HOST PREFERENCE OF RED PUMPKIN BEETLE, *Aulacophora foveicollis* Lucas IN DIFFERENT CUCURBITS

MD. JAHIDUL ISLAM

DEPARTMENT OF ENTOMOLOGY

SHER-E-BANGLA AGRICULTURAL UNIVERSITY
SHER-E-BANGLA NAGAR, DHAKA -1207

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HOST PREFERENCE OF RED PUMPKIN BEETLE, *Aulacophora foveicollis* Lucas IN DIFFERENT CUCURBITS

BY

MD. JAHIDUL ISLAM

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Approved by:

Dr. Md. Mizanur Rahman	**Dr. Mohammed Sakhawat Hossain**
Professor	**Associate professor**
Dept. of Entomology, SAU	Dept. of Entomology, SAU
Supervisor	**Co-Supervisor**

Dr. Mohammed Sakhawat Hossain
Associate professor
Chairman
Dept. of Entomology, SAU

Prof. Dr. Md. Mizanur Rahman
Department of Entomology
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207,
Bangladesh
Mobile: +88 01913521028
E-Mail: dmrsau@yahoo.com

CERTIFICATE

*This is to certify that thesis entitled, "**Host Preference of Red Pumpkin Beetle, Aulacophora foveicollis lucas in Different Cucurbits**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science (M.S.) in Entomology**, embodies the result of a piece of bona fide research work carried out by **MD. JAHIDUL ISLAM**, **Registration No. 09-03537** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated :
Place : Dhaka, Bangladesh

(Prof. Dr. Md. Mizanur Rahman)
Dept. of Entomology, SAU
Supervisor

DEDICATED TO
MY
BELOVED PARENTS

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The Author

HOST PREFERENCE OF RED PUMPKIN BEETLE, *Aulacophora foveicollis* Lucas IN DIFFERENT CUCURBITS

ABSTRACT

The experiment was conducted in the experimental farm of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207 during the period from May to August, 2014 to study the host preference of red pumpkin beetle (*Aulacophora foveicollis* Lucas) in different cucurbits. The research consists of three cucurbitaceous plants *viz.* sweet gourd, bottle gourd and bitter gourd. The seeds of these varieties were collected from the BADC, Jessore. The experiment was laid out in single factor Randomized Completely Block Design (RCBD) with three replications. Data were recorded on damage of infested cotyledon, number of infested plants pit^{-1}, number of infested leaves $plant^{-1}$, number of total infested leaves $plot^{-1}$, damage of infested flowers and percent damage of infested fruits. Sweet gourd cotyledon showed the maximum (47.67%) damage than that of other cucurbits at 20 DAS, all plants of sweet gourd pit^{-1} were infested by red pumpkin beetle. The highest leaf infestation was observed in sweet gourd at 50 DAS. The highest flower damage (31%) $plot^{-1}$ was also observed in sweet gourd at 35 (DAS), where as the highest (39.89%) damage percentage of infested fruits $plot^{-1}$ was also observed in sweet gourd at 50 DAS. Sweet gourd was found in highly preferred condition by RPB and bitter gourd was found in least preferred condition by red pumpkin beetle in this study.

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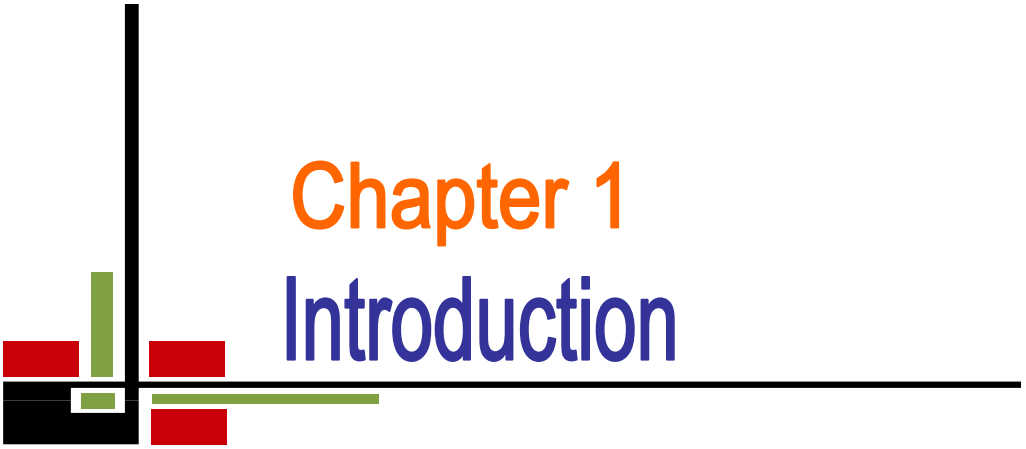
LIST OF ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
FAO	=	Food and Agricultural Organization
N	=	Nitrogen
et al.	=	And others
TSP	=	Triple Super Phosphate
MOP	=	Muriate of Potash
RCBD	=	Randomized Complete Block Design
DAT	=	Days after Transplanting
ha^{-1}	=	Per hectare
g	=	gram (s)
kg	=	Kilogram
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Resources and Development Institute
wt	=	Weight
LSD	=	Least Significant Difference
^0C	=	Degree Celsius
NS	=	Not significant
Max	=	Maximum
Min	=	Minimum
%	=	Percent
NPK	=	Nitrogen, Phosphorus and Potassium
CV%	=	Percentage of Coefficient of Variance



Chapter 1
Introduction

CHAPTER 1

INTRODUCTION

Cucurbitaceous vegetables i.e. cucumber (*Cucumis sativus*), bottle gourd (*Lagenaria siceraria*), Water melon (*Citrullus lanatus*), Muskmelon (*Cucumis melo*), Round gourd and Bitter gourd (*Momordica Charentia*) belongs to same family cucurbitaceae and it is very important and biggest group of vegetables. Cucurbits are mostly grown in tropical and sub tropical conditions but some of the vegetables are grown in temperate zone under artificial conditions like cucumber (Dhaliwal, 2008). The family cucurbitaceae have 118 genera and 825 spp. Most of them derived from the old world (Rai, 2008). Most of the cucurbits are annual and grown through the seeds by direct sowing in the field but some cucurbits are perennial. Cucurbit vegetables are grown in warm weather and these vegetables can not grow under the cold conditions. Cucurbitaceous vegetables are tender annual vegetables and are grown only for their fruits. These vegetables flourish under temperature of about 18 to 30^0 C ($68\text{-}85^0$ F) (Saljoqi and Khan, 2007). All these vegetables are harvested at immature stage and used as raw or after cooking.

Bangladesh is a country where vegetables shortage is a common phenomenon. The consumption of vegetables in Bangladesh is about 50g day^{-1} $capital^{-1}$ which is the lowest amongst the countries of South Asia and South Africa (Rekhi, 1997). But dietitian recommended a daily allowance of 285 g vegetables for an adult person for a balance diet (Ramphall and Gill, 1990).

Here people have been suffering from inadequate supply of vegetables since decades. Total annual vegetable production of Bangladesh 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).

As a result, chronic malnutrition is often seen in Bangladesh. Of the total production, less than 25% is produced during Kharif season and more than 75% is in the Rabi season (Anon, 1993). The major vegetables are cucurbits and they play a prime role to supplement this shortage during the lag period (Rashid, 1993). But their cultivation is interfered by many insect pests. Among them, red pumpkin beetle (RPB) is the major pests and cause considerable damage to all cucurbitaceous crops (Butani and Jotwani, 1984; Yawalker, 1985).

A number of insect pests vines like striped and spotted cucumber beetle, spider mite, melon aphid, fruit fly, leaf minor and red pumpkin beetle. This pest is distributed over Asia Australia Europe and Africa (Atwal and Dhaliwal, 1997). Red pumpkin beetle were active at 27 to 32^0C but they become inactive at temperature above the 35^0C (Khan, 2012). Large number of insect pests infesting cucurbit vegetables right after the germination to the maturity but few of them have serious concern i.e. hadda beetle, red pumpkin beetle and fruit flies (A.K Yadav, 1992). Originally red pumpkin beetle is a pest of pumpkin, bottle gourd, and Musk melon, but it feed all cucurbitaceous

vegetables (Raman, 1985). Red pumpkin beetle is polyphagous insect distributed all over the India (Butani and Jatwani, 1984).

Red pumpkin beetle (RPB), *Aulacophora foveicollis* Lucas is one of the most important constraints to cucurbit production capable of 30-100 (%) yield loss (Alam, 1969). It is polyphagous and attacks more than 81 plant species including pumpkin, squash, cucumber, bottle gourd, snake gourd, wax gourd, water melon, etc and a wide range of fruit crops(Butani and Jotwani ,1984) .

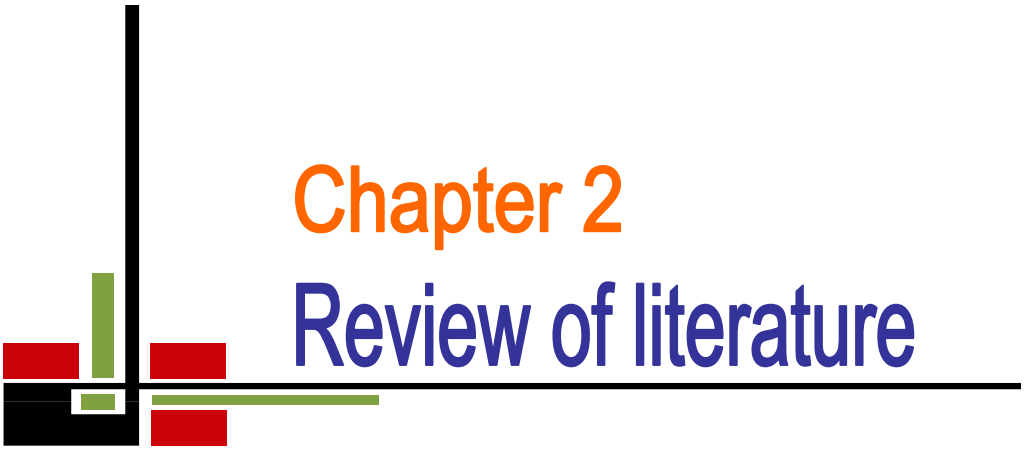
The adult beetles feed voraciously on leaves, flower buds and flowers. But the larvae feed on root tissue and cause direct damage to the newly developed seedlings. Damage is severe since the beetles are difficult to control. At the advent of spring the beetles defoliate the cucurbit seedlings to such an extent that sometimes the crop has to be re-sown for 3 to 4 times. (Parsad and Kumar, 2002).

It causes damage to cucurbits at both larval and adult stages. Damage caused by red pumpkin beetle may range 35 to 75 % (Saljoqi and Khan, 2007). Vines are damaged by feeding on cotyledon or leaves from seedling stage to maturity. Beetles start attack right after the germination and slower down the growth of plants due to serious attack. Both adult and larvae stage attack on the vegetables and larvae lives underground are destructive for the roots. Roots start rottening due to attack of saprophytic fungi. Beetle starts activity from March and remains in the field till October. Peak activity period of red pumpkin beetle is from April to June and its population decreases from September (Butani and Jotwani, 1984).

The adult beetle is red, oblong and approximately 6-8 mm long and lays its eggs at the base of the cucumber stem. A single female can lay 150 to 300 eggs (Srivastava and Butani, 1998). The adult beetles feed voraciously on the leaf lamina making irregular holes and also attack cotyledons and flowers (Butani and Jotwani, 1984). They eat seedlings, young and tender leaves and flowers. They normally occur in large numbers. The grubs are yellowish white and when in the soil cause injury to the roots. (Maniruzzaman, 1981).

Reports on host preference of red pumpkin beetle to different cucurbit vegetables are scanty in Bangladesh or elsewhere. If the most preferred cucurbit fruit vegetable could be identified, it might be used as a trap or barrier crop to decrease infestation on target cucurbit vegetable. In view of the above fact, a research program was undertaken with the following objectives:

i. To evaluate the comparative damage caused by red pumpkin on different cucurbit vegetables and
ii. To identify the less and most preferred cucurbit vegetables to red pumpkin beetle on the basis of host preferences.



Chapter 2
Review of literature

CHAPTER 2

REVIEW OF LITERATURE

The red pumpkin beetle (RPB) *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. The study was conducted to find out the host preference of red pumpkin beetle, *Aulacophora foveicollis* Lucas among different cucurbit plants in the field of the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka. For the purpose of this study, the most relevant information pertaining to origin, distribution, host preference, nature of damage of this pest and yield loss due to their attack are given on the following aspects:

2.1 Origin and distribution of red pumpkin beetle

Hutson (1972) reported that the red pumpkin beetle occurs on various cucurbits in United Kingdom. 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 geographic 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, United

Kingdom, Myanmar, 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. 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 range 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. They 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 (1996) 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.

2.3 Host preferences and nature of damage of red pumpkin beetle

Cucurbits are mostly grown in tropical and sub tropical conditions but some of the vegetables are grown in temperate zone under artificial conditions like cucumber. A number of insect pests vines like striped and spotted cucumber beetle, spider mite, melon aphid, fruit fly, leaf minor and red pumpkin beetle are mainly attack the cucurbits plants. Red pumpkin beetle is the most important and destructive pest of cucurbit vegetables present throughout the world mainly in tropical and sub tropical zones. This study was conducted to check the relative infestation of red pumpkin beetle on cucurbit vegetables. Results of this study showed red pumpkin beetle shows very minute attraction towards the Bitter gourd while it is highly attracted towards the musk melon. This study will

provide helpful information to cucurbit breeders to develop resistance in musk melon in future (Khan, 2015).

Khan (2013) studied to determine the biochemical composition of cucurbit leaves and their influence on red pumpkin beetle. Result revealed that the highest quantity of moisture was recorded in young leaf of bottle gourd (86.49%) and mature leaf of khira (87.95%). The lowest moisture content was obtained in young leaf of snake gourd (79.21%) and mature leaf of ribbed gourd (76.43%). The highest nitrogen content was found in young leaf (6.79%) of sweet gourd and in mature leaf (5.57%) of bottle gourd. The lowest percentage of nitrogen was found in young leaf (3.64%) of bitter gourd and in mature leaf (2.52%) of ribbed gourd. The highest quantity of total sugar was found in young leaf of bottle gourd (4.90%) and mature leaf of sweet gourd (4.76%). The lowest quantity of total sugar was found in young (2.03%) and mature leaves (2.09%) of bitter gourd. The highest quantity of reducing sugar was estimated from young leaves of musk melon (4.14%) and from mature leaves (4.01%) of sweet gourd. The lowest quantity of reducing sugar was in young (1.85%) and mature (1.83%) leaves of bitter 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.

Hassan *et al*. (2012) conducted to find out the host suitability of red pumpkin beetle, *Aulacophora foveicollis* Lucas among different cucurbit hosts in the Laboratory and Field of the Department of Entomology, Bangladesh Agricultural University, Mymensingh. This study was investigated with a view to explore a resistant host to this pest. In the field at three different stages of the plant the highest number of beetle per plant was observed on the sweet gourd and the lowest number was found on bitter gourd. Similarly both in force feeding and choice feeding bioassays the highest leaf feeding was observed on sweet gourd and the lowest leaf feeding was determined on the bitter gourd. Both in the laboratory and field among the three cucurbit hosts sweet gourd was the most suitable and bitter gourd was the least suitable host for 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, cucummber, ribbed gourd and sponge gourd was recorded in the month of May.

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

A field experiment was conducted by Shiva Linga Swamy et *al*. (2008) at research farm of Indian Institute of Vegetable Research, during 2001-2002 (summer). Twenty seven diverse genotypes including some popular cultivars of bottle 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 emerging 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%).

The relative abundance of Red Pumpkin Beetle, *Aulacophora foveicollis* L. on different cucurbitaceous vegetables was carried out by Saljoqi and Khan (2007) from the first week of May, 1998 up to the second week of August, 1998 in the Peshawar valley. Out of eleven varieties, squash and cucumber varieties hosted 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 and supported 8.48, 8.20, 8.52 and 7.29 mean number of red pumpkin beetle, respectively. Two sponge gourd (*Luffa scutannils*) varieties, RKS-6, RKS-7 and three gourd (*Lagenaria siceraria*) varieties, DIK round green, sweet yellow and bottle gourd long varieties were found moderately susceptible to the attack of the red pumpkin beetle, on which 4.00, 4.50, 3.54, 5.47 and 3.56, average number of red pumpkin beetle were recorded, respectively. Mean number of 0.12 and 1.02 of red pumpkin beetle were found on two bitter gourd (*Momordica charentia*) varieties Jaunpuri, Jhalri, respectively and found comparatively more resistant to the red pumpkin beetle. The infestation of red pumpkin beetle was high from May 7 to June 18, 1998, while from June 25 to August 13, 1998, the population gradually declined.

Host preference of eight cucurbit crops i.e., watermelon, long melon, cucumber, ridge gourd, bottle gourd, muskmelon, sponge gourd and tinda gourd against red pumpkin beetle, *Aulacophora foveicollis* Lucas was investigated by Mahmood *et al*., (2005). Long melon and muskmelon was the most favorable host and no plant reached to 5 true leaves stage after germination. Cucumber, watermelon, ridge gourd and tinda gourd were also preferred by red pumpkin beetle but the damage was not as severe as seen in muskmelon and long melon, bottle gourd was medium in preference while sponge gourd was the least preferred host as all plants reached to 5 true leaves stage after germination.

Host preference of red pumpkin beetle, *Aulacophora foveicollis* L. was studied by Deepak *et al*., (2004) on sixty-eight indigenous germplasm lines of cucumber during 2002. Data were collected on 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 cucumber.

Ten cultivated species of cucurbit plants, i.e., sweet gourd (*Cucurbita maxima*) cv. Sitaphal, bottle gourd (*Lagenaria vulgaris L. siceraria*) cv. Lauki, cucumber (*Cucumis sativus*) cv. Kheera, melon (*Cucumis melo* var. *momordica* cv. Kakri or Phut), muskmelon (*Cucumis melo*) cv. Kharbooja, watermelon (*Citrullus vulgaris)* cv. Tarbuj, squash melon or round gourd

(*Citrullus vulgaris* var. *fistulosus)* cv. Tinda, sponge gourd (*Luffa cylindrica*) cv. Ghai tori, ridge gourd (*Luffa acutangula*) cv. Kali tori and bitter gourd or balsam pear (*Momordica charantia*) cv. Karela were found to be hosts of *A. foveicollis*. Sitaphal was the most preferred and common host followed by Lauki. The pest has no preference for Karela (Jori and Johri, 2003b).

It was reported that *A. foveicollis* adults showed poor feeding response on ridge gourd (*Luffa acutangula* cv. Kali tori) and sponge gourd (*Luffa cylindrica*, *L. aegyptiaca* cv. *Ghai tori*) a higher preference on sweet gourd (*Cucurbita maxima* cv. Sitaphal), bottle gourd (*Lagenaria vulgaris L. Siceraria* cv. Lauki), cucumber (cv. Kerala) and muskmelon (*Cucumis melo* cv. Kharbooza), respectively (Jori and Johri, 2003a).

Begum (2002) studied on sweet gourd, ash gourd, sponge gourd, snake gourd and cucumber were screened against the fruit fly and red pumpkin beetle (RPB) to identify the less and most preferred cucurbit host and to evaluate their comparative damage on these hosts in an experiment conducted in the laboratory and field of the Department of Entomology, BSMRAU farm, Salna, Gazipur. The incidence of RPB 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 abrupt fall to the 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 RPB

was observed within 5:00-6:00 PM with the highest peak at 6:00 PM. The overall results revealed that among the five cucurbits, sweet gourd was the most susceptible and highly preferred host of fruit fly and RPB and faced significantly severe damage compared to others. The highest degree of host preference of fruit fly and RPB for sweet gourd and damage severity found were followed by those obtained in ash gourd, sponge gourd and snake gourd. On the contrary, cucumber was recognized as less susceptible and less preferred host for both the pests with significantly lower damage inflicted.

Rajak (2001) studied on the host range and food preference of red pumpkin beelle, *A. foveicollis* Lucas revealed that 10 cucurbitaceous vegetables were its host range bitter gourd. Of major 11 cucurbitaceous crops, musk melon (*C. melo* L.) was the most preferred food. It causes more damage to the crops in kharif season. Host preference of the red pumpkin beetle (*A. foveicollis*) among 11 cucurbitaceous crops sweet gourd (*Cucurbita moschata*), cucumber, bottle gourd (*Lagenaria siceraria*), watermelon, muskmelon (*C. melo*), sponge gourd (*L. cylindrica*),ash gourd (*Benincasa hispida*), ridge gourd (*L. acutangulla*), snake gourd (*Trichosanthes anguina),* pointed gourd (*Trichosanthes dioica*), bitter gourd (*Momordica charantia*) the most preferred host was muskmelon. The least preferred was snake gourd, while bitter gourd was not preferred.

Host preference of *R. fovicollis* (*A. fovicollis*) among 8 plants: Wax gourd, Bottle gourd, Bitter gourd, Cucumber, Watermelon, Ridge gourd, Sweet potato, Muskmelon were the most preferred by the pest in multiple choice tests, In no choice test, water melon, cucumber and *L. siceraria* were most preferred by the pest but *M. charantia* was not preferred (Vandana *et al*., 2001).

Matsuda and Tamaki (2002) reported that the difference in responses of the three leaf beetle species to cucurbitacins is possibly related to the host range of these three beetle species. *A. feoralis* feeds on various cultivated and wild cucurbitaceous plant, but the other two beetles are specialized to their native host plants and scarcely feed on other cucurbitaceous plant species. *A. lewisii* depends on sponge gourd, genus *Luffa*, *A. nigripennis* uses *Trichosanthes cucumeroides* and *T. kirilowii* as hosts. In the cucurbitaceae, cucurbitacin contents differ among plant species, plant part and growth stage. The cucurbitacin concentrations in the leaves possibly vary, as cucurbitacin contents differ among plant species, plant part and growth stage. Therefore, *A. femoralis* and *A. lewisii* probably respond to various concentrations of cucurbitacins contained in their host plant leaves. This is the first report of a cucurbitaceous feeding leaf beetle which was scarcely affected to feed by cucurbitacins. These results also suggest that *A. nigripennis* select their cucurbitaceous host plant without depending on the cucurbitacins and are stimulated to feed by other substances in the host plant leaves.

The host preferences of the red pumpkin beetle, *Aulacophora foveicolli* Lucas, and the melon fruit fly, *Dacus cucurbitae* (*Bactrocera cucurbitae)*, were studied by Singh *et al*. (2000) using different cucurbits during the summer of 1997 in India. Observations on the density of red pumpkin beetles per leaf and percentage infestation on the vines, leaves and flowers of cucurbits were made every morning, while observations on the melon fruit fly were made weekly. Observations of the host preferences of the red pumpkin beetle ranked bitter gourd (*M. charantia)* as least preferred, cucumber, muskmelon, bottle gourd (*L. siceraria)* and pumpkin as medium in preference, round gourd (*Citrullus lanatus* var. *fistulosus)* and long melon (*Cucumis utilissimus)* as highly preferred and watermelon as the favourite host. The percent of fruit damage by the melon fruit fly was under 50% in all cases. However, percentage damage was significantly highest on watermelon (28.55%) and bitter gourd (31.27%).

Investigators observed that host preferences of the red pumpkin beetle ranked bitter gourd (*Momordica charantia)* as least preferred, cucumber, musk melon, bottle gourd (*Lagenaria siceraria)* and pumpkin as medium in preference, round gourd (*Citrullus lanatus)* and long melon (*Cucumis utilissimus*) as highly preferred and watermelon as the favourite host (Singh *et al*., 2000). Host preference of *R. foveicollis* (*Aulacophora foveicollis*) was studied and found that muskmelon was the most preferred host, while bitter gourd (*M. charantia)* was the least preferred (Sharma, 1999).

Eben *et al*. (1997) tested in feeding choice and no-choice assays for their preference for bitter (Cucurbitacin-containing) over non-bitter (without cucurbitacins) cucurbits, and for one of the two primary types of cucurbitacins with three *Acalymma* and five *Diabrotica* (Chrysomelidae: Luperini) species. All species significantly preferred the bitter over the non-bitter cucurbits (*C. pepo* L. var. crookneck) in the test offering a choice between cucurbitacin B-containing plants (*C. pepo* L. var. ambassador) and no cucurbitacin containing plants. Six species significantly preferred cucurbitacin E-containing plants. Cucurbitacin B-containing plants were signifciantly preferred over cucurbitacin E-containing plants. The strong preference for bitter cucurbitacin containing host plants by all species included in this study support the original hypothesis that generalist *Diabrotica spp*. should prefer bitter cucurbits. They results partially support the hypothesis that specialist *Acalymma spp*. should not show a strong preference for bitter cucurbit hosts. The three *Acalymma* and the five *Diabrotica* species tested, significantly preferred 'cuc B' over 'no cuc' bosts. The ready acceptance of 'no cuc' cotyledons by two of the specialist species. *A. blomorum* and *A. fairmairei*, partially support the original hypothesis that *Acalymma spp*. should not depend as *Diabrotica spp*. on cucurbitacins for the acceptance of cucurbits as host plants.

Guru Swamy *et al.* (1995) conducted an experiment under free choice condition where *cucumis melo* var. *utilissimus* Duth. and Full. were the most

preferred cucurbit which recorded the highest leaf area consumption (102.38 cm^2). The beetle consistency after 24, 48 and 72 hours consumed the highest amount of leaf, *charantia* L. recorded the least amount of leaf area consumption (2.13 cm^2) after 24, 48 and 72 hrs. of release. Under no- choice conditions, *C*. *melo* L. leaves were consumed to the maximum extent (48.19 cm2) compared to the minimum consumption of *Citrullus lanatus* (Thumb.) (8.63 cm^2). *Cucumis melo* var *utilissimus* Duth and Full stood next but was statistically on par with *Cucumis melo* L. in leaf consumption (43.31 cm). *Luffa acutangula* (L) and *Mamordica charantia* L. were the next least preferred plants. These results have been confirmed under field cage conditions where *Cucumis melo* L. and *Cucumis melo* var. utilissimus.

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 long melon (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, cucumber, sweet gourd, sponge gourd and water melon were of intermediate types. Among the various insecticidal sprays evaluated on watermelon seedlings, synthetic

pyrethroids (deltamethrin at 0.004%, cypermethrin at 0.012%, and fenvelerate at 0.01%) were effective in controlling the beetle (8.188-96.88% mortality) for about a week. Water melon seed soaking with carbofuran (Furadan 3 G) @ 1 g a.i./L was found effective for only two days after germination, while its application as soil treatment @ 0.12 – 0.36 g a.i./plant was the most effective as indicated by high mortality of beetle and minimum feeding damage for about three weeks. The damaged roots and infested underground portion of stems start rotting due to secondary infection by saprophytic fungi. The young fruits of such vines dry up. Infested fruits become unfit for human consumption. Ground-spreading cucumber plants grown in experimental plots at BARI farm in April, 1986 were found to be killed entirely with dried-up vines, leaves, flower and fruits due to severe damage of underground roots by the grubs of the RPB.

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

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

An analysis of the host plant relationships with respect to the red pumpkin beetle, *Raphidopalpa foveicollis* Lucas is presented by Rahman and Annadurai (1985) based on the role of receptors involved in host selection, the quantitative food utilization on different cucurbitaceous host plants and the biochemical parameters involved in food plant selection. Orientation of the beetles towards the host plants appeared to be profoundly affected when the receptors present on the antennae and mouthparts were ablated or coated. Though significant differences were observed with regard to the quantity of food ingested among different host plants, ingestion of food was higher for mature leaves and flowers compared to young and senescent leaves. Accordingly, mature leaves and flowers showed high nitrogen and proteins, low sugars, moderately high phenols and narrow *C/N* ratio compared to other plant parts. The chemosensory receptors present on the antennae and mouthparts were also studied using scanning electron microscope.

Fifteen crop plants were evaluated by Hwa-Jen Teng *et al*., (1983) to determine performance and host preference of adult banded cucumber beetles (BCB), *Diabrotica balteata.* LeConte. They prefer broccoli, cauliflower (Cruciferae), potato, bell pepper and tomato (Solanaceae), bush bean, hyacinth

bean, soybean, and peanut (Leguminosac), sweet corn (Graminae), beet (Chenopodiaceae), and three varieties of sweet potato (Convolvulaceae). In no-choice tests, greatest fecundity and longevity occurred on broccoli, cauliflower, and potato, even though equal or greater amounts of leaf tissue were consumed on soybean, three varieties of sweet potato, bell pepper, bush bean, and tomato. No eggs were laid on sweet corn, peanut, or hyacinth bean. In multiple·choice tests, broccoli, bell pepper, cauliflower, and bush bean were more preferred for feeding by BCB adults than potato and the other plants, but BCB adults laid most eggs on potato, tomato, sweet corn, bush bean, and 'Morado' (sweet potato). Elytral color remained yellow for adults feeding on the legumes and on beet, but on the other plants the elytra turned green among various percentages of adults.

Butani and Jotwani (1984) have reported that the adult beetles feed voraciously on leaf lamina making irregular holes. They prefer young seedlings and tender leaves and the damage at this stage may even kill the seedlings. They have also reported that the female RPB lays eggs in the moist soil usually around the host plant. On hatching, the grubs feed on the roots and underground portion of host plants as well as fruits touching the soil.

Chapter 3

Materials and Methods

CHAPTER 3

MATERIALS AND METHODS

The experiment was conducted in the experimental farm of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207 during the period from May to August, 2014 to find out the host preference of red pumpkin beetle (*Aulacophora foveicollis* L.*)* in different cucurbits. The details materials and methods that were used to conduct this experiment are presented below under the following headings:

3.1 Description of the experimental site

3.1.1 Location and time

The present research was conducted at the research field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from May to August 2014. The experimental area is located at 23.74^0 N latitude and 90.35^0 E longitudes with an elevation of 8.2 m from the sea level (Khan, 1997).

3.1.2 Soil

The soil of the experimental area was to the general soil type series of shallow red brown terrace soils under Tejgoan series. Upper level soils were clay loam in texture, olive-gray through common fine to medium distinct dark

yellowish brown mottles under the Agro-ecological Zone (AEZ 28) and belonged to the Madhupur Tract (UNDP and FAO, 1988). The selected plot was above flood level and sufficient sunshine was available having irrigation and drainage system during the experimental period. Soil samples from 0-15 cm depths were collected from experimental field. The analyses were done from Soil Resources Development Institute (SRDI), Dhaka. The experimental plot was also high land, fertile, well drained and having pH 5.56. The physicochemical property and nutrient status of soil of the experimental plots are given in Appendix I.

3.1.3 Climate and weather

The experimental area is situated in the sub-tropical climatic zone and characterized by heavy rainfall during the months of March to October (Kharif Season) and scanty rainfall during the rest period of the year (Biswas, 1987). The Rabi season (October to March) is characterized by comparatively low temperature and plenty of sunshine from November to February (SRDI, 1991). The detailed meteorological data in respect of temperature, relative humidity and total rainfall recorded by the weather station of Bangladesh, Sher-e-Bangla Nagar, Dhaka during the period of study have been collected.

3.2 Experimental materials

Three different cucurbitaceous vegetable were used for this study and the seeds of these crops were collected from BADC, Jessore. These cucurbitaceous crops and their scientific names were as follows:

CV_1: Sweet gourd (*Cucurbita moschata* Duch.)

CV_2: Bottle gourd (*Lagenaria siceraria* M.)

CV_3: Bitter gourd (*Momordica charantia*,L.)

3.3 Experimental design and layout

The experiment consisted of three vegetable of cucurbitaceous and was laid out in Randomized Complete Block Design (RCBD) with three replications. Experimental plot was sub-divided into three blocks where two pits were in each plots. Thus, there were 18 (3 × 3×2) pits altogether in the experiment. The size of each plot was 3.0 m × 2.5 m. The treatments (Cucurbit vegetable) of the experiment were randomly distributed in the experimental plots.

3.4 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. So, the experimental plot was well prepared. The size of the experiment plot was

3.0 m × 2.5 m with an inter column distance of 1 m and row to row distance 1.5 m. Three pits of 30 cm × 30 cm × 20 cm size were dug in each plot with a circular arrangement at a distance of 1 m between pits.

3.5 Fertilizer application

Cowdung and fertilizer were applied as recommended (Rashid, 1993) for cucurbits at the rate of 10000, 69, 60 and 60 kg of cowdung, N, P and K ha^{-1}, respectively. The half of cowdung, TSP and MOP. one third of urea were applied as basal dose during land preparation. The remaining cowdung, TSP and MOP 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 Seed sowing

Seeds of these cucurbits were sown in each pit by hand on 02 April, 2014.

3.7 Data collection

For evaluation of target parameters, data on different parameters were recorded for red pumpkin beetle infestation attacking those cucurbit vegetable crops, cotyledon, leaves, flower and fruits. Details of the data recording procedures are explained under the following sub-headings:

3.7.1 Damage of infested cotyledon (%)

Percent of infested cotyledon was recorded at 15 and 20 days after sowing. Mean percent of infested cotyledon was calculated on the basis of the total number of damaged cotyledon divided by the total number of cotyledon by RPB and then multiplied by 100. It was expressed by the following formula:

$$\text{Damage of infested cotyledon (\%)} = \frac{\text{Number of damaged cotyledon}}{\text{Total number of cotyledon}} \times 100$$

3.7.2 Number of infested plants pit^{-1}

Data on infested plant pit^{-1} was recorded at 5 days interval which was started from 15 DAS and continued up to 50 DAS. Mean number of infested plan pit^{-1} was calculated on the basis of the total infested plants of the replicated three pits divided by the total plants (no.) of the replicated three pits.

$$\text{Number of infested plant (\%)} = \frac{\text{Number of infested plant}}{\text{Total Number of plant}} \times 100$$

3.7.3 Number of infested leaves plant^{-1}

Data on leaf infestation plant^{-1} was recorded at 5 days interval which was started from 15 days after sowing and continued up to 50 DAS. 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.

3.7.4 Number of total infested leaves plot^{-1}

Data on total number of leaves infestation plot^{-1} was recorded at 15, 20, 25, 30, 35, 40, 45, and 50 days after sowing. Mean number of total infested leaves plot^{-1} was calculated on the basis of the total infested leaves of the whole plants plot^{-1} divided by the total leaves (infested and healthy) of the whole plants plot^{-1}.

3.7.5 Damage of infested flowers (%)

First flowering was recorded at 35 days after sowing. Data on infested flowers were recorded at 50 days after sowing. Mean percentage of infested flowers was calculated on the basis of the number of damaged flowers divided by the total number infested flowers and then multiplied by 100. It was expressed by the following formula:

$$\text{Damage of infested flowers (\%)} = \frac{\text{Number of infested flowers}}{\text{Total number of infested flowers}} \times 100$$

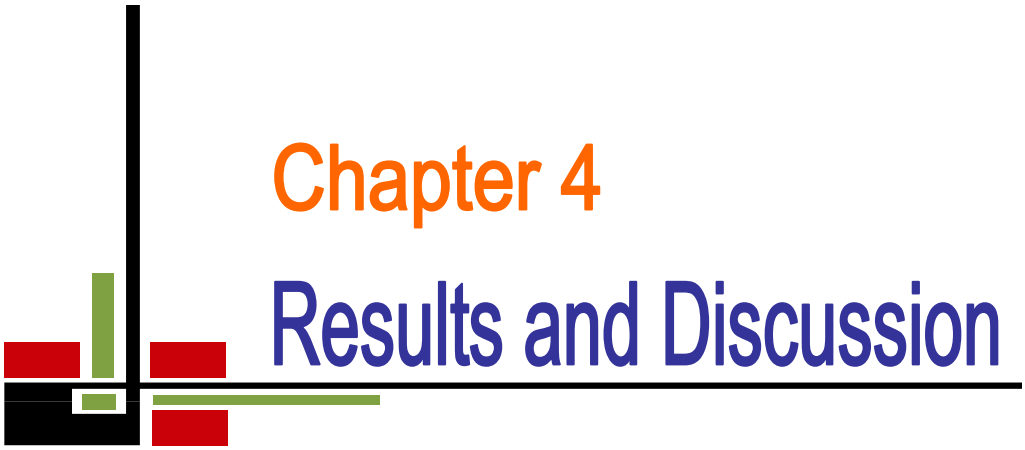
3.7.6 Damage of infested fruits (%)

The data on damage of infested fruits was recorded at 45 and 50 days after sowing (two times). Mean percentage of damaged of infested fruits was calculated on the basis of the total number of damaged fruits divided by the total number infested fruits and then multiplied by 100. It was expressed by the following formula:

$$\text{Damage of infested fruits (\%)} = \frac{\text{Number of damaged fruits}}{\text{Number of total infested fruits}} \times 100$$

3.8 Statistical analysis

The data obtained from experiment on various parameters were statistically analyzed by 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, 1984).



Chapter 4

Results and Discussion

CHAPTER 4
RESULTS AND DISCUSSION

The experiment was conducted to investigate the host preference of red pumpkin beetle (*Aulacophora foveicollis* Lucas) on different cucurbit vegetables under field condition at Sher-e-Bangla Agricultural University, Dhaka. The results have been shown in tables and figures. A detailed discussion on the presented results and possible interpretations are given in this chapter under the following sub headings:

4.1 Effect of host preference of red pumpkin on different cucurbit vegetables

4.1.1 Percent damage of infested cotyledon

Three cucurbit vegetables were attacked by RPB and the percent damage of infested cotyledon after 15 days of sowing and percent damage of infested cotyledon indicated that those were significantly influence on red pumpkin beetle attack. The damage range of infested cotyledon was 7.89 to 35.56%. The maximum damage of cotyledon (35.56%) by red pumpkin beetle was observed in sweet gourd which was statistically dissimilar than bottle gourd (28.22%) at 15 days after sowing (Table 1), while bitter gourd recorded the lowest damage (7.89%) by RPB.

Percent infestation of cotyledon of RPB attacking three cucurbit vegetables were also observed at 20 DAS which showed significant variation among cucurbit vegetables (Table 1). Among the RPB infested cucurbit vegetables, sweet gourd was severely infested by RPB as well as higher damage of cotyledon (47.67%)

was observed, followed by bottle gourd (40.33%). The lowest damage of cotyledon (14.33%) was observed from bitter gourd.

These results revealed that the variation in cotyledon infestation among the cucurbit vegetables was found due to the deviation in infestation by RPB. These results showed that the sweet gourd was most suitable host of RPB while bitter gourd was the least suitable host for RPB among the cucurbit vegetables under this field condition. Similar variation was also obtained by Khan (2012) who found that bitter gourd was the least preferred of RPB among ten tested cucurbit vegetables where the mean in order of preference of RPB was sweet gourd > bottle gourd > bitter gourd. This finding was also supported by, Hassan (2012) and other researchers in home and abroad where they reported that the bitter gourd was the least suitable host for RPB.

Table 1. Suitability of different cucurbit vegetables as host plant for red pumpkin beetle on percent damage of infested cotyledon at different days after sowing (DAS)

Cucurbits	Infested cotyledon (%)	
	15 DAS	20 DAS
Sweet gourd	35.56 a	47.67 a
Bottle gourd	28.22 b	40.33 b
Bitter gourd	7.89 c	14.33 c
$LSD_{(0.05)}$	3.70	4.96
CV (%)	7.56	6.58

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

4.1.2 Number of infested plants pit^{-1}

Mean number of infested plants of cucurbit vegetables infested by red pumpkin beetle were determined at 5 days interval which started from 15 DAS and continued up to 50 DAS (Table 2). This table indicates that the red pumpkin beetle infested plants pit^{-1} differs significantly among the cucurbit vegetables. Highest plant infestation was observed in sweet gourd (2.56) at 15 DAS and continued upto 50 DAS among cucurbitaceous vegetables followed by bottle gourd while bitter gourd showed lower infestation during study period.

4.1.3 Number of infested leaves plant^{-1}

The preferences of red pumpkin beetle for different cucurbit vegetables have been evaluated on the basis of mean percentage of leaf infestation plant^{-1} at 5 days interval which started from 15 DAS and continued up to 50 DAS. Red pumpkin beetle highly preferred to sweet gourd and resulted in the highest (12.45) leaf infestation at different DAS (Table 3).

Leaf infestation by RPB showed significant variation at 15 DAS where sweet gourd recorded the maximum leaf infestation (3.23) while bottle gourd showed statistically similar leaf infestation (3.11). The bitter gourd showed the least leaf infestation (1.22).

Leaf infestation was also significantly higher (5.89) in sweet gourd while bottle gourd showed statistically similar leaf infestation (5.78) at 20 DAS. However bitter gourd had lowest (4.00) infestation of leaf.

Leaf infestation was also significantly influenced by RPB at 25 DAS where sweet gourd had highest (6.78) leaf infestation while bitter gourd showed lowest (4.11) leaf infestation.

Leaf infestation was also significantly influenced by RPB at 30 DAS where sweet gourd had highest (7.56) leaf infestation while bitter gourd showed lowest (5.22) leaf infestation.

At 35 days after sowing, sweet gourd and bottle gourd had statistically similar and significantly higher (8.33 and 8.11 respectively) leaf infestation by RPB among cucurbit vegetables while bitter gourd was also showed significantly lower (6.11) infestation of leaf.

Leaf infestation was also significantly influenced by RPB at 40 DAS where sweet gourd further recorded the higher (9.22) infestation of leaf by RPB while RPB was less attractive to bitter gourd and had lower (7.78) leaf infestation.

Similar effect was also observed at 45 DAS where sweet gourd encountered the higher (11.00) leaf infestation and bottle gourd (10.22) was not statistically similar. Among other RPB attacking cucurbit vegetables, the infestation of leaf was lower (8.33) in bitter gourd (Table 3).

Table 2. Host preference of red pumpkin beetle on different cucurbit vegetables as host plant at different days after sowing (DAS)

Cucurbits	Number of infested plants pit^{-1} at different days after sowing							
	15	**20**	**25**	**30**	**35**	**40**	**45**	**50**
Sweet gourd	2.56 a	2.56 a	2.56 a	2.56 a	2.56 a	2.56 a	2.56 a	2.56 a
Bottle gourd	1.45 b	1.44 b	1.67 b	1.67 b	1.67 b	1.67 b	1.67 b	1.67 b
Bitter gourd	1.11 c	1.22 c	1.33 b	1.33 b	1.33 b	1.33 b	1.33 b	1.33 b
$LSD_{(0.05)}$	0.29	0.60	0.41	0.41	0.41	0.41	0.41	0.41
CV (%)	7.42	15.3	9.78	9.78	9.78	9.78	9.78	9.78

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

Table 3. Host preference of Red Pumpkin Beetle on different cucurbit vegetables as host plant at different days after sowing (DAS)

Cucurbits	Number of infested leaves plant^{-1} at different days after sowing							
	15	20	25	30	35	40	45	50
Sweet gourd	3.22a	5.89 a	6.78 a	7.56 a	8.33 a	9.22 a	11.00 a	12.45 a
Bottle gourd	3.11 a	5.78 a	6.4 ab	7.0 ab	8.11 a	8.78 a	10.2 ab	11.8 ab
Bitter gourd	1.22 b	4.00 b	4.11 b	5.22 b	6.11 b	7.78 b	8.33 b	9.33 b
$LSD_{(0.05)}$	1.73	1.62	2.48	2.08	1.89	0.85	2.23	2.58
CV (%)	10.35	8.24	8.95	6.89	8.91	12.70	10.12	7.38

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

Number of leaf infestation plant^{-1} was also observed at 50 DAS where RPB attacking vegetables showed the significant variation (Table 3). Leaf infestation had numerically highest (12.45) in sweet gourd. The lowest (9.33) number of leaf infestation plant^{-1} was in bitter gourd at 50 DAS.

From the above observation it was indicated that the leaf of sweet gourd was more preferred by RPB and the least preferred by the bitter gourd. However, leaf infestation plant^{-1} significantly increases with increases of DAS. The results also revealed that the RPB had a special preference for the leaves of sweet gourd but bitter gourd was least preferred. The results also indicated that the comparative host preferences of RPB chronologically were sweet gourd > bottle gourd > bitter gourd (Table 3). The results agreed with those of Khan *et al.,* (2012) who reported the order of preference as muskmelon > sweet gourd > cucumber > khira > ash gourd > bottle gourd > sponge gourd > ribbed gourd > snake gourd > bitter gourd on the basis of leaf area damage plan^{-1}. Host preference of red pumpkin beetle, *Aulacophora foveicollis* L. was studied by Khan *et al.,* (2011) among ten cucurbitaceous vegetables (viz., sweet gourd, bottle gourd, ash gourd, bitter gourd, sponge gourd, ribbed gourd, snake gourd, cucumber, khira and muskmelon) where bitter gourd was free from infestation and it was recorded as non-preferred host. In his study, sweet gourd and musk melon were found to be the most preferred host of red pumpkin beetle and bitter gourd was found as non preferred host of RPB. As a result, the highest percentage of leaf area damage per plant was observed on musk melon leaves followed by sweet gourd and ash gourd and the lowest percentage of leaf area damage per plant was on snake gourd

followed by sponge gourd and bottle gourd. Similar observation was also reported by Hassan *et al*., (2012) who observed that the red pumpkin beetle, *Aulacophora foveicollis* L. equal the highest leaf feeding on sweet gourd and the lowest leaf feeding was on the bitter gourd. Similarly, Shiva Linga Swamy *et al*., (2008) also found that the mean damage leaf area among tested cultivars varied from 17.45% In VRBG- 50 to 34.32% in NDBG-56.

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4.1.4 Number of total infested leaves plot^{-1}

This observation was made to identify whether any variation in the total leaf infestation by RPB on different cucurbit vegetables with increasing age and growth of the plant. The probable variation of the RPB attack with the progress of growth period was also determined. So, the occurrence of RPB infestation on three different cucurbits was observed for 5 days beginning from 15 DAS and continued up to 50 DAS. The mean number of total infested leaves plot^{-1} on each cucurbit vegetable is presented in Table 4. The result revealed that there was significant variation in total number of leaf infestation plot^{-1} at all days of data recording and found that sweet gourd was the most preferred and bitter gourd was least preferred by RPB.

At 15 DAS, the total number of infested leaf plot^{-1} was significantly varied where sweet gourd further encountered the maximum (6.11 plot^{-1}) leaf infestation. The lowest (1.78) infestation by RPB was found in bitter gourd.

In another observation at 20 DAS, infestation of red pumpkin beetle was significantly varied on total number of infested leaves plot^{-1} (Table 4). It was appeared that the host preference of cucurbit leaves attack had more (12.67) in sweet gourd at 20 DAS. However, bitter gourd was least preferred host found at 20 DAS (5.00).

The number of total infested leaves plot^{-1} was significantly differed at 25 and 30 DAS. The maximum number of total infested leaves plot^{-1} (15.45 and 17.41) was observed in sweet gourd at 25 and 30 DAS, respectively whereas this was followed by bottle gourd (8.78 and 9.650, respectively). Among other vegetables of cucurbit, the minimum number (6.11 and 7.33) of total infested leaves plot^{-1} was found in bitter gourd at 25 and 35 DAS, respectively.

At 35 DAS, number of total infested leaves plot^{-1} varied significantly by the infestation of RPB while sweet gourd obtained the maximum (19.47) infested leaves plot^{-1}. Similarly, bitter gourd recorded the lowest (9.33) infestation of leaves plot^{-1} (Table 4).

The infested leaves plot^{-1} showed significant variation due attacking deviation of RPB. Among the cucurbitaceous vegetables, the higher (22.33 and 25.44 at 40 and 45 DAS, respectively) infestation of leaves plot^{-1} was occurred in sweet gourd while bitter gourd showed statistically identical but the lowest (11.22 and 11.89 at 40 and 45 DAS, respectively) infestation of leaves plot^{-1}.

Leaf infestation was also significantly varied by the attacking preference of RPB at 50 DAS while the highest preference of RPB was found when attacking sweet gourd (27.43) at 50 DAS. This was followed by bottle gourd. Infestation on bitter gourd was also recorded lowest total leaf infestation (13.89) at 50 DAS.

The results indicated that the total number of infested leaves plot^{-1} significantly varied due to attack of RPB on the plants of cucurbit where leaf infestation was gradually increase from initial stage (15 DAS) to harvest stage (50 DAS). It was also indicated that the leaves of sweet gourd were seriously infested and found to be the most suitable host of RPB while least infestation and least suitable host was the bitter gourd. So, among the cucurbit vegetables sweet gourd plants proved to be the most preferred host in respect of total infested leaves of plot^{-1}. On the other hand the bitter gourd showed preferred least preference of RPB. So, the sweet gourd plants were the most suitable and bitter gourd was the least suitable host of RPB among the cucurbit vegetables. Similar variation among cucurbits were also found by Khan *et*

al., (2012) where order of preference of RPB as hosts were muskmelon > sweet gourd > cucumber > khira > ash gourd > bottle gourd > sponge gourd > ribbed gourd > snake gourd > bitter gourd on the basis of leaf area damage plant^{-1}. Khan *et al.,* (2011) reported that bitter gourd was free from infestation and it was noted as non-preferred host for RPB. Similar observation were also obtained by Hassan *et al.,* (2012) who found that red pumpkin beetle, *Aulacophora foveicollis* Lucas highly preferred sweet gourd and lowest preference for bitter gourd.

Table 4. Effect of different cucurbit vegetables as host plant of red pumpkin beetle on number of total infested leaves plot^{-1} at different days after sowing (DAS)

Cucurbits	Number of infested leaves plot^{-1} at different days after sowing							
	15	**20**	**25**	**30**	**35**	**40**	**45**	**50**
Sweet gourd	6.11 a	12.67 a	15.45 a	17.41 a	19.47 a	22.33 a	25.44 a	27.43 a
Bottle gourd	5.34 b	6.11 b	8.78 b	9.65 b	10.44 b	11.33 b	14.66 b	16.67 b
Bitter gourd	1.78 c	5.00 b	6.11 b	7.33 b	9.33 b	11.22 b	11.89 c	13.89 c
$LSD_{(0.05)}$	0.51	2.40	2.73	3.46	1.97	2.79	1.35	2.57
CV (%)	5.06	13.37	11.9	5.35	6.63	8.21	5.43	5.86

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

4.1.5 Percentage of infested flower plot^{-1}

Damage of infested flower was recorded after flowering at 35 DAS which was significantly differed among the various cucurbit host plants in respect of host preferences of RPB. The mean percent of infested flower damage at 35 DAS range from 15.11 to 31.00, which significantly reduced the fruit yield (Figure 1). In this Figure, the higher percentage of flower damage plot^{-1} (31.00%) was observed in sweet gourd followed by bottle gourd (27.33%). On the other hand, bitter gourd showed statistically identical but lower damage of infested flower plot^{-1} (15.11%). These results revealed that sweet gourd flower was highly preferred by RPB than that of other cucurbitaceous vegetable plants. But the bitter gourd recorded the lowest preference for RPB. These results indicated that the maximum RPB had attraction for sweet gourd and thereby cause higher damage. The host preferences of the red pumpkin beetle, *Aulacophora foveicollis* L. was also conducted by Singh *et al*., (2000). where density of red pumpkin beetles per leaf and percentage infestation on the vines, leaves and flowers of cucurbits were made every morning, where bitter gourd (*Momordica charantia*) ranked least preferred host and long melon (*Cucumis utilissimus*) and water melon ranked highly preferred host by RPB.

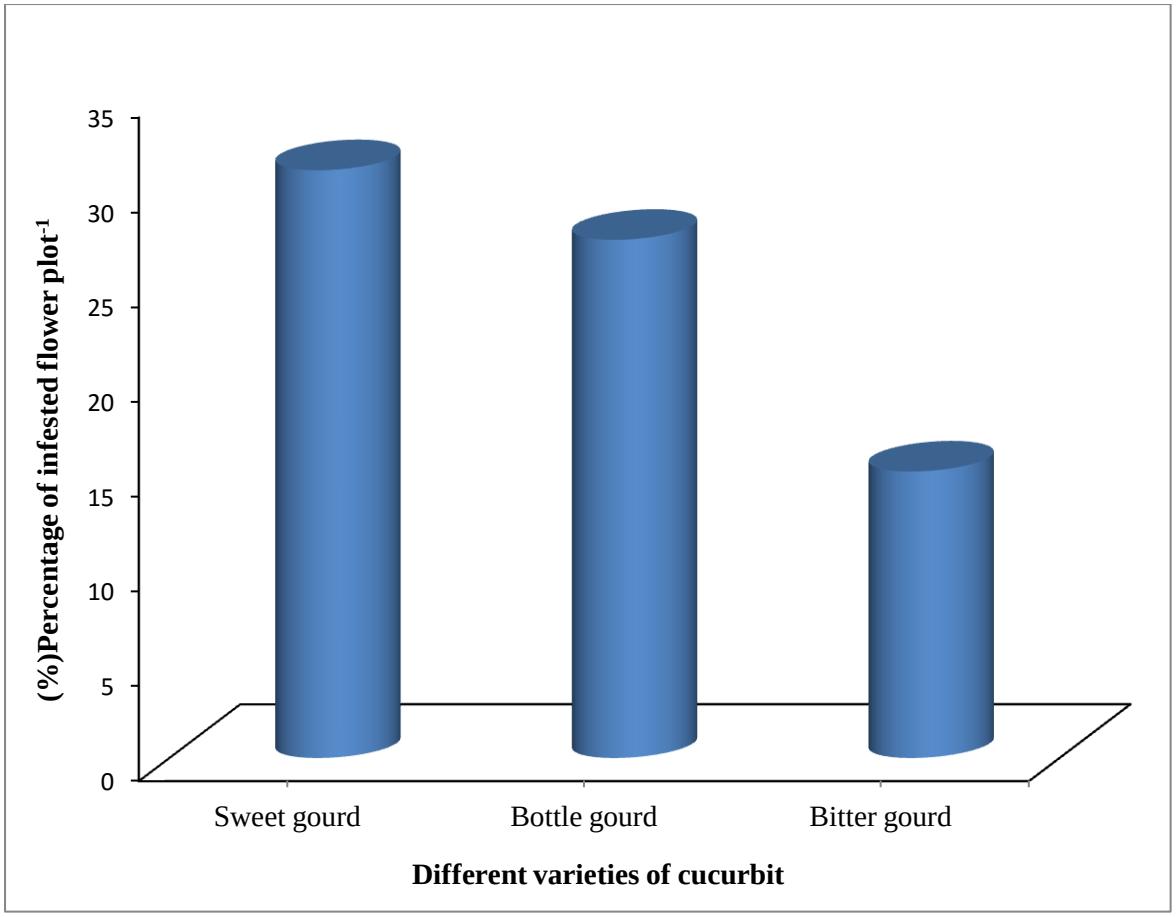


Figure 1. Effect of different cucurbit vegetables as host plant of red pumpkin beetle on percent damage of infested flower plot^{-1} at 35 days after sowing (DAS)

4.1.6 Percentage of infested fruit plot^{-1}

The damage of infested fruits plot^{-1} (%) varied significantly by the infestation of RPB. The results on mean (%) of infested fruit plot^{-1} due to red pumpkin beetle at 45 and 50 DAS of different cucurbit vegetables are shown in Figure 2. This result reveals that at 50 DAS, the maximum damage of infested fruits plot^{-1} (35.56%) due to RPB infestation was obtained in sweet gourd. However, the lowest damage of infested fruits plot^{-1} (16.33%) was recorded in bitter gourd at 45 DAS. Statistically similar results were also observed at 50 DAS or fruiting stages of crop. As a result, sweet gourd showed statistically higher damage of infested fruits plot^{-1} (39.89%) while bitter gourd, observed the statistically lower damage of infested fruits plot^{-1} (18.33) at 50 DAS (Fig. 2). Damage of infested fruits by red pumpkin beetle may also depend on the availability of RPB and also the cucurbit host performance in the habitat. The observation on damages of infested fruits in this study indicated that the highest number of flower as well as maximum fruits was initiated in sweet gourd. The highest damage of infested fruits by RPB at all fruiting stages of sweet gourd might be due to the most host preference of RPB for this gourd. The host preferences of *Aulacophora foveicollis* L. was studied by Singh *et al*., (2000), where red pumpkin beetles infested plant of sweet gourd and water melon showed the higher percentage of fruit damage due to its higher effective population on it.

From the above results, it could be concluded that the sweet gourd plant was highly attractive to red pumpkin beetle to cause higher damage of cotyledon,

maximum infestation of plants plot^{-1}, maximum infestation leaves plant^{-1} and higher infestation of leaves plot^{-1}. Damage of infested flowers and infested fruits plot^{-1} were also recorded in highly the RPB attacking plant of sweet gourd. Therefore, it was clear that sweet gourd would be highly preferred host of red pumpkin (RPB) among other cucurbit vegetables in this study. However, bitter gourd was considered as the least preferred host of RPB due to its probability repelling tendency against RPB.

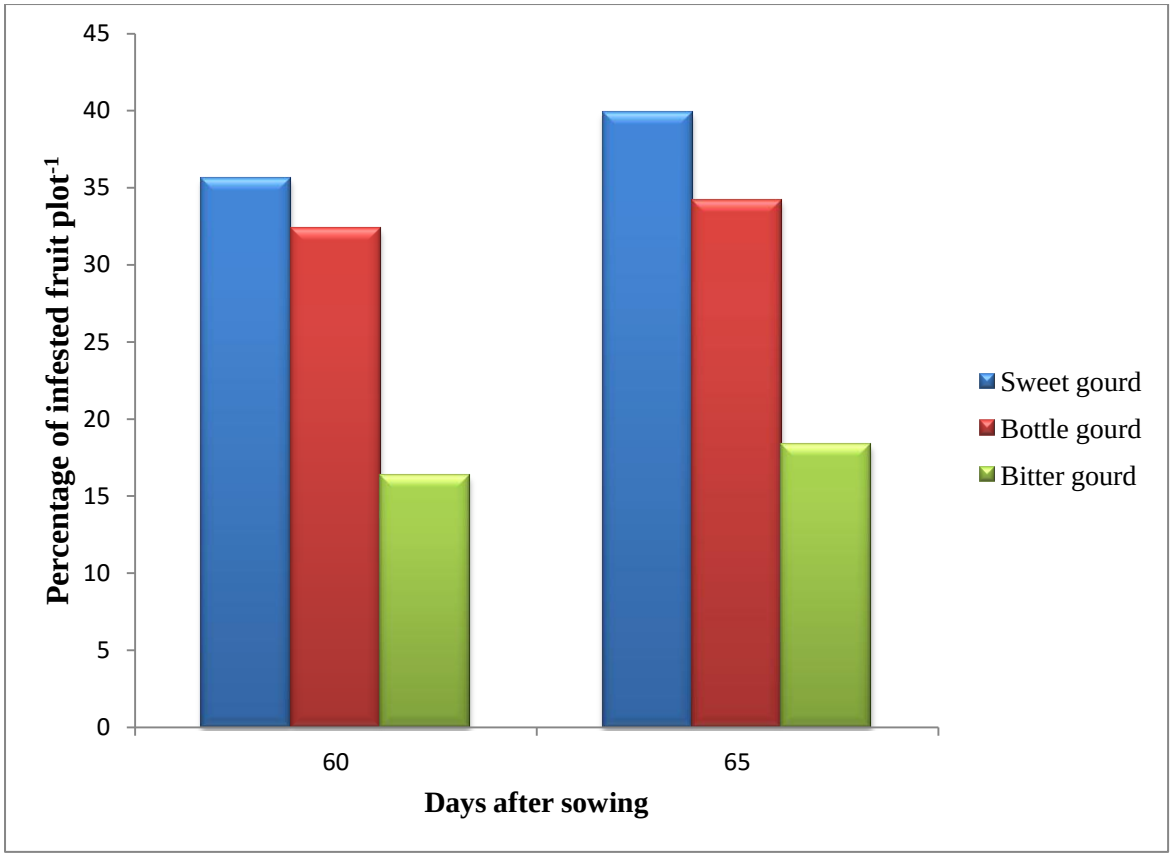
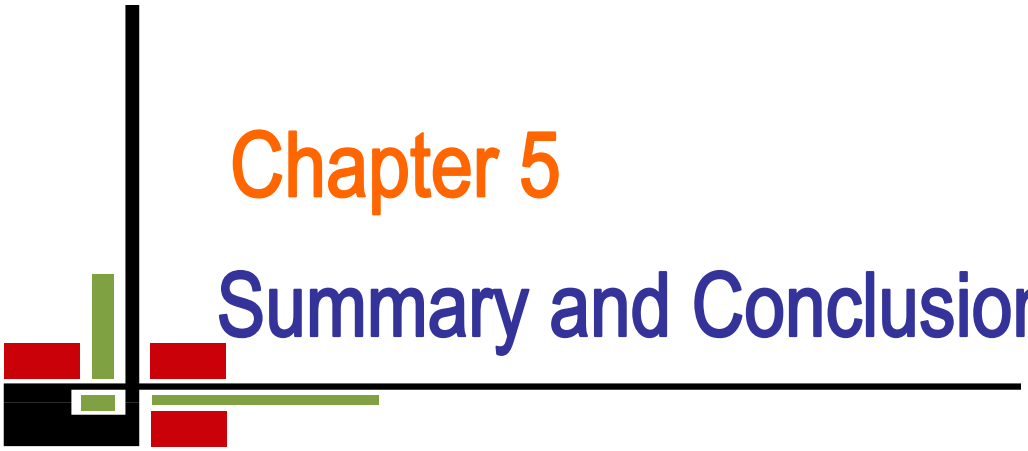


Figure 2. Effect of different cucurbit vegetables as host plant of red pumpkin beetle on percent damage of infested fruits plot^{-1} at 45 and 50 days after sowing (DAS)



Chapter 5

Summary and Conclusion

CHAPTER 5

SUMMARY AND CONCLUSION

The experiment was conducted in the experimental farm of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207 during the period from May to August, 2014 to host preference of red pumpkin beetle (*Aulacophora foveicollis* L.) in different cucurbits. The research consists of three cucurbitaceous plants (varieties) *viz.* sweet gourd, bottle gourd and bitter gourd. The seeds of these varieties were collected from the BADC, Jessore. The experiment was laid out in single factor Randomized Completely Block Design (RCBD) method with three replications. Data were recorded on damage of infested cotyledon (%), number of infested plants pit^{-1}, number of infested leaves per $plant^{-1}$, number of total infested leaves $plot^{-1}$, damage of infested flowers (%) and damage of infested fruits (%). Statistical analysis was done by the MSTAT-C package program and the means were compared by DMRT at 5% level of probability. Red pumpkin beetle (RPB) as a host suitability among the cucurbitaceous plants affected significantly on the whole parameters at all the data recording period during study. Sweet gourd produced maximum plants (2.45 pit^{-1}) and bitter gourd produced minimum (11.27 pit^{-1}) average plants among cucurbits.

Damage of infested cotyledon had also significantly influenced by Red pumpkin beetle (RPB) where sweet gourd took the maximum damage of infested cotyledon at 1 5 DAS (35.56%) and at 20 DAS (47.67%) while bitter gourd observed the lowest damage (7.89 and 14.33% at 15 and 20 DAS, respectively) of red pumpkin infested cotyledon.

Number of infested leaves plant^{-1} were affected significantly due to the effect of RPB where sweet gourd recorded the maximum leaf infestation and bitter gourd showed the lower infestation at all the DAS As a result, sweet gourd took the maximum leaf infestation (3.22, 5.89, 6.78, 7.56, 8.33, 9.22, 11.00 and 12.45 at 15, 20, 25, 30, 35, 40, 45 and 50 DAS respectively). In contrast, bitter gourd recorded the minimum leaf infestation (1.22, 4.00, 5.22, 6.11, 7.78, 8.33 and 9.33 at 15, 20, 25, 30, 35, 40, 45 and DAS respectively).Similarly result was found regardingly.

Damage of infested flower at 35 DAS and fruits plot^{-1} at 45 and 50 DAS was significantly influenced by the RPB as host suitability of cucurbits. The higher percentage of flower damage plot^{-1} (31.00%) was observed in sweet gourd which statistically differed from other cucurbits however it was statistically followed by bottle gourd. Among other cucurbitaceous plants, bitter gourd showed statistically identical lower damage of infested flower plot^{-1} (15.11%). Damage of infested fruits plot^{-1} had also maximum (35.56 and 39.89%) in sweet gourd at 45 and 50 DAS, respectively. In contrast, the lowest damage of infested fruits plot^{-1} was recorded in bitter gourd at 45 and 50 DAS.

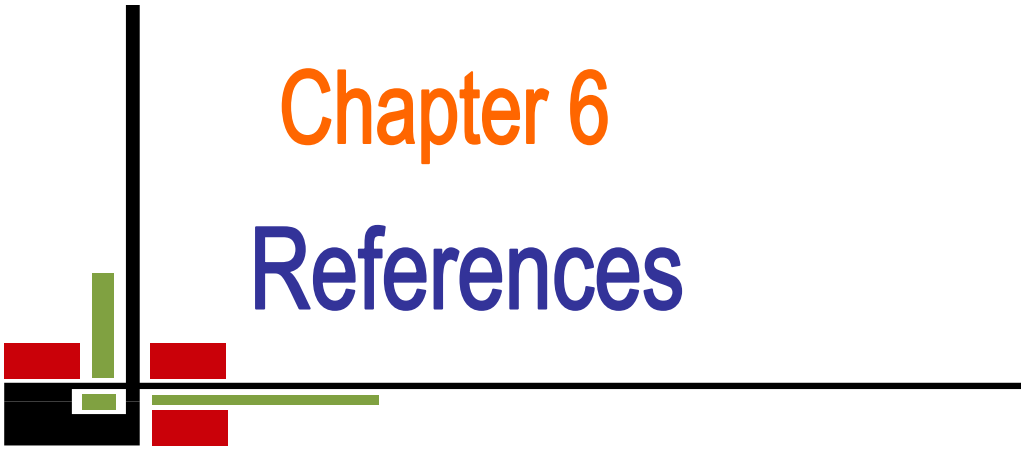
CONCLUSION

From the above results, it could be concluded that the sweet gourd was highly attacked by red pumpkin beetle in case of the damage of cotyledon considering the parameters the maximum infestation of plants pit^{-1}, infestation of leaves $plant^{-1}$ and infestation of leaves $plot^{-1}$. RPB had the highest preference to attack the sweet gourd as well as damaged of infested flowers and infested fruits $plot^{-1}$ So, therefore, it was establish that the sweet gourd would be highly preferable host of red pumpkin beetle (RPB) among other cucurbits in this study. On the other hand, bitter gourd was least preferred as a suitable host and also damage was the minimum.

RECOMMENDATION

1. From the results of the study it may be recommended that sweet gourd is more preferable against the attack of red pumpkin beetle among the different cucurbits.

2. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability and other performance.



Chapter 6

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Appendices

APPENDICES

Appendix I: **Soil characteristics of experimental farm of Sher-e-Bangla Agricultural University are analyzed by soil Resources Development Institute (SRDI), Farmgate, Dhaka.**

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Farm, SAU, Dhaka
AEZ	Modhupur tract (28)
General soil type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	**N/A**

Source: SRDI

B. Physical and chemical properties of the initial soil

Characteristics	Value
Practical size analysis	
Sand (%)	16
Silt (%)	56
Clay (%)	28
Silt + Clay (%)	84
Textural class	Silty clay loam
pH	5.9
Organic matter (%)	1.15
Total N (%)	0.07
Available P (µgm/gm soil)	53.64
Available K (me/100g soil)	0.13
Available S (µgm/gm soil)	9.40
Available B (µgm/gm soil)	0.13
Available Zn (µgm/gm soil)	0.94
Available Cu (µgm/gm soil)	1.93
Available Fe (µgm/gm soil)	240.9
Available Mn (µgm/gm soil)	50.6

Source: SRDI

Appendix II. Analysis of variance of the data on different cucurbit vegetables as host plant for red pumpkin beetle and number of plants pit^{-1} and Percent damage of infested cotyledon at days after sowing

Source of variance	Degrees of Freedom	Number of plants pit^{-1}	Percent damage of infested cotyledon	
			15 DAS	20 DAS
Replication	2	0.086	16.422	15.444
Factor A	2	1.052*	616.333*	920.444*
Error	4	0.15	2.667	4.778

* = Significant at 5% level of probability

Appendix III. Analysis of variance of the data on different cucurbit vegetables as host plant at different days after sowing (Number of infested plants pit^{-1})

Source of variance	Degrees of Freedom	Number of infested plants pit^{-1} at different days after sowing							
		15	20	25	30	35	40	45	50
Replication	2	0.063	0.066	0.066	0.066	0.066	0.066	0.066	0.066
Factor A	2	1.719*	1.533*	1.198*	1.198*	1.198*	1.198*	1.198*	1.198*
Error	4	0.016	0.071	0.033	0.033	0.033	0.033	0.033	0.033

* = Significant at 5% level of probability

Appendix IV. Analysis of variance of the data on different cucurbit vegetables as host plant at different days after sowing (Number of infested leaves plant^{-1})

Source of variance	Degrees of Freedom	Number of infested leaves plant^{-1} at different days after sowing							
		15	20	25	30	35	40	45	50
Replication	2	2.596	3.376	3.364	5.277	5.2	4.943	3.799	4.036
Factor A	2	3.786*	3.376*	6.343*	4.469*	4.48*	1.632*	5.64*	8.27*
Error	4	0.584	0.908	1.199	1.239	0.995	2.64	1.564	1.291

* = Significant at 5% level of probability

Appendix V. Analysis of variance of the data on number of total infested leaves plot^{-1} at different days after sowing

Source of variance	Degrees of Freedom	Number of infested leaves pot^{-1} at different days after sowing							
		15	20	25	30	35	40	45	50
Replication	2	0.643	2.583	0.447	0.857	1.345	0.233	1.817	5.882
Factor A	2	16.04*	51.48*	69.37*	83.60*	92.73*	122.25*	153.85*	153.36*
Error	4	0.05	1.124	1.447	2.33	0.752	1.51	0.353	1.283

* = Significant at 5% level of probability

Appendix VI. Analysis of variance of the data on Damage of infested flowers (%) and percent damage of infested fruits plot^{-1} at 60 and 65 days after sowing

Source of variance	Degrees of Freedom	Damage of infested flowers (%)	Damage of infested fruits (%) at different days after sowing	
			45	50
Replication	2	17.983	22.597	7.853
Factor A	2	207.673*	317.963*	374.647*
Error	4	1.363	1.825	2.493

* = Significant at 5% level of probability