INCIDENCE OF RED PUMPKIN BEETLE AND FRUIT FLY ON DIFFERENT VARIETIES OF SWEET GOURD

SHAKIL AHMED

DEPARTMENT OF ENTOMOLOGY

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

DHAKA-1207

JUNE, 2016

INCIDENCE OF RED PUMPKIN BEETLE AND FRUIT FLY ON DIFFERENT VARIETIES OF SWEET GOURD

BY

SHAKIL AHMED

Reg. No.: 10-04044

A Thesis
Submitted to the Department of Entomology,
Sher-e-Bangla Agricultural University, Dhaka
In partial fulfillment of the requirements
for the degree
of

MASTER OF SCIENCE (MS)
IN
ENTOMOLOGY

SEMESTER: JANUARY - JUNE, 2016

APPROVED BY:

Dr. Mst. Nur Mohal Akhter Banu
Associate professor
Department of Entomology
SAU, Dhaka-1207.
Supervisor

Dr. Md. Abdul Latif
Professor
Department of Entomology
SAU, Dhaka-1207.
Co-Supervisor

Dr. Mst. Nur Mohal Akhter Banu
Chairman
Examination Committee

DEPARTMENT OF ENTOMOLOGY

Sher-e-Bangla Agricultural University

Sher-e-Bangla Nagar, Dhaka-1207

Ref. No. : Date :

CERTIFICATE

This is to certify that the thesis entitled **"INCIDENCE OF RED PUMPKIN BEETLE AND FRUIT FLY ON DIFFERENT VARIETIES OF SWEET GOURD"** submitted to the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **ENTOMOLOGY**, embodies the result of a piece of *bona fide* research work carried out by **SHAKIL AHMED**, Registration No. **10-04044** 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 been duly acknowledged.

Dated: June, 2016

Dhaka, Bangladesh

____

Dr. Mst. Nur Mohal Akhter Banu

Department of Entomology

Sher-e-Bangla Agricultural University,

Dhaka-1207

Supervisor

Dedicated To

My Beloved Parents

ACKNOWLEDGEMENT

The author deems it a much privilege to express his enormous sense of gratitude to the almighty creator for there ever ending blessings for the successful completion of the research work.

The author feels proud to express his deep sense of gratitude, sincere appreciation and immense indebtedness to his supervisor **Dr. Mst. Nur Mohal Akhter Banu**, Associate professor, Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka, for his continuous guidance, cooperation, constructive criticism and helpful suggestions, valuable opinion in carrying out the research work and preparation of this thesis, without his intense co-operation this work would not have been possible.

The author feels proud to express his deepest respect, sincere appreciation and immense indebtedness to his co-supervisor Professor **Dr. Md. Abdul Latif,** Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka, for his scholastic and continuous guidance during the entire period of course, research work and preparation of this thesis.

The author expresses his sincere respect to Chairman, Dr. Mst. Nur Mohal Akhter Banu, Examination committee, Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka, for valuable suggestions and cooperation during the study period and also expresses his heartfelt thanks to all the teachers of the Department of Entomology, SAU, for their valuable teaching, suggestions and encouragement during the period of the study.

The author expresses his sincere appreciation to his father Md. Amirul Islam, beloved mother Shahida Islam, friends and well-wisher.

June, 2016 ***The Author***

SAU, Dhaka

INCIDENCE OF RED PUMPKIN BEETLE AND FRUIT FLY ON DIFFERENT VARIETIES OF SWEET GOURD

ABSTRACT

The experiment was conducted in the central farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from April to July, 2015 to find out the incidence of red pumpkin beetle and fruit fly on different varieties of sweet gourd. Seven varieties of sweet gourd. V_1: Sweet Queen V_2: Pronoy F_1 (hybrid), V_3: Thai Sweet, V_4: Big Boss, V_5: Monika, V_6: Shokti and V_7: Syndrila were the experiment material. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. Data on infestation level of different growth stages were recorded to find out the tolerant variety of sweet gourd for better production. The maximum infestation occurred by Red pumpkin beetle in Thai sweet (32.00 %) variety followed by Pronoy F_1 (20.00 %) variety. On the other hand the minimum infestation percentage occurred in Big Boss (5.00 %) and Shokti (5.00 %) variety. Big Boss and Shokti varieties were found less susceptible to the Red pumpkin beetle than the other varieties. Maximum infestation caused by cucurbit fruit fly were in Thai sweet (23.00 %) and Pronoy F_1 (23.00 %) varieties and the minimum infestation occurred by fruit fly was found in Shokti (2.00 %) variety. Shokti variety also showed the lowest susceptible to cucurbit fruit fly. Shokti (V_6) variety is less susceptible to the red pumpkin beetle and cucurbit fruit fly than the other varieties and it gave better results on growth and yield (25.23 t/ha) of sweet gourd.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

ABBREVIATIONS	ELABORATIONS
AEZ	Agro-Ecological Zone
Anon.	Anonymous
ANOVA	Analysis of Variance
@	at the rate of
a.i	Active ingredient
Adv.	Advanced
Agron .	Agronomy
Agric.	Agriculture Agricultural
Agril.	Agricultural
BRRI	Bangladesh Rice Research Institute
BARI	Bangladesh Agricultural Research Institute
SAU	Sher-e-Bangla Agricultural University
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
RCBD	Randomized Complete Block Design
CV	Coefficient of Variation
cv.	Cultivar
EC	Emulsifiable Concentrate
cm	Centimeter
df	Degrees of Freedom
DAS	Days After Sowing
LSD	Least significance difference
et al.	and others
etc.	etcetera
FAO	Food and Agricultural Organization
Fig	Figure
ns	Non-Significant

ABBREVIATIONS	ELABORATIONS
J.	Journal
PP.	Pages
g	Gram
ha^{-1}	Per hectare
t	Ton
%	Percent
m^2	Square meter
pod^{-1}	Per pod
J.	Journal
kg	Kilogram
No.	Number
NS	Non Significant
NOS	Number of species
^0C	Degree Celsius
Res.	Research
RH	Relative humidity
WCE	Weed control efficiency
SRDI	Soil Resource Development Institute
Sci.	Science 's
HI	Harvest Index
Vol.	Volume

CHAPTER I

INTRODUCTION

Bangladesh is predominantly an agriculture based country. But it has a huge deficit in vegetable production. Total annual vegetable production of Bangladesh is 1.6 million M tones in winter and 1.5 million M tones in summer season while the cultivated area of Bangladesh 0.47 million acres in winter and 0.65 million acres in summer season (BBS, 2012). The consumption of vegetable in Bangladesh is about 50 g day^{-1} $capita^{-1}$ which is the lowest amongst the countries of South Asia and South Africa (Rekhi 1997). But dietitian recommended a daily allowance of 285 g vegetable for an adult person for a balance diet (Ramphall and Gill 1990). Here people have been suffering from inadequate supply of vegetables since decades. As a result, chronic malnutrition is often seen in Bangladesh.

A large number of cucurbit vegetables, viz., bottle gourd, bitter gourd, sweet gourd, snake gourd, white gourd, ridge gourd, sponge gourd, kakrol, cucumber etc. are grown in Bangladesh. Cucurbits occupy 66 per cent of the land under vegetable production in Bangladesh and contribute 11 percent of total vegetable production in the country and 77 thousand tons in the summer season of 2006-2007 (BBS, 2010). The major vegetables are cucurbits and they play a prime role to supplement this shortage during the lag period (Rashid, 1993).

Among the different winter cucurbit vegetables, sweet gourd or pumpkin is a tender tendril bearing and vine like plant from genus Cucurbita belonging to the family Cucurbitaceae of gourd family. There are three common types of pumpkin worldwide, namely Curcurbita pepo, Curcurbita maxima and C. moschata and were originally domesticated in Mexico, South America, and the eastern U.S. (Tecson, 2001). Pumpkin is the best among cucurbits and having the highest economic worth (Paris *et al*. 2008). Sweet gourd or pumpkin is very versatile in their uses for cooking. Most parts of the pumpkin are edible, including the fleshy shell, the seeds, the leaves, and even the flowers. When ripe, the pumpkin can be boiled, baked, steamed, or roasted. The young and tender shoots make good vegetable salads. Leaves and even flowers could be used as vegetables which are rich in various nutrients (Gopalan *et al.* 1982). It provides good source of energy to the people. Pumpkin is a vegetable that fulfill the needs of healthy nourishment (Kadam *et al.* 2014). Its seeds are admirable cradle of protein and furthermore having the pharmacological properties such as antifungal, anti-diabetic and anti-inflammation characteristics (Nkosi *et al.* 2006). The seed extracts have been used as an antidiabetic, antitumor, antibacterial, anti-cancer and antioxidant (Cl *et al.*2006).

Red pumpkin beetle *Raphidopalpa foveicollis* L. and Cucurbit fruit fly viz., *Bactrocera* (Dacus) *cucurbita*ae and *Bactrocera* (Dacus) *caudatus* are the most damaging insect pests. Different sweet gourd or pumpkin varieties are attacked by a number of insect pests and among the various insect pests, Cucurbit fruit fly viz., *Bactrocera cucurbita*ae and *Bactrocera caudatus* are *Aulacophora foveicollis* (Lucas) are commonly found in Bangladesh (Alam *et al.*, 1964). Other species like *Bactrocera cucurbitae, Bactrocera tou* and *Dacus ciliata* have been currently identified in Bangladesh of which *Dacus ciliata* is a new recorded. Red pumpkin beetle *Raphidopalpa foveicollis L.* which has been reported as the most destructive one by Butani and Jotwani(1984). The pest is common in the South-East Asia, Africa as well as in Mediterranean region towards west and Australia in the East (Mckinlay *et al*. 1992). The beetles may kill cucurbit seedlings and sometimes the crops have to be re-sown of 3-4 times (Azim 1996). It may cause up to 70% damage on leaves and 60% damage on flowers of cucurbits (Alam, 1969). The red pumpkin beetle, *Aulacophora foveicollis* (Lucas) is a common, serious and major destructive insect pest of a wide range of cucurbitaceous vegetables and plays a vital role on their yield reduction. It is injurious to the crops and cause severe damage to almost all cucurbits (Hassan, 2012). Shivalingaswamy *et al*. (2008) reported that the maximum population of RPB was active in the month of May. They also reported that such increasing and decreasing trends in red pumpkin beetle population might be due to changes in food availability. Abe *et al*. (2002) reported that the difference in responses the leaf beetle species to cucurbitacin is possibly related to the host range of the beetle species.

Fruit fly, *Bactrocera cucurbitae* (Coquillett) is another major pest causing yield loss in cucurbits, and infests all kinds of cucurbit vegetables grown in Bangladesh (Rakshit *et al.,* 2011). A major constraint of improved cucurbit production is high rate of fruit fly infestation. Fruit flies reduce yield as well as the quality of the fruits (Anon., 2004). The Cucurbit fruit fly, *B. cucurbitae* represents 74.5% of the total number of flies infesting different vegetables growing areas in Bangladesh (Akhtaruzzaman *et al.,* 1999). It prefers young, green, and tender fruits for egg laying. The females lay the eggs 2 to 4 mm deep in the fruit pulp, and the maggots feed inside the developing fruits. At times, the eggs are also laid in the corolla of the flower, and the maggots feed on the flowers. The fruits attacked in early stages fail to develop properly, and drop or rot on the plant. Since, the maggots damage the fruits internally.

Farmers usually spray chemical pesticides many times during the crop season to control insect pests. This leads to environmental pollution with consequent of increased health hazard to the growers and consumers. Moreover, it also leads to the development of resistance to target pests with negative effects on natural enemies, other beneficials and causes disruption of biodiversity.

So it is badly needed to explore different alternate method against these insect pests, which is relatively free from adverse side effects. Among the various alternatives, the exploitation of host plant resistant is perhaps the most effective, convenient, economical and environmentally acceptable method of insect pest control. At present, effective control techniques other than insecticide application against insect pests of agricultural crops are highly demanding. In view of this requirement an experiment was conducted to find the tolerant Sweet gourd varieties against red pumpkin beetle and fruit fly with the following objectives.

- To find out the incidence of red pumpkin beetle and cucurbit fruit fly on different varieties of sweet gourd.
- To evaluate different sweet gourd tolerant varieties against red pumpkin beetle and cucurbit fruit fly.
- To evaluate varietal performance against the infestation of Red pumpkin beetle and Cucurbit fruit fly.

CHAPTER II

REVIEW OF LITERATURE

Sweet gourd is an important vegetable crop in Bangladesh. Red pumpkin beetle, *Aulacophora foveicollis* (Lucas) and Cucurbit Fruit fly are most damaging insect pest of sweet gourd. It causes great yield reduction, which is considered as an important obstacle for economic production of these crops. Substantial works have been done globally on this pest regarding their origin and distribution, Host range, Life cycle, Nature of damage, Rate of infestation and yield loss by fruit fly, Seasonal abundance and Management. But published literature on this pest especially on its infestation status and management are scanty in Bangladesh. Literatures cited below under the following headings and sub-headings reveal some information about the present study.

2.1 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, *Aulacophora 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.

2.2 Host preference of red pumpkin beetle

Alam *et al* (1964) reported that bitter gourd, cucumber, snake gourd, sweet gourd, bottle gourd and many others plants are found to be seriously damaged by the red pumpkin beetle. He also indicated that melon, ribbed gourd, sponge gourd, snake gourd, cucumber, teasle gourd and kankri (*Cucumis utilissimus*) are also attacked by RPB in Bangladesh. Pradhan (1969) has reported that the RPB has a special preference for the leaves of cucurbit plants except those of the bitter gourd on which they have not been reported to feed to any appreciable extent.

Azim (1966) reported that the insect feeds on tomato, maize and lucerne besides cucurbits in Greece. In addition, the pest was recorded to attack forest trees like *Dalbergia latifolia, Michela champaca* and *Tectona grandis* in India. He also reported that this insect was found to feed on rice plants in Indo-China. Butani and Jotwani (1984) reported that this beetle is a polyphagous pest and prefers cucurbit vegetables and melons. However, some leguminous crops are found as their main alternate hosts.

According to Rahman and Annadurai (1985), the RPB is particularly severe pest of pumpkins, muskmelons and bottle gourds, but it appears to be able to feed on any available cucurbits. They also reported that when cucurbits are absent, it is found feeding on other plant families.

According to Uddin (1996), *Aulacophora* sp. is a serious pest of sweet potato and cucurbits attacking cucumber, melons and gourds. Leaves of snake gourd plants at their flowering and fruiting stage were found to be severely damaged by a group of even more than 20 beetles per leaf at Bangladesh Agricultural Research Institute (BARI) farm, Joydebpur, Gazipur.

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, *Aulacophora 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. In the present study sweet gourd and wax gourd were found to be the most preferred host of red pumpkin beetle and bitter gourd was found as non-preferred host of RPB. The highest percentage of leaf area damage per plant was observed on sweet gourd leaves followed by wax gourd. The lowest percentage of leaf area damage per plant was on snake gourd leaves followed by sponge gourd and bitter gourd.

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; sweet gourd, muskmelon and cucumber were susceptible to the pest. They also observed that banana squash, muskmelon, sweet gourd, bottle gourd were the preferred hosts of the adults, while cucumber, white gourd/ash gourd, chinese okra, bitter gourd, snake gourd, watermelon and sponge gourd achieved the second order of preference to the beetle, *Aulacophora foveicollis.*

The incidence of the red pumpkin beetle, *Aulacophora foveicollis* (Lucas), on three cucurbits remained throughout the crop growing season which was reported by Thapa and Neupane (1992). Infestation was high on watermelon (6-24 adults/plant) followed by bottle gourd (4-19 adults/plant) and pumpkin (5-10 adults/plant). Among ten species of cucurbits tested in seedling stage under free choice condition, bitter gourd seedlings were completely free from the beetle damage while muskmelon (80.63% damage) and longmelon (71.69% damage) were highly preferred and snake gourd (7.63% damage) and ash gourd (13.88% damage) seedlings were the least preferred. Bottle gourd, sweet gourd, cucumber, pumpkin, sponge gourd and water melon were intermediate types. Depending on the environmental conditions and susceptibility of the crop species, the extent of damage by red pumpkin beetle varies between 30 to 100% (Gupta and Verma, 1992; Dhillon *et al*, 2005).

Borah (1999) studied the seasonality and varietal preference of red pumpkin beetle on sweet gourd and recorded highest number of beetles in rainy season (June) in all the three varieties with 3.6 – 4.2 beetles/ plant and 39.2 – 46.6 per cent plant damage fallowed by summer crop with 2.8 beetles/ plant and 33.6 per cent plant damage and winter season with 2.1 beetles/ plant and 21.1 per cent plant damage.

Vandana *et al* (2001) studied the host preference of red pumpkin beetle, *A. foveicollis* among five cucurbits *viz.,* sweet gourd, ash gourd, sponge gourd, snake gourd and cucumber, in which sweet gourd was identified as the most susceptible and highly preferred host to red pumpkin beetle and cucumber was recognized as less susceptible and preferred host to the pest.

Gameel (2013) observed in a survey of arthropods associated with cucurbit crops during 2011 and 2012 at the New valley in Egypt and found the existence of insect species belong to 25 genera under 20 families of 9 orders. The important cucurbit fruit flies, *Bactrocera zonata*, *Dacus ciliatus*, *D. frontalis* and *Dacus* sp. (Tephritidae: Diptera) and *Baris granulipennis* (Curculionidae: Coleoptera) were recorded as pests on the fruits of cucurbit plants in the New Valley. The common associated natural enemies inhabiting cucurbit fields were *Coccinella septempunctata* L.; *Chrysoperla carnea* Steph. and *C. undecimpunctata aegyptiaca* Reiche. Whereas *Ooencyrtus* sp. was recorded as a key egg parasitoid of the black melon bug.

Picault (2014) reported that the aphid, *Aphis gossypii* and the thrips, *Thrips tabaci* can cause severe damage, the first on cucurbit vegetables and the second on *Allium* crops. Nath and Thakur (1965) conducted an experiment to evaluate the resistance of gourds against red pumpkin beetle, *Aulacophora foveicollis,* in which lines of ridge gourd were NR 1, NR 2, NR 4, NR 5 and NR 7, lines of sponge gourd were NS 7, NS 10, NS 11, NS 12, NS 14, NS 16 and NS 17, lines of sweet gourd were NB 19, NB 21, NB 22, NB 25, NB 28, NB 29, NB 30 and NB 33. All the lines were found response varies from each other against red pumpkin beetle, *Aulacophora foveicollis*.

Pal *et al* (1978) evaluated 287 indigenous and exotic pumpkin germplsam for resistance to red pumpkin beetle and observed that although no entry was immune, yet rate of damage varied from 1.0 to 5.0. Low cucurbitacin content of the cotyledonary leaves was found to impart resistance to this pest and the two lines/collection numbers 596-2 and 613 contained low cucurbitacin content as 0.005 and 0.010 per cent, respectively showed less susceptibility. Pareek and Kavadia (1993) evaluated seventeen sweet gourd varieties for resistance to red pumpkin beetle infestation and revealed that none of the variety showed resistance, but found significant variations. Among the varieties, Hales Best Jumbo, Jaune Canari, Faradin, Amco Sweet and Honey Dew Golden showed lower susceptibility. Sharma (1999) carried out studies on host preference by red pumpkin beetle and observed highest plant damage in musk melon (15.32%) followed by sweet gourd (7.11), long melon (6.1), and ridge gourd (3.10), whereas bitter gourd was found totally free from any damage by the beetle. Borah (1999) also evaluated three varieties for resistance to red pumpkin beetle and observed lower infestation and maximum yield in AAUC-1.

Satpathy (2002) conducted an experiment and screened sixteen bottle gourd (*Lagenaria siceraria*) germplasms for the degree of infestation by the red pumpkin beetle in Varanasi, Uttar Pradesh, India. In each germplasms, 5 male and 5 female flowers were randomly selected at the peak of the flowering period, and the numbers of red pumpkin beetles were counted. The average beetle population flower among all germplasms was 0.56, with the highest (1.34) and the lowest (0) values being recorded for VRBG-91 and VRBG-91, respectively. There were significant differences in the number of beetles recorded on male (1.04) and female (0.07) flowers, indicating that male flowers were preferred by red pumpkin beetles due to the pollens on which most of the adult survive. Gill (2003) evaluated four melon cultivars *viz.* Punjab Sunehri, MM-28, Punjab Rasia and Hara Madhu under field conditions in Punjab, India against the hadda beetles (*Epilachna dodecastigma* and *Epilachna vigintioctopunctata*), red pumpkin beetle (*R. foveicollis*). The lowest adult populations of both hadda beetle and red pumpkin beetle were recorded on MM-28, and the highest on Punjab Rasila and Hara Madhu. Damage due to feeding by hadda beetles was observed at the early stage of plant growth in all the cultivars, but subsequently the plants grew well.

Saljoqi and Khan (2007) studied the relative abundance of red pumpkin beetle, *Aulacophora foveicollis* L. on different cucurbitaceous vegetables. Out of eleven varieties, squash and cucumber varieties were found more population of red pumpkin beetle during the cropping season. Two cucumber (*Cucumis sativus*) varieties, F1-beitalpha, SK-marketmore and two squash (*Cucurbita pepo*) varieties, light green zucchini, local round green were found susceptible to the attack of the red pumpkin beetle.

Rathod *et al* (2009) conducted an experiment on red pumpkin beetle, *Aulacophora foveicollis* Lucas to check out the susceptibility of pumpkin cultivars. They tested six different cultivars against the beetle for their susceptibility; cultivars were APKL-2, APKL-4, APKL-6, APKL-7, APKL-00-06 and local variety.Among six genotypes of pumpkin screened, genotype APKL-7 and APKL-attacked by less number of beetles, whereas the cultivars APKL-6 and APKL-4 received more number of red pumpkin beetle.

Pal *et al* (1978) evaluated 287 indigenous and exotic pumpkin germplsam for resistance to red pumpkin beetle and observed that although no entry was immune, yet rate of damage varied from 1.0 to 5.0. Low cucurbitacin content of the cotyledonary leaves was found to impart resistance to this pest and the two lines/collection numbers 596-2 and 613 contained low cucurbitacin content as 0.005 and 0.010 per cent, respectively showed less susceptibility.

Grewal and Sandhu (1983) carried out laboratory studies on orientation and feeding responses of beetle to cucurbits and revealed that the beetles were not attracted to bitter gourd and wild melon. Summer squash and pumpkin were found more preferred. Sandhu and Grewal (1985) tested the cucurbits for infestation by red pumpkin beetle and reported that cucurbits exhibited higher injury ratings under multiple choice test except for the pumpkin which showed higher injury under no choice test, whereas 16 musk melon variety Bangan Muktsar and summer squash variety Australian Green showed minor injury under no choice test. Among cucurbits, bitter gourd was found highly resistant; cucumber, musk melon and water melon moderately resistant; round melon and wild melon susceptible to this pest. According to Roy and Pande (1991) red pumpkin was the most preferred and sponge gourd the least out of seven cucurbits offered red pumpkin beetle. In a study on influence of cucurbitacins on the feeding activity of red pumpkin beetle under laboratory conditions.

Singh *et al* (2000) who observed the maximum beetle intensity (0.49) was on musk melon followed by on round gourd (0.44), on cucumber, water melon and long melon 0.40, but bitter gourd was found free from infestation. Among eleven cucurbit vegetables, bitter gourd was not preferred and musk melon most preferred food by the beetle.

Host preference of red pumpkin beetle, *Aulacophora foveicollis* (Lucas) was studied by Deepak *et al* (2004) on sixty-eight indigenous germplasm lines of sweet gourd during 2002. These germplasm lines were grown in randomized block design with three replications. Data were collected on 12 infestation by red pumpkin beetle on plants at different stages like cotyledonary, true leaf, flowering and fruiting of crop. Eight germplasm lines (PCUC7, PCUC36, PCUC47, PCUC66, PCU99, PCUC102, PCUC108 and PCUC110) showed resistance against red pumpkin beetle. These genotypes may be for used in future resistance breeding in sweet gourd. A field experiment was conducted by Shivalingaswamy *et al* (2008) at Research Farm of Indian Institute of Vegetable Research, Variance during 2001-2002 (summer). Twenty seven diverse genotypes including some popular cultivars of sweet gourd were sown in plots (3 m x 2 m) with three replications. After 15 days of germination, the damage level in terms of damaged leaf area was recorded on newly "merging seedlings at 4-6 leaf stages. The findings indicated that none of the genotypes and cultivars was free from the infestation by red pumpkin beetle. The average damage leaf area among test cultivars varied from 17.45% in VRBG-50 to 34.32% in NDBG-56. Only four cultivars that recorded less damage were VRBG-50 (17.45%), VRBG-48 (17.79), VRBG-43 (17.83%), VRBG-17 (18.31 %). On the other extreme, the cultivars manifesting greater susceptibility to the beetle damage were NDBG-56 (34.32%), PSPL (33.77%), DVBG-2 (1) (29.17%) and VRBG-46 (28.55%).

Aslam *et al* (2017) conducted for the evaluation of different pumpkin cultivars against Red Pumpkin Beetle *Aulacophora foveicollis* L. (Chrysomelidae: Coleoptera) at University Research Farm Koont, during 2016. The data regarding number of eggs, larvae and adult population on Bottle Gourd Lattu and Bottle Gourd varieties with 0.26 and 0.23 number of eggs per leaf while 0.31 and 0.22 larvae population per leaf and maximum population of adults with 0.26 and 0.18 per leaf were recorded respectively. The minimum population of eggs, larvae and adult were recorded on Round Gourd Hybrid-F1 with 0.08, 0.06 and 0.05 per leaf respectively

Kamal *et al* (2013) carried out that effect of host and temperature on oviposition and food consumption of red pumpkin beetle (RPB), *Aulacophora foveicollis* (Lucas). Three cucurbitaceous vegetables viz. sweet gourd (BARI Misti Kumra-1, BARI Misti Kumra-2 and Local Misti Kumra), bitter gourd (BARI Karola-1, Taj Karola-88 and Local Karola) and bottle gourd (BARI Lau-3, BARI Lau -4 and Local Lau) were selected to conduct this research.

Host plants had the clear role on the feeding of red pumpkin beetle. Due to feeding of A. foveicollis, the highest percentage of weight loss of leaf was recorded from sweet gourd among the selected cucurbits while Local Misti Kumra was found the most preferred host by beetle considering their feeding efficacy compared to other varieties Percentage weight loss of leaves due to the feeding of red pumpkin beetle on nine selected varieties showed that the highest percentage of weight loss was on Local Misti Kumra (15.34%) followed by BARI Misti Kumra-1 (12.92%) and BARI Misti Kumra-2 (12.78%).

2.3 Damage caused by red pumpkin beetle

Khan (2013) studied to determine the biochemical composition of cucurbit leaves and their influence on red pumpkin beetle. Result revealed that the highest nitrogen content was found in young leaf (6.79%) of sweet gourd .The highest quantity of reducing sugar was estimated from mature leaves (4.01%) of sweet gourd. Relationship of RPB population per leaf with the percent nitrogen, total and reducing sugar content of mature leaves of cucurbits was found positively correlated.

Kabir *et al* (1991) reported yield losses due to red pumpkin beetle infestation at seedlings stage varies in different fruits and vegetables and it was minimum in bitter gourd (19.19%) and maximum in sweet gourd (69.96%).Atwal (1993) found the red pumpkin beetle, *Aulacophora foveicollis* Lucas (Coleoptera: Chrysomelidae) was common and serious pest of a wide range of cucurbits, such as ash gourd (*Benincasa hispida*), pumpkin (*Cucurbita pepo* L.), tinda (*Citrullus vulgaris* var. *fisulosus*), ghia tori (*Luffa aegyptica*), cucumber and melon.

Anonymous (1930) stated that in Bombay, research was performed on red pumpkin beetle and reported it to be the serious pest of the crop that is a more or less constant pest . It becomes sporadically serious on young tender shoots, leaves and flowers of various cucurbits. Experiment was carried out to check the damage, different life stages and effective control measures of the red pumpkin beetle on cucurbitaceous vegetable, those are comparatively safe, health friendly and easily available in local eco-system. In the experiment the span of different stages of the pest was monitored at field conditions under laboratory conditions at variable temperatures and humidities conditions. Different agronomic, chemical and non- chemical control measures were applied for the control of Aulacophora foveicollis. These control measures were ploughing and planking operations, application of kerosine oil, road dust, wood dust, fine tobacco dust or snuff, wood and cowdung ash, spray of led-arsenate and water spray for the control.

Melamed-Madjae, V., (1960) reported that melamed-Madjae performs an experiment to study Aulacophora (Rhaphidopalpa) foveicollis (Lucas) adults feeding on the fruits and leaves of cucurbits in Israel, as in other Mediterranean countries. An investigation was done during 1955-57 and revealed that the adults of this beetle hibernate. Females beetle oviposit in May-August and egg stage last about 10, larval stage about 20 and pupal stage 16 days at 28°C [82.4°F.]. Egg laying capacity of female ranges from 100 to 800.

2.4 Seasonal abundance of Red Pumpkin Beetle

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 plant 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 was recorded in the month of May.

Begum (2002) studied on sweet gourd, ash gourd, sponge gourd, snake gourd and cucumber against the fruit fly and red pumpkin beetle to identify the less and most preferred cucurbit host. The incidence of red pumpkin beetle was evident from early morning to sunset with the maximum number occurring within 8:00-9:00 am with the highest peak at 9:00 am on all the cucurbit plants. Their population gradually declined with lowest beetle density at noon up to 2:00 pm. The number of beetle density gradually increased with gradual progress of the daytime toward sundown to sunset. In the afternoon the maximum occurrence of red pumpkin beetle was observed within 5:00-6:00 PM with the highest peak at 6:00. On the contrary, cucumber was recognized as less susceptible and less preferred host for both the pests with significantly lower damage inflicted.

Yamaguchi (1983) Reported that the Cucurbits; Cucumber (Cucumis sativus), Muskmelon (Cucumis melo), Watermelon (Citrullus lanatus), Gourd (Lagenaria siceraria) Squash (Cucurbita pepo), Bitter Gourd (Momordica charentia) are tender annuals, grown for their fruits, thrive only in hot weather and would not with stand frost. All these vegetables belong to the same family, (Cucurbitaceae), having homogenous cultural requirements and almost, same diseases and same insect pests. Most of them are monoecious some are andromonoecious and some are dioecious. They thrive well with mean optimum temperature of 18-30 C 0 (68-85 F 0). All are harvested as immature fruits and are ready for harvest within 3-7 days. Usual storage temperature require 7-13 C 0 with relative humidity 85-95% for 14 days to 4-6 months. Cucurbits are attacked by a number of insect pests, including striped cucurbit beetle, 12 spotted cucumber beetles, squash bug, squash vine borers, melon aphids and Red Pumpkin Beetle. The Red Pumpkin Beetle, Aulacophora 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 resown. 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.

Kamal *et al*. (2012) reported that effect of temperature on oviposistion of red pumpkin beetle among different crops. The egg laying performance on three cucurbits at different controlled temperatures varied significantly. The maximum number of egg was laid at 30ºC temperature followed by 25ºC and the lowest at 15ºC. At 30ºC temperature, the maximum number of egg was laid on the sweet gourd (19.89) followed by bottle gourd (14.78) and minimum egg was laid on the bitter gourd (8.89). At 25ºC temperature,no egg was laid on bitter gourd whereas the highest number of eggs (17.0) was laid on sweet gourd followed by bottle gourd (11.11). At 15ºC temperature, no egg was laid on bitter gourd by RPB and the highest (9.78) was found on sweet gourd followed by bottle gourd (7.67). Among three temperature 30ºC was the optimum for the beetle oviposition where they laid maximum number of eggs.

According to Gupta and Verma, (1992) and Dhillon et al. (2005), depending on the environmental conditions and susceptibility of the crop species, the extent of damage by red pumpkin beetle varies between 30 to 100%. To manage this serious pest it is necessary to study the effect of host and temperature on the feeding and oviposition of red pumpkin beetle. Borah (1999) studied the seasonality and varietal preference of red pumpkin beetle on sweet gourd and recorded highest number of beetles in rainy season.

2.5 Origin and distribution of cucurbit 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). In the

Commonwealth of the Northern Mariana Islands, it was detected in 1943 and eradicated by sterile-insect release in 1963 (Steiner *et al* 1965; Mitchell 1980), but re-established from the neighboring Guam in 1981 (Wong *et al*, 1989). It was detected in Nauru in 1982 and eradicated in 1999 by male annihilation and protein bait spraying, but was re-introduced in 2001 (Hollingsworth and Allwood 2002). Although it is found in Hawaii, it is absent from the continental United States (Weems and Heppner 2001). In July 2010, fruit flies were discovered in traps in Sacramento and Placer counties.

The distribution of a particular species is limited perhaps due to physical, climatic and gross vegetational factors but most likely due to host specificity. Such species may become widely distributed when their host 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. 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 (Fletcher 1987; Cavalloro 1983; Drew and Hooper 1983; Munro 1984).

Amongst these, *Bactrocera cucurbitae* (Coquillett) is a major threat to cucurbits (Shah *et al*, 1948). Senior-White (1924) listed 87 species of Tephritidae in India. Amongst these, the genus, *Bactrocera* (Dacus) causes heavy damage to fruits and vegetables in Asia (Nagappan *et al*, 1971). 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 Aktheruzzaman (1999) *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*.

2.6 Host preference of Cucurbit fruit Fly

The melon fly, *B. cucurbitae* (Coq.) is a polyphagous fruit fly that infests as many as 125 plant species most of them belong to Cucurbitaceae and Solanaceae (Dhillon *et al*, 2005; Doharey, 1983; Bezzi, 1913). Presently, four Asian Bactrocera species- *Bactrocera cucurbitae, B. invadens, B. latifrons and B.zonata* Invaded Africa (Mwatawala, *et al,* 2010; White, 2006; Lux *et al,* 2003). Studies so far have shown that although these invasive Bactrocera species are polyphagous, they show preference in host utilization. the host range of B. invadens in Africa comprises 72 plant species spread across 28 families (Goergen *et al*, 2011; Ekesi *et al*, 2006; Vayssieres *et al*, 2005). In West and Central Africa, B. invadens is highly polyphagous, infesting wild and cultivated fruit of at least 46 species from 23 families with guava, mango and citrus being the preferred hosts. *Terminalia catappa* (Tropical almond), *Irvingia gabonensis* (African wild mango), and *Vitellaria paradoxa* (Sheanut) are important wild hosts with high infestations (Goergen *et al*, 2011). In Tanzania, *B. invadens* was found to infest 15 fruit species of which the major commercial fruits: Mango, Loquat and guava were the preferred hosts. Other major hosts were Flacourtia indica (Governor’s plum) and Annona muricata (Soursop) (Mwatawala *et al*, 2010). *B. latifrons* have been found to utilize 12 Solanaceous fruit species and 3 cucurbit species in Tanzania (Mziray *et al*, 2010). According to them, *Solanum incanum, S. sodomeum* (Sodom apple) and *Lycopersicon pimpinellifolium* (Cherry tomato) were recorded as wild hosts, the rest were cultivated hosts.

The study revealed that *S. nigrum* (Black nightshade), *S. anguivi* (African eggplant) and *S. scabrum* was the preferred host; however *S. scabrum* was the most preferred host among the cultivated Solanaceae. Vayssieres *et al*, (2007) reported *B. cucurbitae* to be polyphagous in West Africa infesting 17 fruits pecies however in Reunion Island they found *B. curcubitae* to be oligophagous depending primarily on Cucurbitaceae family. Generally, there preferred hosts are members of Cucurbitaceae.

In Tanzania, Mwatawala *et al* (2010) found *B. cucurbitae* to be polyphagous utilizing 19 hosts out of which 11 belong to Cucurbitae family. According to them melon (*Cucumis melo*) is the most preferred host while Momordica cf trifoliate was the most important wild host. For all others both cultivated and wild hosts, infestation rate ranged from 37 to 157 flies/Kg fruit. The fruiting season of these plants were also the period of highest population density for *B. cucurbitae.* Melon fruit fly damages over 81 plant species. Based on the extensive surveys carried out in Asia and Hawaii, plants belonging to the family Cucurbitaceae are preferred most (Allwood *et al*, 1999).

Doharey (1983) reported that it infests over 70 host plants, amongst which, fruits of bitter gourd (*Momordica charantia*), muskmelon (Cucumis melo), snap melon (*Cucumis melo* var. momordica) and snake gourd (*Trichosanthes anguina* and *T. cucumeria*) are the most preferred hosts. However, White and Elson-Harris (1994) stated that many of the host records might be based on casual observations of adults resting on plants or caught in traps set in non-host plant species. In the Hawaiian Islands, melon fruit fly has been observed feeding on the flowers of the sunflower, Chinese bananas and the juice exuding from sweet corn.

(Khan *et al* (2007) reported that the melon fly has a mutually beneficial association with the Orchid, Bulbophyllum paten, which produces zingerone. In Bangladesh, fruits of melon (*Cucumis melo*), sweet gourd (*Cucurbita maxima*), snake gourd (*Trichosanthes cucumerina, Benincasa hispida*), watermelon (*Citrullus lanatus*), ivy gourd (*Coccinia grandis*), cucumber (*Cucumis sativus, Cucumis trigonus*), white-flowered gourd (*Lagenaria siceraria*), luffa (*Luffa aegyptiaca*) balsam-apple (*Momordica balsamina*), bitter gourd (*Momordica charantia*) etc. are infested by this pest species. Naqvi (2005) reported that losses due to fruit fly infestation were estimated from 10 to 30% of annual agricultural produces in the country.

Gupta and Verma (1992), Dhillon *et al* (2005) and Shooker *et al* (2006) reported that depending on the environmental conditions and susceptibility of the crop species, the extent of losses varies between 30 to 100%. According to the reports of Bangladesh Agricultural Research Institute (BARI), fruit infestations were 22.48, 41.88 and 67.01% for snake gourd, bitter gourd, and sweet gourd, respectively. Gupta and Verma (1992) reported that the infested fruits become rotten, dry up and finally shed up prematurely. Hollingsworth *et al* (1997) reported that the field experiment on assessment of yield losses caused by cucurbit fruit fly in different cucurbits have been reported as 28.7-59.2, 24.7-40.0, 27.3-49.3, 19.4-22.1 and 0-26.2% in pumpkin, bitter gourd, bottle gourd, cucumber and sponge gourd respectively, in Nepal. The melon fruit fly has been reported to infest 95% of bitter gourd fruit in Papua New Guinea, and 90% snake gourd and 60 to 87% pumpkin fruit in Solomon Island. Singh *et al* (2000) reported 31.27% damage on bitter gourd and 28.55% on water melon in India.

2.7 Damage caused by Cucurbit 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). Singh *et al* (2000) reported 31.27% damage on bitter gourd and 28.55% on watermelon in India.

Due to the infestation rate ranging 21.5 – 71.5%, *B. cucurbitae* has caused more than 30 % economic losses on sweet gourd and ridge gourd in Bangladesh. Tephritidae are hence disastrous pests on horticultural crops which are mainly introduced into new places by human activities particularly trade (Qin *et al,* 2015).

Shah *et al.,* (1948) reported that the damage done by fruit flies in North West Frontier Province (Pakistan) cost an annual loss of over $655738. Lee (1972) observed that the rate of infestation in bottle gourd and sweet gourd flowers were 42.2± 8.6% and 77.1±3.5%, respectively the highest occurring in sweet gourd (32.5±3.9) and the lowest in sponge gourd (14.7±4.0).York (1992) reviewed that the loss of cucurbits caused by fruit fly in South East Asia might be up to 50%. The field experiments on assesment of losses caused by cucurbit fruit fly in different cucurbits been reported 28.7-59.2, 24.7- 40.0, 27.3- 49.3, 19.4-22.1, and 0 -26.2% yield losses in pumpkin, bitter gourd, cucumber, and sponge gourd, respectively, in Nepal (Pradhan, 1969). According to the reports of Bangladesh Agricultural Research Institute, fruit infestations were 22.48, 41.88 and 67.01 per cent for snake gourd, bitter gourd, and musk melon, respectively (Anon., 1988).

Kabir *et al.,* (1991) reported that yield losses due to fly infestation varies different fruits and vegetables and it is minimun in cucumber (19.19%) and maximum in sweet gourd (69.96%). The damage caused by fruit fly is the most serious in melon after the first shower in monsoon when it often reaches up to 100%. Other cucurbit might also be infected and the infestation might be gone up to 50% (Atwal, 1993).

Borah and Dutta (1997) studied the infestation of tephritids on the cucurbits in Assam, India and obtained highest fruit fly infestation rate in sweed gourd (62.02%). Depending on the environmental conditions and susceptibility of the crop species, the extent of losses varies between 30 to 100% (Shooker *et al,* 2006; Dhillon *et al*, 2005; Gupta and Verma, 1992).

Cucurbit fruit fly preferred young and immature fruits and resulted in a loss of 9.7% female flowers. Out of total fruits set, more than one-fourth (26%) fruits were damaged just after set and 14.04% fruits were damaged during harvesting stage. The fly has been reported to infest 95 per cent of bitter gourd fruits in Papua New Guinea, 90 per cent snake gourd and 60 to 87 per cent pumpkin fruits in Solomon Islands (Hollingsworth *et al*, 1997).

Chaudhary and Patel (2007) evaluated that area under commercial cultivation of cucurbitaceous vegetables had gradually increasing during recent years. The attack of fruit fly was a major constraint in profitable farming of cucurbits.

Dhillon *et al*, (2005) found that cucurbit fruit fly, *B. cucurbitae* was distributed widely throughout the world damaging 81 host plants and a major pest of cucurbitaceous crops with losses varying between 30-100 per cent depending upon the crop and season.

2.8 Seasonal abundance of Cucurbit fruit fly

The cucurbitaceous crops form one of the largest groups in the vegetable kingdom with their wide adaptation from arid to the humid tropic environments. It is also known as gourd family or melon family comprising about 118 genera and 825 species (Jeffrey, 1990). The cucurbits such as cucumber, bitter gourd, sponge gourd, ridge gourd, bottle gourd, sweet gourd, snake gourd, ash gourd, pointed gourd, and pumpkins are some of the major vegetables grown across Bangladesh. Cucurbits are cultivated in both summer and winter seasons. During the summer season, it becomes principal vegetables mostly covering the market due to the scarcity of other vegetables specially winter vegetables. The major constraint to sustainable increased productivity of cucurbits is the high incidence of insect pests. Cucurbits are infested by a number of pests such as cucurbit fruit fly, red pumpkin beetle, epilachna beetle etc. Among them cucurbit fruit fly, *Bactrocera cucurbitae* (Coquillett) is a devastating pest of different cucurbit vegetables in many parts of the world which may cause more than 60% yield loss (Kapoor, 1993). The pest has been reported to damage 81 host plants and as a major pest of cucurbitaceous vegetables, especially the bitter gourd, musk melon, snap melon, and snake gourd, ridge gourd (Anonymous, 2004). The female adults lay eggs inside the fruits with their sharp ovipositor. Afterward, fruit juice oozes out which transforms into resinous brown deposit. The eggs hatch inside the fruit into maggots (worms) which feed on the flesh (pulp) of the fruit and make tunnels.

Borah (1996) reported 39.10% infestation in the kharif cucumber crop, while 27.60% in the summer crop. Similar findings were noted by Gupta and Verma (1992), who reported more than 50% bitter gourd fruit damage in the rainy season.

Manjunathan (1997) and Mandal (2000) reported that the cucurbits such as cucumber, bitter gourd, sponge gourd, ridge gourd, bottle gourd, snake gourd, ash gourd, chayote, pointed gourd, and pumpkins are some of the major vegetables grown across Nepal. Gupta and Verma (1992), Dhillon *et al* (2005) and Shooker *et al* (2006) reported that several biotic factors limit the production and productivity of cucurbits, of which cucurbit fruit fly (Bactrocera cucurbitae Coquillett) has been the most prominent pest over the last several decades in Nepal. Pawar *et al* (1991) Zaman (1995) reported depending on the environmental conditions and susceptibility of the crop species, the extent of losses varies between 30 to 100%. Pradhan (1976) reported the field experiments on assessment of losses caused by cucurbit fruit fly in different cucurbits been reported 28.7 - 59.2, 24.7 - 40.0, 27.3 - 49.3, 19.4 - 22.1, and 0 - 26.2% yield losses in pumpkin, bitter gourd, bottle gourd, cucumber, and sponge gourd, respectively, in Nepal. Considering previous facts and reports, it is apparent that >50% of the cucurbits are either partially or totally damaged by fruit flies and are unsuitable for human consumption. Although, several management options, such as hydrolyzed protein spray, para-pheromone trap, spraying of ailanthus and cashew leaf extract, neem products, bagging of fruits, field sanitation, food baits, and spray of chemical insecticides. Neupane (1999) Akhtaruzzaman *et al* (2000) GC and Mandal

(2000) Palaniappan and Annadurai (2006) Jacob *et al* (2007) Manjunathan (1997) had been in use for the management of cucurbit fruit fly, some of them either fail to control the pest and/or are uneconomic and hazardous to non-target organisms and the environment. Sapkota (2009) reported in mid hill district of Nepal, farmers attempted different methods of management, like indigenous (70%), chemical (32%), mechanical (80%) and combination of two or more methods (68%) to combat the problems of fruit fly. Satpathy and Rai (2002) and Dhillon *et al* (2005) reported considering the hazardous impact of chemicals on non-target organisms and the environment, present studies were undertaken to assess the losses caused by B. cucurbitaeand efficacy of different control measures aiming to develop an eco-friendly and sustainable pest management system in cucurbits (1).

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted to study the incidence of red pumpkin beetle and fruit fly on different varieties of sweet gourd during the period from April to July, 2015. A brief description of the experimental site, climatic conditions, soil characteristics, experimental design, treatments, cultural operations, data collection and analysis of different parameters were used for conducting this experiment are presented under the following headings:

3.1 Location of the experimental field

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from April to July, 2015. The location of the experimental site was at 23^0 $46^,$ N latitude and 90^0 $22^,$ E longitudes with an elevation of 8.24 meter from sea level (Khan, 1997).

3.2 Climate condition during the experiment

The experimental area is characterized by subtropical rainfall during the month of April to September and scattered rainfall during the rest of the year. Information regarding average monthly temperature as recorded by Bangladesh Meteorological Department (climate division) during the period of study has been presented in Appendix I.

3.3 Soil of the experimental field

Soil of the study site was silty clay loam in texture belonging to series. The area represents the Agro-Ecological Zone of Madhupur tract (AEZ No. 28) (UNDP and FAO, 1988) with pH 5.8-6.5 (Haider, 1991). The analytical data of the soil sample collected from the experimental area were determined in the Soil Resources Development Institute (SRDI), Soil Testing Laboratory, Khamarbari, Dhaka and have been presented in Appendix II.

3.4 Experimental materials

Seven different varieties of sweet gourd were used for this study as treatments and the seeds of these crops were collected from different seed stores and sources of Bangladesh. These varieties of sweet gourd were as follows:

V_1: Sweet Queen
V_2: Prony F_1 (hybrid)
V_3: Thai Sweet
V_4: Big Boss
V_5: Monika
V_6: Shokti
V_7: Syndrila

3.5 Experimental design and layout

The experiment consisted of seven sweet gourd varieties and was laid out in Randomized Complete Block Design (RCBD) with four replications. Experimental plot was sub-divided into three blocks where two pits were in each plots. Thus there were 28 (4 × 7) unit plot and 56 pits altogether in the experiment. The size of each plot was 3.0 m × 2.0 m. The treatments (sweet gourd varieties) of the experiment were randomly distributed in the experimental plots.

3.6 Cultivation procedure

3.6.1 Land preparation

Power tiller was used for the land preparation of the experimental field. Then it was exposed to the sunshine for 7 days before to the next ploughing. Thereafter, the land was ploughed and cross-ploughed to obtain good tilth. Thus the experimental plot was well prepared. The size of the experiment plot was 3.0 m × 2 m. Two pits of 30 cm × 30 cm × 30 cm size were dug in each plot with a rectangular arrangement at a distance of minimum 1.5 m between pits. There are 2 plants in each pit and total 4 plants per plot.

3.6.2 Manures and fertilizers and its methods of application

Fertilizer	Quantity	Application method
Cow dung	10 t /ha	Basal dose
Urea	69 kg/ha	20, 35 and 50 DAT
TSP	60 kg/ha	Basal dose
MOP	60 kg/ha	Basal dose

Rashid (1993).

The half of cow dung, TSP and MP and one third of urea were applied as basal dose during land preparation. The remaining cow dung, TSP and MP were applied in the pit 15 days before seed sowing. The rest of urea was top dressed after each flush of flowering and fruiting in three equal splits.

3.6.3 Seedling production and transplanting

Seeds of these cucurbits were sown in polybag on 14 April, 2015. After 6-7 days the seeds were germinated. After 10 days of germination seedlings were transplanted into the experimental field.

3.6.4 Cultural practices

After sowing the seeds, a light irrigation was applied to the plots. Subsequent irrigation was done whenever needed. Sevin 85WP @ 1.5 kg/ha followed by a light irrigation was applied in soil around each plant in ring method and then covered with soil to avoid cutworm infestation. After germination of seedlings, soil of each plot was drenched with 1 % solution of Vitavax 200 to protect the plants from the anthracnose disease. Weeding and drainage facilities were provided as needed.

3.7 Data collection

Data on different parameters were recorded for red pumpkin beetle and Fruit fly infestation attacking those cucurbit vegetable crops, cotyledon, leaves, flower and fruits. Details of the data recording procedures are explained under the following sub-headings. Data were collected on different days after transplanting depend on different stages. Which were as follows

01-25 DAT = Early stage

26-55 DAT = Mid stage

56-75 DAT = Late stage

Fig1. Experimental field

Fig 2. Fruit Fly infestation fruit

3.7.1 Number of infested plants plot^{-1}

Data on plant infestation plot^{-1} was recorded at 10 days interval which was started from 15 days after sowing and continued up to 75 DAT. Mean number of infested plants plot^{-1} was calculated on the basis of the total infested plants of the selected plots divided by the total number of plants of the selected plots.

3.7.2 Number of branches plant^{-1}

The number of branches per plant was manually counted at 15, 25, 35, 45, 55, 65 and 75 days after sowing from randomly selected tagged plants. The average of four plants were computed and expressed in average number of branches per plant.

3.7.3 Number of infested branches plant^{-1}

Data on branches infestation plant^{-1} was recorded at 10 days interval which was started from 15 days after sowing and continued up to 75 DAT. Mean number of infested branch plant^{-1} was calculated on the basis of the total infested branches of the selected plants divided by the total number of branches of the selected plants.

3.7.4 Number of leaves plant^{-1}

The number of leaves per plant was manually counted at 15, 25, 35, 45, 55, 65 and 75 days after sowing from randomly selected tagged plants. The average of four plants were computed and expressed in average number of leaves per plant.

3.7.5 Number of infested leaves plant^{-1}

Data on leaf infestation plant^{-1} was recorded at 10 days interval which was started from 15 days after sowing and continued up to 75 DAT. Mean number of infested leaves plant^{-1} was calculated on the basis of the total infested leaves of the selected plants divided by the total number of leaves of the selected plants.

3.7.6 Number of infested leaves branch^{-1}

Data on leaf infestation branch^{-1} was recorded at 10 days interval which was started from 15 days after sowing and continued up to 75 DAT. Mean number of infested leaves branch^{-1} was calculated on the basis of the total infested leaves of the selected branch divided by the total number of leaves of the selected branch.

3.7.7 Number of Red pumpkin beetle plant^{-1}

The number of Red Pumpkin Beetle per plant was manually counted at 15, 25, 35, 45, 55, 65 and 75 days after sowing from randomly selected tagged plants. The average of four plants were computed and expressed in average number of Red pumpkin beetle per plant

3.7.8 Number of cucurbit fruit fly fruit^{-1}

The number of cucurbit fruit fly per plant was manually counted at 45, 55, 65 and 75 days after sowing from randomly selected tagged plants. The average of four plants were computed and expressed in average number of cucurbit fruit fly per plant

3.7.9 Infestation percentages of varieties by Red pumpkin beetle

Infestation percentage of different sweet gourd varieties was calculated on the basis of 65 DAT data. Because in that time the plants were highest susceptible and maximum Red pumpkin beetle infestation was occurred. This was calculated by the following formula.

$$\text{Single variety infestation \%} = \frac{\text{Single variety infestation}}{\text{All varieties infestation (total)}} \times 100$$

3.7.10 Infestation percentages of varieties by Cucurbit fruit fly

Infestation percentage of different sweet gourd varieties was calculated on the basis of 65 DAT data though the cucurbit fruit fly infestation occurs lately from 45 DAT. Because at that time the plants were highly susceptible and maximum cucurbit fruit fly infestation was occurred. This was calculated by the following formula.

$$\text{Single variety infestation \%} = \frac{\text{Single variety infestation}}{\text{All varieties infestation (total)}} \times 100$$

3.8 Statistical Analysis

The data obtained from experiment on various parameters were statistically analyzed in MSTAT-C computer program (Russel, 1986). The mean values for all the parameters were calculated and the analysis of variance for the characters was accomplished and means were separated by Duncan’s Multiple Range Test (DMRT) and the significance of difference between pair of means was tested by the Least Significant Differences (LSD) test at 5 % levels of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULT AND DISCUSSION

The present study was conducted to find the effect of different varieties on number of infested plants plot^{-1} at different days after transplanting. Data on different growth and yield contributing characters were recorded. The analysis of variance (ANOVA) of the data on different growth and yield parameters are given in Appendix III-VIII. The results have been presented and discussed with the help of tables and graphs and possible interpretations were given under the following headings:

4.1 Number of infested plants plot^{-1} by red pumpkin beetle (RPB)

The significant difference was observed due to planting different varieties of sweet gourd at 25, 35, 45, 55, 65 and 75 DAT (Appendix III) except 15 DAT. At 25 DAT the maximum number of infested plants plot^{-1} (2.00) was recorded from V_3 (Thai Sweet) variety where no plant infestation was found in V_6 (Shokti) variety which is statistically identical to V_4 variety. At 35 DAT the maximum number of infested plants plot^{-1} (2.25) was recorded from V_1 (Sweet Queen) variety which is statistically identical to V_2, V_3 and V_5 varieties and the minimum number of infested plants plot^{-1} (1.00) was recorded from V_4 (Big Boss) variety which is statistically identical to V_6 and V_7 varieties. At 45 DAT the maximum number of infested plants plot^{-1} (2.25) was recorded from V_3 (Thai Sweet) variety which is statistically identical to V_1, $V_{2,}$ V_5 and V_7 varieties and the minimum number of infested plants plot^{-1} (1.00) was recorded from V_4 (Big Boss) variety which is statistically identical to V_6 variety. At 55 DAT the maximum number of infested plants plot^{-1} (3.00) was recorded from V_1 (Sweet Queen) variety which is statistically identical to V_2 and V_3 varieties and the minimum number of infested plants plot^{-1} (1.25) was recorded from V_6 (Shokti) variety. At 65 DAT the maximum number of infested plants

Table 1. Effect of different varieties on number of infested plants plot^{-1} at different days after transplanting (DAT) by red pumpkin beetle (RPB)

Varieties	Mean number of infested plant per plot at different days after transplanting(DAT)						
	15 DAT	**25 DAT**	**35 DAT**	**45 DAT**	**55 DAT**	**65 DAT**	**75 DAT**
V_1	0.00	1.00 b	2.25 a	2.00 a	3.00 a	3.00 b	3.00 b
V_2	0.00	1.25 b	2.00 a	2.00 a	3.00 a	3.00 b	4.00 a
V_3	0.00	2.00 a	2.25 a	2.25 a	3.00 a	4.00 a	4.25 a
V_4	0.00	0.25 c	1.00 b	1.00 b	2.00 b	2.25 c	3.00 b
V_5	0.00	1.00 b	2.00 a	2.00 a	2.25 b	3.00 b	3.00 b
V_6	0.00	0.00 c	1.00 b	1.00 b	1.25 c	2.00 c	2.00 c
V_7	0.00	1.00 b	1.00 b	2.00 a	2.00 b	3.00 b	3.00 b
LSD $_{0.05}$	0.00	0.36	0.28	0.28	0.36	0.28	0.28
CV (%)	0.00	8.15	9.35	10.80	10.35	6.53	5.46

In a column, means with similar letter (s) are not significantly different by DMRT at 5% level of probablity.

V_1: Sweet Queen, V_2: Pronoy F_1 (Hybrid), V_3: Thai Sweet, V_4: Big Boss, V_5: Monika, V_6: Shokti, V_7: Syndrila. DAT: Days after transplant plot^{-1} (4.00) was recorded from V_3 (Thai Sweet) variety and the minimum number of infested plants plot^{-1} (2.00) was recorded from V_6 (Shokti) variety. At 75 DAT the maximum number of infested plants plot^{-1} (4.25) was recorded from V_3 (Thai Sweet) variety which is statistically identical to V_2 variety and the minimum number of infested plants plot^{-1} (2.00) was recorded from V_6 (Shokti) variety (Table 1).Infestation was increased with the time increased. 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. According to York (1992), this insect pest is found in the Mediterranean region, Africa and Asia. Vandana *et al* (2001) studied the host preference of red pumpkin beetle, *A. foveicollis* among five cucurbits *viz.*, sweet gourd, ash gourd, sponge gourd, snake gourd and cucumber, in which sweet gourd was identified as the most susceptible and highly preferred host to red pumpkin beetle

4.2 Branch infestation by RPB at early stage

At 15 DAT the maximum number of branches plant^{-1} (1.25) was recorded from V_2 (Pronoy F_1 Hybrid) variety which is statistically identical to V_1, $V_{3,}$ V_4 and V_7 varieties and the minimum number of branch plant^{-1} (0.25) was recorded from V_5 (Monika) and V_6 (Shokti) varieties which are statistically identical to V_1, V_3 and V_7 varieties. At that time the maximum number of infested branches plant^{-1} (1.00) was recorded from V_2 (Pronoy F_1 Hybrid) variety which is statistically identical to V_1 and V_3 varieties and the minimum number of infested branches plant^{-1} (0.00) was recorded from V_6 (Shokti) variety which is statistically identical to V_4, V_5 and V_7 varieties. The highest infestation percentage in branches plant^{-1} at 15 DAT was found (100.00) in V_1 (Sweet Queen) variety which is statistically identical to V_2, $V_{3,}$ and V_5 varieties and the lowest was (0.0) in V_6 (Shokti) which is statistically identical to V_4, and V_7 varieties (Table 2). At 25 DAT the maximum number of branches plant^{-1} (4.00) was recorded from V_2 (Pronoy F_1 Hybrid) variety which is not identical to other varieties and the

Table 2. Effect of different Cucurbit varieties on branch infestation by RPB at early stage

Varieties	15 DAT			25 DAT		
	No. of Branch plant^{-1}	**Infested Branch Plant^{-1}**	**% Branch Infestation**	**No. of Branch plant^{-1}**	**Infested Branch Plant^{-1}**	**% Branch Infestation**
V_1	0.75 ab	0.75 ab	100.00 a	1.25 c	1.00 a	80.00 ab
V_2	1.25 a	1.00 a	80.00 a	4.00 a	1.00 a	25.00 c
V_3	0.75 ab	0.75 ab	100.00 a	2.00 b	1.25 a	62.50 b
V_4	1.00 a	0.25 bc	25.00 b	1.25 c	0.25 b	20.00 c
V_5	0.25 b	0.25 bc	100.00 a	1.00 c	1.00 a	100.00 a
V_6	0.25 b	0.00 c	00.00 b	1.25 c	0.25 b	20.00 c
V_7	0.75 ab	0.25 bc	33.33 b	2.00 b	0.25 b	12.50 c
$LSD_{0.05}$	0.6424	0.667	35.79	0.39	0.39	29.22
CV (%)	4.12	6.70	16.00	5.14	7.42	14.00

In a column, means with similar letter (s) are not significantly different by DMRT at 5% level of probablity.

V_1: Sweet Queen, V_2: Pronoy F_1 (Hybrid), V_3: Thai Sweet, V_4: Big Boss, V_5: Monika, V_6: Shokti, V_7: Syndrila DAT: Days after transplant

minimum number of branches plant^{-1} (1.00) was recorded from V_5 (Monika) variety which is statistically identical to $V_{1,}$ V_4 and V_6 varieties. At 25 DAT the maximum number of infested branches plant^{-1} (1.25) was recorded from V_3 (Thai Sweet) variety which is statistically identical to V_1, V_2 and V_5 varieties and the minimum number of infested branches plant^{-1} (0.25) was recorded from V_4 (Big Boss) variety which is statistically identical to V_6 and V_7 varieties. The highest percentage of infestation in branches per plant at 25 DAT was found (100.00) in V_5 (Monika) variety which is statistically identical to V_1 variety and the lowest was (20.00) in V_6 (Shokti) which is statistically identical to V_4, variety (Table 2).

4.3 Branch infestation by RPB at mid stage

At 35 DAT the maximum number of branches plant^{-1} (5.75) was recorded from V_2 (Pronoy F_1 Hybrid) variety which is not statistically identical to other variety and the minimum number of branches plant^{-1} (2.00) was recorded from V_5 (Monika) variety which is statistically identical to V_6, V_1 and V_4 varieties. At same DAT the maximum number of infested branches plant^{-1} (2.00) was recorded from V_1 (Sweet Queen) variety which is statistically identical to V_2 and V_3 varieties and the minimum number of infested branches plant^{-1} (1.00) was recorded from V_6 (Shokti) variety which is statistically identical to V_4, V_5 and V_7 varieties. The highest percentage of infestation in branches per plant at 35 DAT was found (88.89) in V_1 (Sweet Queen) variety which is not statistically identical to others and the lowest was (33.33) in V_7 (Syndrila) which is statistically identical to $V_{2,}$ V_3 and V_4, varieties. (Table3).

At 45 DAT the maximum number of branches plant^{-1} (7.50) was recorded from V_3 (Thai Sweet) variety which is not statistically identical to other varieties and the minimum number of branches plant^{-1} (3.00) was recorded from V_6 (Shokti) variety which is statistically identical to V_2 variety. At same DAT the maximum number of infested branches plant^{-1} (4.75) was recorded from V_3 (Thai Sweet) variety which is not statistically identical to other variety and the minimum number of infested branches plant^{-1} (1.25) was recorded from V_6 (Shokti) variety

Table 3. Effect of different Cucurbit varieties on branch infestation by RPB at mid stage

Varieties	35 DAT			45 DAT			55 DAT		
	No. of Branch plant^{-1}	**Infested Branch Plant^{-1}**	**% Branch Infestation**	**No. of Branch plant^{-1}**	**Infested Branch Plant^{-1}**	**% Branch Infestation**	**No. of Branch plant^{-1}**	**Infested Branch Plant^{-1}**	**% Branch Infestation**
V_1	2.25 c	2.00 a	88.89 a	4.75 c	3.00 b	63.16 b	6.00 c	3.25 c	54.17 b
V_2	5.75 a	2.00 a	34.78 c	3.00 d	3.00 b	100.00 a	4.00 d	4.00 b	100.00 a
V_3	3.75 b	2.00 a	53.33 bc	7.50 a	4.75 a	63.33 b	9.75 a	5.00 a	51.28 b
V_4	2.25 c	1.00 b	44.44 bc	4.25 c	2.00 c	47.06 c	7.25 b	2.00 d	27.59 d
V_5	2.00 c	1.25 b	62.50 b	4.00 c	2.00 c	50.00 c	6.00 c	2.25 d	37.50 c
V_6	2.00 c	1.00 b	50.00 bc	3.00 d	1.25 d	41.67 c	5.25 c	1.25 e	23.81 d
V_7	3.75 b	1.25 b	33.33 c	6.75 b	2.00 c	29.63 d	9.50 a	2.00 d	21.05 d
$LSD_{0.05}$	0.667	0.36	22.17	0.42	0.42	10.32	0.72	0.39	6.84
CV (%)	6.27	6.27	7.88	11.23	11.23	12.27	9.47	9.47	10.27

In a column, means with similar letter (s) are not significantly different by DMRT at 5% level of probablity.
V_1: Sweet Queen, V_2: Pronoy F_1 (Hybrid), V_3: Thai Sweet, V_4: Big Boss, V_5: Monika, V_6: Shokti, V_7: Syndrila DAT: Days after transplant

which is not statistically identical to other varieties. The highest percentage of infestation in branches per plant at 45 DAT was found (100.00) in V_2 (Pronoy F_1 Hybrid) variety which is not statistically identical to other varieties and the lowest was (29.63) in V_7 (Syndrila) which is not statistically identical to other varieties (Table 3).

At 55 DAT the maximum number of branches plant^{-1} (9.75) was recorded from V_3 (Thai Sweet) variety which is statistically identical to V_7 variety and the minimum number of branches plant^{-1} (4.00) was recorded from V_2 (Pronoy F_1 Hybrid) variety which is not statistically identical to other varieties. At same DAT the maximum number of infested branches plant^{-1} (5.00) was recorded from V_3 (Thai Sweet) variety which is statistically not identical to other varieties and the minimum number of infested branches plant^{-1} (1.25) was recorded from V_6 (Shokti) variety which is statistically not identical to other varieties. The highest percentage of infestation in branches per plant at 55 DAT was found (100.00) in V_2 (Pronoy F_1 Hybrid) variety which is not statistically identical to other variety and the lowest was (21.05) in V_7 (Syndrila) which is statistically identical to V_4 and V_6 other varieties. (Table 3).

4.4 Branch infestation by RPB at late stage

At 65 DAT the maximum number of branches plant^{-1} (13.00) was recorded from V_7 (Syndrila) variety which is statistically identical to V_3 and the minimum number of branches plant^{-1} (7.25) was recorded from V_1 (Sweet Queen) variety which is statistically identical to V_5 and V_6 varieties. At same DAT the maximum number of infested branches plant^{-1} (5.00) was recorded from V_3 (Thai Sweet) variety which is not statistically identical to other varieties and the minimum number of infested branches plant^{-1} (2.25) was recorded from V_4 (Big Boss) variety which is statistically identical to V_6 and V_7 varieties. The highest percentage of infestation in branches per plant at 65 DAT was found (100.00) in V_1 (Sweet Queen) variety which is not statistically identical to other varieties and the lowest was (17.31) in V_7 (Syndrila) which is not statistically identical to other varieties (Table 4).

Table 4. Effect of different Cucurbit varieties on branch infested by RPB at late stage

Varieties	65 DAT			75 DAT		
	No. of Branch plant^{-1}	Infested Branch Plant^{-1}	% Branch Infestation	No. of Branch plant^{-1}	Infested Branch Plant^{-1}	% Branch Infestation
V_1	7.25 d	3.25 b	44.83 a	10.25 e	3.75 b	36.59 b
V_2	8.25 c	3.50 b	42.42 ab	12.25 cd	6.25 a	51.02 a
V_3	12.75 a	5.00 a	39.22 bc	16.00 b	6.50 a	40.63 b
V_4	10.25 b	2.25 c	21.95 e	13.25 c	3.25 b	24.53 d
V_5	8.00 cd	3.00 b	37.50 c	11.25 de	3.50 b	31.11 c
V_6	7.50 cd	2.25 c	30.00 d	12.25 cd	2.25 c	18.37 e
V_7	13.00 a	2.25 c	17.31 f	17.25 a	3.25 b	18.84 e
$LSD_{0.05}$	0.72	0.51	4.19	1.112	0.58	5.26
CV(%)	11.29	11.33	8.50	9.58	8.58	11.24

In a column, means with similar letter (s) are not significantly different by DMRT at 5% level of probablity.

V_1: Sweet Queen, V_2: Pronoy F_1 (Hybrid), V_3: Thai Sweet, V_4: Big Boss, V_5: Monika, V_6: Shokti, V_7: Syndrila DAT: Days after transplant

At 75 DAT the maximum number of branches plant^{-1} (17.25) was recorded from V_7 (Syndrila) variety which is not statistically identical to other varieties and the minimum number of branches plant^{-1} (10.25) was recorded from V_1 (Sweet Queen) variety which is statistically identical to V_5 variety. At same DAT the maximum number of infested branches plant^{-1} (6.50) was recorded from V_3 (Thai Sweet) variety which is statistically identical to V_2 variety and the minimum number of infested branches plant^{-1} (2.25) was recorded from V_6 (Shokti) variety which is not statistically identical to other variety. The highest percentage of infestation in branches per plant at 75 DAT was found (51.02) in V_2 (Pronoy F_1 Hybrid) variety which is not statistically identical to other varieties and the lowest was (18.37) in V_6 (Shokti) which is statistically identical to V_7 variety. (Table 4).

4.5 Leaves infestation plant^{-1} by RPB at early stage

At 15 DAT the maximum number of leaves plant^{-1} (9.00) was recorded from V_2 (Pronoy F_1 Hybrid) variety and the minimum number of leaves plant^{-1} (4.00) was recorded from V_7 (Shokti) variety which is statistically different than other varieties. At same DAT the maximum number of infested leaves plant^{-1} (4.50) was recorded from V_3 (Thai Sweet) variety and the minimum number of infested leaves plant^{-1} (1.00) was recorded from V_4 (Big Boss) variety which is statistically identical to V_6 and V_7 varieties. The highest percentage of infestation in leaves per plant at 15 DAT was found (90.00) in V_3 (Thai Sweet) variety which is statistically different than other varieties and the lowest was (20.00) in V4 (Big Boss) which is statistically identical to V_1 and V_7 varieties (Table 5).

At 25 DAT the maximum number of leaves plant^{-1} (20.75) was recorded from V_3 (Thai Sweet) variety which is not statistically identical to other varieties and the minimum number of leaves plant^{-1} (11.00) was recorded from V_6 (Shokti) variety which is statistically similar to V_4, V_5 and V_7 varieties. At same DAT the maximum number of infested leaves plant^{-1} (6.00) was recorded from V_3 (Thai Sweet) variety which is statistically identical to V_2 variety and the minimum number of infested leaves plant^{-1} (2.00) was recorded from V_4 (Big Boss) variety

Table 5. Effect of different Cucurbit varieties on leaves infestation by RPB at early stage

Varieties	15 DAT			25 DAT		
	No. of leaves plant^{-1}	Infested leaves Plant^{-1}	% leaf infestation	No. of leaves plant^{-1}	Infested leaves Plant^{-1}	% leaf infestation
V_1	6.00 b	3.00 b	50.00 b	15.00 bc	3.00 b	20.00 c
V_2	9.00 a	3.00 b	33.33 d	15.75 b	5.50 a	34.92 a
V_3	5.00 c	4.50 a	90.00 a	20.75 a	6.00 a	28.92 b
V_4	5.00 c	1.00 d	20.00 e	14.50 bc	2.00 c	13.79 d
V_5	5.00 c	2.00 c	40.00 c	14.00 bc	3.00 b	21.43 c
V_6	4.75 c	1.00 d	21.05 e	11.00 c	2.00 c	18.18 c
V_7	4.00 d	1.00 d	25.00 e	14.00 bc	2.00 c	14.29 d
$LSD_{0.05}$	.28	0.32	6.50	3.71	0.56	3.39
CV(%)	6.45	9.86	10.96	5.57	11.26	10.47

In a column, means with similar letter (s) are not significantly different by DMRT at 5% level of probablity.

V_1: Sweet Queen, V_2: Pronoy F_1 (Hybrid), V_3: Thai Sweet, V_4: Big Boss, V_5: Monika, V_6: Shokti, V_7: Syndrila DAT: Day After Transplanting which is statistically identical to V_6 and V_7 varieties. The highest percentage of infestation in leaves per plant at 25 DAT was found (34.92) in V_2 (Pronoy F_1 Hybrid) variety which is not statistically similar to other varieties and the lowest was (14.29) in V_7 (Big Boss) which is statistically similar to V_4 variety (Table 5).

4.6 Leaves infestation plant^{-1} by RPB at mid stage

At 35 DAT the maximum number of leaves plant^{-1} (57.50) was recorded from V_3 (Thai Sweet) variety which is statistically similar to V_1 and V_5 varieties and the minimum number of leaves plant^{-1} (23.00) was recorded from V_6 (Shokti) variety which is statistically similar to V_4 variety. At same DAT the maximum number of infested leaves plant^{-1} (8.00) was recorded from V_3 (Thai Sweet) variety and the minimum number of infested leaves plant^{-1} (4.00) was recorded from V_6 (Shokti) variety. The highest percentage of infestation in leaves per plant at 35 DAT was found (17.68) in V_2 (Sweet Queen) variety which is statistically similar to V_1 and V_6 varieties and the lowest was (13.91) in V_3 (Thai Sweet) variety which is statistically similar to $V_{1,}$ $V_{4,}$ V_5 and V_7 varieties (Table 6).

At 45 DAT the maximum number of leaves plant^{-1} (82.00) was recorded from V_3 (Thai Sweet) variety and the minimum number of leaves plant^{-1} (35.25) was recorded from V_6 (Shokti) variety which is statistically similar to V_4 and V_7 varieties. At same DAT the maximum number of infested leaves plant^{-1} (15.00) was recorded from V_3 (Thai Sweet) variety and the minimum number of infested leaves plant^{-1} (7.00) was recorded from V_6 (Shokti) variety. The highest percentage of infestation in leaves per plant at 45 DAT was found (21.15) in V_7 (Syndrila) variety which is statistically similar to V_3 and V_6 variety and the lowest was (15.68) in V1 (Sweet Queen) which is statistically similar to $V_{2,}$ $V_{3,}$ V_4 and V_5 varieties. (Table 6)

At 55 DAT the maximum number of leaves plant^{-1} (228.25) was recorded from V_3 (Thai Sweet) variety which is statistically similar to $V_{1,}$ V_2 and V_5 varieties and the minimum number of leaves plant^{-1} (87.00) was recorded from

Table 6. Effect of different Cucurbit varieties on leaves infestation by RPB at mid stage

Varieties	35 DAT			45 DAT			55 DAT		
	No. of Leaves plant^{-1}	Infested Leaves Plant^{-1}	% leaf infestation	No. of Leaves plant^{-1}	Infested Leaves Plant^{-1}	% leaf infestation	No. of Leaves plant^{-1}	Infested Leaves Plant^{-1}	% leaf infestation
V_1	45.00 ab	7.00 b	15.56 abc	59.00 b	9.25 c	15.68 b	176.00 ab	13.00 c	7.39 b
V_2	41.00 b	7.25 b	17.68 a	59.25 b	10.00 b	16.88 b	175.25 ab	14.00 b	7.99 ab
V_3	57.50 a	8.00 a	13.91 c	82.00 a	15.00 a	18.29 ab	228.25 a	18.00 a	7.89 b
V_4	32.50 bc	5.00 d	15.38 bc	48.75 bc	8.00 d	16.41 b	113.75 bc	11.25 e	9.89 ab
V_5	44.00 ab	6.75 b	15.34 bc	57.00 b	9.00 c	15.79 b	188.75 a	13.00 c	6.89 b
V_6	23.00 c	4.00 e	17.39 ab	35.25 c	7.00 e	19.86 a	87.00 c	11.00 e	12.64 a
V_7	38.00 b	5.75 c	15.13 bc	39.00 bc	8.25 d	21.15 a	107.00 c	12.25 d	11.45 ab
$LSD_{0.05}$	14.27	0.51	2.14	19.43	0.36	3.135	62.69	0.36	3.976
CV(%)	6.67	5.52	13.30	14.08	6.57	12.49	7.45	8.85	7.81

In a column, means with similar letter (s) are not significantly different by DMRT at 5% level of probablity.

V_1: Sweet Queen, V_2: Pronoy F_1 (Hybrid), V_3: Thai Sweet, V_4: Big Boss, V_5: Monika, V_6: Shokti, V_7: Syndrila DAT: Days After Transplant

V_6 (Shokti) variety which is statistically similar to V_4 and V_7 varieties. At same DAT the maximum number of infested leaves plant^{-1} (18.00) was recorded from V_3 (Thai Sweet) variety and the minimum number of infested leaves plant^{-1} (11.00) was recorded from V_6 (Shokti) variety which is statistically similar to V_4 variety. The highest percentage of infestation in leaves per plant at 55 DAT was found (12.64) in V6 (Shokti) variety which is statistically similar to $V_{2,}$ $V_{4,}$ V_7 and V_5 varieties and the lowest was (6.89) in V5 (Monika) which is statistically similar to other varieties except V_6 (Table 6).

4.7 Leaves infestation plant^{-1} by RPB at late stage

At 65 DAT the maximum number of leaves plant^{-1} (273.75) was recorded from V_3 (Thai Sweet) variety which is statistically similar to V_1, V_2 and V_5 varieties and the minimum number of leaves plant^{-1} (105.00) was recorded from V_6 (Shokti) variety which is statistically similar to V_4 and V_7 varieties. At same DAT the maximum number of infested leaves plant^{-1} (23.00) was recorded from V_3 (Thai Sweet) variety which is not statistically identical to other varieties and the minimum number of infested leaves plant^{-1} (14.00) was recorded from V_6 (Shokti) variety which is not statistically identical to other varieties. The highest percentage of infestation in leaves per plant at 65 DAT was found (13.33) in V6 (Shokti) variety and the lowest was (8.29) in V5 (Monika) which have not significantly difference among the varieties. (Table 7).

At 75 DAT the maximum number of leaves plant^{-1} (335.50) was recorded from V_3 (Thai Sweet) variety which is statistically similar to V_1, and V_2 varieties and the minimum number of leaves plant^{-1} (145.00) was recorded from V_6 (Shokti) variety which is statistically similar to V_4 and V_7 varieties (Table 7). At same DAT the maximum number of infested leaves plant^{-1} (32.75) was recorded from V_3 (Thai Sweet) variety which is statistically similar to V_2 variety and the minimum number of infested leaves plant^{-1} (18.00) was recorded from V_6 (Shokti) variety which is not statistically identical to other varieties. The highest percentage of infestation in leaves per plant at 75 DAT was found (12.41) in V_6 (Shokti) variety

Table 7. Effect of different Cucurbit varieties on leaves infested by RPB at late stage

Varieties	65 DAT			75 DAT		
	No. of leaves plant^{-1}	Infested leaves Plant^{-1}	% leaf infestation	No. of leaves plant^{-1}	Infested leaves Plant^{-1}	% leaf infestation
V_1	206.00 abc	20.50 b	9.95	288.00 ab	30.75 b	10.68
V_2	246.75 ab	21.00 b	8.51	283.25 ab	31.75 ab	11.21
V_3	273.75 a	23.00 a	8.40	335.50 a	32.75 a	9.76
V_4	162.25 bcd	15.75 e	9.71	197.75 bc	23.00 e	11.63
V_5	217.25 abc	18.75 c	8.29	282.50 ab	28.25 c	10.00
V_6	105.00 d	14.00 f	13.33	145.00 c	18.00 f	12.41
V_7	147.00 cd	17.75 d	12.07	226.00 bc	25.75 d	11.39
$LSD_{0.05}$	87.18	0.56	4.39	86.28	1.26	4.22
CV(%)	10.25	7.02	NS	13.12	9.14	NS

In a column, means with similar letter (s) are not significantly different by DMRT at 5% level of probablity.

V_1: Sweet Queen, V_2: Pronoy F_1 (Hybrid), V_3: Thai Sweet, V_4: Big Boss, V_5: Monika, V_6: Shokti, V_7: Syndrila
DAT: Days After Transplant

and the lowest was (9.76) in V_3 (Thai Sweet) variety which have not significantly difference among the varieties. (Table 7).

Atwal (1993) found the red pumpkin beetle, *Aulacophora foveicollis* Lucas (Coleoptera: Chrysomelidae) was common and serious pest of a wide range of cucurbits, such as ash gourd (*Benincasa hispida*), pumpkin (*Cucurbita pepo* L.), tinda (*Citrullus vulgaris* var. *fisulosus*), ghia tori (*Luffa aegyptica*), cucumber and melon.

4.8 Number of infested leaves branch^{-1} by Red pumpkin beetle

The significant difference was observed due to planting different varieties of sweet gourd at 15, 25, 35, 45, 55, 65 and 75 DAT (Appendix VIII). At 15 DAT the maximum number of infested leaves branch^{-1} (1.00) was recorded from V_1 (Sweet Queen) variety which is statistically identical to V_2 and V_3 varieties and the minimum number of infested leaves branch^{-1} (0.00) was recorded from V_4 (Big Boss) variety which is statistically similar to V_5, V_6 and V_7 varieties. At 25 DAT the maximum number of infested leaves branch^{-1} (1.00) was recorded from V_1 (Sweet Queen) variety which is statistically identical to V_2, V_3, V_5 and V_7 varieties and the minimum number of infested leaves branch^{-1} (0.00) was recorded from V_4 (Big Boss) variety which is statistically similar to V_6 variety. At 35 DAT the maximum number of infested leaves branch^{-1} (7.00) was recorded from V_3 (Thai Sweet) variety and the minimum number of infested leaves branch^{-1} (1.00) was recorded from V_6 (Shokti) variety. At 45 DAT the maximum number of infested leaves branch^{-1} (5.25) was recorded from V_3 (Thai Sweet) variety and the minimum number of infested leaves branch^{-1} (2.00) was recorded from V_4 (Big Boss) variety which is statistically identical to V_6 variety. At 55 DAT the maximum number of infested leaves branch^{-1} (7.00) was recorded from V_3 (Thai Sweet) variety and the minimum number of infested leaves branch^{-1} (2.00) was recorded from V_6 (Shokti) variety which is statistically similar to V_4 variety. At 65 DAT the maximum number of infested leaves branch^{-1} (8.00) was recorded from V_3 (Thai Sweet) variety which is statistically similar to V_2 and the minimum number of infested leaves branch^{-1} (2.75) was recorded from V_6

Table 8. Effect of different varieties on number of infested leaves branch^{-1} at different days after transplanting

Varieties	Different days after transplanting						
	15 DAT	**25 DAT**	**35 DAT**	**45 DAT**	**55 DAT**	**65 DAT**	**75 DAT**
V_1	1.00 a	1.00 a	2.50 c	4.00 b	4.00 c	6.25 b	7.50 b
V_2	1.00 a	1.00 a	3.25 b	4.25 b	4.75 b	7.25 ab	7.75 b
V_3	1.00 a	1.00 a	7.00 a	5.25 a	7.00 a	8.00 a	9.00 a
V_4	0.00 b	0.00 b	2.00 c	2.00 d	2.00 e	3.50 cd	3.75 e
V_5	0.25 b	1.00 a	2.50 c	3.75 b	4.00 c	4.50 c	6.50 c
V_6	0.00 b	0.00 b	1.00 d	2.00 d	2.00 e	2.75 d	2.75 f
V_7	0.00 b	0.75 a	2.00 c	2.75 c	2.75 d	4.50 c	4.50 d
LSD $_{0.05}$	0.25	0.28	0.70	0.60	0.36	1.02	0.56
CV (%)	8.70	7.85	6.44	11.91	6.44	13.14	6.34

In a column, means with similar letter (s) are not significantly different by DMRT at 5% level of probablity.

V_1: Sweet Queen, V_2: Pronoy F_1 (Hybrid), V_3: Thai Sweet, V_4: Big Boss, V_5: Monika, V_6: Shokti, V_7: Syndrila DAT: Days After Transplant

(Shokti) variety which is statistically similar to V_4 variety. At 75 DAT the maximum number of infested leaves branch^{-1} (9.00) was recorded from V_3 (Thai Sweet) variety and the minimum number of infested leaves branch^{-1} (2.75) was recorded from V_6 (Shokti) variety (Table 8). Sharma (1999) carried out studies on host preference by red pumpkin beetle and observed highest plant damage in musk melon (15.32%) followed by sweet gourd (7.11).

4.9 Number of red pumpkin beetle plant^{-1}

The significant difference was observed due to planting different varieties of sweet gourd at 15, 25, 35, 45, 55, 65 and 75 DAT (Appendix IX). At 15 DAT the maximum number of red pumpkin beetle plant^{-1} (3.00) was recorded from V_2 (Pronoy F_1) variety which is statistically identical to V_3 variety and the minimum number of red pumpkin beetle plant^{-1} (0.00) was recorded from V_4 (Big Boss) variety which is statistically identical to V_6 variety. At 25 DAT the maximum number of red pumpkin beetle plant^{-1} (3.00) was recorded from V3 (Thai Sweet) variety and the minimum number of red pumpkin beetle plant^{-1} (0.00) was recorded from V_4 (Big Boss) variety which is statistically identical to V_6 variety. At 35 DAT the maximum number of red pumpkin beetle plant^{-1} (5.00) was recorded from V_2 (Pronoy F_1) variety which is statistically identical to V_3 variety and the minimum number of red pumpkin beetle plant^{-1} (2.00) was recorded from V_4 (Big Boss) variety which is statistically identical to V_6 variety. At 45 DAT the maximum number of red pumpkin beetle plant^{-1} (5.00) was recorded from V_3 (Thai Sweet) variety which is statistically identical to V_2 variety and the minimum number of red pumpkin beetle plant^{-1} (1.00) was recorded from V_6 (Shokti) variety. At 55 DAT the maximum number of red pumpkin beetle plant^{-1} (4.75) was recorded from V_3 (Thai Sweet) variety and the minimum number of red pumpkin beetle plant^{-1} (1.00) was recorded from V_4 (Big Boss) variety which is statistically identical to V_6 variety. At 65 DAT the maximum number of red pumpkin beetle plant^{-1} (6.50) was recorded from V_3 (Thai Sweet) variety and the minimum number of red pumpkin beetle plant^{-}

^{1} (1.00) was recorded from V_6 (Shokti) variety which is statistically similar to V_4 variety. At 75 DAT the

Table 9. Effect of different varieties on number of Red Pumpkin Beetle plant^{-1} at different days after transplanting

Varieties	Mean number of Red pumpkin beetle plant^{-1} different days after transplanting						
	15 DAT	**25 DAT**	**35 DAT**	**45 DAT**	**55 DAT**	**65 DAT**	**75 DAT**
V_1	2.00 b	1.00 c	4.00 b	4.00 b	2.00 c	3.00 c	3.00 c
V_2	3.00 a	2.00 b	5.00 a	5.00 a	3.00 b	4.00 b	4.00 b
V_3	3.00 a	3.00 a	5.00 a	5.00 a	4.75 a	6.50 a	4.75 a
V_4	0.00 d	0.00 d	2.00 d	2.00 c	1.00 d	1.00 e	2.00 d
V_5	1.00 c	1.00 c	3.00 c	1.75 c	2.00 c	2.75 c	2.25 d
V_6	0.00 d	0.00 d	2.00 d	1.00 d	1.00 d	1.00 e	1.00 e
V_7	0.75 c	0.75 c	2.50 cd	2.00 c	1.25 cd	2.00 d	2.00 d
LSD $_{0.05}$	0.28	0.28	0.56	0.28	0.84	0.58	0.42
CV (%)	13.57	7.07	11.26	6.38	6.46	13.60	10.64

In a column, means with similar letter (s) are not significantly different by DMRT at 5% level of probablity.

V_1: Sweet Queen, Pronoy F_1 (Hybrid), V_3: Thai Sweet, V_4: Big Boss, V_5: Monika, V_6: Shokti, V_7: Syndrila.
DAT: Days after transplant

maximum number of red pumpkin beetle plant^{-1} (4.75) was recorded from V_3 (Thai Sweet) variety and the minimum number of red pumpkin beetle plant^{-1} (1.00) was recorded from V_6 (Shokti) variety (Table 9). According to Rahman and Annadurai (1985), the RPB is particularly severe pest of pumpkins, muskmelons and bottle gourds, but it appears to be able to feed on any available cucurbits. Khan (2013) studied to determine the biochemical composition of cucurbit leaves and their influence on red pumpkin beetle. Result revealed that the highest nitrogen content was found in young leaf (6.79%) of sweet gourd. Khan *et al* (2011) observed that sweet gourd and wax gourd were found to be the most preferred host of red pumpkin beetle. Pareek and Kavadia (1993) evaluated seventeen sweet gourd varieties for resistance to red pumpkin beetle infestation and revealed that none of the variety showed resistance, but found significant variations. Saljoqi and Khan (2007) studied the relative abundance of red pumpkin beetle, *Aulacophora foveicollis* L. on different cucurbitaceous vegetables.

4.10 Number of cucurbit fruit fly larvae fruit^{-1}

The significant difference was observed due to planting different varieties of sweet gourd at 45, 55, 65 and 75 DAT (Appendix X). At 45 DAT the maximum number of cucurbit fruit fly fruit^{-1} (3.25) was recorded from V_3 (Thai Sweet) variety which is statistically identical to V_2 variety and the minimum number of cucurbit fruit fly plant^{-1} (0.00) was recorded from V_6 (Shokti) variety. At 55 DAT the maximum number of cucurbit fruit fly fruit^{-1} (3.00) was recorded from V_2 (Pronoy F_1) variety which is statistically identical to V_3 variety and the minimum number of cucurbit fruit fly fruit^{-1} (0.25) was recorded from V_6 (Shokti) variety. Similar trend was found at 65 DAT. At 75 DAT the maximum number of cucurbit fruit fly plant^{-1} (3.25) was recorded from V_3 (Thai Sweet) variety and the minimum number of cucurbit fruit fly fruit^{-1} (0.25) was recorded from V_6 (Shokti) variety which is statistically similar to V_4 (Big Boss) and

Table 10. Effect of different varieties on number of cucurbit fruit fly fruit^{-1} at different days after transplanting

Varieties	Different days after transplanting			
	45 DAT	**55 DAT**	**65 DAT**	**75 DAT**
V_1	2.00 b	2.00 b	2.00 b	1.25 bc
V_2	3.00 a	3.00 a	3.00 a	1.50 b
V_3	3.25 a	3.00 a	3.00 a	3.25 a
V_4	1.50 b	1.50 bc	1.50 bc	0.75 cde
V_5	2.00 b	2.00 b	2.00 b	1.00 bcd
V_6	0.00 c	0.25 d	0.25 d	0.25 e
V_7	2.00 b	1.00 c	1.00 c	0.50 de
LSD $_{0.05}$	0.61	0.61	0.61	0.61
CV (%)	12.68	4.41	12.17	9.12

In a column, means with similar letter (s) are not significantly different by DMRT at 5% level of probablity.

V_1: Sweet Queen, Pronoy F_1 (Hybrid), V_3: Thai Sweet, V_4: Big Boss, V_5: Monika, V_6: Shokti, V_7: Syndrila.
DAT: Day After Transplant

V_7(Syndrila) varieties (Table 10). In Tanzania, Mwatawala *et al* (2010) found *B. cucurbitae* to be polyphagous utilizing 19 hosts out of which 11 belong to Cucurbitae family. According to them melon (*Cucumis melo*) is the most preferred host while Momordica cf trifoliate was the most important wild host. Cucurbit fruit fly preferred young and immature fruits and resulted in a loss of 9.7% female flowers. Out of total fruits set, more than one-fourth (26%) fruits were damaged just after set and 14.04% fruits were damaged during harvesting stage (Sapkota *et al*, 2010).

4.11 Infestation percentages of varieties by Red pumpkin beetle

At 65 DAT the plants were most vulnerable for the insect infestation and the plants were in the highest levels of their vegetative and reproductive stage. So, to record the infestation percentage (%) at the 65 DAT was the appropriate time. In that time maximum infestation percentage occurred by Red pumpkin beetle in Thai sweet (32.00 %) variety (V_3) followed by Pronoy F_1 (20.00 %) variety (V_2). On the other hand, the minimum infestation percentage occurred in Big Boss (5.00 %) variety (V_4) and Shokti (5.00 %) variety (V_6) equally. It can be said that Big Boss and Shokti variety is less susceptible to the Red pumpkin beetle than the other varieties (Fig 1). Begum (2002) studied on sweet gourd, ash gourd, sponge gourd, snake gourd and cucumber against the fruit fly and red pumpkin beetle to identify the less and most preferred cucurbit host. Depending on the environmental conditions and susceptibility of the crop species, the extent of damage by red pumpkin beetle varies between 30 to 100% (Gupta and Verma, 1992; Dhillon *et al*, 2005). Khan and Hajela (1987) determined that red pumpkin beetles preferred sweet gourd followed by cucumber, squash, sponge gourd and bottle gourd. Rathod *et al.* (2011) conducted an experiment on red pumpkin beetle, *Aulacophora foveicollis* Lucas to check out the susceptibility of pumpkin cultivars. According to Roy and Pande (1991) red pumpkin was the most preferred to sponge gourd.

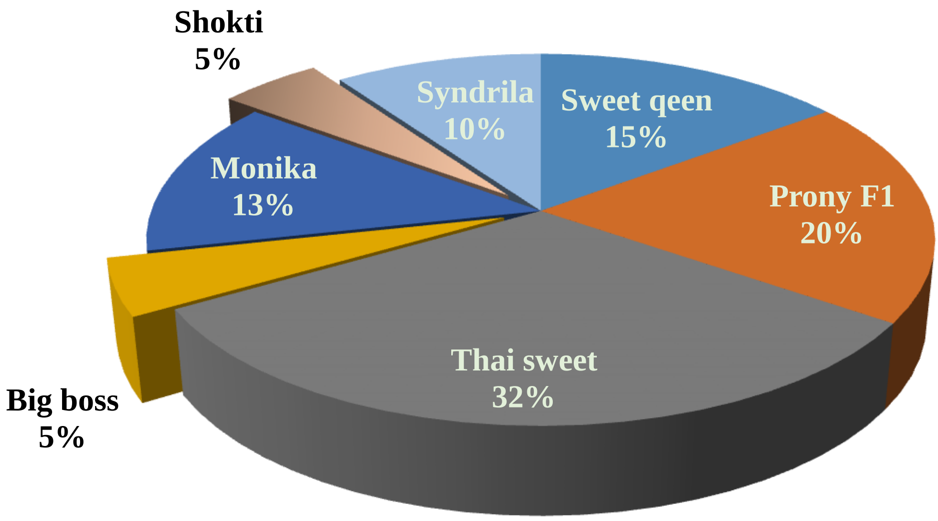

Fig 1. Infestation percentages of different sweet gourd varieties by Red pumpkin beetle

4.12 Infestation percentages of varieties by Cucurbit fruit fly

Generally, cucurbit fruit fly attacks the plant after fruit setting. It had started to attack the pant from 45 DAT up to final stage. At 65 DAT the plants were most vulnerable for the insect infestation and the plants were in the highest levels of their vegetative and reproductive stage. So, to record the infestation percentage (%) at the 65 DAT was the appropriate time. In that time maximum infestation percentage occurred by cucurbit fruit fly in Thai sweet (23.00 %) variety (V_3) and Pronoy F_1 (23.00 %) variety (V_2) equally. On the other hand, the minimum infestation percentage occurred in Shokti (2.00 %) variety (V_6). It can be said that Shokti variety is less susceptible to the cucurbit fruit fly than the other varieties (Fig 2). Kabir *et al.*, (1991) reported that yield losses due to fly infestation varies different fruits and vegetables and it is minimun in cucumber (19.19%) and maximum in sweet gourd (69.96%). Chaudhary and Patel (2007) evaluated that area under commercial cultivation of cucurbitaceous vegetables

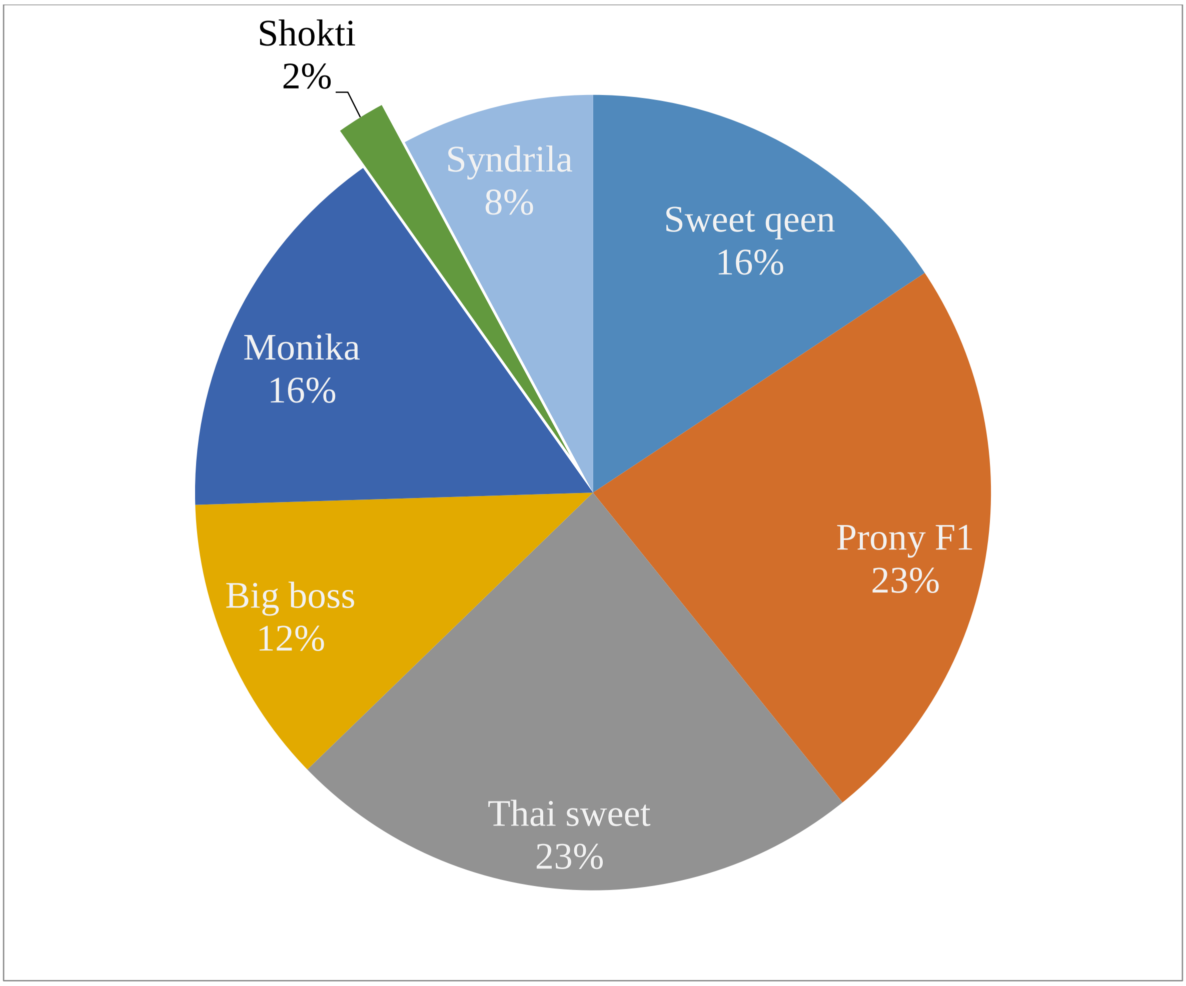

Fig 2. Showing the infestation percentages of different sweet gourd varieties by Cucurbit fruit fly at 65 DAT

had gradually increasing during recent years. The attack of fruit fly was a major constraint in profitable farming of cucurbits. Nath (1966) categorized the fruit damage as- immune (no damage), highly resistant (1-10%), resistant (11-20%), moderately resistant (21-50%), susceptible (51-75%) and highly susceptible (76-100%).

4.13 Comparative yield of different varieties (t ha^{-1})

The maximum yield (25.23 t ha^{-1}) was obtained from V_6 (Shokti) variety and the minimum yield (18.31 t ha^{-1}) was obtained from V_2 (Pronoy) variety. The insect infestation of Shokti variety was less than other varieties. Due to the lower insect infestation all the leaves were good shape and good physiological activities occurred and the variety gave the highest yield.

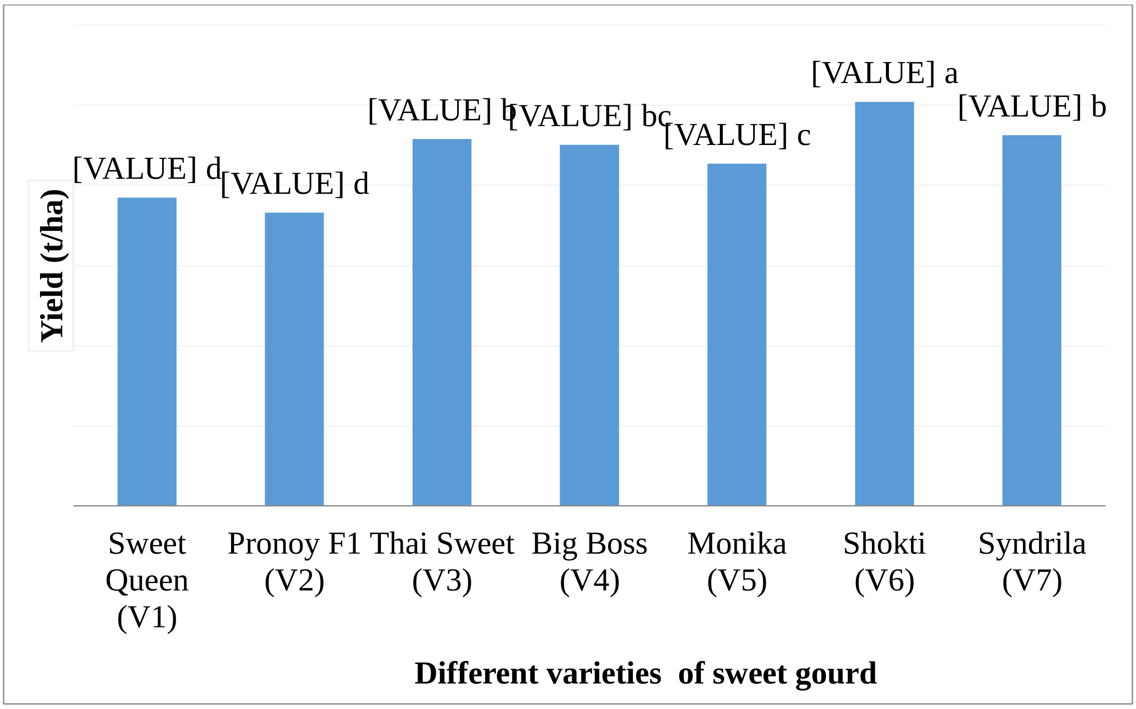

Fig 3. Yield of different cucurbit varieties

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted in the central farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from April to July, 2015 to find out the incidence of red pumpkin beetle and fruit fly on different varieties of sweet gourd. This is the single factor experiment. Factor A: seven varieties of sweet gourd. $\mathbf{V_1}$**:** Sweet Queen $\mathbf{V_2}$: Pronoy F_1 (hybrid), $\mathbf{V_3}$: Thai Sweet, $\mathbf{V_4}$: Big Boss, $\mathbf{V_5}$: Monika, $\mathbf{V_6}$: Shokti, $\mathbf{V_7}$: Syndrila. There were 7 treatment combinations. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. Data on different growth and infestation stage were recorded to find out the good variety of sweet gourd for better production.

In case of number of infested plants plot^{-1} at 75 DAT, the maximum number of infested plants plot^{-1} (4.25) was recorded from V_3 (Thai Sweet) variety which is statistically identical to V_2 (Pronoy F_1) variety followed by V_1, V_4, V_5 and V_7 varieties and the minimum number of infested plants plot^{-1} (2.00) was recorded from V_6 (Shokti) variety. In case of number of branches plant^{-1} at 75 DAT, the maximum number of branches plant^{-1} (17.25) was recorded from V_7 (Syndrila) variety and the minimum number of branches plant^{-1} (10.25) was recorded from V_1 (Sweet Queen) variety which is statistically similar to V_5 (Monika) variety. In case of number of infested branches plant^{-1} at 75 DAT, the maximum number of infested branches plant^{-1} (6.50) was recorded from V_3 (Thai Sweet) variety which is statistically identical to V_2 variety and the minimum number of infested branches plant^{-1} (2.25) was recorded from V_6 (Shokti) variety. In case of number of leaves plant^{-1} at 75 DAT, the maximum number of leaves plant^{-1} (335.50) was recorded from V_3 (Thai Sweet) variety which is statistically similar to V_1, V_2 and V_5 variety and the minimum number of leaves plant^{-1} (145.00) was recorded from V_6 (Shokti) variety which is statistically similar to V_4 and V_7 variety. In case of branch infestation percentage by RPB at 75 DAT, the maximam infestation percentage (51.02) was recorded from V_2 (Pronoy F_1 Hybrid) variety and the minimum infestation percentage (18.37) was recorded from V_6 (Shokti) variety. In case of number of infested leaves plant^{-1} at 75 DAT, the maximum number of infested leaves plant^{-1} (32.75) was recorded from V_3 (Thai Sweet) variety which is statistically similar to V_2 variety and the minimum number of infested leaves plant^{-1} (18.00) was recorded from V_6 (Shokti) variety. In case of number of infested leaves branch^{-1} at 75 DAT, the maximum number of infested leaves branch^{-1} (9.00) was recorded from V_3 (Thai Sweet) variety and the minimum number of infested leaves branch^{-1} (2.75) was recorded from V_6 (Shokti) variety. In case of number of red pumpkin beetle plant^{-1} at 75 DAT, the maximum number of red pumpkin beetle plant^{-1} (4.75) was recorded from V_3 (Thai Sweet) variety and the minimum number of red pumpkin beetle plant^{-1} (1.00) was recorded from V_6 (Shokti) variety. In case of leaves infestation percentage by RPB at 75 DAT, the maximam infestation percentage (12.41) was recorded from V_6 (Shokti) variety and the minimum infestation percentage (9.76) was recorded from V_3 (Thai Sweet) variety. In case of number of cucurbit fruit fly plant^{-1} at 75 DAT, the maximum number of cucurbit fruit fly plant^{-1} (3.25) was recorded from V_3 (Thai Sweet) variety and the minimum number of cucurbit fruit fly plant^{-1} (0.25) was recorded from V_6 (Shokti) variety which is statistically similar to V_4 and V_7 variety.

At 65 DAT the maximum infestation percentage occurred by Red pumpkin beetle in Thai sweet (32.00 %) variety followed by Pronoy F_1 (20.00 %) variety. On the other hand the minimum infestation percentage occurred in Big Boss (5.00 %) and Shokti (5.00 %) variety which are equally infested. It can be said that Big Boss and Shokti variety is more resistant to the Red pumpkin beetle than the other varieties and the maximum infestation percentage occurred by cucurbit fruit fly in Thai sweet (23.00 %) and Pronoy F_1 (23.00 %) variety, which was equally infested. On the other hand the minimum infestation percentage occurred in Shokti (2.00 %) variety. Here Shokti variety also showed the highest resistance to cucurbit fruit fly.

Conclusion

In a nutshell it can be concluded that Shokti (V_6) variety is less suseptable to the Red pumpkin beetle and Cucurbit fruit fly than the other 6 varieties.

All varieties were infested by red pumpkin beetle and fruit fly. But the Shokti (V_6) variety is less suseptable to the Red pumpkin beetle and Cucurbit fruit fly than the other 6 varieties and Shokti (V_6) variety also showed better performance regarding yield.

REFERENCES

Abe, M., Matsuda, K. and Tamaki, Y. (2002). Differences in feeding response among three cucurbitaceous feeding leaf beetles to cucurbitacins. *Appl. Entomol. Zool.* **35**(1): 137-142.

Akhtaruzzaman, M., Alam, M.Z. and Sarder, M.A. (1999). Identification and distribution of fruit cucurbits in Bangladesh. *Bangladesh J. Entomol.* **9** (1 and 2): 93-101.

Alam, M.Z., Ahmed, A., Alam, S. and Islam, M.A. (1964). A review of Research Div. Ent., Agri. Infor. Serv. in collaboration with EPART, Dept. Agri., East Pakistan, Dacca., 272p.

Alam, M.Z. (1965). Insect pests of vegetables and their control. East Pakistan Agricultural Research Institute and Agricultural Information Service. Dacca. 146p.

Alam, M.Z. (1969). Insect pests of vegetables and their control in East Pakistan. The Agricultural Information service, 3, R. K. Misson Road, Dhaka. 146p.

Allwood, A.L., Chinajariyawong, A., Drew, R.A.I., Hamacek, E.L., Hancock, D.L., Hengsawad, C., Jipanin, J.C., Jirasurat, M., Kong Krong, C., Kritsaneepaiboon, S., Leong, C.T. S. and Vijaysegaran, S. (1999). Host plant records for fruit flies (Diptera: Tephritidae) in Southeast Asia. *Raff Bull. Zool.* **7**: 1-92.

Anonymous. (1930). Control of red pumpkin beetle (Aulacophora abdominalis). Department of Agriculture, Bombay, India. No.9 pp.2. http://www cabdirect.org/abstracts/19310501893.html

Anonymous. (1987). Comparative efficacy of bagging and trapping in controlling fruit fly, Bactrocera cucurbitae Coq. Attacking kakrol research report on fruit fly in cucurbits (1987-1988). Paper presented at the International Review Workshop held on August 28-30, 1988. Division of Entomology, BARI, Gazipur, Bangladesh. 17p.

Anonymous. (1988). Melon Fly Eradication Project in Okinawa Prefecture. Akatsuki Pruning Ltd., Japan. 28p.

Anonymous. (2004). Technical Bulletin, USAID funded integrated pest management collaborative research support programme (IPM CRSP), Bangladesh Agricultural Research Institute, Gazipur, Bangladesh. 8p.

Anonymous. (1993). Bangladesh Bureau of Statistics. Statistics Division, Ministry of Planning. Dhaka. pp. 189-190.

Aslam, M.R., Javed, K., Javed , H., Ahmad, T., Kassi, A.K. (2017). Varietal resistance of pumpkin (Cucurbita pepo L.) Germplasms against Red Pumpkin Beetle *Aulacophora foveicollis* L. in Pothwar region. *J. Entomol. and Zool. Studies.* **5**(1): 07-12.

Atwal, A.S. (1993) Agricultural pests of India and South Asia. Kalyani pub. New Delhi, Ludhiana. pp. 189-190.

Azim, M.I.I. (1996). Studies on the biology of red pumpkin beetle, *Aulacophora foveicollis* (Luca) (Chrysomelidae: Coleoptera) in Bangladesh. M.Sc. Thesis, Department of Engomology, Bangladesh Agricultural University, Mymensingh. pp. 1-95.

BBS (Bangladesh Bureau of Statistics). (2012). Summary crop statistics and crop indices (2010–11). BBS Division, Govt. of the People’s Republic of Bangladesh. pp. 137 and 148.

BBS. (2010). Year Book of Agricultural Statistics of Bangladesh. Statistics Division, Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka. 97p.

Begum, L.A.A. (2002). Host preference of fruit fly and red pumpkin beetle to different cucurbit vegetables grown in summer. Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Dhaka. pp. 1-64.

Bezzi, M. (1913). Indian Tephritids (fruit flies) in the collection of the Indian Museum, Calcutta. Mem. *Indian Mus.* **3**: 153-175.

Borah, R.K. (1999). Seasonality and varietal preference red pumpkin beetle (Raphidopalpa foveicollis) on cucumber (Cucumis sativus) in Assam. *Indian J. Agric. Sci.* **69**(3): 180-181.

Borah, R.K. and Datta, K. (1997). Infestation of fruit fly in some cucurbitaceous vegetables. *J. Agric. Sci. Soc. North East India.* **10**(1): 128-131.

Butani, D.K. and Jotwani, M.G. (1984). Insects in Vegetables. Periodical Expert Book Agency. Vivek-Vihar, Delhi , India. 356p.

Cavalloro, R. (1983). Fruit Flies of Economic Importance. In: Cavalloro R. editor. CEC/IOBC Symposia, Athens, Greece 1982. Rotterdam: Balkema, Germany. 642p.

Chaudhary, F.K. and Patel, G.M. (2007). Ovipositional preference of melon fly, *B.cucurbitae* Coquilett in its cultivated hosts. *Insect Environment*. **13**(3): 135-137.

CL, F., Shi, H., Li, Q.H. (2006). A Review on Pharmacological Activities and Utilization Technologies of Pumpkin. Plant Foods Hum. Nutr. **61**: 73-80.

Deepak, R., Singh, R.K., Ram, H.H. and Singh, D.K. (2004). Evaluation of Sweet gourd Genotypes for Field Resistance to Red Pumpkin Beetle (Aulacophora foveicollis Lucas). *Indian J. Plant Genet. Res.* **17**(1): 8-9.

Dhillon, M.K., Naresh, J.S. and Sharma, N.K. (2005). Influence of physico-chemical traits of bitter gourd, *Momordica charantia* L. on larval density and resistance to melon fruit fly, *Bactrocera cucurbitae* (Coquillett). *J. Appl. Entomol.* **129**: 393-399.

Doharey, K.L. (1983). Bionomics of fruit flies (*Dacus spp.)* on some fruits. *Indian J. Entomol*. **45**: 406-413.

Drew, R.A.I. and Hooper, G.H.S. (1983). Population studies of fruit flies (Diptera: Tephritidae) in South-East Queensland. *Oecologia.* **56**: 153-159.

Ekesi, S, Nderitu, P.W and Rwomushana, I. (2006). Field infestation, life history and demographic parameters of *Bactrocera invadens* Drew, Tsuruta and White, a new invasive fruit fly species in Africa. *Bull. Entomol. Res*. **96**: 379–386.

Eta, C.R. (1985). Eradication of the melon flies from Shortland Islands (special report). Solomon Islands Agricultural Quarantine Service, Annual Report. Ministry of Agriculture and Lands, Honiara.

Fletcher, B.S. (1987). The biology of Dacine fruit flies. *Annu. Rev. Entomol.* **32**: 115-144.

Gameel, S.M.M. (2013). Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt. *Egyptian Academic J. Biol. Sci.: Entomol*. **6**(2):73-79.

Gill, C.K. (2003). Insect pests and cucumber mosaic virus on muskmelon. *Insect Environ.*, **9**(3): 102-103.

Goergen, G., Vassieres, J.F., Gnanvossou, D. and Tindo, M. (2011*). Bactrocera invadens* (Diptera: Tephritidae), a new invasive fruit fly pest for the Afrotropical region: Host range and distribution in West and Central Africa. *Environ. Entomol.* **40**(4): 844–854.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedure for Agricultural Research. John Willey and Sons, New York, (2nd edn.): 28-411

Gopalan, C., Rum, S.B.V., Ubramanion, B.S.C. (1982). Nutritive value of Indian Food. I.C.H.R., Hyderabad, India, referred by R.G. Smith, Home Economicst, M.C.C. pp. 23-29.

Gupta, D. and Verma, A.K. (1992). Population fluctuations of the maggots of fruit flies *Dacus Cucurbitae* (Coquillett) and D. tau (Walker) infesting cucurbitaceous crops. *Adv. Pl. Sci.* **5**: 518-523.

Gupta, J.N. and Verma, A.N. (1978). Screening of different cucurbit crops for the attack of the melon fruit fly, *Dacus cucurbitae* Coq. (Diptera: Tephritidae). *Haryana J. Hort. Sci*. **7**: 78–82.

Haider, E.A. 1991. Agro Ecological Region of Bangladesh. Land Resources Appraisal of Bangladesh Agricultural Development. *Plant Physiology.* **31**: 312-323.

Hassan, K., Uddin, M.M. and Haque, M.A. (2012). Host suitability of red pumpkin beetle, Aulacophora foveicollis (Lucas) among different cucurbitaceous hosts. IRJALS. **1**(4): 91-100.

Hollingsworth, R. and Allwood, A.J. (2002). Melon fly. In: SPC Pest Advisory Leaflets. pp. 1-2.

Hollingsworth, R., Vagalo, M. and Tsatsia, F. (1997). Biology of melon fly, with special reference to the Solomon Islands. In: Allwood AJ and Drew RAI editors. Management of fruit flies in the Pacific. *Proc. Australian Ind. Agric. Res*. **76**: 140-144.

Hutson, J.G. (1972). Report of the Entomological Division in Ceylon. *Rev. Appl. Ent. Sci. America*. **16**: 303.

Kabir, S.M.H., Rahman, R. and Mollah, M.A.S. (1991). Host plants of Dacinae fruit flies (Diptera:Tephritidae) of Bangladesh. *Bangladesh J. Entomol.* **1**: 60-75.

Kadam, P.V., Patil, M.J. (2014) Pharmacognostic study of *Cucurbita moschata* (cucurbitaceae). *Pharmacognosy J.* **5**: 201-209.

Kamal, MM., Uddin, M.M., Shajahan, M., Rahman, M.M.(2013). ROLE OF HOST AND TEMPERATURE ON THE FEEDING AND OVIPOSITION BEHAVIOUR OF RED PUMPKIN BEETLE *Aulacophora foveicollis* (LUCAS). *Agric.* **24**(1 & 2): 53 – 60.

Kapoor, V.C. (1993). Indian Fruit Flies. Oxford and IBH Publishing Co. Ltd. New Delhi, India. 228p.

Khan M.M.H., Alam, M.Z. and Rahman, M.M. (2011). Host preference of red pumpkin beetle in a choice test under net case condition. *Bangladesh J. Zool.* **39**(2): 231-234.

Khan, M.M.H. (2012). Host preference of pumpkin beetle to cucurbits under field conditions. *J. Asiaitic. Soc. Bangladesh, Sci.* **38**(1): 75-82.

Khan, M.M.H. (2013). Biochemical composition of cucurbit leaves and their influence on red pumpkin beetle. *Intl. J. Res. Appl., Natural Social Sci.* (IJRANSS). **1**(2): 131-138.

Khan, M.M.H., Alam, M.Z., Rahman, M.M., Miah, M.I.H. and Hossain, M.M. (2012). Influence of weather factors on the incidence and distribution of pumpkin beetle infesting cucurbits. *Bangladesh J. Agril. Res.* **37**(2): 361-367.

Khan, M.S.K. (1997). Effect of different levels of nitrogen on growth, yield and quality of wheat. MS Thesis, Dept. Agron. Bangladesh Agric. Univ. Mymenisngh. pp. 35–38.

Khan, M.Z. and Hajela, K.P. (1987). Studies on Aulacophora foveicollis Lucas (Coleoptera : Chrysomelidae) food preference and extent of damage. *Indian J. Entomol*. **49**(4): 457-459.

Kushwaha, K.S., Pareek, B.L. and Noor, A. (1973). Fruit fly damage in cucurbits at Udaipur. *Udaipur Unv. Res. J.* **11**: 22-23.

Lall, B.S. and Sinha, S.N. (1959). On the biology of the melon fly, Dacus cucurbitae (Coq.) (Diptera: Tephritidae). *Sci. and Cul.* **25**: 159-161.

Lux, S.A., Copeland, R.S., White, I.M., Manrakhan, A. and Billah, M.K. (2003). A new invasive fruit flyspecies from the Bactrocera dorsalis Hendel group detected in East Africa. *Insect Sci. Appl.* **23**(4): 355–361.

Manson, F.R. (1942). Annual Report of the Dept. Agric. Fisheries (Palestine) for the Year Ended on March 31, (1942). *Rev. Ent. Sci. America.* **32**.

Mckinlay, R.G., Spavll, A.M. and Straub, R.W. (1992). Pests of Solanaceous crops. *In:* Vegetable crop pests. Mckinlay. R.G. (ed.). Mckinlay Press, Houndmills, Basingstok, Hampshire London. pp. 263-326.

Melamed-Madjae, V., (1960). Studies on the red pumpkin beetle in Israel. Ktavim, **10**(3-4): 139-145.

Mitchell, W.C. (1980). Verification of the absence of Oriental fruit and melon fruit fly following an eradication program in the Mariana Islands. Proc. *Hawaiian Entomol. Soc.* **23**: 239-243.

Munro, K.H. (1984). A taxonomic treatise on the Decidae (Tephritoidea: Diptera) of Africa. Entomological Memories of the Department of

Agriculture, Republic of South Africa. *J. Entomol. Soc. South Africa.* **61**: 1-313.

Mwatawala, M., Maerere, A.P., Makundi, R. and De Meyer, M. (2010). Incidence and host range of the melon fruit fly *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae) in Central Tanzania. *Intl. J. Pest Manage*. **56**(3): 265-273.

Miyatake, N., Tatawala, M., Vrere, D.P., Dkundi, R. and De Meyer, M. (1993). Incidence and host range of the fruit fly *Bactrocera cucurbitae* (Coquillett) in Central Africa. *Intl. J. Pest Manage*. **46**(3): 212-227.

Mziray, H.A., Makundi, R.H., Mwatawala, M., Maerere, A. and De Meyer, M. (2010). Host use of Bactrocera latifrons, a new invasive tephritid species in Tanzania. *J. Econ. Entomol.* **103**: 70-76.

Nagappan, K., Kamalnathan, S., Santharaman, T. and Ayyasamy, M.K. (1971). Insecticidal trials for the control of the melon fruit fly, *Dacus cucurbitae* Coq. infesting snake gourd, *Trichosanthes anguina. Madras Agric. J.* **58**: 688-690.

Naqvi, M.H. (2005). Management and quality assurance of fruits and vegetables for export needs for product to market approach, In: Use of Irradiation for Quarantine Treatment of Fresh Fruits and Vegetables, 19 September 2005, Dhaka, Bangladesh. pp. 14-24.

Narayanan, E.S. (1953). Seasonal pests of crops. Indian Farming. **3**(4): 8-11 and 29-31.

Narayanan, E.S. and Batra, H.N. (1960). Fruit flies and Their Control Indian Council of Agricultural Research, New Delhi. 68p.

Nath, P. (1965). Varietal resistance of gourds to the fruit fly. *Indian J. Hort*. **23** : 69-78.

Nath, P. and Thakur, M.R. (1965). Evaluation of red pumpkin beetle resistance in gourds. *Indian J. Hort*. **22** (2&4): 330-339.

Nkosi, C.Z., Opaku, A.R. (2006). Antioxidant effects of pumpkin seeds (*Cucurbita pepo*) protein isolate in CCl_4 included liver injury in low protein fed rats.

Pal, A.B., Srinivasan, K., Bharatan, G., Chandravadana, M.V. (1978). Location of source of resistance to the red pumpkin beetle, Rapidopalpa foveicollis Lucas against pumpkin germplasm. *J. Entomol. Res*. **2**(2): 148-153.

Pareek, B.L. and Kavadia, V.S. (1993). Screening of musk melon varieties against red pumpkin beetle, *Aulacophora foveicollis* Lucas. *Indian J. Entomol.* **55**(3): 245-251.

Paris, H.S. (2008). Summer squash. In: Prohens J, Nuez F (eds) Handbook of plant breeding, Vegetables I. Springer, New York . 351-379.

Pawlacos, J.G. (1940). *Raphidopalpa foveicollis* (Lucas) as a pest of melon in Greece and its control. *Rev. Ent. Sci. A.*, **32**: 161.

Picault, S. (2014). Functional biodiversity in vegetable crops: working towards agroecological management of aphids and thrips. CTIFL, Paris, France. *Infos- Ctifl.* **300**: 45-55.

Pradhan, S. (1969). Insect pests of crops. First Edition, National Book Trust, India, New Delhi. 208p.

Qin, Y., Paini, D.R., Wang, C., Fang, Y. and Li, Z. (2015). Global establishment risk of economically important fruit fly species (Tephritidae). *PloS one*.**10**(1): 0116424.

Rabindranath, K. and Pillai, K.S. (1986). Control of fruit fly of bitter gourd using synthetic pyrethroids. *J. Entomol.* **11**: 269–272.

Rahman, K. and Annadurai, R.S. (1985). Host selection and food utilization of the red pumpkin beetle, *Raphidopalpa foveicollis* (Lucas) (Chrysomelidae: Coleoptera). *Proc. Animal Sci.* **94**(5): 547-556.

Rakshit, A., Rezaul Karim, A.N.M., Hristovska, T. and George W.N. (2011). Impact Assessment of Pheromone Traps to Manage Fruit Fly on Sweet Gourd Cultivation. *Bangladesh J. Agric. Res*. **36**(2):197-203.

Ramphall and Gill, H.S. (1990). Demand and supply of vegetables and pulses in South Asia. *In:* vegetable research and development in South Asia. S. Shanmugasundram (ed.). Proc. Workshop held at Islamabad, Pakistan, on 24-29 September, 1990. AVRDC Publication No. 90-331. AVRDC, Taiwan. pp. 159-165.

Rashid, M.M. (1993). Kumra Paribarer Shabji. In: *Shabji Bijnan* (in Bengali). Bangla Academy, Dhaka, Bangladesh. pp. 254-356.

Rathod, S.T., Borad, P.K., Bhatt, N.A. (2009). Bio-efficacy of neem based and synthetic insecticides against red pumpkin beetle, *Aulacophora foveicollis* (Lucas) on bottle gourd. *Pest Manag. Hort. Ecos.* **15**(2): 150-154.

Rekhi, S.S. (1997). Vegetable improvement and seed production. Key note paper presented in the National Seminar on March 3-4 at BARI, Joydebpur, Gazipur, Bangladesh.

Roy, D.C. and Pande, Y.D. (1990). Seasonal incidence, host preference and feeding rate of red pumpkin beetle (Aulacophora foveicollis) in Tripura. *Indian J. Agric. Sci*. **61** (8): 603-607.

Roy, D.C. and Pande, Y.D. (1991). Seasonal incidence, host preference and feeding rate of red pumpkin beetle (*Aulacophora foveicollis*) in Tripura. Indian *Journal of Agricultural Sciences.* **61**(8): 603-607

Russell, D.F. (1986). MSTAT-C computer based data analysis software). Crop and Soil Science Department, Michigan State University, USA.

Saljoqi, A.U.R. and Khan, S. (2007). Relative abundance of the red pumpkin beetle, *Aulacophora foveicophora* (Lucas), on different cucurbitaceous vegetables. *Sarhad J. Agric*. **23**(1).

Sandhu, G.S. and Grewal, S.S. (1985). Testing cucurbits through multiple-choice and no-choice tests under cages by infesting red pumpkin beetle adults. *Indian J. Entomol.* **47**(2): 169-172.

Sarker, M.N.I., Ali, M.A., M.S., Bari, M.A. (2016). Feeding Behavior and Food Preference of Red Pumpkin Beetle, *Aulacophora Foveicollis. American J. Plant Biol.* **1**(1): 13-17.

Satpathy, S. and Samarjit, R. (2002). Luring ability of indigenous food baits for fruit fly, *Bactrocera cucurbitae* (Coq.). *J. Entomol. Res.* **26**: 249-252.

Senior-White, R. (1924). Trypetidae. Catalogue of Indian Insects IV, Government of India, Calcutta, India. pp. 1-33.

Shah, M.I., Batra, H.N. and Ranjhen, P.L. (1948). Notes on the biology of *Dacus* (Strumeta) *ferrugineus Fab*. and other fruit flies in the North-West Frontier Province. *Indian J. Entomol.* **10:** 249-266.

Sharma, S.S., Bhanot, J.P., Kalra, V.K. (1999). Host preference, extent of damage and control of red pumpkin beetle, *Raphidopalpa foveicollis* (Lucas). *J. Insect Sci.* **12**(2): 168-170.

Shivalingaswamy, T.M., Kumar, A., Satpathy, S., Bhardwaj, D.R. and Rai, A.B. (2008). Relative susceptibility of bottle gourd cultivars to red pumpkin beetle, Aulacophora foveicollis (lucas) (short communication). *Vegetable Sci*. **35**(1): 97.

Shooker, P., Khayrattee, F. and Permalloo, S. (2006).Use of maize as a trap crops for the control of melon fly, *B. cucurbitae* (Diptera:Tephritidae) with GF-120. Bio –control and other control methods (online). Available on: http//www.fcla.edu/FlaEnt/fe87p354.pdf.[Retrieved on 20th jan.2008].

Singh, S.V., Mishra, A., Bisan, R.S., Malik, Y.P. and Mishra, A. (2000). Host preference of red pumpkin beetle, Aulacophora foveicollis and melon fruit fly, *Dacus cucurbitae*. *Indian J .Entomol.* **62**: 242–246.

Steiner, L.F., Mitchell, W.C., Harris, E.J., Kozuma, T.T. and Fuj imoto, M.S. (1965). Oriental fruit fly eradication by male annihilation. *J. Econ. Entomol.* **58**(5): 1961-1964.

Tecson, A.M. (2001). Pumpkin production guide, Bureau of Plant Industry, Horticulture Section. Crop Research Division, Manila.

Thapa, R.B. and Neupane, F.P. (1992). Incidence, host preference and control of the red pumpkin beetle, *Aulacophora foveicollis* (Lucas) (Coleoptera: Chrysomelidae) on Cucurbits. *J. Insect. Agric. Anim. Sci.* **13**: 71-77.

Uddin, M.J. (1996). Development of suitable packages of IPM components for the management of selected insect pests of cucumber. MS Thesis, Department of Entomology, Institute of Post Graduate Studies in Agriculture, Gazipur, Bangladesh. 72p.

UNDP and FAO. (1988). Land Resources Appraisal of Bangladesh for Agricultural Development. Report 2. Agroecological Regions of Bangladesh. United Nations Development Programme and Food and Agriculture Organization. pp. 212-221.

Vandana, R.M., Prashad, P.R. and Rao, N.V. (2001). Host preference of R. Foveicollis (Lucas). *Vegetable Sci.* **28**(1): 95-97.

Vayssieres, J.F., Goergen, G., Lokossuo, O., Dossa, P. and Akponon, C. (2005). A new *Bactrocera* species in Benin among mango fruit fly (Diptera: Tephritidae) species. *Fruits.* **60**: 371–377.

Vayssieres, J.F., Rey, J.Y. and Traore, L. (2007). Distribution and host plants of Bactrocera cucurbitae in West and Central Africa. *Fruits.* **62**: 391–396.

Vijaysegaran, S. (1987). Combating fruit fly problem in Malaysia. The current situation and strategies to overcome the existing problems. Plant Quarantine and Phytosanitary Barriers to Trade in the ASEAN, Selangor, Malaysia. ASEAN Plant Quarantine Center and Training Institute OE Review of Applied Entomology. 9-12 December, 1986. pp. 209-216.

Weems, H.V.Jr., Heppner, J.B. (2001). Melon fly, *Bactrocera cucurbitae Coquillett* (Insecta: Diptera: Tephritidae). Florida Department of Agriculture and Consumer Services, Division of Plant Industry, and T.R. Fasulo, University of Florida. University of Florida Publication EENY- 199.

White, I.M., Elson-Harris, M.M. (1994) Fruit Flies of Economic Significance: Their Identification and Bionomics. Commonwealth Agriculture Bureau International, Oxon, UK. pp. 1-601.

White, I.M. (2006). Taxonomy of the Dacina (Diptera: Tephritidae) of African and the Middle East. *African Entomol. Memoir.* **2**: 1–156.

Wong, T.T.Y., Cunningham, R.T., Mcinnis, D.O. and Gilmore, J.E. (1989). Seasonal distribution and abundance of Dacus cucurbitae (Diptera: Tephritidae) in Rota, Commonwealth of the Mariana Islands. *Environ. Entomol.* **18**: 1079-1082.

York, A. (1992). Pest of cucurbit crops: Marrow, pumpkin, squash, melon and cucumber. **In**: Vegetable Crop Pests. Mckinlay, R.G. (ed.). McMillan Press. Houndmills,

APPENDICES

Appendix I. Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from October 2015 to May 2016

Month	Air temperature (^0C)		R. H. (%)	Total rainfall (mm)
	Maximum	Minimum		
October,15	29.18	18.26	81	39
November,15	25.82	16.04	78	0
December,15	22.4	13.5	74	0
January,16	24.5	12.4	68	0
February,16	27.1	16.7	67	3
March,16	31.4	19.6	54	11
April, 16	35.3	22.4	51	15
May, 16	38.2	23.2	62	17

Source: Bangladesh Metrological Department (Climate and weather division) Agargaon, Dhaka

Appendix II. Results of morphological, mechanical and chemical analysis of soil of the experimental plot

A. Morphological Characteristics

Morphological features	Characteristics
Location	Field Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow redbrown terrace soil
Land Type	Medium high land
Soil Series	Tejgaon
Topography	Fairly leveled
Flood Level	Above flood level
Drainage	Well drained

B. Mechanical analysis

Constituents	Percentage (%)
Sand	28.78
Silt	42.12
Clay	29.1

C. Chemical analysis

Soil properties	Amount
Soil pH	5.8
Organic carbon (%)	0.95
Organic matter (%)	0.77
Total nitrogen (%)	0.075
Available P (ppm)	15.07
Exchangeable K (%)	0.32
Available S (ppm)	16.17

Source: Soil Resource Development Institute (SRDI)

Appendix III: Analysis of variance of data on infected plant plot^{-1} at different DAT of sweet gourd

Source of Variation	Degrees of freedom (df)	Means square of infected plant plot^{-1} at						
		15 DAT	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT
Replication	3	6.872	0.142	9.231	0.035	0.142	0.035	0.035
Factor A: (Variety)	6	1.142	1.726*	1.142*	1.083*	1.821**	1.654*	1.369*
Error	18	1.532	0.059	1.532	0.035	0.059	0.035	0.035
** : Significant at 1% level of probability; * : Significant at 5% level of probability								

Appendix IV: Analysis of variance of data on number of branches plant^{-1} at different DAT of sweet gourd

Source of Variation	Degrees of freedom (df)	Means square of number of branches plant^{-1} at						
		15 DAT	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT
Replication	3	1.048	0.321	0.036	0.321	0.321	0.571**	0.143
Factor A: (Variety)	6	0.536	4.310*	7.821**	12.333*	18.476*	24.143*	25.702**
Error	18	0.187	0.071	0.202	0.238	0.238	0.238	0.560
** : Significant at 1% level of probability; * : Significant at 5% level of probability								

Appendix V: Analysis of variance of data on number of infected branches plant^{-1} at different DAT of sweet gourd

Source of Variation	Degrees of freedom (df)	Means square of number of infected branches plant^{-1} at						
		15 DAT	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT
Replication	3	0.036	0.571	0.143	2.220	0.321	1.286	4.321
Factor A: (Variety)	6	0.536*	0.786*	0.917**	5.226**	6.976*	3.976*	10.488**
Error	18	0.202	0.071	0.060	0.083	0.071	0.119	0.155
** : Significant at 1% level of probability; * : Significant at 5% level of probability								

Appendix VI: Analysis of variance of data on number of leaves plant^{-1} at different DAT of sweet gourd

Source of Variation	Degrees of freedom (df)	Means square of number of leaves plant^{-1} at						
		15 DAT	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT
Replication	3	0.036	6.359	5.962	6.036	5.867	1.016	2.006
Factor A: (Variety)	6	10.702	34.588**	464.905*	965.976*	10649.10*	13976.833**	16825.30**
Error	18	0.036	6.250	92.333	171.119	1780.83	3444.167	3373.08
** : Significant at 1% level of probability; * : Significant at 5% level of probability								

Appendix VII: Analysis of variance of data on number of infected leaves plant^{-1} at different DAT of sweet gourd

Source of Variation	Degrees of freedom (df)	Means square of number of infected leaves plant^{-1} at						
		15 DAT	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT
Replication	3	0.047	0.142	0.035	0.142	0.142	0.892	0.893
Factor A: (Variety)	6	7.285*	11.571**	7.833*	27.250*	22.202*	39.142**	113.060**
Error	18	0.047	0.142	0.119	0.059	0.059	0.142	0.726
** : Significant at 1% level of probability; * : Significant at 5% level of probability								

Appendix VIII: Analysis of variance of data on number of infected leaves branch^{-1} at different DAT of sweet gourd

Source of Variation	Degrees of freedom (df)	Means square of number of infected leaves branch^{-1} at						
		15 DAT	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT
Replication	3	0.035	0.035	0.892	3.533	0.142	2.892	2.892
Factor A: (Variety)	6	1.035*	0.892*	14.988**	5.976*	12.530**	15.333**	21.619*
Error	18	0.035	0.035	0.226	0.166	0.059	0.476	0.142
** : Significant at 1% level of probability; * : Significant at 5% level of probability								

Appendix IX: Analysis of variance of data on number of red pumpkin beetle plant^{-1} at different DAT of sweet gourd

Source of Variation	Degrees of freedom (df)	Means square of number of red pumpkin beetle plant^{-1} at						
		15 DAT	25 DAT	35 DAT	45 DAT	55 DAT	65 DAT	75 DAT
Replication	3	0.035	0.035	0.142	0.035	0.571	0.321	2.393
Factor A: (Variety)	6	6.654*	4.654*	6.904*	11.035**	7.321*	14.821*	6.702*
Error	18	0.035	0.035	0.142	0.035	0.321	0.154	0.083
** : Significant at 1% level of probability; * : Significant at 5% level of probability								

Appendix X: Analysis of variance of data on number of cucurbit fruit fly plant^{-1} at different DAT of sweet gourd

Source of Variation	Degrees of freedom (df)	Means square of number of cucurbit fruit fly plant^{-1} at			
		45 DAT	55 DAT	65 DAT	75 DAT
Replication	3	0.226	0.226	1.743	1.952
Factor A: (Variety)	6	4.535**	4.059*	4.571*	3.952**
Error	18	0.170	0.170	6.523	0.174
** : Significant at 1% level of probability; * : Significant at 5% level of probability					