOCUMENTATION OF INSECT PESTS COMPLEX OF CUCURBIT VEGETABLES IN SELECTED AREA AND FARMER'S MANAGEMENT PRACTICES**' 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. Ridwanul Haque**, Registration number: **10-04029** 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: June, 2016
Dhaka, Bangladesh

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Dedicated

To

My Beloved Parents

ACKNOWLEDGEMENT

All of my gratefulness to almighty Allah who enabled me to accomplish this thesis paper.

I would like to express my heartiest respect, deepest sense of gratitude, profound appreciation to my supervisor, **Dr. Tahmina Akter**, Professor, Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka for his sincere guidance, scholastic supervision, constructive criticism and constant inspiration throughout the course and in preparation of the manuscript of the thesis.

I would like to express my heartiest respect and profound appreciation to my co-supervisor, **Professor Dr. Md. Mizanur Rahman**, Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka for his utmost cooperation and constructive suggestions to conduct the research work as well as preparation of the thesis.

I express my sincere respect to the **Dr. Mst. Nur Mohal Akhter Banu,** Chairman, Examination Committee, Department of Entomology and all the teachers of the Sher-e-Bangla Agricultural University, Dhaka for providing the facilities to conduct the experiment and for their valuable advice and sympathetic consideration in connection with the study.

I would like to thank all of my family members who have helped me with technical support to prepare this thesis paper. I also thank all of my roommates and friends to help me in my research work.

Mere diction is not enough to express my profound gratitude and deepest appreciation to my mother, brothers, sisters, and friends for their ever ending prayer, encouragement, sacrifice and dedicated efforts to educate me to this level.

The Author

Survey and documentation of insect pests complex of cucurbit vegetables in selected area and farmer’s management practices

ABSTRACT

The study was conducted in selected three upazila under Dhaka and Manikgonj districts to survey and document the distribution pattern of insect pests complex of cucurbits vegetable and farmer’s knowledge to perception of insecticide. As a part of the survey, purposely selected a total of 75 vegetable growers were interviewed and made a clear observation during the study period from 23 November 2015 to 14 March 2016. A well structured interview schedule was developed based on objectives of the study for collecting information. Red pumpkin beetle, Fruit fly, White fly, Aphid, Jute hairy caterpillar, Stink bug and Cut worm were insect pests in cucurbit vegetable. Based on the cucurbits crops that cultivated by the cucurbits vegetable growers were classified into six categories as, bottle gourd and bitter gourd; bottle gourd and sweet gourd; bitter gourd and sweet gourd; bottle gourd, bitter gourd and ash gourd; bottle gourd, sweet gourd and cucumber; and bottle gourd, sweet gourd and ash gourd . Among the respondent the highest (38.67%) cucurbits vegetable growers cultivated bottle gourd and bitter gourd; 16.00% cultivated bitter gourd and sweet gourd, 14.67% cultivated bottle gourd and sweet gourd and 13.33% cultivated bottle gourd, sweet gourd and ash gourd. Incase of management practices, The highest cucurbit vegetables plant infestation was recorded from PMP_1 (11.86%) while the lowest plant infestation was observed from PMP_6 (3.94%). The highest fruit infestation was recorded from PMP_1 (15.02%), whereas the lowest fruit infestation was observed from PMP_6 (5.38%) and the highest benefit cost ratio was recorded from PMP_6 (2.31), while the lowest benefit cost ratio was observed from PMP_1 (1.86). For using different combination of insecticide the highest plant infestation was recorded from IC_1 (15.56%), while the lowest plant infestation was observed from IC_7 (1.11%). The highest fruit infestation was recorded from IC_1 (18.89%), while the lowest fruit infestation found from IC_7 (4.44%). From this study it was observed that considering management practices and benefit cost ratio, vegetable growers prefer to using insecticides for controlling insect pest of cucurbits vegetable and the highest proportion 60% of the vegetable growers possessed moderate level knowledge, whereas 9.33% who have high level knowledge and 6.67% have no knowledge in using insecticide against those insect pest of cucurbit vegetables.

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LIST OF ABBRIVIATIONS

RCBD	=	Randomized Complete Block Design
LSD	=	Least Significant Difference
BARI	=	Bangladesh Agricultural Research Institute
CBR	=	Cost Benefit Ratio
cm	=	Centimeter
^0C	=	Degree Centigrade
et al.	=	and others *(at elli)*
Kg	=	Kilogram
Kg/ha	=	Kilogram/hectare
g	=	gram (s)
LER	=	Land Equivalent Ratio
MP	=	Muriate of Potash
m	=	Meter
P^H	=	Hydrogen ion conc.
TSP	=	Triple Super Phosphate
t/ha	=	ton/hectare
%	=	Percent

CHAPTER I

INTRODUCTION

Cucurbits are one of the most important summer vegetables crop in Bangladesh (Rahman, 2005). Cucurbits belong to the family Cucurbitaceae, which includes about 118 genera and 825 species. As a result, cucurbitaceous vegetables play an important role to supplement this shortage during the lag period (Rashid 1993). Cucurbits include sweet gourd, bottle gourd, cucumber, squash, bitter gourd, watermelon etc. Cucurbits occupy 66% of the land under vegetable production in Bangladesh and contribute 11% of total vegetable production in our country (IPM CRSP, 2004). Bangladesh produced 103 thousand tons of sweet gourd in the winter season and 77 thousand in the summer season of 2006-2007 (BBS 2007). These crops are attacked by a variety of insect pests from seeding until harvest. A lot of time, money, and natural resources are invested to grow these vegetables. Good pest management practices can save this investment by avoiding losses. Successful cultivation of cucurbits requires an effective and economical control of insect pests. Commercial vegetable growers must produce a quality product that is attractive and safe to the consumer at a minimum cost. Insect pest infestations in cucurbits bring about heavy losses through reduction in yield, lowered quality of produce, and increased cost of production and harvesting besides expenditure incurred on materials and equipments to apply control measures. These losses individually and collectively reduce the income of growers and are unacceptable. Effective and economic pest control management requires the use of cultural, mechanical, biological, and chemical methods. The combination of these different methods is necessary for achieving good management of pests. Insecticides are highly effective in controlling most insect pests. However, a limited number of generally effective pesticides may be used that are safe to apply, handle, and store. The different agencies at their respective countries at the world level regulate the registration and use of pesticides on vegetables and set the tolerance labels for miniscule amounts of residues that are allowed on a crop at the time of harvest. The continual tightening of pesticide regulations has resulted in the present tendency for growers to use a minimum of pesticides and those that disappear rapidly and are readily biodegradable. Consequently, renewed interest is being devoted to research on biological and cultural methods of control besides breeding insect pest-resistant cultivars. Pest management can be achieved only by a long-term assurance to integrated pest management practices (IPM). IPM involves the strategic use of resistant varieties, cultural measures, crop rotations, biological control, and selective pesticides. IPM requires an understanding of the interaction between pests, plants, and the environment. IPM must ensure optimal use of chemical pesticides and minimum environmental contamination to maintain crop production. Cucurbits are attacked by a number of insect pests at different growth stages that cause defoliation of leaves, damage roots or flowers, contribute to poor crop stand, transmit bacterial and viral diseases, and generate wounds that help the invasion of fungal pathogens. Major insect pests include cucumber beetles, red pumpkin beetles, fruit flies, beetles, squash bugs, aphids, white flies, squash vine borers, two-spotted spider mites, and nematodes. Although no regular statistical records are kept, as per conservative estimate the yield loss in cucurbit vegetables due to insect pest. Different methods of controlling the pest are available, growers in Bangladesh, however, frequently use chemical insecticides in order to protect vegetables from damages due to insect attacks (Rahman, 2006 and Karim, 1995).

A survey on pesticide use in vegetables conducted in 1998 revealed that only about 15% to 16% of the farmers received information from the pesticide dealers and extension agents respectively (Islam, 1999). In most cases, the farmers either forgot the instructions or did not care to follow those instructions and went on using insecticides at their own choice or experience. As a result, the indiscrimination use of chemical pesticides has given rise to many well known serious problems including resistance of pest species, toxic residues in stored products, increasing cost of application, environmental pollution, hazards from handling, destruction of natural enemies of pests and non-target organisms etc. Hence, search for the alternative method of insect pest control utilizing some non-toxic, environment friendly and human health hazard free methods are being pursued now-a-days. Pest management in tropical and sub-tropical cucurbit vegetable crops has been particularly problematical for many years. The complex of insect pests, the quality issues regarding the level of control required problems with insecticide resistance and the health risks to operators and consumers associated with excessive insecticide use all contribute to the intractability of the problem. Implementation of Integrated Pest Management (IPM) systems in vegetable crops is also difficult as it usually involves more complex decision-making processes when compared with calendar treatment with insecticides. Considering the above condition, the present piece of research work has been undertaken with fulfilling the following objectives:-

- To find out the intensity of infestation at different location of Bangladesh.
- To gather baseline information about insecticides and current pattern of their uses against insect pests complex of cucurbits vegetable.
- To find out the level of farmer's knowledge in using insecticides against insect pests complex of cucurbits vegetable.

CHAPTER II

REVIEW OF LITERATURE

This review is an overview of the literature on cucurbit vegetable pests which focuses on the cucurbit pest. Literatures cited below under the following headings and sub-headings reveal some information about the present study.

2.1 Insect pests in cucurbits vegetables

Among them insect pests is considered the important one. Generally the following listed insect pests that attack cucurbits vegetables-

Common name	Scientific name	Order
Red pumpkin beetle	*Aulacophora faveicollis*	Coleoptera
Fruit fly	*Bactrocera cucurbitae*	Diptera
Thrips	*Megalurothrips distalis*	Thysanoptera
Hairy caterpillar	*Spilarctia oblique*	Lepidoptera
Aphid	*Aphis spp.*	Homoptera
Whitefly	*Bemisia tabaci*	Homoptera
Epilachna beetle	*Epilachna spp*.	Coleoptera

2.2 Origin and distribution of red pumpkin beetle

Hutson (1972) reported that the red pumpkin beetle occurs on various cucurbits in Ceylon. Pawlacos (1940) stated *Raphidopalpa foveicollis* (Lucas) as one of the most important pests of melon in Greece. Manson (1942) reported it to occur in Palestine. Azim (1966) indicated that the red pumpkin beetle, *Aulacophora foveicollis* (Lucas), is widely distributed throughout all zoogeographic regions of the world except the Neo-arctic and Neo-tropical region. Alam (1969) reviewed that the red pumpkin beetle, *A. foveicollis* (Lucas), is widely distributed throughout the Pakistan, India, Afghanistan, Ceylon, Burma, Indo-China, Iraq, Iran, Persia, Palestine, Greece, Turkey, Israel, South Europe, Algeria, Egypt, Cyprus and the Andaman Island. Butani and Jotwani (1984) reported that the RPB is widely distributed all over the South-East Asia as well as the Mediterranean region towards the west and Australia in the east. In India, it is found in almost all the states, though it is more abundant in the northern states (Butani and Jotwani, 1984). According to York (1992), this insect pest is found in the Mediterranean region, Africa and Asia.

2.3 Nature of damage and host preferences of red pumpkin beetle

Cucurbits are attacked by a number of insect pests, including striped cucurbit beetle, 12 spotted cucumber beetles and Red Pumpkin Beetle. The Red Pumpkin Beetle, *A. foveicophora* Lucas is the most serious pest of the cucurbits. It causes 35-75% damage to all cucurbits except Bitter Gourd at seedling stage and the crop needs to be re-sown. They feed underside the cotyledonous leaves by bitting holes into them. Percent damage rating gradually decreases from 70-15% as the leaf canopy increases. Percent losses are obvious from the percent damage, which may reach upto 35-75% at seedling stage.

Khan (2013) studied to determine the biochemical composition of cucurbit leaves and their influence on red pumpkin beetle. Result revealed that the highest quantity of moisture was recorded in young leaf of bottle gourd (86.49%) and mature leaf of khira (87.95%). The lowest moisture content was obtained in young leaf of snake gourd (79.21%) and mature leaf of ribbed gourd (76.43%).

Khan *et al*. (2012) reported that the highest population of RPB was recorded in the month of May. In March, food availability was the lowest because plants were young. In May, plant growth was maximal covering largest canopy. In June, plants were at their senescent stage causing food scarcity. From the present study, it was also found that the highest incidence of pumpkin beetles was observed at around 9:00 am and 6:00 pm, while the lowest incidence was at 2:00 pm. The highest population of red pumpkin beetle on sweet gourd, cucumber, ribbed gourd and sponge gourd was recorded in the month of May.

Khan (2012) studied to find out preferred cucurbit host(s) of the pumpkin beetle and to determine the susceptibility of ten different cucurbits to the pest under field conditions. The results revealed that the most preferred host of the red pumpkin beetle (RPB) was muskmelon, which was followed by khira, cucumber and sweet gourd, and these may be graded as susceptible hosts. Bitter gourd, sponge gourd, ribbed gourd and snake gourd were least or non preferred hosts of RPB and these may be graded as resistant hosts. Other two crops, the bottle gourd and ash gourd were moderately preferred hosts of the insect and these may be graded as moderately susceptible hosts. According to his result, it indicate that the order of preference of RPB for ten tested cucurbit hosts was muskmelon> sweet gourd> cucumber > khira > ash gourd > bottle gourd > sponge gourd . ribbed gourd . snake gourd > bitter gourd.

Host preference of Red Pumpkin Beetle, *A. foveicollis* was studied by Khan *et al*. (2011) among ten cucurbitaceous crops (viz., sweet gourd, bottle gourd, ash gourd, bitter gourd, sponge gourd, ribbed gourd, snake gourd, cucumber, khira and muskmelon). At 1, 6, 12 and 24 hours after release (HAR), RPB population was found highest on sweet gourd. At 48 HAR the highest peak was found on muskmelon. The population of RPB on those two crops was significantly different only at 6 HAR. The populations of RPB on ash gourd, ribbed gourd, cucumber and khira ranged 1.00-3.33, 0.00-2.00, 0.67-1.67 and 0.00-2.00 per two plants, respectively. Three crops (Sweet gourd, musk melon and ash gourd) may be noted as highly preferred hosts of RPB. Bitter gourd was free from infestation and it was noted as non-preferred host. On khira and cucumber average population of RPB was 1.07-1.53 per two plants. On other cucurbits, population of RPB was less than one accordingly the highest percentage of leaf area damage per plant was observed on musk melon leaves followed by sweet gourd and ash gourd. The lowest percentage of leaf area damage was found on snake gourd followed by sponge gourd and bottle gourd. This insect showed different preference for various host species. Sweet gourd (pumpkin), Cucurbita maxima Duch was the preferred host.

An experiment was conducted on the host preference of *A. foveicollis* Lucas (Coleoptera, Chrysomelidae) on melon Cucumis melo, snake cucumber *C. flexuosus*, cucumber *C. sativus* and bottle gourd *Lagenaria siceraria*. Descending order of host preference was *C. melo, C. sativus* and *L. siceraria* for both 1975 and 1978 seasons. Yet, the first three crops did not differ significantly in their preference from each other and, thus, can be regarded collectively as the beetle's first choice.

Roy and Pande (1990) investigated the preference order of 21 cucurbit vegetables and noted that bitter gourd was highly resistant to the beetle, while the sponge gourd and bottle gourd were moderately resistant; muskmelon and cucumber were susceptible to the pest. They also observed that banana squash, muskmelon and bottle gourd were the preferred hosts of the adults, while cucumber, white gourd/ash gourd, chinese okra, snake gourd, watermelon and sponge gourd achieved the second order of preference to the beetle, *A. foveicollis*.

Mehta and Sandhu (1989) studied 10 cucurbitaceous vegetables and noted that bitter gourd was highly resistant to the RPB, while sponge gourd and bottle gourd were resistant. The cucumber, muskmelon and water melon were moderately resistant to the pest.

Management of red pumpkin beetle

Dabi *et al*. (1980) evaluated fourteen insecticides for the control of *A. foveicollis* and reported that phosphamidon @ 0.03 per cent was the most effective throughout the observation period with 64 per cent reduction in population over control even after 15 days treatment followed by carbaryl @ 0.2 per cent and endosulfan @ 0.05 per cent. Six granular insecticides for the control of *A. foveicollis* and reported that carbofuran @ 0.5

and 1 kg a.i per hectare proved quite effective in controlling the beetles up to 37 days after its application followed by carbaryl @ 1 kg a.i per hectare up to 25 days after its application.

A field study at Hissar (Haryana) for the simultaneous control of *A. foveicollis*, mite, Tetranychus cucurbitae (Rahman & Sapra) and powdery mildew and observed that sevisulf 40:50 WP and tank mixture of carbaryl and sulphur gave good control of these pests. According to Sinha and Chakrabarti (1983), the soil application with carbofuran granules @ 0.5 kg a.i per hectare proved to be most effective and seed treatment with carbofuran WP 3 to 4 per cent equally effective against *A. foveicollis* without any adverse effect on seed germination.

Pawar *et al*. (1984) used seven insecticides for the control of *A. foveicollis* and reported that fortnightly sprays of carbaryl @ 0.5 per cent was the most effective (6.75 beetles/wine) as compared to untreated check (23.00 beetles/wine). Application of phoxim and pirimiphos-methyl @ 187.5 g a.i per hectare provided effective control of *A. foveicollis* for 10 days (Mavi and Bajwa, 1984). In a field study conducted at Ludhiana, (Punjab) by Mavi and Bajwa (1985) for the control of this pest, carbaryl @ 0.05 percent and @ 0.075 per cent was found the most potent insecticide up to 10 days after its application followed by permethrin, phoxim and pirimiphos, each @ 0.075 per cent remained effective for 4 days after their application.

A field experiment was conducted by Pareek and Kavadia (1988) in two different agro-climatic regions of Rajasthan, the semi-humid Udaipur and the semi-arid Jobner which revealed that four sprays of 0.2 per cent carbaryl at 3, 5, 9 and 11 weeks after sowing of musk melon proved the most effective against *A. foveicollis*, resulting in increased yield and net profit. Mehta and Sandhu (1990) used cucurbitacin as kairomones in combination with malathion and carbaryl as poison baits for the monitoring of beetles and observed that maximum number of beetles were trapped in carbaryl poison baits than that of malathion and concluded that these baits could be used to reduce the destructive behavior of this pest.

The application of carbofuran @ 1.5 kg a.i per hectare at sowing, vining and flowering stages was found to be the most effective treatment in controlling *A. foveicollis* with 84.3 per cent reduction over control after 80 days of sowing (Thomas and Jacob 1994). Chaudhary (1995) found monocrotophos @ 200 g a.i. followed by carbaryl @ 500 g a.i (spray and dust) effective during first year and cypermethrin 25 g a.i. followed by deltamethrin 10g a.i and carbaryl @ 500g a.i. (spray) per hectare during second year. Under field conditions, cypermethrin 0.1 per cent + molasses solution 1 per cent was found most effective in reducing the beetle population (8.8 beetles/5 plants) followed by cypermethrin 0.01 per cent (9.2 beetles/5 plants) and deltamethrin 0.0028 per cent (10.2 beetles/5 plants) as compared to control (18.0 beetles/5 plants) (Borah, 1997).

Borah (1998) observed that application of carbofuran @ 1.5 kg a.i. at 15 days after germination to be the most effective followed by deltamethrin @ 12.5 g a.i. and decis 12.5 g a.i. per hectare at flower bud initiation stage followed by another spray at 15 days later.

Khan and Jehangir (2000) studied the efficacy of different concentrations of sevin dust and found high concentration (2.0 %) to be the most effective followed by medium (1.0 %) and low (0.5 %).

Khan and Wasim (2001) assessed different plant extracts and found neem extract in benzene most effective in repelling *A. foveicollis* followed by bakaion extract in benzene. Comparative efficacy of seven insecticides viz., neem, triazophos, chlorpyriphos, monocrotophos, abamectin, SIL-942 and Beta-cyfluthrin evaluated under field conditions against *A. foveicollis* by Babu *et al*. (2002) revealed that beta-cyfluthrin @ 18.75 g a.i. per hectare (6.86 % damaged leaves/plant) to be the most effective followed by beta-cyfluthrin @ 12.5 g a.i. (14.9 % damaged leaves/plant), monocrotophos @ 700 g a.i.

(14.12 % damaged leaves/plant), neem 3ml per liter of water (15.33 % damaged leaves/plant) and SIL-942 @ 100 g a.i. (17.28 % damaged leaves/plant).

Rajak and Singh (2002) evaluated various insecticides and biopesticides for the control of A. foveicollis and found deltamethrin followed by carbofuran and carbaryl most effective among the tested insecticides. Whereas, among biopesticides only neem powder proved to be effective against this pest.

Mehmood *et al*. (2006) studied the comparartive effect of different control methods against red pumpkin beetle and observed insecticidal treatments viz., carbofuran and carbaryl dust more effective in killing the beetles, near the plants. In Sri Lanka, neem based formulations were also effectively used for the control of this pest in organic crop production (Rajpakse and Ratnasekera, 2007).

Rahaman and Prodhan (2007) studied the effect of net barrier and synthetic pesticides on *A. foveicollis* and reported zero infestation in case of net barrier and lowest infestation by the use of carbofuran. Soil treatment with carbofuran @ 500 g a.i per hectare at the time of sowing proved effective (0.93 adult/plant) followed by seed treatment with thiamethoxam @ 3 g per kg of seed + rice husk ash @ 30 kg per hectare at 15, 25, 35 and 45 days after sowing (1.26 adults/plant) (Anonymous, 2007-2008). Bio-efficacy of neem based and synthetic insecticides against red pumpkin beetle was studied by Rathod *et al*. (2009) under laboratory conditions and found maximum mortality in neem based commercial formulation gronim and neem-azal-F (29.98%) and carbaryl (63.36%).

2.4 Origin and distribution of 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, China, Philippines, Formosa(Taiwan), Japan, Indonesia, East Africa, Australia, and Hawaiian Island (Alam, 1965). It was discovered in Solomon Islands in 1984, and is now widespread in all the provinces, except Makira, Rennell-Bellona and Temotu (Eta, 1985). Such species may become widely distributed when their host plant are widespread, either naturally or cultivation by man (Kapoor, 1993). The dipteran family Tephritidae consists of over 4000 species, of which nearly 700 species belong to Dacine fruit flies (Fletcher, 1987). Nearly 250 species are of economic importance, and are distributed widely in temperate, sub-tropical, and tropical regions of the world (Christenson and Foote, 1960). The first report on melon fruit flies was published by Bezzi (1913), who listed 39 species from India. Forty-three species have been described under the genus *Bactrocera* including *cucurbitae, dorsalis, zonatus, diversus, tau, oleae, opiliae, kraussi, ferrugineus, caudatus, ciliatus, umbrosus, frauenfeldi, occipitalis, tryoni, neohumeralis, opiliae, jarvisi, expandens, tenuifascia, tsuneonsis, latifrons, cucumis, halfordiae, cucuminatus, vertebrates, frontalis, vivittatus, amphoratus, binotatus, umbeluzinus, brevis, serratus, butianus, hageni, scutellaris, aglaia, visendus, musae, newmani, savastanoi, diversus, and minax,* from Asia, Africa, and Australia.

Amongst these, *Bactrocera cucurbitae* (Coquillett) is a major threat to cucurbits (Shah *et al.*, 1948). Senior white listed 87 species of Tephritidae in India. Amongst these, the genus, *Bactrocera (Dacus*) causes heavy damage to fruits and vegetables in Asia. The melon fruit fly is distributed all over the world, but India is considered as its native home. Two of the world most damaging tephritids, *Bactrocera dorsalis* and *B. cucurbitae,* are widely distributed in Malaysia and other South East Asian countries (Vijaysegaran, 1987).

According to Aktharuzzaman *et al.*, (2000*) Bactrocera cucurbitae Bactrocera tau and Bactrocera ciliates* have been currently identified in Bangladesh of which *Bactrocera ciliates* is a new record. *B. cucurbitae* is dominant in all the locations of Bangladesh followed by *B. tau and B. ciliates*.

2.5 Nature of damage of fruit fly

Maggots feed inside the fruits, but at times, also feed on flowers, and stems. Generally, the females prefer to lay the eggs in soft tender fruit tissues by piercing them with the ovipositor. A watery fluid oozes from the puncture, which becomes slightly concave with seepage of fluid, and transforms into a brown resinous deposit. Sometimes pseudo-punctures (punctures without eggs) have also been observed on the fruit skin. This reduces the market value of the produce. In Hawaii, pumpkin and squash are heavily damaged even before fruit set. The eggs are laid into unopened flowers, and the larvae successfully develop in the taproots, stems, and leaf stalks (Weems and Heppner, 2001). Miyatake *et al.* (1993) reported more than 1% damage by pseudo-punctures by the sterile females in cucumber, sponge gourd and bitter gourd. After egg hatching, the maggots bore into the pulp tissue and make the feeding galleries. The fruit subsequently rots or becomes distorted. Young larvae leave the necrotic region and move to healthy tissue, where they often introduce various pathogens and hasten fruit decomposition. The vinegar fly, *Drosophilla melanogaster* has also been observed to lay eggs on the fruits infested by melon fly, and acts as a scavenger (Dhillon *et al.*, 2005). The extent of losses varies between 30 to 100%, depending on the cucurbit species and the season. Fruit infestation by melon fruit fly in bitter gourd has been reported to vary from 41 to 89% (Rabindranath and Pillai, 1986; Gupta and Verma, 1978; Kushwaha *et al.*, 1973; Narayanan and Batra, 1960; Lall and Sinha, 1959). The melon fruit fly has been reported to infest 95% of bitter gourd fruits in Papua (New Guinea), and 90% snake gourd and 60 to 87% pumpkin fruits in Solomon Islands (Hollingsworth *et al.*, 1997).

Management practices of fruit fly

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 fruit flies werte described by the following headings.

In the pupal stage of fruit fly, it pupates in soil and also over winter in the soil. In the winter period, the soil in the field as 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 (Kapoor, 1993; Nasiruddin and Karim, 1992; Chattopadhyay, 1991 and Agarwal *et al.,* 1987). The female fruit fly lays eggs and the larvae hatch inside the fruit, it becomes essential to look for the available measures to reduce their damage on fruit. One of the safety measures is the field sanitation (Nasiruddin and Karim, 1992).

Field sanitation is an essential pre requisite 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 in to 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 flies infesting cucurbit, guava, mango, peach etc. and many borers of plants (Chattopadhyay, 1991).

Mechanical control

Mechanical destruction of non-cultivated alternate wild host plants reduced the fruit fly population, which survive at times of the year when their cultivated hosts are absent (Kapoor, 1901). Collection and destruction of infested fruits with the larvae inside helped population reduction of fruit flies (Nasiruddin and Karim, 1992).

Sometimes each and every fruit is covered by a paper or cloth bag to block the contact of flies with the fruit thereby protecting from oviposition by the fruit fly and it is quite useful when the flies are within the reach and the number of fruits to be covered and less and it is a tedious task for big commercial orchards Kapoor (1993). Baggging of the fruits against *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 (Fang, 1989).

Amin (1995) obtained significantly lowest fruit fly infestation (4.61%) in bagged cucumber compared to other chemical and botanical control measures. 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).

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

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

Chemical control

The method of insecticide application is still popular among the farmers because of its quick and visible results but insecticide spraying alone has not yet become a potential method in controlling fruit flies. A wide range of organophosphoras, carbamate and synthetic pyrethroid of various formulations have been used from time to time against fruit fly (Kapoor, 1993; Nayar *et al.,* 1989; Grazdyev *et al.,* 1983). Spraying of conventional insecticide is preferred in destroying adults before sexual maturity and oviposition (Willoamson, 1989). 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% Phosnhamidon and Endosulfan are effectively used for the control of melon fly (Agarwal *et al.,* 1987). In field trials in Pakistan in 1985-86, the application of Cypermethrin 10EC and Malathion 57 EC at 10 days intervals (4 sprays in total) significantly reduced the infestation of *B. cucurbitae* on Melon (4.8-7.9) compared with untreated control. Malathion was the most effective insecticide (Khan *et al.,* 1992*).*

Hameed *et al.* (1980) observed that 0.0596 Fenthion, Malathion, Trichlorophos and Fenthion with waiting period of five, seven and nine days respectively was very effective in controlling *B. cucurbitae* on cucumber in Himachal Pradesh, Various insecticide schedules were tested against *B. cucurbitae* on pumpkin in Assam during 1997. The most effective treatment in terms of lowest pest incidence and highest yield was carbofuran at 1.5 kg a.i.ha^{-1} (Borah, 1998).

Nasiruddin and Karim (1992) reviewed that comparatively less fruit fly infestation (8.56%) was recorded in snake gourd sprayed with Dipterex 80SP compared to those in untreated plot (22.485%). Pawer *et al.* (1984) reported that 0.05% Monocrotophos was very effective in controlling *B. cucurbitae* in muskmelon. Rabindranath and Pillai (1986) reported that Synthetic pyrethroids. Permethrin, Fenvelerate, Cypermethrin (ail at 100h a.i.ha^{-1}) were very useful in controlling *B. cucurbitae,* in bittere gourd 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.

2.6 Origin and distribution of aphid

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. 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 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).

2.7 Nature of damage of aphid

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 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.

Management of aphid

A field experiment was conducted by Yadav (2004) in Punjab, India to investigate the integrated control of pests. Integrated pest management was possible using the tolerant genotype PBR 91, sowing on 20 October, seed treatment with Apron 35 SD [metalaxyl] at 6 g/kg, and need based spraying with Ridomil MZ 72 WP [mancozeb + metalaxyl] at 0.25% + Indofil M-45 [mancozeb + thiophanate-methyl] at 0.2% (2 sprays at 20-day intervals).

An experiment was conducted by Singh *et al*. (2003a) during 1995/96 and 1996/97 to develop and validate an integrated pest management (IPM) module under Haryana, India, agroclimatic conditions. The treatments comprised IPM module (T1); chemical control (T2); and control (T3). Data were recorded for the incidence of pests, i.e. painted bug (*Bagrada hilaris*), saw fly (*Athalia lugens proxima* [*Athalia lugens*]), leaf miner (*Chromatomia horticola* [*Chromatomyia horticola*]), and aphid (*Lipaphis erysimi*). T1 reduced pest incidence compared to T2 and T3. There was no observed incidence of painted bug and saw fly. Leaf miner incidence was low during both cropping seasons. Crop yield was highest with T1 compared to T2 and T3. Tabulated data on the IPM module for crop is also presented.

Singh *et al*. (2003b) reported an integrated pest management (IPM) module, involving the timely sowing of the crop, seed treatment with carbendazim at 2 g/kg seed, soil application of the fungal biological control agent *Trichoderma viride* at 1 kg/acre, mechanical removal of aphid-infested twigs at the initial stage of attack and 3 inoculative releases of aphid predator (Chrysoperla carnea) larvae, was validated at farmers' fields in Bhora Khurd village, Guargon district, Haryana, India during 1997-98, for the management of pests and diseases of cucurbits. The IPM module reduced the pest attack on the crop and gave higher yield compared to untreated plots.

Four neem (*Azadirachta indica*) formulations, two synthetic insecticides (dimethoate and endosulfan) and *Bacillus thuringiensis* used alone and in combination with endosulfan were evaluated by Men *et al*. (2002) for safety to *Diaeretiella rapae*, a potential parasitoid of the mustard aphid, *Lipaphis erysimi*, on Indian mustard cv. Pusa Bold at Akola, Maharashtra, India, during 1999. It was found that *B. thuringiensis* (1 kg/ha) and Neemark (1%) were the safer treatments followed by neem leaf extract (5%), *B. thuringiensis* at 0.5 kg/ha + endosulfan (0.03%), endosulfan (0.05%), Achook (0.15%) and neem seed extract (5%). Dimethoate (0.03%) proved toxic to the hyperparasitoid.

The role of aphidophagous insects for field control of cucurbit aphid (*Lipaphis erysimi*), which infests cucurbits is discussed by Devi *et al*. (2002) along with the efficacy of neem product and conventional chemical insecticides.

Singh and Singh (2002) presented a comprehensive review of the integrated management of insect pests of cucurbits in India. The pests belonging to the insect families Aphididae, Pentatomidae, Tenethridinidae, Agromyzidae, Pieridae, Pyralidae, Arctiidae and Noctuidae are controlled by cultural, biological and chemical methods.

Field experiments were conducted by Kular *et al*. (2001) in Punjab, India, from 1995/96 to 1999/2000 to study the effect of aphid management practices, such as cultural methods, use of resistant/tolerant genotypes, biological control agents (*Chrysoperla carnea* and *Verticillium lecanii*), and need [*Azadirachta indica*]-based applications of insecticides, on the seed yield of cucurbits.

2.8 Origin and distribution of whitefly

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.

2.9 Nature of damage of whitefly

The whitefly acts as a mechanical vector of many viral diseases for different vegetable 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. Yield loss due to *Bean golden mosaic virus* (BGMV) varied from 40-100 %, depending on age, variety.

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 (Hirano *et al*., 1993). 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. 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.

Management of Whitefly:

To manage whiteflies, it is necessary to know which plants are affected by whiteflies and to understand the nature of its damage to crops, the biology of the whiteflies and their natural enemies, and how to monitor whitefly populations (sites, population dynamics, action thresholds). Also, it is critical to know the limitations of various control tactics, which include cultural controls (such as altered planting practices and physical barriers), host plant resistance, chemical controls, and natural controls.

The use of insecticides and oils to affect virus transmission by whiteflies has yielded more or less satisfactory results in a limited number of cases. Cultural control measures to reduce the disease incidence included sanitation, mixed cropping, use of reflective surfaces by way of mulches, physical barriers and cultivation of resistant varieties. No strategy for control of whitefly borne geminiviruses has proved effective in practice (Brown and Bird, 1992).

Many reports, from cultural to transgenics have been published on the management of Tomato in the world. Few works are reviewed under the following subheading.

i) Sanitation: To manage the leaf curl disease tomato fields should be kept weed free and TYLCV infected plants should be clean out immediately. Tomato fields should be cleaned up immediately after harvest. TYLCV resistant cultivars should be used if available (Schuster and Polston 1999).

ii) Use of Reflective Surfaces: *B. tabaci* is strongly attracted to yellow plastic or straw mulches and killed by reflected heat. Mulching of tomatoes and cucumber fields with saw dust, straw or yellow polythene sheets markedly reduced the incidence of TYLCV and cucumber vein virus and populations of the whitefly vector (Cohen and Melamed-Madjar 1978). In West Bengal, India, the incidence of yellow mosaic disease of okra was 24.3% in plots with yellow polythene mulch against 58.6% in control (Khan and Mukhopadhyay 1985).

Chemical Control of Whiteflies

Chemical control of whiteflies is both expensive and increasingly difficult. If the rate of whitefly re-infestation is great enough, the cost of effective insecticide treatments may be prohibitive. Besides the cost of treatment, other factors involved in chemical control decisions are the need for thorough coverage, the risk of secondary pest outbreaks, the risk of whiteflies developing insecticide resistance, and the regulatory restrictions on the use of insecticides. These factors have to be weighed against the expected returns for a given crop at a given planting date. Many systemic and contact insecticides have been tested for control of whiteflies, but few give effective control. Currently registered systemic insecticides, such as oxamyl, have been only partially effective. Certain contact insecticide combinations, especially pyrethroids such as fenpropathrin or bifenthrin plus organo-phosphates such as acephate or metamidophos, have provided excellent control in greenhouse and field studies as long as there was thorough coverage of the foliage. However, by exposing pest populations to two types of chemicals at once, combinations may accelerate selection for resistance to both materials. Therefore, tank mixes should be resorted to only when single applications are not effective. Other products with contact activity, such as oils, soaps and K-salts of fatty acids, can be very effective with thorough coverage, but in field tests they are often less effective because of poor coverage. Good coverage of the foliage with contact insecticides is essential for best results. Most whiteflies are located on the undersides of leaves where they are protected from overtop applications, and the immature stages (except for the crawler) are immobile and do not increase their exposure to insecticides by moving around the plant. Use drop nozzles where appropriate, adequate pressure, and calibrate and maintain equipment carefully. Specific insecticides should be selected according to the stage(s) of whitefly to be controlled. To minimize this potential problem, insecticide applications should be used judiciously and combined with non-chemical control tactics. Furthermore, distinct classes of chemical compounds should be rotated at least every other spray. Distinct classes of insecticide include the pyrethroids (Ambush, Asana, Danitol, Karate, etc.), organo-phosphates (Orthene, Monitor, Lorsban), carbamates (Vydate), chlorinated hydrocarbons (Thiodan), insect growth regulators (Applaud, fenoxicarb), oils, and soaps and detergents. Resistance to soaps and oils is unlikely to ever develop, so these materials should be used as much as possible.

The effectiveness of 19 insecticides and insecticides combinations against the Aleyrodid, *B. tabaci* were evaluated in Venezuela by Marcano and Gonzalz (1993) and they observed that the most effective insecticedes against eggs and nymphs of the pest were: Imidacloprid (91.67 and 78.61 litres/ha); Mineral oil +Imidacloprid (88.85 and 71.33litres/ha); Cyfluthrin + Methamidophos (87.85 and 69.08 litres/ha); Buprofezin (86.1 and 53.19 litres/ha); Lambda-cyhalothrin (86.1 and 47.47 liters/ha); Profnofos + Cypermethrin (85.93 and 70.18 litres/ha).

Imidacloprid (a systemic chloronicotinyl insecticide) gained major importance for control of *Bemisia tabaci* in both field and protected crops, in view of extensive resistance to Organophosphorous, Pyrethroid and Cyclodiene insecticides (Cahil *et al.* 1995).

Azam *et al.* (1997) conducted an experiment during 1993-95 with some insecticides (Carbofuran, Endosulfan, Dimethoate, Buprofezin and Triazophos) for the control of *B. tabaci* and yellow leaf curl bigeminivirus (TYLCV) and found that Endosulfan had the most affect to control *Bemisia tabaci.*

The plots treated with seed bed netting and two spray of Imidacloprid 200SL had the lowest number of Whitefly and it was statistically similar with the treatment seed bed netting with the spraying Nimbicidine and seed treatment only (Anon. 2005).

2.10 Origin and distribution of thrips

Thrips (order Thysanoptera) are minute, slender insects with fringed wings (thus the scientific name, from the Greek word *thysanos* ("fringe") + *pteron* ("wing").Other common names for thrips include thunder flies, thunder bugs, storm flies, thunder blights, storm bugs, corn flies and corn lice. (Tipping, 2008).

The word thrips is used for both the singular and plural forms, so there may be many thrips or a single thrips (Kobro and Sverre, 2011).

In general, thrips are very small insects (a few mm in length) with yellowish orange to brown in color. They belong to the order Thysanoptera and are distinguished from other insect orders by their fringed wings and “punch and suck” mouthparts (Lewis, 1997).

Thrips are unique in having only one mandible, the left one. The right one is resorbed by the embryo (Mound, 2005). The word thrips is from the Greek meaning "woodworm" (Kobro and Sverre, 2011; Kirk, 1996).

2.11 Nature of damage of thrips

Most thrips are phytophagous, but a few genera will feed on fungi or are considered predatory feeding on other thrips, mite adults and eggs, scale insects, and whiteflies (Mound and Teulon, 1995).

Thrips cause damage to their host plants directly through feeding and oviposition and indirectly through the spread of tospoviruses (Arevalo-Rodriguez, 2006). Thrips feed by “punching” into the plant tissue with their single mandible and sucking out cell contents with a pair of maxillary stylets (Lewis, 1997).

Thrips may also cause indirect damage by transmitting viruses or as passive carriers of fungal and bacterial spores (Childers and Achor, 1995).

Feeding causes cellular evacuation, necrosis, plasmolysis, and cellular collapse, which often spreads to nearby cells up to five cells deep. Some leaf feeding thrips can induce gall formation in plants (Mound, 2005). Feeding on inflorescences can cause drooping and discoloration of petals (Rhainds *et al.,* 2007).

Childers and Achor (1991) found that 73% of thrips larvae emerged from the pistil-calyx units of open flowers, which indicates a preference for these tissues. Ovipostion damage is localized and affects only cells directly adjacent to the oviposition site (Childers and Achor, 1991). Large numbers of thrips can cause economic damage and even abortion of flowers (Arevalo-Rodriguez, 2006).

Thrips prefer to feed on young plants and their ability to transmit diseases through their saliva while feeding. Larvae tend to cause more damage than adults because they occur in larger numbers and some species are gregarious (Childers, 1997). Their damage to crops includes stunted plant growth, leaf stippling, distortion, blemishes, slowed maturity, plant death, and reduction in yield and quality. Quite often, thrips damage is not readily apparent because effects are delayed; the pest may not even be present by the time damage is noticeable. Oviposition and feeding injury cause direct damage to crops (Childers, 1997).

In 2008, thrips caused an estimated loss of 2, 625 bales of cotton in Virginia (Herbert *et al.*, 2009). At the end of the 2007 tomato season, several large commercial growers reported millions of dollars in losses due to thrips feeding injury (Herbert *et al.*, 2009). In 2009, research showed a 12% yield loss from thrips in non-insecticide treated Virginia peanuts (Herbert *et al.*, 2009)

2.12 Review of literature on the extent of perception of different aspects

Kabir and Rainis (2012) conducted a study on farmers' perception on the adverse effects of pesticides on environment: the case of Bangladesh. The Results showed that an overwhelming majority (86.1 %) of the farmers had low to medium level of perception; while only 13.9% farmers had high perception regarding adverse effects of pesticides on environment.

Adeola (2012) conducted a study on perceptions of environmental effects of pesticides use in vegetable production by farmers in Ogbomoso, Nigeria. The Results showed that majority (85 %) of the farmers had low to medium level of perception; while only 15% farmers had high perception regarding environmental effects of pesticides use in vegetable production. Pal (2009) conducted a study on the perception of organic farmers regarding introduction of ICT in organic farming. The Results showed that more than half (54 percent) of the farmers perceived that organic products are superior to inorganic one.

Roy (2009) conducted a study on farmers' perception of the effect of IPM for sustainable crop production. The Results showed that most of the respondents (55.0 percent) had favorable perception while 23.75 percent and 21.25 percent of them had low favorable and medium favorable perception respectively. Majlish (2007) conducted a study on perception of participant women on social forestry program of BRAC. The findings revealed that most (59.0 percent) of the respondents had favorable perception while 30.0 percent and 11.0 percent of them had moderately favorable and unfavorable perception of social forestry program respectively. Afique (2006) stated that majority (97.5 percent) of the respondent rural women had favorable perception while only 2.5 percent had moderately favorable perception of the benefits of agricultural model farm activities of Sabalamby Unnayan Samity (SUS). Islam (2005) found in his study that 57.8 percent had high perception, 41.4 percent had moderate perception and only 0.8 percent had less perception about causes of monga. On the other hand, 91.4 percent of the respondents had high perception compared to 8.6 percent having moderate perception and none had less perception about remedies of monga in Kurigram district.

Sharmin (2005) conducted her study on rural women's perception of benefits of involvement in Income Generating Activities (IGAs) under a non government Organization (NGO) and she found that majority (91 percent) of the respondents had medium perception of benefit of involvement in IGAs under a NGO, while 9 percent had high perception of this issue.

Sayeed (2003) conducted a study on perception on farmer's benefits from using manure towards Integrated Nutrient Management (INM) for sustainable crop production. He found that 56.7 percent of the farmers had less favorable perception of benefit of using manure towards INM for sustainable crop production, while the rest 43.3 percent had favorable perception of this issue.

Chakraborty (2002) conducted a study on Sub Assistant Agriculture Officers' (former BS) perception of changes from mono rice culture to diversified crop cultivation. He reported that the highest proportion (68.0 percent) had high perception and 10.0 percent had low perception of changes.

Fardous (2002) showed that majority (95.5 percent) of the farmers perceived the forestry development activities moderately positive to highly positive effect of village and farm forestry program activities, while the rest 4.5 percent perceived in a less positive way.

Kabir (2002) observed that majority (65.0 percent) of the farmers had moderately favorable perception on the effect of Barind Integrated Area Development Project (BIADP) towards environmental upgradation where only 16.0 and 19.0 percent of them had low and highly favorable perception respectively on this issue.

2.13 Relationships between farmers' characteristics and their perception on the effect of IPM

2.13.1 Age and farmers' perception

Adeola (2012) conducted a study on perceptions of environmental effects of pesticides use in vegetable production by the farmers in Ogbomoso, Nigeria. Adeola found that age had a significant influence on the farmers' perception. Pal (2009) conducted a study on the perception of organic farmers regarding introduction of ICT in organic farming. Pal found that age had no significant relationship with farmer's perception. Roy (2009) stated that age had no significant relationship with farmer's perception.

Majlish (2007) conducted a study regarding perception of participant women on social forestry program of BRAC. The study revealed that the relationship between age and perception of social forestry program was negatively significant. Afique (2006) mentioned that there was no significant relationship between the age of the rural women and their perception of benefits of invovement in agricultural model farm project activities of Sabalam by Unnayan Samity (SUS). Islam (2005) found that age of the farmers had no significant relationship with their perception of causes und remedies of Monga in Kurigram district. Sharmin (2005) stated that age of the rural women had no significant relationship with the perception of benefits of involvement in IGAs under a NGO. Uddin (2004) conducted a study on perception of sustainable agriculture. The findings revealed that age of the respondents had negative significant relationship with their perception of sustainable agriculture. Sayeed (2003) found that age had negative relation with farmers' perception of benefit from using manure towards INM for sustainable crop production by the farmers. Ismail (1979), Chowdhury (2001) and Alom (2001) obtained similar type of findings in their respective studies. Kabir (2002) studied perception of farmers on the effects of integrated area development project towards environmental upgradation. The study revealed that there was no significant relationship between age and perception of environmental upgradation. Similar finding was obtained by Fardous (2002) in his study.

Islam (2000) stated that age of farmers had no significant relationship with their perception of the harmful effect of agro-chemical with regard to environmental pollution. Hossain (2000) and Parveen (1995) obtained similar result in their studies.

2.13.2 Education and farmers' perception

Kabir and Rainis (2012) conducted a study on farmers' perception on the adverse effects of pesticides on environment: the case of Bangladesh. They found that education had a significant influence on the farmers' perception. Adeola (2012) conducted a study on perceptions of environmental effects of pesticides use in vegetable production by farmers in Ogbomoso, Nigeria. The study revealed that education had a significant influence on the farmers' perception. Pal (2009) conducted a study on the perception of organic farmers regarding introduction of ICT in organic farming. The study revealed that education had a positive significant influence on the farmers' perception. Roy (2009) stated that education had a negative significant relationship with farmer's perception. Majlish (2007) found that the relationship between education of participant women and their perception of social forestry program of BRAC was positively significant. Afique (2006) mentioned negatively significant relationship between personal education of the rural women and their perception of benefits of involvement in agricultural model farm project activities of Sabalamby Unnayan Snmity (SUS).

Sharmin (2005) found that personal education of the rural women had significant positive relationship with their perception of benefits of involvement of IGAs under a NGO. Uddin (2004) concluded that the level education of the farmers had a significant positive relationship with their perception of sustainable agriculture.

Sayeed (2003) revealed that the education of the respondents had significant positive relationship with their perception from using manure towards Integrated Nutrient Management (INM) for sustainable crop production. Fardous (2002) found a significant positive relationship between education of the farmers' and their perception of the forestry development activities of Village and Farm Forestry Program (VFFP) towards sustainable forestry development.

Alom (2001) found that education of farmers ‘had a significant and positive relationship with their perception of Binamoog-5 as a summer crop. Majydyan (1996) and Sarker (1999) and Islam (2001) found similar type of result. But, Kashem and Mikuni (1998) did not find any relationship between education of farmers and their perception about benefit of using Indigenous Technical Knowledge (I TK).

2.13.3 Family size and farmers’ perception

Pal (2009) conducted a study on the perception of organic farmers regarding introduction of ICT in organic farming. The study revealed that family size had no significant relationship with farmer’s perception. Roy (2009) stated that family size had a positive significant relationship with farmer’s perception.

Majlish (2007) found that the relationship between family size of the participant women and perception of social forestry program of BRAC was non-significant and followed a negative trend. Afique (2006) found no significant relationship between family size of the rural women and their perception of benefits of involvement in agricultural model farm project activities of Sabalamby Unnayan Samity (SUS). Islam (2005) found that family size of the farmers had no significant relationship with their perception of both causes and remedies of Monga in Kurigram district. Sharmin (2005) in a study found that family size of the rural women had no significant relationship with their perception of benefits involvement of IGAs under a NGO. Uddin (2004) found that the family size of the farmers had no relationship with their perception of sustainable agriculture. Sayeed (2003) found that family size of farmers had no significant relationship with their perception of benefit from using manure towards Integrated Nutrient Management (INM) for sustainable crop production. Kabir (2002) in his study found that family size of farmers had negative relationship with their perception on the effects of BIADP towards environmental upgradation. Similar finding was also obtained by Alom (2001) in his study.

2.13.4 Annual family income and farmers' perception

Pal (2009) conducted a study on the perception of organic farmers regarding introduction of ICT in organic farming. The study showed that annual family income had no significant relationship with farmer's perception

Roy (2009) stated that annual family income had a positive significant relationship with farmer's perception. Majlish (2007) found that the relationship between family income of participant women and perception of social forestry program of BRAC was non-significant but followed a negative trend. Afique (2006) found no significant relationship between annual family income of the rural women and their perception of benefits of involvement in agricultural model farm project activities of Sabalamby Unnayan Samity (SUS). Islam (2005) found that annual income of the farmers had positive significant relationship with their perception regarding causes and remedies of Monga in Kurigram district. Uddin (2004) concluded that annual family income of the farmers had significant and positive relationship with their perception of sustainable agriculture. Sayeed (2003) found that annual family income of the farmers had a significant relationship with their perception of benefit from using manure towards Integrated Nutrient Management (INM) for sustainable crop production. Kabir (2002) found that there was non-significant relationship between annual family income of the farmers and their perception of the effects of BIADP towards environmental upgradation.

2.13.5 Farm size and farmers' perception

Adeola (2012) conducted a study on perceptions of environmental effects of pesticides use in vegetable production by farmers in Ogbomoso, Nigeria. The study revealed that household size had a non-significant influence on the farmers' perception.

Pal (2009) conducted a study on the perception of organic farmers regarding introduction of ICT in organic farming. The study revealed that farm size had no significant relationship with farmer's perception. Roy (2009) stated that farm size had negatively significant relationship with farmer's perception. Majlish (2007) revealed from her study that the relationship between farm size of participant women and perception of social forestry program of BRAC was non-significant and followed a positive trend. Afique (2006) stated that there was no significant relationship between family farm size of the rural women and their perception of benefits of involvement in agricultural model farm project activities of Sabalamby Unnayan Samity (SUS). Islam (2005) found that farm size of farmers had no significant relationship with their perception of both causes and remedies of Monga in Kurigram district. Sharmin (2005) found in her study that farm size of the rural women had no significant relationship with their perception of benefits of involvement in IGAs under a NGO. Uddin (2004) found that farm size of the farmers had significant and positive relationship with their perception of sustainable agriculture. Sayeed (2003) observed that farm size of the farmers had a significant positive relationship with their perception of benefit from using manure towards Integrated Nutrient Management (INM) for sustainable crop production.

Fardous (2002) found that there was no significant relationship between farm size of the farmers and their perception of Village and Farm Forestry Program (VFFP) towards sustainable forestry development. Hossain (2001), Hossain (1999) and Majydyan (1996) found similar findings in their respective studies.

2.13.6 Training received and farmers' perception on the effect of IPM practices

Kabir and Rainis (2012) conducted a study on farmers' perception on the adverse effects of pesticides on environment: the case of Bangladesh. They found that training had a significant influence on the farmers' perception. Pal (2009) conducted a study on the perception of organic farmers regarding introduction of ICT in organic farming. The study revealed that training received had a positive significant influence on the farmers' perception. Roy (2009) stated that training received had a positive significant relationship with farmer's perception. Majlish (2007) found from her study that the relationship between training experience of participant women and perception of social forestry program of BRAC was positively significant. Afique (2006) mentioned that there was no significant relationship between training exposure of the rural women and their perception of benefits of involvement in agricultural model farm project activities of Sabalamby Unnayan Samity (SUS). Sharmin (2005) reported from her study that training exposure of the rural women had no significant relationship with their perception of benefits of involvement in Income Generating Activities (IGAs) under a NGO.

Uddin (2004) from his study concluded that farmers' training exposure had a significant positive relationship with their perception of sustainable agriculture.

Kabir (2002) found that training experience of the farmers had a significant positive relationship with their perception of the effects of BIADP on environmental upgradation. Fardous (2002) observed that training exposure of the farmers was significantly correlated with the perception of the respondents of VFFP towards sustainable forestry development.

2.13.7 Organizational participation and farmers' perception

Pal (2009) conducted a study on the perception of organic farmers regarding introduction of ICT in organic farming. The study revealed that organizational participation had no significant relationship with farmer's perception. Roy (2004) stated that organizational participation had no significant relationship with farmer's perception. Uddin (2004) studied on fanners' perception of sustainable agriculture and concluded that organizational participation of the farmers had a significant positive relationship with their perception of sustainable agriculture.

Sayeed (2003) reported that organizational participation of the farmers had no significant effect on their perception of benefit from using manure towards INM for sustainable crop production. Fardous (2002) found that organizational participation of the farmers had significant positive relationship with their perception of VFFP towards sustainable forestry development. Chowdhury (2001) found a significant relationship between organizational participation and the impact of a forestation as perceived by the farmers.

Alom (2001) reported that organizational participation of the farmers had significant positive relationship with their perception of Binamoog-5 as a summer crop.

2.13.8 Knowledge on IPM practices and farmers' perception

Kabir and Rainis (2012) conducted a study on Farmers' Perception on the Adverse Effects of Pesticides on Environment: The Case of Bangladesh. They found that experience of farmers had a significant influence on the farmers' perception. Adeola (2012) conducted a study on perceptions of environmental effects of pesticides use in vegetable production by farmers in Ogbomoso, Nigeria. The study revealed that farming knowledge had a significant influence on the farmers' perception. Roy (2009) stated that knowledge on IPM practices had a positive significant relationship with farmer's perception. Majlish (2007) conducted her study regarding perception of participant women on social forestry program of BRAC. She found from her study that the relationship between knowledge on tree plantation and perception of social forestry program of BRAC was positively significant.

Uddin (2004) conducted his study on farmers' perception of sustainable agriculture. He found that knowledge of environment friendly farming had significant and positive relationship with their perception of sustainable agriculture. He further conduct environment friendly farming had higher perception of sustainable agriculture.

Furdous (2002) conducted a study and found that there was a significant positive relationship between knowledge of forestry of farmers and their perception of VFFP towards sustainable forestry development.

2.13.9 Constraints faced by the farmers in using IPM practices and farmers' perception

Pal (2009) conducted a study on the perception of organic farmers regarding introduction of ICT in organic farming. The study revealed that several constraints in using organic fertilizer had a significant influence on the farmers' perception.

Roy (2009) stated that majority (98.75 percent) of the respondent had high problem while only 1.25 percent had medium problem in using IPM.

2.13.10 Farmers' awareness about environmental pollution and farmers' perception

Pal (2009) conducted a study on the perception of organic farmers regarding introduction of ICT in organic farming. The study revealed that awareness of environmental degradation had a positive significant relationship with farmer's perception.

Majlish (2007) conducted her study regarding perception of participant women on social forestry program of BRAC. She found from her study that the relationship between knowledge on tree plantation and perception of social forestry program of BRAC was positively significant.

Uddin (2004) conducted his study on farmers' perception of sustainable agriculture. He found that knowledge of environment friendly faming had significant and positive relationship with their perception of sustainable agriculture. He further concluded that the respondents with higher knowledge of environment friendly farming had higher perception of sustainable agriculture

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 Study area

The survey was conducted in two selected major vegetable growing districts of Bangladesh namely Dhaka and Manikgonj and considering one upazila for Dhaka district and two upazila for Manikgonj district. Savar upazila under Dhaka district is an important area of potentiality for cucurbit vegetables production and that is why this upazila was purposively selected for the study. The study was also conducted in Manikganj sadar and Singair upazila under Manikganj district. The experimental site were situated in savar at 23.86 N latitude and 90.27 E longitude, in singair at 23.81N latitude and 90.13 E longitude, in Manikganj at 23.86 N latitrude and 90.00 E longitude. The Manikgang and Dhaka area represents the agro ecological zone of Young Brahmaputra and Jamuna Floodplain (AEZ 8).

3.2 Study design

3 (Three) upazilas were selected under two sampled districts and 25 vegetable growers were interviewed in each upazila through pre-tested questionnaire. Thus a total of 75 vegetable growers were interviewed from two sampled districts.

3.3 Study period

In the selected upazila there were a huge number of vegetable growers and most of them have a good experience as vegetable growers. As a part of survey total of 100 vegetable growers were interviewed and make a clear observation during the period from 23 November 2015 to 14 March 2016.

Plate 01: Farmer's field in Savar Upazila under Dhaka district (**A** &**B**)

The research instrument

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

- **Study indicators**

The researcher has proposed the following variables/indicators were considered:

1. Demographic : Name, age and sex
2. Social : Education and profession
3. Study related indicators :

- Farm size, cultivated different vegetable including cucurbits vegetable;
- Occurrence and severity of insect pests of cucurbits vegetable;
- Economic damage caused by these insect pests;
- Status of insect pests of cucurbits vegetable;
- Effective measures practiced by the farmers in controlling the insect pests of cucurbits vegetable;
- Suggestions for improving management options for controlling insect pests of cucurbits vegetable

Necessary corrections, additions, alternations, rearrangements and adjustments were made in the interviewed 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 1.

3.4 Data collection

Direct personal interview approach was adopted for collection of primary data. The researcher personally contacted with the vegetable growers in the respective upazila

Plate 02: Farmer’s field in Manikgonj Sadar under Manikgonj district (**A** &**B**)

under two selected major vegetable growing districts. When found the target vegetable growers and the researcher stared interview by explaining the objectives of the study to the vegetable growers. After getting vegetable growers, the researcher filled up each question of the questionnaire one by one and obtained desired information. The field level data collection was conducted for a period of cucurbits vegetable growing season. Several factors were to find out the influence of management practices on vegetables production during the study period considered.

Major insect pests of cucurbit vegetables were recorded through per the opinion and observation of the growers. The management procedures for controlling of these insect pests were identified with the opinion and observation in cucurbit vegetables field. During the study period data recorded on different insecticides that were used by growers in controlling these insect pests for vegetables cultivation, their cost as well as production and benefit cost ratio in cultivation. Thana Agricultural Officer (TAO) of each Thana in Dhaka and Manikganj district was visited and asked about insect pest status. Based on TAO information the respective location was visited to observe the insect pest status. Infested cucurbit vegetables and their infested parts like leaves, stems, tender shoot, flowers, fruits and root, were recorded separately. From these data percent infestation, percent plant parts infestation were calculated. Severity was classified as severe (above 50%), High (31-50%), Moderate (11-30%), Mild (5-10%), Low (1-4%), No infestation (0%).

After the completion of data collection, all filled up questionnaires were preserved according to the category of vegetable growers for processing and data analysis.

3.5 Calculation of survey data

Survey data was collected from leaf, stem, branch, inflorescence and fruit of infested host plant.. Percent plant infestation, percent plant parts infestation, number of insect will be calculated using the following formula:

$$\% \text{ Plant infestation} = \frac{\text{Total number of the infested host plant observed}}{\text{Total number of host plant observed}} \times 100$$

$$\%\text{Plant parts infestation} = \frac{\text{Total number of the infested plant parts observed}}{\text{Total number of infested host plant observed}} \times 100$$

$$\text{Number of insect per infested plant parts} = \frac{\text{Total number of insect per plant parts observed}}{\text{Total number of plant parts observed}} \pm \text{SE}$$

SE= Standard deviation

3.6 Benefit cost ratio analysis

Five cucurbit vegetable growers field were selected from the 3 (Three) upazilas under two sampled districts Dhaka and Manikgonj for determination benefit cost ratio of their cucurbit vegetables production. These purposes time to time visited selected cucurbit vegetable growers field and asked about their field status of the respective location. Collected information about using different pest management practices, chemical insecticides which used by the vegetable growers for pest management practices, percent of plant infestation, percent of fruit infestation, vegetables production cost and gross return of their vegetable productions. Then calculate the Benefit cost ratio (BCR) of different pest management practices and chemical insecticides which used by the vegetable growers.

3.7 Data processing and analysis

Data on different parameters were analyzed through SPSS version 20. As soon as collected from the field, the filled up questionnaires were coded and data entry were completed using SPSS and MS Access computer packages as well as the data were analyzed for tabulation of the primary data into data tables.

For impact assessment**,** PMPs (Pest Management Practices) and chemical insecticides used were identified on cucurbits vegetable insect pest management practices and their impacts were assessed. Respondents wise information of PMPs was analyzed by considering three recorded from each different PMPs and chemical used treated as replications. The data obtained for different characters were statistically analyzed to find out the significance of the different PMPs and chemical insecticides combination (ICs) used by the respondents' cucurbits vegetable growers infestation level, production cost, net return, benefit cost ratio and abundance of insect pest of the different PMPs and chemical insecticides combination (ICs). The mean values of all the characters were evaluated and analysis of variance was performing by the 'F' (variance ratio) test using MSTAT-C computer program. The significance of the difference among the different PMPs and chemical insecticides combination (ICs) for different characters were estimated by the Duncan's Multiple Range Test (DMRT) at 5% levels of probability (Gomes and Gomes, 1984).

Plate 03: Farmer's cucumber cultivated homestead land in Singair upazila under Manikgonj district

Plate 04: Farmer’s field in Singair upazila under Manikgonj district

CHAPTER IV

RESULTS AND DISCUSSION

In this chapter the findings of the study were presented in accordance with the objectives of the study and possible interpretation of the recorded information also presented. The chapter has four sections. The first section deals with the characteristics of the cucurbits vegetables growers. The second section deals with the damage severity of different organs of cucurbits vegetable. The third section deals with the different insect pest management practices for managing insect pests of cucurbits vegetable and their impacts on benefit cost ratio. The fourth section deals with the Chemical insecticides used for managing nursery insect pests of vegetables grower's field and their impacts on insect pests abundance.

4.1 Characteristics of the cucurbits vegetable growers

There are different interrelated characteristics and practices of the cucurbits vegetable growers which influence the distribution pattern of insect pests complex of cucurbits vegetable and their knowledge to perception of insecticide. It was therefore, hypothesized that these characteristics would have an effect on insect pests complex of cucurbits vegetable and farmer's knowledge to perception of insecticide. Among the various characteristics the most important nine as age, level of education, farm size, pest control training status, crops that being cultivated, vegetable crops that being cultivated, cucurbits crops that being cultivated, insect pests of cucurbits vegetables and infested plant parts of cucurbits vegetable crops were selected for this study. Character wise summary of descriptive statistics of the respondents are presented in Table 4.1.1 to 4.1.9.

4.1.1 Age of the cucurbits vegetable growers

The age of the cucurbits vegetable growers have been varied from 23 to 65 years with a mean and standard deviation is 25 and 10.82, respectively. Age of the cucurbits vegetable growers were classified into three categories as young, middle and old aged. Among the respondents, the highest (45.33%) respondents of cucurbits vegetable growers were middle aged followed by 37.33% were young aged and the lowest 17.33% were old aged category (Table 4.1.1).

Table 4.1.1 Distribution of the respondents' cucurbits vegetable growers according to their age

Categories	Respondents'		Mean	Standard deviation
	Number	Percent		
Young aged (below 35 years)	28	37.33	25	10.82
Middle aged (35-50 years)	34	45.33		
Old aged (above 50 years)	13	17.33		
Total	75	100		

4.1.2 Level of education of the cucurbits vegetable growers

The level of educational scores of the cucurbits vegetable growers ranged from 0 to 14 with a mean and standard deviation of 7.22 and 3.36, respectively. Level of education of the cucurbits vegetable growers were classified into four categories as can sign only, primary education, secondary education and above secondary education. Among the respondents, the highest (38.67%) cucurbits vegetable growers were educated at primary level, 28.00% were secondary level, 17.33%

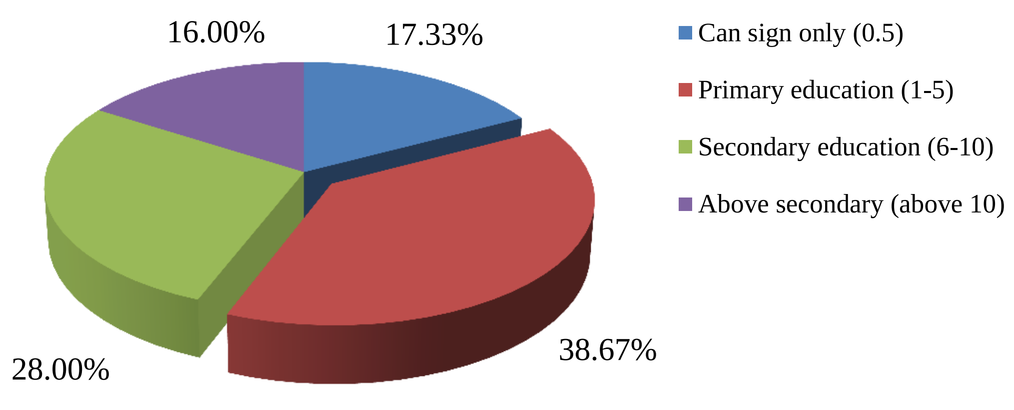

Figure 4.1. Level of education of the cucurbits vegetable growers

can sign only and only 16.00% were above secondary level educated (Figure 1).

4.1.3 Farm size of the cucurbits vegetable growers

The farm size of the respondent's cucurbits vegetable growers ranged from 0.32 ha to 2.34 ha with a mean and standard deviation of 25 and 9.64, respectively. Based on the farm size status the cucurbits vegetable growers were classified into three categories as marginal, small and medium size farmers. Among the respondents, the highest (48.00%) cucurbits vegetable growers have small farmers, where as 28.00% were medium farmer and 24.00% were marginal sized farmers in the study area (Table 4.1.3).

Table 4.1.3 Distribution of the respondents' cucurbits vegetable growers according to their farm size

Categories	Respondents'		Mean	Standard deviation
	Number	Percent		
Marginal (upto 0.2 ha)	18	24.00	25	9.64
Small (0.201-1.0 ha)	36	48.00		
Medium (1.01 to 3.0 ha)	21	28.00		
Total	75	100		

4.1.4 Pest control training status of the cucurbits vegetable growers

Mean and standard deviation of pest control training status of the respondent's cucurbits vegetable growers is 37.5 and 14.85, respectively. On the basis of pest control training status, the cucurbits vegetable growers were classified into two categories as received training and didn't receive training. The highest (64.00%) cucurbits vegetable growers received training on pest management and 36.00% have not received any training on pest management (Table 4.1.4).

Table 4.1.4 Status of the cucurbits vegetable growers according to their pest control training status

Categories	Respondents'		Mean	Standard deviation
	Number	Percent		
Received training	48	64.00	37.5	14.85
Didn't received training	27	36.00		
Total	75	100		

4.1.5 Knowledge on the use of insecticides of cucurbits vegetable growers

The score of the knowledge on the use of insecticides of the cucurbits vegetable growers could range from 0 to 3 with mean and standard deviation of 18.75 and 18.41, respectively. According to the status of knowledge on the use of insecticides of the cucurbits vegetable growers were classified into four categories as, no knowledge, low knowledge, medium knowledge and high knowledge. Among the respondent the highest (60.00%) cucurbits vegetable growers have moderate knowledge on insecticides followed by 24.00% in low knowledge. On the other hand, the lowest 6.67% cucurbits vegetable growers have no knowledge on insecticides followed by 9.33% who have high knowledge (Table 4.1.5).

Table 4.1.5 Distribution of the respondents' cucurbits vegetable growers according to their knowledge on insecticides

Categories	Respondents'		Mean	Standard deviation
	Number	Percent		
No knowledge	5	6.67	18.75	18.41
Low knowledge	18	24.00		
Moderate knowledge	45	60.00		
High knowledge	7	9.33		
Total	75	100		

4.1.6 Crops that being cultivated by the cucurbits vegetable growers

The score of the crops that cultivated by the cucurbits vegetable growers could range from 1 to 4 with mean and standard deviation of 18.75 and 6.02, respectively andthey were classified into four categories as, cereals and vegetables crops; cereals and fruit crops; cereal, vegetables and fruits crops; and cereal, vegetable, fruits and other crops. Among the respondent the highest (32.00%) cucurbits vegetable growers cultivated cereal, vegetable, fruits and other crops followed by 30.67% cultivated cereals and vegetables crops, while, the lowest 14.67% cultivated cereal, vegetables and fruits crops followed by 22.67% who cultivated cereals and fruit crops in their land (Table 4.1.6).

Table 4.1.6 Distribution of the respondents' cucurbits vegetable growers according to their crops that being cultivated

Categories	Respondents'		Mean	Standard deviation
	Number	Percent		
Cereal and vegetable crops	23	30.67	18.75	6.02
Cereal and fruits crops	17	22.67		
Cereal, vegetable and fruits crops	11	14.67		
Cereal, vegetable, fruits and other crops	24	32.00		
Total	75	100		

4.1.7 Vegetables crops that being cultivated by the cucurbits vegetable growers

The score of the vegetables crops that being cultivated by the cucurbits vegetable growers could range from 1 to 5 with mean and standard deviation of 15 and 13.84, respectively and they were classified into five categories as cucurbits; leafy vegetables, cucurbits and others; leafy vegetables and others; and cucurbits, leafy vegetables and others. Based on the vegetables crops that being cultivated, the highest (52.00%) respondent cultivated cucurbits vegetable only, 18.67% cultivated leafy vegetables only, whereas 13.33% cultivated leafy vegetables and others. On the other hand, the lowest 6.67% growers cultivated cucurbits and other vegetables followed by 9.33% and they cultivated cucurbits, leafy vegetables and others vegetable crops (Table 4.1.7).

Table 4.1.7 Distribution of the respondents' cucurbits vegetable growers according to their vegetables crops that being cultivated

Categories	Respondents'		Mean	Standard deviation
	Number	Percent		
Cucurbits	39	52.00	15	13.84
Leafy vegetables	14	18.67		
Cucurbits and others	5	6.67		
Leafy vegetables and others	10	13.33		
Cucurbits, leafy vegetables and others	7	9.33		
Total	75	100		

4.1.8 Cucurbits crops that being cultivated by the cucurbits vegetable growers

The score of the cucurbits crops that being cultivated by the cucurbits vegetable growers could range from 1 to 6 with mean and standard deviation of 12.5 and 8.46, respectively. Based on the cucurbits crops that being cultivated by the cucurbits vegetable growers were classified into six categories as, bottle gourd and bitter gourd; bottle gourd and sweet gourd; bitter gourd and sweet gourd; bottle gourd, bitter gourd and ash gourd; bottle gourd, sweet gourd and cucumber; and bottle gourd, sweet gourd and ash gourd. Among the respondent,

Table 4.1.8 Distribution of the respondents' cucurbits vegetable growers according to their cucurbits crops that being cultivated

Categories	Respondents'		Mean	Standard deviation
	Number	Percent		
Bottle gourd and bitter gourd	29	38.67	12.5	8.46
Bottle gourd and sweet gourd	11	14.67		
Bitter gourd and sweet gourd	12	16.00		
Bottle gourd, bitter gourd and ash gourd	8	10.67		
Bottle gourd, sweet gourd and cucumber	5	6.67		
Bottle gourd, sweet gourd and ash gourd	10	13.33		
Total	75	100		

the highest (38.67%) cucurbits vegetable growers cultivated bottle gourd and bitter gourd; 16.00% cultivated bitter gourd and sweet gourd, 14.67% cultivated bottle gourd and sweet gourd and 13.33% cultivated bottle gourd, sweet gourd and ash gourd. On the other hand, the lowest 6.67% cultivated bottle gourd, sweet gourd and cucumber followed by 10.67% who cultivated bottle gourd, bitter gourd and ash gourd as cucurbits vegetables (Table 4.1.8).

Table 4.1.9 Distribution of the respondents' cucurbits vegetable growers according to their opinion on insect pests of cucurbits vegetable crops that being cultivated

Categories	Respondents'		Mean	Standard deviation
	Number	Percent		
RPB + EB + FF + LEC	25	33.33	15	5.87
RPB + EB + WF + Ap+ FF + Tp	12	16.00		
RPB + EB + WF + Ap+ LEC + SB	15	20.00		
RPB + EB + Tp+ WF + Ap+ FF + JHC	10	13.33		
RPB + EB + FF + Ap+ JHC + LEC + SB	13	17.33		
Total	75	100		

RPB : Red pumpkin bettle
FF : Fruit fly
LEC : Leaf eating caterpillar
Ap : Aphid
Tp : Thrips
EB : Epilachna bettle
WF : White fly
SB : Stink bug
JHC : Jute hairy caterpillar
TB : Tortoise bettle

4.1.9 Insect pests of cucurbits vegetable crops

The score of the insect pests of cucurbits vegetable crops that being cultivated by the cucurbits vegetable growers could range from 1 to 5 with mean and standard deviation of 15 and 5.87, respectively. Generally cucurbits vegetable growers identified Red pumpkin bettle (RPB), Epilachna bettle (EB), Fruit fly (FF), White fly (WF), Leaf eating caterpillar (LEC), Stink bug (SB), Aphid (Ap), Jute hairy caterpillar (JHC), Thrips (Tp) and Tortoise bettle (TB) insects pests in their cucurbits vegetable crops. Based on the insect pests of cucurbits vegetable crops that being cultivated by the cucurbits vegetable growers were classified into five categories based on their observation as RPB + EB + FF + LEC; RPB + EB +

WF + Ap+ FF + Tp; RPB + EB + WF + Ap+ LEC + SB; RPB + EB + Tp+ WF + Ap+ FF + JHC; and RPB + EB + FF + Ap+ JHC + LEC + SB (Table 4.1.9). Among the respondents the highest (33.33%) observed RPB + EB + FF + LEC insect pests in their cucurbits field, 20.00% observed RPB + EB + WF + Ap+ LEC + SB insect pests and 17.33% observed RPB + EB + FF + Ap+ JHC + LEC + SB. On the other hand, the lowest 13.33% cucurbits growers observed RPB + EB + Tp+ WF + Ap+ FF + JHC insect pests followed by 16.00% RPB + EB + WF + Ap+ FF + Tp insect pests in their cucurbits crop.

Table 4.110 Distribution of the respondents' cucurbits vegetable growers according to their opinion on infested plant parts due to insect pests of cucurbits vegetable crops that being cultivated

Categories	Respondents'	
	Number	Percent
Leaf + Fruit	17	22.67
Leaf + Tender shoot + Fruit	7	9.33
Leaf + Stem + Flower +Fruit	11	14.67
Leaf + Stem +Tender shoot + Fruit	8	10.67
Leaf + Stem +Tender shoot + Flower	10	13.33
Leaf + Stem +Tender shoot + Flower +Fruit	22	29.33
Total	75	100

4.1.10 Infested plant parts due to insect pests of cucurbits vegetable crops

Cucurbits vegetable growers identified infested plant parts due to insect pests are as six categories namely, Leaf + Fruit; Leaf + Tender shoot + Fruit; Leaf + Stem + Flower +Fruit; Leaf + Stem +Tender shoot + Fruit; Leaf + Stem +Tender shoot + Flower; and Leaf + Stem +Tender shoot + Flower +Fruit (Table 4.1.10). Among the respondent the highest (29.33%) cucurbits vegetable growers identified Leaf + Stem +Tender shoot + Flower +Fruit as infested plant parts; 22.67% identified Leaf + Fruit as infested plant parts, 14.67% identified Leaf +

Stem + Flower +Fruit as infested plant parts and 13.33% identified Leaf + Stem +Tender shoot + Flower as infested plant parts. On the other hand, the lowest 9.33% identified Leaf + Tender shoot + Fruit as infested plant parts followed by 10.67% identified Leaf + Stem + Tender shoot + Fruit as infested plant parts.

4.2 Damage severity of different organs of cucurbits vegetable

Damage severity of different organs of cucurbits vegetables was assessed. Based on the infestation damage severity were assessed in the category of 1: Severe infestation (above 50% infestation); 2: High infestation (31-50% infestation); 3: Moderate infestation (11-30% infestation); 4: Mild infestation (5-10% infestation); 5: Low infestation (1-4% infestation) and6: No infestation (0% infestation). Organ wise infestation level due to different insect pest were presented in Table 4.2.1.

In case of leaf infestation score, the highest infestation level score (5.40) was recorded due to white fly which was statistically similar (5.04, 4.88 and 4.60) to red pumpkin beetle, jute hairy caterpillar and stink bug that is closely followed (1.40) by leaf eating caterpillar, thrips and tortoise beetle, whereas no infestation level score (0.00) were recorded for fruit fly and cutworm (Table 4.2.1). For stem infestation score, the highest infestation level score (2.80) was recorded due to jute hairy caterpillar which was followed (2.40) by sting bug, while no infestation level score (0.00) were recorded for red pumpkin beetle, fruit fly and cutworm. In tender shoot infestation score, the highest infestation level score (3.60) was recorded due to jute hairy caterpillar which was statistically similar (3.20) to sting bug that is closely followed (3.00 and 2.80) by tortoise beetle, red pumpkin beetle and epilachna beetle. On the other hand, no infestation level score (0.00) were recorded for fruit fly. For flower infestation score, the highest infestation level score (3.80) was found for white fly which was statistically similar (3.68 and 3.48) to stink bug and jute hairy caterpillar, while the no infestation level score (0.00) were recorded for cutworm. In case of fruit

Table 4.2.1 Damage severity of different organs of cucurbit vegetables by the different insect pests

Insects of cucurbits vegetables	Infestation level score of						Status
	Leaf	Stem	Tender shoot	flower	Fruit	Root	
Red pumpkin beetle	5.04 a	0.00 d	2.80 bc	2.72 c	0.00 f	1.30 b	Major
Epilachna beetle	3.56 b	1.60 c	2.80 bc	1.40 e	0.00 f	0.00 c	Moderate
Fruit fly	0.00 d	0.00 d	0.00 e	0.80 f	5.16 a	0.00 c	Major
White fly	5.40 a	2.00 c	3.00 b	3.80 a	0.80 d	0.00 c	Major
Leafeating caterpillar	1.40 c	1.80 c	2.40 d	2.16 d	3.88 b	0.00 c	Minor
Aphid	4.28 ab	2.00 c	3.00 b	2.52 c	1.60 c	0.00 c	Major
Jute hairy caterpillar	4.88 a	2.80 a	3.60 a	3.48 ab	0.40 e	0.00 c	Major
Stink bug	4.60 a	2.40 b	3.20 ab	3.68 ab	0.00 f	0.00 c	Major
Thrips	1.40 c	1.80 c	2.60 cd	2.60 c	0.00 f	0.00 c	Minor
Jassids	3.00 b	1.80 c	2.40 d	2.20 c	1.40 c	0.00 c	Moderate
Tortoise beetle	1.40 c	2.00 c	3.00 b	3.24 bc	0.00 f	0.00	Minor
Cut worm	0.00 d	0.00	0.00 e	0.00 g	0.00 f	5.36 a	Major
$LSD_{(0.05)}$	0.813	0.382	0.396	0.439	0.322	0.524	
CV(%)	10.01	12.84	7.81	10.97	5.34	11.05	

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

1: Severe infestation (above 50% infestation); 2: High infestation (31-50% infestation)

3: Moderate infestation (11-30% infestation) 4: Mild infestation (5-10% infestation)

5: Low infestation (1-4% infestation) 6: No infestation (0% infestation)

infestation score, the highest infestation level score (5.16) was recorded due to fruit flywhich was followed (3.88) by leaf eating caterpillar, whereas no infestation level score (0.00) were recorded for red pumpkin beetle, epilachna beetle, stink bug, thrips, tortoise beetle and cutworm. For root infestation score, the highest infestation level score (5.36) was found for cut worm which was followed (1.30) by red pumpkin bettle, while the no infestation level score (0.00) were recorded for all the insect pests except cutworm and red pumpkin beetle.

Cucurbits are one of the most important summer vegetables crop in Bangladesh (Rahman, 2005). Red pumpkin beetle (RPB), *Aulacophora foveicollis*(Lucas) is one of the most important constraints to cucurbit production capable of 30-100% yield loss (Dhillon *et al*., 2005; Gupta and Verma, 1992).

4.3 Different insect pest management practices for managing insect pests of cucurbits vegetable and their impacts on benefit cost ratio during the study period

Accordingly, the study reveals a total of 6 PMPs (Pest Management Practices) as PMP_1: Chemical control; PMP_2: Chemical and Mechanical control; PMP_3: Chemical, Mechanical and Cultural control; PMP_4: Chemical, Mechanical and Pheromone trap; PMP_5: Chemical and Field sanitation control; and PMP_6: Chemical, Mechanical control and Field sanitation; were practices as insect pest management by the cucurbits vegetable growers which may be designated as follows:

PMP_1	Chemical control
PMP_2	Chemical and Mechanical control
PMP_3	Chemical, Mechanical and Cultural control
PMP_4	Chemical, Mechanical and Pheromone trap
PMP_5	Chemical and Field sanitation
PMP_6	Chemical, Mechanical control and field sanitation

4.3.1 Plant infestation

For the management of insect pests, the highest plant infestation was recorded from PMP_1 (11.86%) followed by PMP_2 (7.94%) and then PMP_3 (7.14%), while the lowest plant infestation was observed from PMP_6 (3.94%) which was statistically similar (4.94%) to PMP_4 which was followed by PMP_5 (5.47%) (Table 4.3.1). Management of this pest can be done using different chemical, botanical, mechanical control measure or the integration of these control measures (Mehta and Sandhu, 1990; Xue *et al.*, 2006; Sami and Shakoori, 2008).

4.3.2 Fruit infestation

Due to different pest management practices, the highest fruit infestation was recorded from PMP_1 (15.02%) which was followed by PMP_2 (9.51%) and then PMP_3 (8.14%), whereas the lowest fruit infestation was observed from PMP_6 (5.38%) which was statistically similar (5.84%) to PMP_4 which was followed by

PMP_5 (7.19%) (Table 4.3.1). The most commonly used method for controlling red pumpkin beetle in Bangladesh is the application of insecticides (Karim, 1992; Anonymous. 1994).

Table 4.3.1 Pest management practices and their effects on vegetable seedlings and plants infestation in the vegetable grower's fields

Practices	Plant infestation (%)	Fruit infestation (%)	Production cost (BDT/ha)	Gross return (BDT/ha)	Benefit cost ratio (BCR)
PMP_1	11.86 a	15.02 a	164,405 c	306,000 f	1.86 d
PMP_2	7.94 b	9.51 b	171,146 b	321,000 e	1.88 d
PMP_3	7.14 b	8.14 bc	189,122 a	372,000 b	1.97 c
PMP_4	4.94 cd	5.84 de	171,146 b	363,000 c	2.12 b
PMP_5	5.47 c	7.19 cd	164,405 c	354,000 d	2.15 b
PMP_6	3.94 d	5.38 e	171,146 b	396,000 a	2.31 a
$LSD_{(0.05)}$	1.149	1.701	2816.55	3871.65	0.042
CV(%)	9.60	11.40	7.75	9.34	6.33

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.3.3 Production cost

For the management of insect pests, the highest production cost per hectare was recorded from PMP_3 (BDT 189,122) followed by PMP_2, PMP_4 and PMP_6 (BDT 171,146), while the lowest production cost was observed from PMP_1 and PMP_5 (BDT 164,405) (Table 4.3.1).

4.3.4 Gross return

In different pest management practices, the highest gross return per hectare was recorded from PMP_6 (BDT 396,000) which was followed by PMP_5 (BDT 372,000), whereas the lowest gross return was observed from PMP_6 (BDT 306,000) which was followed by PMP_2 (BDT 321,000) (Table 4.3.1).

4.3.5 Benefit cost ratio

For the management of insect pests, the highest benefit cost ratio was recorded from PMP_6 (2.31) followed by PMP_5 (2.15) and PMP_4 (2.12), while the lowest benefit cost ratio was observed from PMP_1 (1.86) which was statistically similar to PMP_2 (1.88) and closely followed by PMP_3 (1.97) (Table 4.3.1).

Data revealed that highest net return was recorded from the combination of Chemical, Cultural control and Field sanitation practices required the moderate production cost than the sole chemical for management of insect pests of cucurbits vegetable growers.

4.4 Chemical insecticides used for managing insect pests of cucurbits vegetable and their impacts on insect pests abundance

The insecticides combination (ICs) for pest management of cucurbit vegetables as reported by the entire location together was primarily into different group. Accordingly, the study reveals a total of 7 ICs for pest management of cucurbit vegetables, which may be designated as follows:

IC_1	Sevin 85D
IC_2	Suntaf Folithion 50Ec
IC_3	Sumialpha Animire 200SL
IC_4	Sevin 85D + Syfanon 57 EC
IC_5	Sevin 85D + Marshal 20EC
IC_6	Folithion 50EC + Rogor 40L
IC_7	Sevin 85D + Folithion 50Ec + Rogor 40L

4.4.1 Plant infestation

For the management of insect pests through chemicals, the highest plant infestation was recorded from IC_1 (15.56%) followed by IC_2 (6.67%) and then IC_3 (5.56%), while the lowest plant infestation was observed from IC_7 (1.11%) which was statistically similar to IC_6 (2.22%) (Table 4.4.1).

4.4.2 Fruit infestation

For the management of insect pests through chemicals, the highest fruit infestation was recorded from IC_1 (18.89%) followed by IC_2 (10.00%) and then IC_3 and IC_4 (7.78%), while the lowest fruit infestation found from IC_7 (4.44%) which was statistically similar to IC_6 (5.56%) and IC_5 (6.67) (Table 4.4.1).

Table 4.4.1 Chemical insecticides used by the farmers' for pest management of cucurbit vegetables and their impacts on benefit cost ratio during the study period

Insecticide combinations	Plant infestation (%)	Fruit infestation (%)	Production cost (BDT/ha)	Gross return (BDT/ha)	Benefit cost ratio (BCR)
IC_1	15.56 a	18.89 a	186,389 f	230,400 g	1.24 c
IC_2	6.67 b	10.00 b	189,422 e	258,000 e	1.36 c
IC_3	5.56 bc	7.78 bc	190,433 d	238,800 f	1.25 c
IC_4	4.44 bcd	7.78 bc	190,883d	259,200 d	1.36 c
IC_5	3.33 bcd	6.67 c	193,916 c	401,400 b	2.07 b
IC_6	2.22 cd	5.56 c	194,927 b	379,800 c	1.95 b
IC_7	1.11 d	4.44 c	196,163 a	453,600 a	2.31 a
$LSD_{(0.05)}$	3.087	3.021	512.55	827.34	0.185
CV(%)	14.31	20.70	12.33	9.55	7.33

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability

4.4.3 Production cost

In case of the management of insect pests through chemicals, the highest production cost per hectare was recorded from IC_7 (BDT 196,163) which was followed by IC_6 (BDT 194,927) and then IC_5 (BDT 193,916), while the lowest production cost was found from IC_1 (BDT 186,389) which was followed by IC_2 (BDT 189,422) (Table 4.4.1).

4.4.5 Gross return

Due to the management of insect pests through chemicals, the highest gross return per hectare was recorded from IC_7 (BDT 453,600) which was followed by

IC_5 (BDT 401,400) and then IC_6 (BDT 379,800), whereas the lowest gross return was found from IC_1 (BDT 230,400) which was followed by IC_3 (BDT 238,800) (Table 4.4.1).

4.4.6 Benefit cost ratio

For the management of insect pests through chemicals, the highest benefit cost ratio was recorded from IC_7 (2.31) which was followed by IC_5 (2.07) and then IC_6 (1.95) and they were statistically similar, while the lowest benefit cost ratio was found from IC_1 (1.24) which was statistically similar to IC_3 (1.25), IC_2 (1.36) and IC_4 (1.36) (Table 4.4.1).

CHAPTER V

SUMMARY AND CONCLUSION

Seventy five growers of greater Dhaka and Manikganj district were selected for conducting the study. As a part of survey, total of 75 growers were interviewed and make a clear observation through a questionnaire survey during the period from November 2015 to May 2016. Objective-oriented, structured questionnaires were used to identify socio-economic status of the vegetable growers, intensity of infestation, major insect pests in cucurbits vegetable and use of different insecticides for managing these insect pests for specific seedlings or saplings species were surveyed through a semi structured questionnaire.

In case of different interrelated characteristics of the vegetable growers, among the respondents, the highest (45.33%) respondents of cucurbits vegetable growers were middle aged followed by 37.33% were young aged and the lowest 17.33% were old aged category. On the otherwise, among the respondents, the highest (38.67%) cucurbits vegetable growers were educated at primary level, 28.00% were secondary level, 17.33% can sign only and only 16.00% were above secondary level educated. Based on the farm size status, the highest (48.00%) cucurbits vegetable growers have small farmers, where as 28.00% were medium farmer and 24.00% were marginal sized farmers in the study area and on the basis of pest control training status, the highest (64.00%) cucurbits vegetable growers received training on pest management and 36.00% have not received any training on pest management. Based on the crops that cultivated by the cucurbits vegetable growers, the highest (32.00%) cucurbits vegetable growers cultivated cereal, vegetable, fruits and other crops followed by 30.67% cultivated cereals and vegetables crops and the lowest 14.67% cultivated cereal, vegetables and fruits crops**.** Based on the vegetables crops that being cultivated, the highest (52.00%) respondent cultivated cucurbits vegetable only, 18.67% cultivated leafy vegetables only, whereas 13.33% cultivated leafy vegetables and others. On the other hand, the lowest 6.67% growers cultivated cucurbits and other vegetables**.** Among the respondent the highest (38.67%) cucurbits vegetable growers cultivated bottle gourd and bitter gourd; 16.00% cultivated bitter gourd and sweet gourd, 14.67% cultivated bottle gourd and sweet gourd and 13.33% cultivated bottle gourd, sweet gourd and ash gourd. On the other hand, the lowest 6.67% cultivated bottle gourd, sweet gourd and cucumber followed by 10.67% who cultivated bottle gourd, bitter gourd and ash gourd as cucurbits vegetables. However, based on the infestation damage severity were assessed in the category of 1: Severe infestation (above 50% infestation); 2: High infestation (31-50% infestation); 3: Moderate infestation (11-30% infestation); 4: Mild infestation (5-10% infestation); 5: Low infestation (1-4% infestation) and6: No infestation (0% infestation).

For the management of insect pests, the highest plant infestation was recorded from PMP_1 (11.86%) while the lowest plant infestation was observed from PMP_6 (3.94%) which was statistically similar (4.94%) to $PMP_{4.}$ Due to different pest management practices, the highest fruit infestation was recorded from PMP_1 (15.02%) whereas the lowest fruit infestation was observed from PMP_6 (5.38%). For the management of insect pests, the highest production cost per hectare was recorded from PMP_3 (BDT 189,122) while the lowest production cost was observed from PMP_1 and PMP_5 (BDT 164,405). In different pest management practices, the highest gross return per hectare was recorded from PMP_6 (BDT 396,000) and for the management of insect pests, the highest benefit cost ratio was recorded from PMP_6 (2.31). For the management of insect pests through chemicals, the highest plant infestation was recorded from IC_1 (15.56%) and In case of the management of insect pests through chemicals, the highest production cost per hectare was recorded from IC_7 (BDT 196,163). Due to the management of insect pests through chemicals, the highest gross return per hectare was recorded from IC_7 (BDT 453,600). For the management of insect pests through chemicals, the highest benefit cost ratio was recorded from IC_7 (2.31) and the lowest benefit cost ratio was found from IC_1 (1.24). Among the vegetable growers practices chemical, mechanical, cultural and field sanitation (NP5) were suitable in terms of insect pests control and benefit cost ratio (BCR); From this study it was observed that considering management practices and benefit cost ratio, vegetable growers prefer to using insecticides for controlling insect pest of cucurbits vegetable and the highest proportion 60% of the vegetable growers possessed moderate level knowledge, whereas 9.33% who have high level knowledge and 6.67% have no knowledge in using insecticide against those insect pest of cucurbit vegetables.

RECOMMENDATION

Based on the findings it may be recommended that-

- For the highest benefit from cucurbit vegetable business IPM practices would be more effective in controlling insect pests of vegetables and also attaining highest benefit;
- Combination of different pesticides as chemical control would be more appropriate for management of cucurbits insect pests;
- For final recommendation more vegetable growers need to be included in the survey system

CHAPTER VI

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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 AND DOCUMENTATION OF INSECT PESTS COMPLEX OF CUCURBIT VEGETABLES IN SELECTED AREA AND FARMER'S MANAGEMENT PRACTICES"

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. Sex: (Code: 1= Male, 2=Female) ☐

3. Educational level

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

a) Do not know reading and writing …………….☐
b) Can you sign only ………….☐
c) I Read upto class ………….☐.

5. Professional: **[**Code: 1=Large farmer, 2=Medium farmer,

3=Small farmer and 4=Marginal farmer**]**

☐ ☐ ☐ ☐

6. Farm size: please give information of the area of your utilizing land

SL NO.	Land use type	Area of Land	
		Local unit	Hectare
1.	Homestead area (including pond, garden etc)		
2.	Own land under own cultivation		
3.	Land given others on borga		
4.	Land taken from others on borga		
5.	Land given others on lease		
6.	Land taken from others as lease		
7.	Fallow land (if any please specity)		
Total			

7. Pest control training status

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

a) Received pest control training……………………………………………☐

b) Did not received pest control training……………………………………☐

8. Knowledge on the use of insectaries:

Please give the tick mark against appropriate answer)

	Name of insecticides	Dose	Mode of application	For which insects	Summary
1.					No knowledge ☐ Low knowledge ☐ Medium knowledge ☐ High Knowledge ☐
2.					
3.					
4.					

9. Crops being cultivated

Write down the code number of the following box: [Code: 1=Cereal crops, 2=Vegetables, 3=Fruits and 4=others]

SL.No.	Types of cultivated Crops	Amount of Production (Mon/shatoc) [1 Mon=40 Kg
1.		
2.		
3.		
4.		

10. If Vegetables cultivated: Please put the code number in the following boxes [Code 1= Cucurbits (eg. Cucumber, Bottle gourd etc.), 2=Leafy vegetables and others=3]

a) Cucurbits ☐

b) Leafy vegetables ☐

c) Others ☐

11. Types of Cucurbits Vegetables are being cultivated: (Please give tick mark against appropriate answer)

i) Bottle gourd ………………… ☐

ii) Bitter gourd ………………… ☐

iii) Ash gourd ………………… ☐

iv) Sweet gourd ………………… ☐

v) Cucumber ………………… ☐

vi) Squash ………………… ☐

vii) Others ………………… ☐

12. List of insect / insect pests of Cucurbits Vegetables are being cultivated: (Please give tick mark against appropriate answer)

i) Red pumpkin bettle ……………………… ☐

ii) Epilachna bettle ………………………… ☐

iii) Fruit fly …………………………… ☐

iv) White fly ……………………………… ☐

v) Leaf eating caterpillar ………………… ☐

vi) Stink bug ……………………………… ☐

vii) Aphid ……………………………… ☐

viii) Jute hairy caterpillar ………………… ☐

ix) Thrips ………………………………… ☐

x) Tortoise bettle ………………………….. ☐

xi) Lady bird bettle (natural enemy)………. ☐

xii) Ants (natural enemy)…………………… ☐

xiii) Others ………………………………… ☐

13. Plant parts affected by of insect pests of Cucurbit Vegetables: (Please give tick mark against appropriate answer)

i) Leaf …………………….. ☐

ii) Stem …………………………… ☐

iii) Tender shoot …………………………… ☐

iv) Flower ……………………………….. ☐

v) Fruit ……………….. ………………….. ☐

vi) Root…………………………………….. ☐

14. Severity of damage (level of infestation) by of insect pests of Cucurbit Vegetables: Please put the code number in the following blank boxes [Code 1= Severe (above 50%), 2=High (31-50%), 3=Moderate (11-30%), 4 = Mild (5-10%), 5=Low (1-4%) and 6=No infestation (0%]

Insects of Cucurbit Vegetables	**Affected Plant parts by of insect pests of Cucurbit Vegetables**					
	Leaf	Stem	Tender shoot	Flower	Fruit	Root
Red pumpkin bettle						
Epilachna bettle						
Fruit fly						

White fly						
Leaf eating caterpillar						
Aphid						
Jute hairy caterpillar						
Stink bug						
Thirips						
Tortoise bettle						
Lady bird bettle (natural enemy)						
Ants (natural enemy)						

15. Please give information about the Source(s) of Seeds or Seedling of Cucurbit Vegetables:

16. Pest control training status

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

c) Received pest control training...☐

d) Did not received pest control training...................................☐

17. 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)					
2	Agriculture Extension Officer (AEO)					
3	Assistant Agriculture Extension Officer (AAEO)					

4	Sub Assistant Agril. Officer (SAAO)					
5	Field worker of NGOs					
6	Dealer of Agril. Commodities					
7	Progressive farmers					
8	Neighbors					

18. 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)

19. If use of chemical insecticides to control insect pest of Cucurbit vegetables: Please answer the following questions

Insects of Cucurbit vegetables	Impact of the use of the chemical insecticides				
	Plant infestation (%)	Fruit infestation (%)	Production Cost (BDT/ha)	Net return (BDT/ha)	Benefit Cost-ratio (BCR)
Red pumpkin bettle					
Epilachna bettle					
Fruit fly					

White fly					
Leaf eating caterpillar					
Aphid					
Jute hairy caterpillar					
Stink bug					
Thirips					
Tortoise bettle					
Others					

Thank you for giving your valuable time.

Signature of the Farmer

Signature of the Interviewer

Date: