INFESTATION STATUS AND MANAGEMENT OF CUCURBIT FRUIT FLY (*BACTROCERA CUCURBITAE*) IN BOTTLE GOURD AND SPONGE GOURD IN SUMMER SEASON

MD. ABU RAYHAN SIDDIQUE

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

JUNE, 2015

INFESTATION STATUS AND MANAGEMENT OF CUCURBIT FRUIT FLY (*BACTROCERA CUCURBITAE*) IN BOTTLE GOURD AND SPONGE GOURD IN SUMMER SEASON

BY

MD. ABU RAYHAN SIDDIQUE

Registration No.: 09-03670

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, 2015

APPROVED BY:

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

Dr. Mohammed Sakhawat Hossain
Associate professor &
Chairman
Examination Committee

INFESTATION STATUS AND MANAGEMENT OF CUCURBIT FRUIT FLY (*BACTROCERA CUCURBITAE*) IN BOTTLE GOURD AND SPONGE GOURD IN SUMMER SEASON

By

MD. ABU RAYHAN SIDDIQUE

ABSTRACT

A field experiment was conducted at Sher-e-Bangla Agricultural University farm to find out the effect of different treatment for management of cucurbit fruit fly, *(Bactrocera cucurbitae)* during March to October 2015. The treatments of the experiment were T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval, T_2 = Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3 = Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a alternative sprays at 10 days interval ,T_4=Cue-lure traps+ hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_6 = Untreated control. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Among the treatments T_3 (Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays) showed the best performance in controlling cucurbit fruit fly on bottle gourd and sponge gourd. Consequently highest total weight of healthy fruits/plot (37.57 kg) and (13.62 kg), highest per cent increase of yield by weight (193.53 %) and (158.36 %), highest total yield per hector (41.74 t ha^{-1}) and (15.14 t ha^{-1}) were achieved from the T_3 (Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a alternative sprays at 10 days interval) treatment on bottle gourd and sponge gourd. Respectively better result also found from T_2 (Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays). The lowest weight of healthy fruit (12.8 kg/plot) and (5.27 kg/plot),lowest total yield per hector (14.22 t ha^{-1}) and (5.86 t ha^{-1}) were obtained from control plot of bottle gourd and sponge gourd . The experiment revealed that Cue-lure traps combined with Neem oil @ 4ml/Liter and Ripcords 10EC @ 1ml/Liter as a alternative sprays could be effectively utilized for fruit fly management on bottle gourd and sponge gourd in summer season.

DEPARTMENT OF ENTOMOLOGY

Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207

Ref. No. : Date :

CERTIFICATE

This is to certify that thesis entitled, **"INFESTATION STATUS AND MANAGEMENT OF CUCURBIT FRUIT FLY *(Bactrocera cucurbitae*) IN BOTTLE GOURD AND SPONGE GOURD IN SUMMER SEASON"** submitted to the Department of Entomology, Faculty of Agriculture**,** Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS)** in **ENTOMOLOGY**, embodies the result of a piece of *bona fide* research work carried out by **MD. ABU RAYHAN SIDDIQUE** bearing **Registration No. 09-03670** under my supervision and guidance. No part of the thesis has been submitted in before for any other degree or diploma.

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

Dated: June, 2015
SAU, Dhaka.

Prof. Dr. Mohammed Ali
Department of Entomology
Sher-e-Bangla Agricultural University
Dhaka-1207
Supervisor

ACKNOWLEDGEMENT

All the praises due to the Almighty Allah, who enabled the author to pursue his education in Agriculture discipline and to complete this thesis for the degree of Master of Science (M.S.) in Entomology. I am proud to express my deepest gratitude, deep sense of respect and immense indebtedness to my supervisor, ***Professor Dr. Mohammed Ali*** *Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka for his constant supervision, invaluable suggestion, scholastic guidance, continuous inspiration, constructive comments and encouragement during my research work and guidance in preparation of manuscript of the thesis. I express my sincere appreciation, profound sense, respect and immense indebtedness to my respected co-supervisor,* ***Professor Dr. Md. Abdul Latif,*** *Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka for providing me with all possible help during the period of research work and preparation of the thesis. I would like to express my deepest respect and boundless gratitude to my honorable teachers, and staffs of the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka for their valuable teaching, sympathetic co-operation and inspirations throughout the course of this study and research work. Cordial thanks are also due to all field workers of SAU farm for their co-operation to complete my research work in the field. I would like to express my last but not least profound and grateful gratitude to my beloved parents, friends and all of my relatives for their inspiration, blessing and encouragement that opened the gate of my higher studies in my life.*

The Author


Dedicated To
My Beloved Parents

LIST OF TABLES

TABLE No.	TITLE	PAGE
1.	Doses of manures and fertilizer and their methods of application used for this experiment	25
2.	Effect of different treatments against cucurbit fruit fly in bottle gourd on the basis of healthy fruits and infested fruits infestation by number at early fruiting stage	32
3.	Effect of different treatments against cucurbit fruit fly in bottle gourd on the basis of healthy fruits and infested fruits infestation by number at mid fruiting stage	34
4.	Effect of different treatments against cucurbit fruit fly in bottle gourd on the basis of healthy fruits and infested fruits infestation by number at late fruiting stage	35
5.	Effect of different treatments against cucurbit fruit fly in Sponge gourd on the basis of healthy fruits and infested fruits infestation by number at early fruiting stage	36
6.	Effect of different treatments against cucurbit fruit fly in Sponge gourd on the basis of healthy fruits and infested fruits infestation by number at mid fruiting stage	38
7.	Effect of different treatments against cucurbit fruit fly in Sponge gourd on the basis of healthy fruits and infested fruits infestation by number at late fruiting stage	39
8.	Effect of different treatments against cucurbit fruit fly in bottle gourd on the basis of healthy fruits and fruit infestation by weight at early fruiting stage	45
9.	Effect of different treatments against cucurbit fruit fly in bottle gourd on the basis of healthy fruits and fruit infestation by weight at mid fruiting stage	47
10.	Effect of different treatments against cucurbit fruit fly in bottle gourd on the basis of healthy fruits and fruit infestation by weight at late fruiting stage	48
11	Effect of different treatments against cucurbit fruit fly in Sponge gourd on the basis of healthy fruits and fruit infestation by weight at early fruiting stage	49

TABLE No.	TITLE	PAGE
12	Effect of different treatments against cucurbit fruit fly in Sponge gourd on the basis of healthy fruits and fruit infestation by weight at mid fruiting stage	50
13	Effect of different treatments against cucurbit fruit fly in Sponge gourd on the basis of healthy fruits and fruit infestation by weight at late fruiting stage	51
14	Effect of different treatments on total yield of healthy fruit through total growing season of Bottle gourd	54
15	Effect of different treatments on total yield of healthy fruit through total growing season of Bottle gourd	56

LIST OF FIGURES

FIGURE	TITLE	PAGE
1.	Effect of different treatments on percent (%) increase of healthy fruits of Bottle gourd by number	41
2.	Effect of different treatments on percent (%) increase of healthy fruits of Sponge gourd by number	43
3.	Effect of Cue-lure traps on capturing adult cucurbit fruit fly at different dates of fruiting of bottle gourd and sponge gourd	44
4.	Effect of different treatments on percent (%) increase of healthy fruits of Bottle gourd by weight	52
5.	Effect of different treatments on percent (%) increase of healthy fruits of Sponge gourd by weight	53

LIST OF PLATES

PLATE	TITLE	PAGE
1.	Adult cucurbit fruit fly.	10
2.	The experimental plot at SAU, Dhaka	22
3.	Untreated control plot	27
4.	Cue-lure trap (Plastic pot)	27
5.	Data collection and harvesting	28
6.	Infested fruits (IF)	29

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
I.	Experimental site at Sher-e-Bangla Agricultural University, Dhaka-1207	72
II.	Monthly average air temperature, relative humidity, rainfall during the cropping period (May to October, 2015)	73
III.	Physical characteristics and chemical composition of soil of the experimental plot.	73

LIST OF ACRONYMS

ABBREVIATIONS		ELABORATIONS
%	:	Percent
et all	:	And others
J	:	Journal
No.	:	Number
Cm	:	Centimeter
Agric.	:	Agriculture
^{o}C	:	Degree centigrade
Etc.	:	Etcetera
TSP	:	Triple Super Phosphate
MP	:	Murate of Potash
BARI	:	Bangladesh Agricultural Research Institute
LSD	:	Least Significant Difference
RCBD	:	Randomized Completely Block Design
Res.	:	Research
SAU	:	Sher-e-Bangla Agricultural University
Viz.	:	Namely
@	:	At the rate of
BRRI	:	Bangladesh Rice Research Institute
i.e.	:	That is
BBS	:	Bangladesh Bureau of Statistics
CV%	:	Percentage of Co-efficient of Varience
g	:	Gram
kg	:	Kilogram
mg	:	Miligram
t	:	Ton
Agril.	:	Agricultural
BARC	:	Bangladesh Agricultural Research Council
UNDP	:	United Nations Development Programme
AEZ	:	Agro-ecological Zones

CHAPTER I
INTRODUCTION

Bangladesh is predominantly an agriculture based country. But it has a huge deficit in vegetable production. The annual production of vegetables is only 2.5 million tons, including potato and sweet potato (Anon.1993). The optimum requirement of vegetable for a full grown person is 285g but in Bangladesh it is only 32g (Ramphall and Gill 1990). Vegetables are not equally produced throughout the year in the country. Most of the important vegetables are produced in winter and the production in summer is tremendously low (Anon. 1993). In summer the major vegetables grown are cucurbits. As a result, cucurbitaceous vegetable plays an important role to supplement this shortage during the lag period (Rashid 1993).

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 are infested by several insect pests which are considered to be the significant obstacles for economic production. Among them, cucurbit fruit fly is the serious pest responsible for considerable damage of cucurbits (Alam 1969, Butani and Jotwani 1984).The cucurbit fruit fly *Bactrocera cucurbitae* can attack about 16 different types of cucurbit crops. Although the rate of attack varies among the crop, infestation reduced both the yield and quality of the cucurbit fruits.

The dipteran family *Tephritidae* consists of nearly 250 species of economically important insects are distributed widely in temperate, sub-tropical, and tropical regions of the world (Christenson and Foote, 1960). Amongst these, *Bactrocera cucurbitae (Coquillett)* is a major threat to cucurbits (Shah et al., 1948). For cucurbits, the cucurbit fruit fly damage is the major limiting factor in obtaining good quality fruits and high yield (Rabindranath and Pillai, 1986). 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. A few maggots have also been observed to feed on the stems . The fruits attacked in early stages fail to develop properly, and drop or rot on the plant. Since, the maggots damage the fruits internally; it is difficult to control this pest with insecticides. Therefore, there is a need to explore alternative methods of control, and develop an integrated control strategy for effective management of this pest.

Yield losses due to fruit fly infestation vary from 19.19 to 69.96 percent in different fruits and vegetables (Kabir *et al.*,1991) and the damage caused by fruit fly is the most serious in melon which may be up to 100 percent (Atwal 1993).Due to its nature of infestation, it is very difficult to control the pest. A cluster method have been developed and suggested by Kapoor (1993) to control these pests. Each and every method has its positive and negative effects. Among all these methods, the chemical control method is still popular to the Bangladeshi farmers because of its quick and visible results. Nasiruddin and Karim (1992) found that 61.92% reduction of fruit fly infestation over control by spraying Dipterex 80SP in snack gourd, but Dipterex 80SP is not recently available in market for farmer use. Protein hydrolysate insecticide formulations and other insecticides (Malathion 57EC, and Diazinon 60EC) with molasses as attractant are being widely used for the control of fruit fly (Kapoor, 1993; Nasiruddin and Karim, 1992; Smith,1992). Some insecticides have been used satisfactorily in minimizing the damage to fruits and vegetables against fruit fly (Kapoor, 1993; York, 1992; Nair, 1986; Hameed *et al.*, 1980).

Considering previous facts and reports, it is apparent that more than 50% of the cucurbits are either partially or totally damaged by fruit flies become 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 (Dhillon *et al*., 2005; Neupane, 2000; Akhtaruzzaman *et al.,* 2000; Yubak Dhoj and Mandal, 2000; Pawar *et al*.,

1991) have 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 (Dhillon *et al.*, 2005; Neupane, 2000).

In the year 2010 EU team reported on "Pest risk analysis" of cucurbits of Bangladesh listing cucurbit fruit fly as a quarantine pest. Cucurbits have high potentiality for export in Europe and Middle East and are highly prone to damage by this pest in Bangladesh From previous reports, it is apparent that more than 50% of the cucurbits are either partially or totally damaged by fruit flies and are unsuitable for human consumption. Although, several management options, including chemical insecticides have 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. 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 (Sapkota, 2009).

However, alarming consequences of pesticide usage and residual effect on the environment, pragmatic programmer is now needed to minimize the dependency on insecticides without hampering crop production. IPM, undoubtedly since last few years has been a much talked scientific phenomenon in Bangladesh, particularly in the area of the agricultural policy makers. Bangladesh has shown strong interest in adopting the pheromone lure for monitoring of peak pest infestation periods as well as for mass trapping. They are able to minimize fruit fly damage, and reduce the use of toxic insecticides. To monitor the fruit fly population pheromone trappings have been successfully used in different countries (Gillani *et al.*, 2002; Marwat and Baloch, 1986).

Considering the impact of chemicals on crops, and the environment, efficacy of different control measures aiming to develop an eco-friendly and sustainable pest management system in cucurbits is urgently needed. And considering the hazardous impact of chemicals on non-target organisms and the environment,

present studies were undertaken to assess the losses caused by *B. cucurbitae* and efficacy of different control measures aiming to develop an eco-friendly and sustainable pest management system in cucurbit .

Considering the above facts view in mind, the experiment has been undertaken with the following objectives:

- to evaluate the infestation of fruit fly in cucurbit vegetables in summer
- to find out a suitable management practice for the control of insect pest of bottle gourd and sponge gourd
- to highlight the establishment of an eco-friendly pest control measure in cucurbit vegetables

CHAPTER II
REVIEW OF LITERATURE

The cucurbit fruit fly is a highly damaging pest of almost all the cucurbit vegetables. Indiscriminate use of pesticides by farmers to control the pest has endangered the safety of the environment and increased the chances of accumulation of poisonous residues in the produce. Mass-trapping of fruit flies through pheromone and other bait traps will reduce the fruit fly population, minimize the use of pesticides and help establish a safe control measure for the production of pesticide-free cucurbit crops. . Substantial works have been done globally on this pest regarding their origin, distribution, biology, seasonal abundance, host range, nature of damage, yield loss, rate of infestation and control measures. The information related to the studies reviewed is given below under the following sub-headings.

2.1 Classification of Insect

Kingdom: Animalia
Phylum: Arthropoda
Class: Insecta
Order: Diptera
Section: Schizophora
Family: Tephritidae
Genus: *Bactrocera*
Species*: B. curcurbitae*

Synonyms

Chaetodacus cucurbitae (Coquillett)
Dacus cucurbitae (Coquillett)
Strumeta cucurbitae (Coquillett)
Zeugodacus cucurbitae (Coquillett)

2.2 Origin and distribution of cucurbit fruit fly

Fruit flies are distributed all over the world and infest a large number of host plants. The distribution of particular species is limited perhaps due to physical,

climate 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).Two of the world's most damaging tephritids *Bactrocera (Dacus) dorsalis* and *Bactrocera* (Dacus) cucurbitae,are widely distributed in Malaysia and South East Asian countries (Vijaysegaran 1987).Gupud(1993) has cited references of five species of fruit fly in Bangladesh e.g., *Bactrocera bervistylus*(melon fruit fly) ,*Dacus (Zeugo Dacus)* caudatus (fruit fly) *D.(strumeta)cucurbitae* (melon fly),D.(Bractocera) dorsalis Hendel (mango fruit fly) and *D. (Chacto Dacus) zonatus(*zonata fruit fly).

According to Akhtaruzzaman *et al*., (2000) Bactrocera cucurbitae. Bactrocera tau and Dacus ciliates have been currently identified in Bangladesh of which *Ducus ciliutus* is a new record . *Bactrocera cucurbitae* is dominant in all location of Bangladesh followed by *Bactrocera tau* and *Dacus cilialus*.

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 in Japan in 1919(Anon,1987). However ,the fruit fly is widely distributed in India, Bangladesh, Pakistan, Mayanmar, Nepal, Malaysia, China, Philippines, Formosa(Taiwan), Japan, Indonesia, East Africa , Australia and Hawiian Island (Atwal 1993).

Although, this pest is widely distributed, it does not occur in UK, central Europe and continental USA (*et al*., 1992). Kapoor (1993) reviewed that fruit fly was originally reported from Hawaii and now widely distributed throughout the oriental region including China, Japan, much of the pacific region including New Guinea, Soloman and Bismark islands, Australia, Mauritius, East Africa, Kenya and Tanzania.

2.3 Host range of fruit fly

Many fruit fly species do serious damage to vegetables, oil-seeds, fruits and ornamental plants. In Bangladesh, Alam *et al.*, (1969) recorded ten cucurbit vegetables as the host of fruit fly. Tomato, green, pepper, papaya, cauliflower,

mango, guava, citrus, pear, fig and peaches are also infested by fruit fly (Anon, 1987 and Atwal,1993).

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

Batra (1968) listed as many as 70 hosts of fruit fly species, whereas. Christenson and Foote (1960) reported more than 80 kinds of vegetables and fruits as hosts. Batra (1968) observed that the male flowers and flowers bud of sweet gourd were found to serve as usual host with anthers being the special food for the larvae and only occasionally small sweet gourd fruits attacking perhaps through the female flower.

Kapoor (1993) reported that more than one hundred vegetables and fruits are attacked by *Bactrocera sp*. Atwal (1993) and McKinlay *et al*., (1992) reported that cucurbit as well as 70-100 non-cucurbitaceous vegetables and fruits are the host of fruit fly.

According to Narayanan and Batra (1960),different species of fruit fly attack a wide variety of fruits and vegetables such as mango, guava, loquat, plum, peach, apple, quince, persimmon, banana, pomegranate, jujube, sweet lime, orange, chilies, jack fruit, carambola, papaya, avocado, bread fruit, coffees, berries, passion fruit, star apple, Spanish pepper, cucurbit fruit, cherries, black berry , grapes etc.

2.4 Lifecycle of Cucurbit fruit fly

The life cycle from egg to adult requires 14-27 days. Insects are able to grow and develop on a variety of host species which effect on their growth, reproduction and development (Tikkanen *et al*., 2000). Mukherjee *et al*., (2007) studied the life history of *B. cucurbitae* on sweet gourd and reported pre-oviposition, oviposition, incubation, larval and pupal periods, and adult male and female longevity 11.25, 9.75, 0.81, 12.25, 7.75, 18.25, and 23.50 days, respectively. They also reported that the mean fecundity of fruit fly on this crop was 52.75 female^{-1}.

Eggs

The eggs of the melon fly are slender, white and measure 1/12 inch in length. Eggs are inserted into fruit in bunches of 1 to 37. They hatch in 2 to 4 days. The melon fruit fly remains active throughout the year on one or the other host. During the severe winter months, they hide and huddle together under dried leaves of bushes and trees. During the hot and dry season, the flies take shelter under humid and shady places and feed on honeydew of aphids infesting the fruit trees. The lower developmental threshold for melon fruit fly was recorded as 8.1° C (Keck, 1951). The lower and upper developmental thresholds for eggs were 11.4 and 36.4° C (Messenger and Flitters, 1958). The accumulative day degrees required for egg, larvae, and pre-egg laying adults were recorded as 21.2, 101.7, and 274.9 day degrees, respectively (Keck, 1951). This species actively breeds when the temperature falls below 32.2° C and the relative humidity ranges between 60 to 70%. The egg incubation period on pumpkin, bitter gourd, and squash gourd has been reported to be 4.0 to 4.2 days at 27 ± 1° C (Doharey, 1983), 1.1 to 1.8 days on bitter gourd, cucumber and sponge gourd (Gupta and Verma, 1995), and 1.0 to 5.1 days on bitter gourd (Koul and Bhagat, 1994; Hollingsworth *et al*., 1997).

Larvae

The larval period lasts from 6 to 11 days, with each stage lasting 2 or more days. Duration of larval development is strongly affected by host. The larval period lasts for 3 to 21 days (Renjhan, 1949; Narayanan and Batra, 1960; Hollingsworth et al., 1997), depending on temperature and the host. On different cucurbit species, the larval period varies from 3 to 6 days (Gupta and Verma, 1995; Koul and Bhagat, 1994; Doharey, 1983; Chelliah, 1970; Chawla, 1966).

Larval feeding damage in fruits is the most damaging (Wadud *et al.*, 2005). Mature attacked fruits develop a water soaked appearance (Calcagno *et al*., 2002). Young fruits become distorted and usually drop. The larval tunnels

provide entry points for bacteria and fungi that cause the fruit to rot (Collins *et al.*, 2009). These maggots also attack young seedlings, succulent tap roots, stems and buds of host plants such as mango, guava, cucumber, custard apple and others (Weldon *et al.*, 2008). Egg viability and larval and pupal survival on cucumber have been reported to be 91.7, 86.3, and 81.4%, respectively; while on pumpkin these were 85.4, 80.9, and 73.0%, respectively, at 27 ± 1° C. 53 The full-grown larvae come out of the fruit by making one or two exit holes for pupation in the soil. The larvae pupate in the soil at a depth of 0.5 to 15 cm. The depth up to which the larvae move in the soil for pupation, and survival depend on soil texture and moisture (Jackson *et al.*, 1998).

Pupae

Doharey (1983) observed that the pupal period lasts for 7 days on bitter gourd and 7.2 days on pumpkin and squash gourd at 27 ± 1° C. In general, the pupal period lasts for 6 to 9 days during the rainy season, and 15 days during the winter (Narayanan and Batra, 1960). Depending on temperature and the host, the pupal period may vary from 7 to 13 days (Hollingsworth *et al.*, 1997). On different hosts, the pupal period varies from 7.7 to 9.4 days on bitter gourd, cucumber, and sponge gourd (Gupta and Verma, 1995), and 6.5 to 21.8 days on bottle gourd (Koul and Bhagat, 1994; Khan *et al.*, 1993).

Adults

The adults survive for 27.5, 30.71 and 30.66 days at 27 ± 1° C on pumpkin, squash gourd and bitter gourd, respectively (Doharey, 1983). Khan *et al.*, (1993) reported that the males and females survived for 65 to 249 days and 27.5 to 133.5 days respectively. The premating and oviposition periods lasted for 4 to 7 days and 14 to 17 days, respectively. The females survived for 123 days on papaya in the laboratory (24° C, 50% RH and LD 12: 12) (Vargas *et al.*, 1992), while at 29° C they survived for 23.1 to 116.8 days (Vargas et *al., 1997).* Mean single generation time is 71.7 days, net reproductive rate 80.8 births per female, and the intrinsic rate of increase is 0.06 times (Vergas *et al.*,

1992). Yang et al. (1994) reported the net reproductive rate to be 72.9 births per female.

Plate 1: Adult cucurbit fruit fly.

Bactrocera cucurbitae strains were selected for longer developmental period and larger body size on the basis of pre-oviposition period, female age at peak fecundity, numbers of eggs at peak fecundity, total fecundity, longevity of males and females, age at first mating, and number of life time mating (Miyatake, 1995). However, longer developmental period was not necessarily associated with greater fecundity and longevity (Miyatake, 1996).

2.5 Seasonal abundance of fruit fly

The population of fruit fly fluctuates throughout the year and the abundance of fruit fly population varies from month to month, season to season, even year to year depending upon various environmental factors. The fly has been observed to be active in the field almost throughout the year where the weather is equable (Narayan and Batra 1960). Tanaka *et al*., (1978) reported that population of melon fly was increased in autumn and decreased in winter in Kikai islands Japan. Narayan and Batra (1960) reported that most of the fruit fly species are more or less active at temperatures ranging between 12ºC-15ºC and become inactive below 10°C. Cucurbit fruit flies normally increases

their multiplication when the temperature goes below 15°C and relative humidity varies from 60-70 % (Alam 1966).

The fruit fly population is generally low during dry weather and increases with adequate rainfall (Butani and Jotwani 1984). The peak population of fruit fly in India is attained during July and August in rainy months and January and February in cold months (Nair 1986). The adults of melon fly *Bactrocera cucurbitae* over winter November to December and the fly is the most active during July to August (Agarwal *et al*., 1987). Fruit fly populations were in general positively correlated with temperature and relative humidity. Amin (1995) observed the highest population incidence at ripening stage of cucumber in Bangladesh.

2.6 Nature of damage of fruit fly

According to Janjua (1984) the nature of infestation of fruit fly varies with the kinds of fruits. Shah et al. (1984) and York (1992) observed the formation of brown resinous deposits on fruits as the symptom of infestation. The insertion of the ovipositor causes wounds on the fruits and vegetables in the form of puncture. The adult female lays eggs just below the epidermis or sometimes a little deeper in the pulp, and/or sometimes on the young leaves or stems of the host plants. After that fluid substance oozes out which transform into a brown resinous deposits. After hatching, the larva feed into pulpy tissues and make tunnels in fruits causing direct damage.

They also indirectly damages the fruits by contaminating it with frass and accelerate rotting of fruits by pathogenic infection. Infested fruits if not rotten, become deformed and hardy , which make it unfit for consumption. They fly also attacks flowers and the infested flowers often become juicer and drop from the stalk at slight jerk Kabir *et al* ., (1991)

According to Kapoor (1993), some flies make mines and a few from galls on different Darts of the plants. Singh (1984) reviewed that the maggots bore and feed inside the fruits causing sucken discolored patches , distortion and open

cracks .Affected fruits prematurely ripe and drop from the plant. The cracks on fruit serve as the predisposing factor to cause pathogenic infection resulting in decomposition of fruits.

2.7 Rate of infestation at yield loss by fruit fly

Borah and Dutta (1997) studied the infestation of *tephritids* on the cucurbits in Assam, India and obtained the highest best fruit fly infestation rate in snake gourd (62.02%). Larger proportion of marketable fruits was obtained from ash gourd in and bottle gourd in summer season. Snake gourd and pumpkin yielded the lowest proportion of marketable fruits. Gupta (1992) investigated the rate of infestation of *(Bactrocera cucurbitae)* and *Bactrocera tau* on cucurbit in India during 1986-87 and recorded that 80% infestation on cucumber and bottle gourd in July-August and 50% infestation on bitter gourd, 50% infestation on sponge gourd in August-September. 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%. Kabir *et al.,* (1991) reported that yield losses due to fly infestation varies in different fruits and vegetables and it is minimum 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). 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.

2.8 Management of fruit fly

Fruit fly is the most damaging factor of cucurbits almost all over the world . Although there are various methods are available to combat this cost , there is not a single such method which has far been successfully reduced the damage of fruit fly. This perhaps , is mainly due to polyphagus nature of these pests

that helps their year round population build-up .the available literatures on the measures for the controlling of these flies are discussed under the following sub-heading:

2.8.1 Ploughing of soil

IN the pupal stage of fruit fly, it pupates in soil and also over winter in the soil. In the winter period, the soil n the field s turned over or given a light ploughing ; the pupa underneath are exposed to direct sunlight and killed . They also become prey to the predators and parasitoids. A huge number of pupae are died due to mechanical injury during ploughing. (Agarwal *et al.,* 1987; Chattopadhyay, 1991; Nasiruddin and karim, 1992; Kapoor, 1993).

2.8.2 Field sanitation

The female fruit fly lay eggs and the larve hatch inside the fruit, it become essential to look for the available measure to reduce their damage on fruit. One of the Safety measures is the field sanitation (Nasiruddin and karim, 1992) .Field sanitation is an essential prerequisite to reduce the insect population or defer the possibilities of the appearance of epiphytotics or epizootics (Reddy and Joshi,1992).According to Kapoor (1993), in this method of field sanitation, the infested fruits on the plat or fallen on the ground should be collected and buried deep into the soil or Cooked and fed to animals. Systematic picking and destruction of infested fruits in Proper manner to keep down the population is resorted to reduce the damages caused by fruit flies infesting cucurbits , guava, mango, peach etc. and many borers of plants (Chattopadhyay,1991).

2.8.3 Cultural control

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

2.8.4 Mechanical control

Mechanical destruction of non-economic and non-cultivated alternate wild host plants reduced the fruit fly populations, which survive at times of the year when their cultivated hosts are absent (Kapoor, 1993). Collection and destruction of infested fruits with the larvae inside helped population reduction of fruits flies (Nasiruddin and karim, 1992)

2.8.5 Fruit picking

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

2.8.6 Bagging of fruits

Sometimes each and every fruit is covered by a paper or cloth to block the contact of flies with the fruit thereby protecting from oviposition by the fruit fly and it is quite useful when the flies are within the reach and the number of fruits to be covered are less and it is a tedious task for big commercial orchards Kapoor(1993). Bagging of the fruits against *Dacus (Bactrocera) cucurbitae* greatly promoted fruit quality and the yields (net income increased by 45 and 58% respectively in bitter gourd and 40 and 45% in sponge gourd (Fang, 1989). Covering of fruits by polyhene bag is an effective method to control fruit fly in teasel gourd and the lowest fruit fly incidence in teasel gourd occurred in bagging. Fruits (4.2%) while the highest (39.35) was recorded in the fruits of control plot (Anon., 1988).Amin (1995) obtained significantly lowest fruit fly infestation (4.61%) in bagged cucumber compared to other chemical and botanical control measures.

2.8.7 Wire netting

Kapoor (1993) reviewed that fine wire netting may sometimes be used to cover small orchards. Though it is a costly method, but it can be effectively reduce

the fruit fly infestation and protect the fruit from injury and deform , and also protects fruit crops against vertebrate pest.

2.8.8 Chemical control

The method of insecticide application is still popular among the farmers because of its quick and visible results but insecticide spraying alone is not yet becomes a potential method in controlling fruits flies. There are number of studies on the applications of chemical insecticide in the form of cover sprays ,baits sprays, attractants and repellents have been undertaken globally .Available information relevant are given below:

2.8.9 Cover spray of insecticide

A wide range of organophosphoras, carbamate and synthetic pyrethroids of various formulations have been used from time to time against fruit fly (Kapoor, 1993). Spraying of conventional insecticide is preferred in destroying adults before sexual maturity and oviposition (Williamson, 1989). Kapoor (1993) reported that 0.05% Fenitrothion, 0.05% Malathion, 0.03% Dimethoate and 0.05% Fenthion have been used successfully in minimizing the damage to fruit and vegetables against fruit fly but the use of DDT or BHC is being discouraged now. Sprays with 0.03% Dimethoate and 0.035% Phesalone were very effective against the fruit fly (Pareek and Kavadia, 1988). Fenthion, Dichorovos, phosnhamidon and Endosulfan are effectively used for the control of melon fly (Agarlwal et al., 1987). In field trials in pakistan in 1985-86, the application of Cypermethrin 10 EC and Malathion 57 EC at 10 days intervals (4 sprays in total) significantly reduced the infestation of *Bactrocera cucurbitae* on Melon (4.8-7.9) compared with untreated control. Malathion was the most effective insecticide (Khan *et al*., 1992).

Hameed *et al* .(1980) observed that 0.0596 FEnthion, Malathion,Trichorophos and Fenthion with waiting period of five, seven and nine days respectively was very effective in controlling *Bactrocera cucurbitae* on cucumber in Hmachal Pradesh, various insecticide schedules were tested against dacus (*Bactrocera*)

on pumpkin in Assam during 1997. The most effective treatment in terms of lowest pest incidence and highest yield was carbofuran @ 1.5 a.i./ha (Borah and Dutta,1997).

Nasiruddin and Karim (1992) reviewed that comparatively less fruit fly infestation (8.56%) was recorded in snake gourd sprayed with Dipterex 80SP compared to those in untreated plot (22.48%). Pawer et al. (1984) reported that 0.05% Monocrotophos was very effective in controlling *Bactrocera cucurbitae* in muskmelon. Rabindranath and Pillai (1986) reported that Synthetic pyrethroids, Permethrin, Fenvelerate, Cypermethrin @ 100g a.i./ha and Deltamethrin (@15g a.i/ha) were very useful in controlling Bactrocera cucurbitae, in bitter gourd in South India. Kapoor (1993) listed about 22 references showing various insecticidal spray schedules for controlling for fruit on different plant hosts tried during 1968-1990.

2.8.10 Attractants and others

The fruit flies have long been recognized to be susceptible to attractants. A successful suppression program has been reported from Pakistan where mass traping with Methyl eugenol, from 1977 to 1979, reduced the infestation of *Bactrocera zonata* below economic injury levels. *Bactrocera dorsalis* was eradicated from the island of Rota by male annihilating using Methyl Eugenol as attractant (Steiner *et al.,* 1988).

The attractant may be effective to kill the captured flies in the traps as reported several authors, one percent Methyl eugenol plus 025 percent Malathion have been used for the trapping the oriental fruit fly, *Bactrocera dorsalis* and *Bactrocera zonata.* Neem beriatives have been demonstrated as repelients, antifeedants, growth inhibitor and chemosterilant (Butterworth and Morgan, 1968). Singh and Srivastava (1985) found that alcohol extract of neem oil Azadirachta indica(%) reduced oviposition of *Bactrocera cucurbitae* on bitter gourd completely and its 20% concentration was highly effective to inhibit oviposition of *Bactrocera zonata* on guava. Stark *et al*., (1990) studied the

effect of Azadiractin on metamorphosis, longevity and reproduction of Ceratilis capital (Wiedemann), *Bactrocera cucurbitae* and *Bactrocera dorsalis*.

2.8.11 Bait Spray

Protein hydrolysate insecticide formulations are now used against various dacine fruit fly species (Kapoor 1993). New a day, different poison baits are used against various *Bactocera* species which are 20 g Malathion 50% Or 50 ml of Diazinon plus 200 g of molasses in 2 liters of water kept in flat containers or applying the bait Spray containing Malathion 0.05% plus 1 % sugar/molasses or 0.025% of protein water) or spraying plants with 500 g molasses plus 50 g Malathion in 50 liters of water or 0.025% Fenitrothion plus 0.5% molasses. This is repeated at weekly intervals where the fruit fly infestation is serious (Kapoor 1993). Nasiruddin and Karim (1992) reported that bait spray (1.0 g Dipterex 80SP and 100 g of molasses per liter of water) on snake gourd against fruit fly (*Bactrocera cucurbitae*) showed 8.50% infestation compared to 22.48% in control. Agarwal *et al*. (1987) achieved very good results for fruit fly (*Bactrocera cucurbitae*) management by spraying the plants with 500 g molasses and 50 litres of water at 7 days intervals. According to Steiner *et al*. (1988), poisoned bait containing Malathion and protein hydrolysate gave better results in fruit fly management program in Hawaii. A field study was conducted to evaluate the efficacy of some bait sprays against fruit fly (*Bactrocera cucurbitae*) in comparison with a standard insecticide and bait traps. The treatment comprised 25 g molasses + 2.5 ml Malathion, and 2.5 litres water at a ratio of 1:0.1:100 satisfactorily reduced infestation and minimized the reduction in edible yield (Akhtaruzzaman *et al*., 2000).

2.8.12 Use of Sex pheromone in management of fruit fly

Results of an experiment on monitoring the sweet potato weevil in the farmers' field by sex pheromones at the river belt of Jamalpur revealed that sweet potato weevils were a problem in this area .The idea on the weevil population density in the field can guide the farmers to schedule their proper management Anon, Cheng, and Struble, (1982) conducted an experiment on field evaluation of

black light, Inc 1 sex attractant traps for monitoring seasonal distribution of the dark sided cutworm (Lepidoptera: Noctuidae) in Ontario. Of these, the dark sided cutworm, *Euxoa messoria*, as expected , was the most numerous over the 5 year study. These results proved, further, that the sex attractant trap is highly specific.

The effect of the height of sex attractant traps on catches of male *E. messoria* moths in the field was consistent among the years. In general, all baited traps. Although there were no significantly more moths as compared with the unbaited traps. Although there were no significant differences between the catches of traps set at 1.0 m and 0.5 m above the ground level, traps set at 0.5 m tented to capture more moths than the traps at 1.0 m above the ground level. The unbaited traps occasionally captured a moth by chance.

Results of initial test comparing sex attractant with black light traps are presented. In the 5-year test, all sex attractant trap catches, regardless of the light, were much greater than backlight trap catches. During the study period , the sex attractant traps captured 3155 male *E. messoria* moths, while the black light traps captured 205 *E. messoria* moths. The data clearly indicate that the sex attractant traps were more effective than the black light traps for monitoring population of this species especially considering their species specificity, low cost and convenience Cheng and Struble(1982). The sex attractant traps provide more exact information about the activity of the *E. messoria* populations than the black light traps and they should be valuable aid in predicting outbreaks of this pest. In addition this technique can easily be fitted into a system of integrated pest management program the monitoring station or farm level.

Kehat *et al.*,(1998) observed that suppression of mating of *H. armigera* females was high throughout the entire test (49 days), even a high population levels, particularly with the two-component blend (mixture of two pheromone component) and it was significantly better than that obtained with the five-

component (mixture of five pheromone component) blend .When percentage mating was determined by using six to eight mating tables per plot each containing one female , the two component blend was, again, very effective but on two occasions (days 26,34) there was a low percentage of mating. The five component blend was, in this case, clearly inferior to the two-component blend and low percentage of mating (15-30) were observed more often. Statistical analysis indicated that the use of six to eight mating table each containing one female per table was significantly more sensitive in detecting percent mating than the use of two mating tables, each containing five to seven females. Each of the two methods showed that the binary blend was significantly better in disrupting mating of *H. armigera* than the five-component blend. On the test 2 mating of *P. gossypiella* females in the HPROPE treated plot were completely suppressed throughout the entire test (161 days). Mating percentage of sentient females in the control were low in the test .On test 3, this mating disruption test was conducted only against *P. gossypiella*, using " PBW rope L" pheromone. It was sufficient to achieve complete suppression of male captures and of mating during the 75 days of the field experiment.

Mating disruption of Yellow Stem Borer (YSB) by pheromone was tested by Cork et al.,(1992) and they observed the tiller and particle assessments and the effects of mating on final yield. In order to compare damage estimates for the treatment plot for DH (dead heart), and WH (white head), data from 21 to 41 DAT and 69 to DAT respectively, were used. The results show that the level of DH damage in the farmers' practice plot was lower than that in either the untreated control pheromone treated plots, but the differences were not statistically significant. However, the levels of WH damage recorded in the farmers' practice and the untreated control plots were significantly higher than that observed in the pheromone treated plot.

Islam (1994) conducted an experiment on trapping of the male pulse beetle, *Callosobruchus chinensis* (L) (*Coleoptera; Bruchidae*), in the laboratory using

crude extract of female sex pheromone and observed the trapping efficiency of new plastic trap developed for *Callosobruchus chinensis* On the result of male response to pheromone baited traps Containing crude female extract or live females he observed that there was no significant difference between the number of males caught with crude female extract or live females.

Tamaki *et al*. (1983) conducted an experiment on impact of removal of males with sex pheromone baited traps on suppression of the peach twig borer, *Anarsia lineatella* (Zeller). Male removal sex pheromone – baited traps has been successful in reducing damage caused by the red banded leafroller, *Agrotaenia velutinana* (Walker), the grapeberry moth, Endopiza viteana Clemens. However, in few of the cases has the amount of damage observed been at or below corn commercially acceptable levels.

In Bangladesh the adoption of sex pheromone traps by Syngenta Bangladesh Ltd. Has been parallel by the govt. of Bangladesh's adoption of the concept of IPM (Integrated Pest management) whereby the more toxic pesticides are replaced by sustainable and environmentally benign mean of pest and disease control. IPM provides a role for alternative approaches such as cultural methods , use of predators, viruses and use of sex pheromone etc. Syngenta in Bangladesh in collaboration with UK's Department for International Development (DFID) and BRRI (Bangladesh Rice Research Institute) made program on mass trapping by sex pheromone to control Yellow Stem Borer (YSB) of rice Comilla and Mymensingh districts for 2001-2003. The traps used in their program are inexpensive, easy to maintain and catch only male YSB. Farmers involved in the trials were so enthusiastic that they wanted pheromone for use on their others crops.

To make the pheromone component, E-11 hexadacenyle acetate and E-11-hexadacene-1.01 were used from 10:1 to 100:1 ratio. A tube filled with 2-3 mg of mixture was used in a trap for 6 weeks and it proved a significant result the population bellow the economic injury level.

2.8.13 Integrated management of fruit fly

At attempt for developing IPM program or package(s) related experiments are very few almost everywhere in the world. Uddin(1996) studied the comparative effectiveness of three IPM package vix., the IPM package 2 comprising Malathion spray (Hilthion 57 EC @ 2ml/liter of water) plus mechanical control and IPM package 3 containing bait spray @ 25 g of 14 G (@ 2g/plot) in reducing the infestation level of fruit fly ,red pumpkin beetle and aphids on cucumber. To investigate *Bactrocera cucurbitae* control at different place of Nepal during 1996-97, a survey among 32 farmers indicated the great loss in productivity of cucurbit vegetables. Use of pheromone traps (cue-lure) and field sanitation proved very effective. Integrated control (pheromone traps, field sanitation and bagging of individual fruits) in marrows showed varietal difference (Jaiswal *et al.,* 1997)

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the Agricultural Research Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from March to October 2015 to study the fruit fly infestation in summer bottle gourd and sponge gourd. Research was conducted to develop a suitable management technique for controlling cucurbit fruit fly which is the major pest of cucurbit. The materials and methods that were used for conducting the experiment are presented under the following headings:

3.1 Experimental site

The present experiment was conducted at the Agricultural Research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh. The location of the experimental site is 23074´N latitude and 90035´ E longitude and at an elevation of 8.2 m from sea level. Appendix I.

Plate 2. The experimental plot at SAU, Dhaka

Cont'd Plate 2. The experimental plot at SAU, Dhaka

3.2 Climate

The climate is subtropical in nature with moderate temperature and scanty rainfall. The soil of the experimental land belongs to the Madhupur tract and was silty clay in nature having pH ranging from 5.5 to 6.2. Details of the meteorological data during the period of the experiment was collected from the Bangladesh Meteorological Department, Agargoan, Dhaka and presented in Appendix II.

3.3 Characteristics of Soil

The soil of the experimental area belongs to the Modhupur Tract under AEZ No. 28. It had shallow red brown terrace soil. The selected plot was medium high land and the soil series was Tejgaon. Details of the recorded soil characteristics were presented in Appendix III.

3.4 Treatments

The comparative effectiveness of the following six treatments for Cucurbit fruit fly was evaluated on the basis of reduction of this pest

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval.

T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays.

T_3= Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a alternative sprays.

T_4=Cue-lure traps + hand picking at 10 days interval.

T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval.

T_6 = Untreated control.

3.5 Design of experiment

The experiment was laid out in a randomized complete block design (RCBD) with three replications. The unit plot size was 3m x 3m. The distance between plots and blocks was 1m and 1m respectively.

3.6 Land preparation and fertilization

The experimental plot was ploughed thoroughly by a tractor drawn disc plough followed by harrowing. The land was then labeled prior to transplanting .During land preparation, cow dung was incorporated into the soil at the rate of 10 t/ha. Recommended doses of fertilizer comprising urea, TSP and MP at the rate of 160, 125 and 100 kg/ha were applied .TSP and MP were applied as a basal dose at the time of sowing in all treatments (BARC, 1997). The nitrogen in from of urea was applied in 3 equal splits at basal, 30 days after sowing (DAS) and 50 DAS.

Manures and fertilizers with their doses and their methods of application followed in this study are shown in Table 1:

Table 1. Doses of manures and fertilizer and their methods of application used for this experiment

Manure / fertilizer	Dose per ha	Basal dose (kg/ha)	Top dressing (kg/ha)	Top dressing
Cow dung	10	Entire amount	------	------
Urea	160 kg	70kg	45kg	45kg
TSP	125 kg	Entire amount	------	------
MP	100 kg	Entire amount	------	------

3.7 Plant materials:

3.7.1Crop

Bottle gourd and sponge gourd was considered as test crop under the present study. Lal Teer variety was used for the experiment. Advanced summer variety of Bottle gourd and sponge gourd are used in this experiment.

3.7.2 Seed source and sowing

The seed of bottle gourd and sponge gourd were collected from Lal Teer seed company, Dhaka. Seeds were sown in the field on 20th June 2015. Five seeds per pit were sown directly. Before sowing the seed was treated with Vitavax 200@ 2 gm. per kg of seed. Regular irrigation was done after sowing. Finally three healthy plats were kept in each pit. Damaged and virus infected seed were replaced by new one.

3.8 Collection of trap and Pesticides

The Cue lure trap was collected from BARI, and other botanicals neem oil, ripcord, sevin were collected from local market.

3.9 Cultural practices

After sowing the seeds, a light irrigation was applied to the plots. Subsequent irrigation was done and when needed. Sevin 85 WP @ 1.5 kg/ha followed by light irrigation was applied in soil around each plat 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 cover the plants from the anthracnose disease. Weeding and drainage facilities were provided as recommended by Rashid (1993). Infestation of red pumpkin beetle was managed mechanically by hand picking. Dithane M-45@ 2.5 gm/litter of water was applied at the flower initiation stage for controlling the prevailing anthracnose and downy mildew disease.

3.10 Preparation of the Treatment

3.10.1 Cue-lure traps

The pheromone, 'cue-lure', which mimics the scent of female flies, attracts the male flies and traps them in large numbers resulting in mating disruption. Simple plastic containers developed by BARI scientists known as 'BARI trap' or popularly known as 'Magic trap' were used for deployment of the pheromones.

3.10.2 Neem oil

For proper management of cucurbit fruit fly 4 ml neem oil was poured in 1Litre of water and then 1ml trix was mixed to obtain fine droplet to spray 2m x 2m area.

3.10.3 Ripcords 10EC

For proper management of cucurbit fruit fly 1 ml ripcord 10EC was poured in water to obtain fine droplet to spray 3m x 3m area.

3.10.4 Sevin 85 wp

For proper management of cucurbit fruit fly 2 g Sevin 85 wp was poured in water to obtain fine droplet to spray 3m x 3m area.

3.10.5 Untreated control:

The plots under the untreated control were left without any control measures. All other intercultural operations were similar to those of other treatments. The

infestations of red pumpkin beetles appeared before flowering was controlled by hand picking.

Plate 3: Untreated control plot

3.11 Application of the Treatments

Cuelure was set for three months; the soap water in the pheromone traps was changed in every week. Neem oil@ 4ml/Liter, Ripcord 10 EC @ 1 ml/Liter Sevin 85 wp @2g/Liter were applied at 10 days intervals.

Plate 4: Cue-lure trap (Plastic pot)

3.12 Data collection and analysis:

The whole reproductive period of bottle gourd and sponge gourd was divided into three stage viz., early, mid and late fruiting stages. First flower initiation to 20 days was treated as early fruiting stage, 20 days to 40 days was called mid fruiting stage and after 40 day to end of the final harvest was called late fruiting stage. The effectiveness of each treatment was evaluated on the basic of some pre-selected parameters. The following parameters were considered during data collection at each stage of production. Number of captured insects per plant or plot, number of infested fruits per plot, number of healthy fruits per plot, weight of healthy fruits and infested fruits, yield per plot and total yield in the experimental plot.

Plate 5: Data collection and harvesting

3.13 Percent fruit infestation by number

After harvesting the healthy fruits (HF) and the infested fruits (IF) were separated by visual observation. The number of healthy fruits (HF) and the infested fruits (IF) of early, mid and late fruiting stages were counted and the percent fruit Infestation for each treatment was calculated by using the following formula:

% fruit infestation by number

$$= \frac{\text{Number of infested fruit(IF)}}{\text{Nmber of heathy fruit(HF)+Number of infested fruit(IF)}} \times 100$$

Plate 6: Infested fruits (IF)

3.14 Percent fruit infestation by weigh

After sorting of healthy fruits (HF) and the infested fruits (IF), the weight was taken for healthy infested and total one separately.

The percent infested fruit by weight for each treatment was calculated by using the following formula:

$$\% \text{ fruit infestation by weight} = \frac{\text{Weight of infested fruit(IF)}}{\text{Weight of heathy fruit(HF)+Weight of infested fruit(IF)}} \times 100$$

3.15 Fruit yield

After harvesting, the weight of healthy fruits and infested fruits were separately recorded, the total yield under each treatment was finally converted to determine the yield (ton/ha). The percent increase and decrease of yield over control was computed by using the following formula:

$$\% \text{ increase of yield over control} = \frac{\text{Yield of treated plot} - \text{Yield of control plot}}{\text{Yield of control plot}} \times 100$$

3.16 Statistical analyses

The data on different parameters as well as yield of country bean were statistically analyzed to find out the significant differences among the effects of different treatments. The mean values of all the characters were calculated and analyses of variance were performed by the 'F' (variance ratio) test. The significance of the differences among the mean values of treatment in respect of different parameters was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez,1984).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment on the effect of different treatment on incidence and management of cucurbit fruit fly in bottle gourd and sponge gourd was conducted during March to October 2015 at the experimental farm of Sher-e-Bangla Agricultural University (SAU), Dhaka. The results have been presented and discussed under the following headings and sub-headings:

4.1 Effect of different treatment on healthy and infested fruits by number

4.1.1 Early fruiting stage (bottle gourd)

The effect of different treatment on the number healthy fruits/plot at early fruiting stage of bottle gourd has been shown in Table 2. The highest number of healthy fruits/plot (9.33) was harvested from T_3 (Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a alternative sprays), which was significantly different from other, followed by 7.00 in T_2(Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays) and T_5 (Neem oil @ 4ml/Liter of water sprayed at 10 days interval), which were different from each number of healthy fruits/plot (6.33) was harvested in T_4(Cue-lure traps+ hand picking at 10 days interval). The lowest number of healthy fruits/plot (3.00) was harvested from T_6 (Control plot) which was significantly different from other, followed by (5.00) was harvested from T_1 (Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval) which were significantly different from other. The data on number of infested fruits/plot have shown Table 2. It was found that the lowest number of infested fruits/plot (2.00) was harvested from T_3 which was significantly different from other. The number of infested fruits/plot were harvested from T_1 (3.66), T_2 (4.00), T_4 (4.00) and T_6 (4.21) have no significant difference among them. Similarly, the lowest level of infestation (17.65 %) was recorded from

T_3 and 32.26 % was found from T_2 which was significantly different from each other, followed by 36.36 % was found in T_4.

Moreover, the highest level of infestation was obtained in the fruits harvested from the untreated control plot T_6 (58.39 %) which was significantly different from other, followed by (42.26 %) was found in T_1, (38.71%) from T_4 have no significance difference between them.

Table 2: Effect of different treatments against cucurbit fruit fly in bottle gourd on the basis of healthy fruits and infested fruits infestation by number at early fruiting stage

Treatments	Number of		% fruit infestation
	Healthy fruits/plot	Infested fruits/plot	
T_1	5.00 c	3.66 a	42.26 b
T_2	7.00 b	3.33 b	32.26 c
T_3	9.33 a	2.00 c	17.65 d
T_4	6.33 b	4.00 a	38.71 b
T_5	7.00 b	4.00 a	36.36 bc
T_6	3.00 d	4.21 a	58.39 a
$LSD_{(0.05)}$	1.03	0.66	4.42
CV%	9.04	10.95	6.56

In a column, means with same letter(s) are not significantly different by LSD at 5% level of significance.

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

4.1.2 Mid fruiting stage (bottle gourd)

At the mid fruiting stage the highest number of healthy fruits/plot (5.33) was harvested from T_3(Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords

10EC @ 1ml/Liter as a alternative sprays) which was significantly different from other, followed by 5.00 in T_2(Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays) , number of healthy fruits/plot (3.66) were harvested in T_4(Cue-lure traps + hand picking at 10 days interval) and healthy fruits/plot (3.00) was found in T_5 (Neem oil @ 4ml/Liter of water sprayed at 10 days interval) treatment which are not statically similar(Table 3). The lowest number of healthy fruits/plot (2.00) was harvested from T_6 (untreated Control plot) which was significantly different from other, followed by (3.00) was harvested from T_1 (Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval).The data on number of infested fruits/plot have shown Table 3. It was found that the lowest number of infested fruits (2.00) was harvested from T_3 which was significantly different from other, followed by (3.00) and (3.33) was found in T_1 and T_2 which were statically similar. On the other hand highest number of infested fruits/plot (5.00) was harvested from T_6 (Untreated control) which was significantly different from other and the same number of infested fruits/plot (4.00) was found have in T_4 and T_5 have no significant difference between them. Moreover, the lowest level of infestation (27.27 %) was recorded from T_3, which was significantly different from other and 37.51 % in T_2 followed by 52.17% in T_4 which were statically dissimilar. Similarly, the highest level of infestation was obtained in the fruits harvested from the control plot T_6 (71.43 %) which was significantly different from other, followed by 57.14 % in T_5, 52.61 % in T_1 which are statically dissimilar.

4.1.3 Late fruiting stage (bottle gourd)

The effect of different treatment on production of number healthy fruits/plot at late fruiting stage of bottle gourd has been shown in Table 4. The highest number of healthy fruits/plot (8.66) was harvested from T_3(Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a alternative sprays) which was significantly different from other, followed by 6.66 in T_2(Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative

sprays),6.00 in T_5 (Neem oil @ 4ml/Liter of water sprayed at 10 days interval). The lowest number of healthy fruits/plot (3.00) was harvested from T_6 (Control plot), followed by (5.33) was

Table 3: Effect of different treatments against cucurbit fruit fly in bottle gourd on the basis of healthy fruits and infested fruits infestation by number at mid fruiting stage

Treatments	Number of		% fruit infestation
	Healthy fruits/plot	Infested fruits/plot	
T_1	3.00 b	3.33 c	52.61 c
T_2	5.00 a	3.00 c	37.51 d
T_3	5.33 a	2.00 d	27.27 e
T_4	3.66 b	4.00 b	52.17 c
T_5	3.00 b	4.00 b	57.14 b
T_6	2.00 c	5.00 a	71.43 a
$LSD_{(0.05)}$	0.87	0.42	4.28
CV%	13.17	6.63	4.80

In a column, means with same letter(s) are not significantly different by LSD at 5% level of significance.

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

harvested from T_4 (Cue-lure traps + hand picking at 10 days interval),6.00 from T_1(Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval).The lowest percent of fruit infestation was found in 18.75% was found in T_3 which is significantly different from other ,and highest percent of fruit infestation 57.14% was found in T_6 (Table 4).

Table 4: Effect of different treatments against cucurbit fruit fly in bottle gourd on the basis of healthy fruits and infested fruits infestation by number at late fruiting stage

Treatments	Number of		% fruit infestation
	Healthy fruits/plot	Infested fruits/plot	
T_1	6.00 bc	2.33 cd	27.97 c
T_2	6.66 b	3.00 b	31.03 b
T_3	8.66 a	2.00 d	18.75 d
T_4	5.33 c	2.66 bc	33.36 b
T_5	6.00 bc	3.00 b	33.33 b
T_6	3.00 d	4.00 a	57.14 a
$LSD_{(0.05)}$	0.79	0.66	4.18
CV%	7.31	12.89	6.97

In a column, means with same letter(s) are not significantly different by LSD at 5% level of significance.

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

4.1.4 Early fruiting stage (sponge gourd)

The effect of different treatment on production of number healthy fruits/plot at early fruiting stage of sponge gourd has been shown in Table 5. The highest number of healthy fruits/plot (14.00) was harvested from T_3(Cue-lure traps+ Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a alternative sprays) which was significantly different from other, followed by 12.00 from T_2(Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @

1ml as a alternative sprays) , 9.50 from T_5 (Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval) have significance difference among them. The lowest number of healthy fruits/plot was harvested from T_6 (4.80), followed by 7.66 was harvested from T_1, and 10.80 was harvested from T_2 have significant difference among them. The lowest number of infested fruits/plot (3.20) was harvested from T_3. The intermediate number of infested fruits/plot (4.50) was observed from T_2, and T_5. Significance difference was observed in terms of number of infested fruits/plot among them. In contrast, the highest number of infested fruits/plot (6.40) was recorded from T_6, followed by 5.90 and 5.13 was found in T_4 and T_1.

Table 5: Effect of different treatments against cucurbit fruit fly in Sponge gourd on the basis of healthy fruits and infested fruits infestation by number at early fruiting stage

Treatments	Number of		% fruit infestation
	Healthy fruits/plot	Infested fruits/plot	
T_1	11.00 bc	3.66 bc	24.96 c
T_2	12.00 b	4.00 b	25.00 c
T_3	14.00 a	3.33 c	19.23 d
T_4	10.00 cd	4.00 b	28.57 b
T_5	9.00 de	4.00 b	30.77 b
T_6	7.33 e	6.00 a	45.00 a
$LSD_{(0.05)}$	1.71	0.66	2.86
CV%	8.93	8.76	5.51

In a column, means with same letter(s) are not significantly different by LSD at 5% level of significance.

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

The data in Table 5 also indicated that the lowest level of infestation (18.11 %) was recorded from T_3 followed by 29.41 % was recorded in T_2 and 32.14 % from T_5 have no significance difference among them. The highest level of infestation (57.14 %) was obtained from T_6 which is significantly different from other, followed by 40.10 % in T_1 and 38.56 % from T_4 have significance difference between them.

4.1.5Mid fruiting stage (sponge gourd)

The highest number of healthy fruits/plot (11.00) was harvested from T_3 (Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a alternative sprays) which was significantly different from other, followed by 9.00 in T_2 (Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays) treatment , 8.33 in T_1(Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval) have significant different between them .

The lowest number of healthy fruits/plot (3.00) was harvested from T_6(Control plot) , followed by 6.00 was harvested from T_4(Cue-lure traps + hand picking at 10 days interval) and T_5 (Neem oil @ 4ml/Liter of water sprayed at 10days interval) have significant different among them .The lowest number of infested fruits/plot (4.00) was harvested from T_3,which is significantly different from other, followed by 4.33 and 4.66 was found in T_1 and T_4 which were statically similar. In contrast, the highest number of infested fruits/plot (6.00) was recorded from T_6 followed by (5.00) number of infested fruits/plot was recorded from T_2 and T_5. The data in Table 6 also indicated that the lowest level of infestation (26.67%) was recorded from T_3, followed by 34.21 and 35.71 was recorded in T_1 and T_2. The highest level of infestation (66.67%) was obtained from T_6 (Untreated control), followed by 45.45% of infestation was recorded in T_5 and 43.75% from T_4 have significant difference among them.

Table 6: Effect of different treatments against cucurbit fruit fly in Sponge gourd on the basis of healthy fruits and infested fruits infestation by number at mid fruiting stage

Treatments	Number of		% fruit infestation
	Healthy fruits/plot	Infested fruits/plot	
T_1	8.33 b	4.33 cd	34.20 d
T_2	9.00 b	5.00 b	35.71 c
T_3	11.00 a	4.00 d	26.67 e
T_4	6.00 c	4.66 bc	43.75 b
T_5	6.00 c	5.00 b	45.45 b
T_6	3.00 d	6.00 a	66.67 a
$LSD_{(0.05)}$	1.71	0.66	3.67
CV%	13.05	7.55	4.86

In a column, means with same letter(s) are not significantly different by LSD at 5% level of significance.

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

4.1.6 Late fruiting stage (sponge gourd)

The effect of different treatment on production of number healthy fruits/plot at early fruiting stage of sponge gourd has been shown in Table 7. The highest number of healthy fruits/plot (13.00) was harvested from T_3(Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a alternative sprays) which was significantly different from other. The intermediate number of healthy fruits/plot 12.00 on T_2 (Cue-lure traps+ Neem oil @ 4ml/Liter of water sprayed at 10 days interval) and (11.00) was found on T_2 (Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays) The lowest number of healthy fruits/plot (6.66) was harvested from T_6 (Control plot), which was significantly different from

other, followed by (9.00) was harvested from T_5 (Neem oil @ 4ml/Liter of water sprayed at 10days interval) treatment and 10.00 was found in T_4 (Cue-lure traps+ hand picking at 10 days interval) and which were statistically similar. The lowest number of infested fruits/plot (3.00) was harvested from T_3, followed by number of infested fruits/plot (4.00) was found on T_1, T_4 and T_5. In contrast, the highest number of infested fruits/plot (5.00) was recorded from T_6, followed by 4.33 was recorded from T_2. The data in Table 7 also indicated that the lowest level of infestation (18.75 %) was recorded from T_3, followed by 26.52 % was recorded on T_2 and 26.67 was recorded in T_1. The highest level of infestation (42.86 %) was obtained from T_6 (Untreated control), followed by 30.77 % was recorded in T_5 and (28.57 %) in T_4 have significant difference among them.

Table 7: Effect of different treatments against cucurbit fruit fly in Sponge gourd on the basis of healthy fruits and infested fruits infestation by number at late fruiting stage

Treatments	Number of		% fruit infestation
	Healthy fruits/plot	Infested fruits/plot	
T_1	11.00 abc	4.00 b	26.66 d
T_2	12.00 ab	4.33 ab	26.52 cd
T_3	13.00 a	3.00 c	18.75 e
T_4	10.00 bc	4.00 b	28.57 bc
T_5	9.00 c	4.00 b	30.77 b
T_6	6.66 d	5.00 a	42.86 a
$LSD_{(0.05)}$	2.14	0.85	4.01
CV%	11.47	11.62	7.73

In a column, means with same letter(s) are not significantly different by LSD at 5% level of significance.

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

4.2.1 Effect of different treatment on percent increase of healthy fruit by number over control (bottle gourd)

The result on effect of different treatment on percent increase of healthy fruits has been presented in Figure 1. The graph illustrated that the highest percent increase of healthy fruit (211.11%) was found in T_3(Cue-lure traps+ Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays) at early stage which was significantly different from all other treatments. The second highest percent increase of healthy fruits(133.33 %) was found in T_2 (Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays) and in T_5 (Neem oil @ 4ml/Liter of water sprayed at 10 days interval).At early fruiting stage lowest percent percent increase of healthy fruits (66.67%) was found in T_1(Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval) followed by 111.11 % percent percent increase of healthy fruits was found in T_4(Cue-lure traps + hand picking at 10 days interval).In case of mid fruiting stage T_3 (Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays) also gave the highest percent increase of healthy fruit (166.67 %). The second highest percent increase of healthy fruits (150 %) was found in T_2 (Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays),followed by 83.34 % percent increase of healthy fruit was found in T_4 (Cue-lure traps+ hand picking at 10 days interval). lowest percent percent increase of healthy fruits (50%) was found in T_1 (Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval) and T_5 (Neem oil @ 4ml/Liter of water sprayed at 10 days interval).Similarly ,the graph (Figure 1) illustrated that the highest percent increase of healthy fruit (188.89 %) was found in T_3(Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays) at late stage. The second highest percent increase of healthy fruits (122.22 %) was found T_2 (Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays). (Neem oil @ 4ml/Liter of water sprayed at 10 days interval) showed the same results.

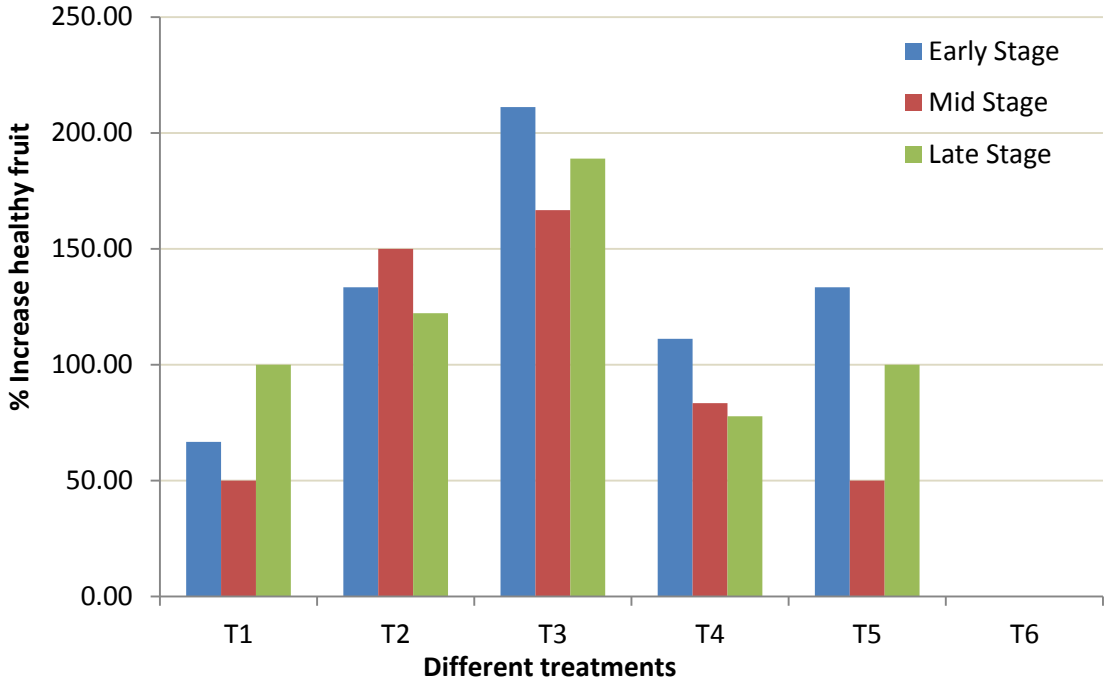


Figure 1. Effect of different treatments on percent (%) increase of healthy fruits of Bottle gourd by number

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

In contrast T_1 (Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval) gave lowest percent percent increase of healthy fruits (100%) ,T_5

4.2.2 Effect of different treatment on percent increase of healthy fruit by number over control (sponge gourd)

The graph (Figure 2) illustrated that the highest percent increase of healthy fruit (91.00 %) was found in T_3 (Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays) at early stage which was significantly different from all other treatments. The second highest percent increase of healthy fruits(63.71 %) was found in T_2 (Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays). followed by 50.07 % percent increase of healthy fruits was found in T_1 (Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval).At early fruiting

stage lowest percent percent increase of healthy fruits (22.08 %) was found in T_5 (Neem oil @ 4ml/Liter of water sprayed at 10 days interval).In case of mid fruiting stage T_3 (Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays) also gave the highest percent increase of healthy fruit (266.67 %). The second highest percent increase of healthy fruits (200.00 %) was found in T_2(Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays) followed by 177.77 % increase of healthy fruits was observed in T_1(Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval).The lowest percent percent increase of healthy fruits (100.00 %) was found in T_4 (Cue-lure traps+ hand picking at 10 days interval) and T_5 (Neem oil @ 4ml/Liter of water sprayed at 10 days interval).The graph (Figure 2) illustrated that the highest percent increase of healthy fruit (94.90 %) was found in T_3(Cue-lure traps+ Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays) at late stage.The intermediate percent increase of healthy fruits (79.91 %) was found from T_2 (Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays) followed by 64.92 % was found in T_1 (Cue-lure traps+ Neem oil @ 4ml/Liter of water sprayed at 10 days interval).And In contrast 34.93 % was found in T_5 (Neem oil @ 4ml/Liter of water sprayed at 10 days interval) gave lowest percent percent increase of healthy fruits, followed by 49.93% increase was found in T_4 (Cue-lure traps+ hand picking at 10 days interval).

4.3 Trends of adult fruit fly captured in bottle gourd and sponge gourd

Along with Neem oil @ 4ml/Liter of water sprayed at 10 days interval, Cue-lure traps was used in T_1 (Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval). similarly Sevin 85wp , Ripcords 10EC with Cue-lure traps was used in T_2 (Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays) and it also used in T_3 (Cue-lure traps+ Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays) on both bottle gourd and sponge gourd. The graph illustrated that the number of

fruit fly captured by cue-lure trap was highest 20 in bottle gourd and 15 in sponge gourd at early fruiting stage on July (Figure 3) .The field experiment also found that the number of captured adult fruit fly reduced with weather change. It was found that in September the total captured fruit fly was found 9 in bottle and 3 on sponge gourd (Figure 3).

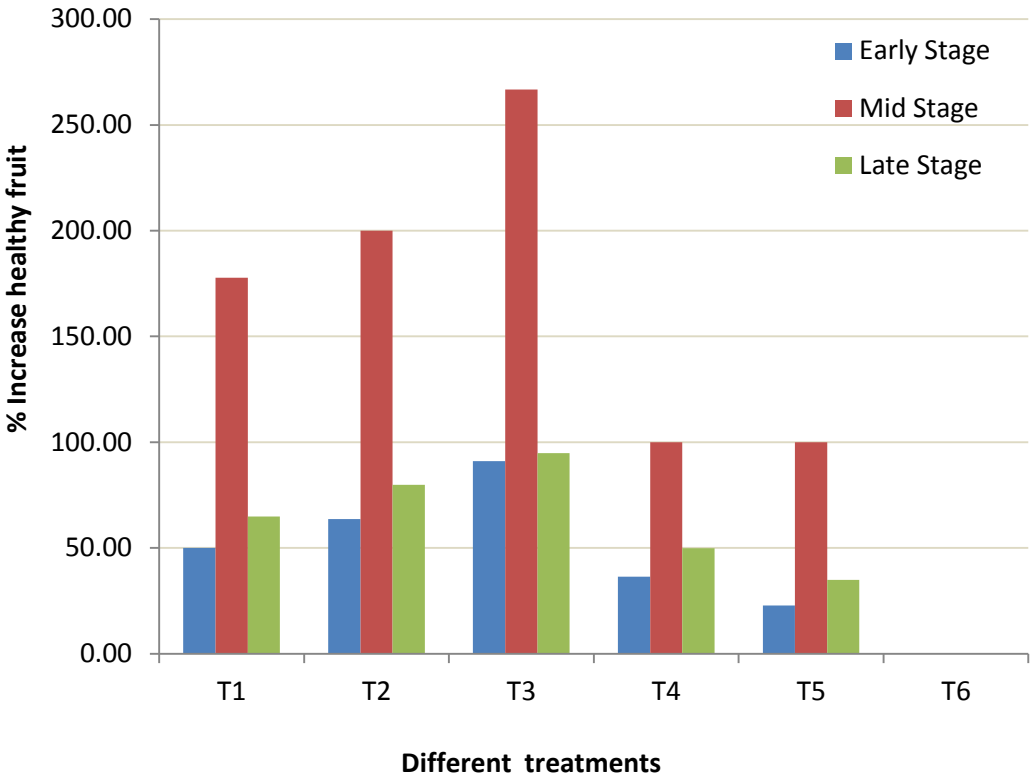


Figure 2. Effect of different treatments on percent (%) increase of healthy fruits of Sponge gourd by number

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

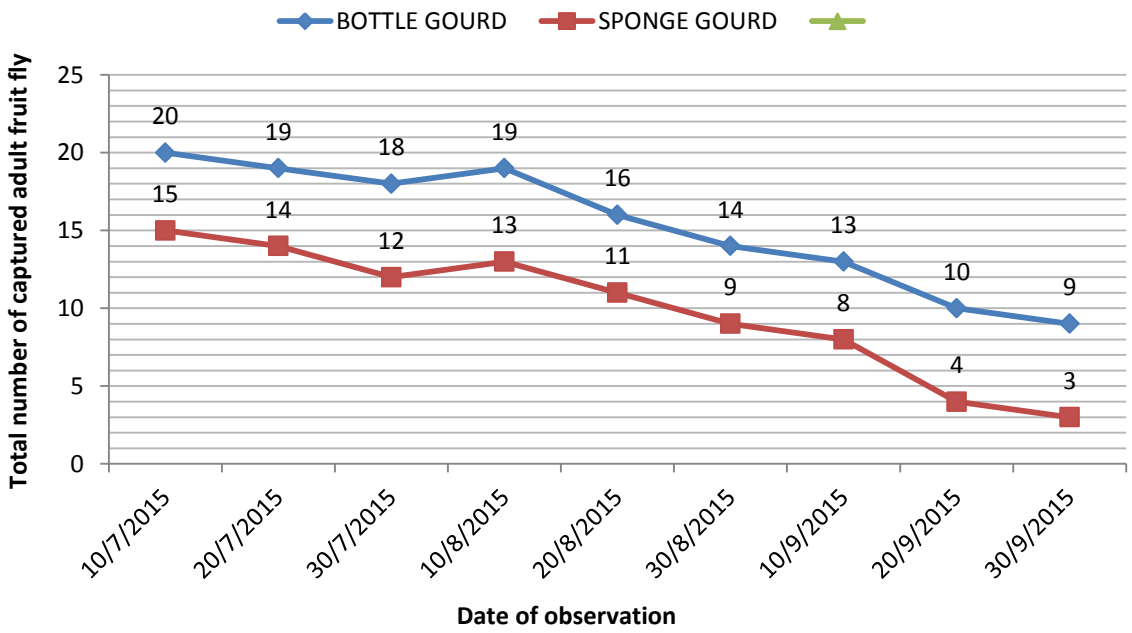


Figure 3: Effect of Cue-lure traps on capturing adult cucurbit fruit fly at different dates of fruiting of bottle gourd and sponge gourd.

As a result percent increase yield of sponge gourd increase at late fruiting stage. This Field experiment also found in case of bottle gourd such result is not found because of excessive rain. Rain reduces the vegetative growth of bottle gourd plant but sponge gourd show highest adaptability on rainy condition.

4.4.1 Weight of healthy fruits/plot at early fruiting stage (bottle gourd)

The data on effect of different treatment in fruit weight of healthy bottle gourd at early fruiting stage has been presented in Table 8. The highest amount of healthy fruits/plot (14.46 kg) was harvested from T_3 (Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a alternative sprays),which was significantly different from other, followed by 10.80 kg in T_2 (Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays), number of healthy fruits/plot (9.50 kg) were harvested in T_5 (Neem oil @ 4ml/Liter of water sprayed at 10 days interval) .

Table 8: Effect of different treatments against cucurbit fruit fly in bottle gourd on the basis of healthy fruits and fruit infestation by weight at early fruiting stage

Treatments	Weight (kg) of		% fruit infestation
	Healthy fruits/plot	Infested fruits/plot	
T_1	7.66 d	5.13 bc	40.10 b
T_2	10.80 b	4.50 c	29.41 c
T_3	14.46 a	3.20 d	18.11 d
T_4	9.40 c	5.90 ab	38.56 b
T_5	9.50 c	4.50 c	32.14 c
T_6	4.80 e	6.40 a	57.14 a
$LSD_{(0.05)}$	1.06	1.24	3.19
CV%	6.21	13.84	4.95

In a column, means with same letter(s) are not significantly different by LSD at 5% level of significance.

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

The lowest number of healthy fruits/plot (4.80 kg) was harvested from T_6 (Control plot), followed by (7.66 kg) was harvested from T_1(Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval) and (9.40 kg) was harvested from T_4 (Cue-lure traps + hand picking at 10 days interval) which is significantly different from each other. The lowest percent of fruit infestation by weight (18.11 %) was found in T_3 and highest percent of fruit infestation by weight (57.14 %) was found in T_6.

4.4.2 Weight of healthy fruits/plot at mid fruiting stage (bottle gourd)

At the mid fruiting stage the highest amount of healthy fruits/plot (9.70 kg) was harvested from T_3 (Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a alternative sprays), followed by 7.80 kg in T_4 (Cue-

lure traps+ hand picking at 10 days interval) and 7.70 kg was found in T_2(Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays) treatment which were significantly different form each other. The intermediate amount of healthy fruits/plot (5.83 kg) were harvested in T_1 (Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval) .The lowest amount of healthy fruits/plot (3.20 kg) was harvested from T_6 (Control plot), followed by (4.80 kg) was harvested T_5 (Neem oil @ 4ml/Liter of water sprayed at 10 days interval) have significant difference between them. The lowest percent of fruit infestation by weight (25.38 %) was found in T_3 and highest percent of fruit infestation by weight (52.91 %) was found in T_6.

4.4.3 Weight of healthy fruits/plot at late fruiting stage (bottle gourd)

The effect of different treatment on production of number healthy fruits/plot at late fruiting stage of bottle gourd has been shown in Table 9. The highest number of healthy fruits/plot (13.40 kg) was harvested from T_3(Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a alternative sprays), followed by 10.70 kg in T_2(Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays), 9.20 kg in T_4 (Cue-lure traps+ hand picking at 10 days interval) have significance difference among them. The middle amount of fruits/plot (8.90 kg) was found in T_1 (Cue-lure traps+ Neem oil @ 4ml/Liter of water sprayed at 10 days interval). The lowest amount of healthy fruits/plot (4.80 kg) was harvested from T_6 (Control plot), followed by (8.40 kg) was harvested from T_5 (Neem oil @ 4ml/Liter of water sprayed at 10 days interval) have significance difference between them. The lowest percent of fruit infestation by weight (16.25 %) was found in T_3 and highest percent of fruit infestation by weight (53.55 %) was found in T_6.

Table 9: Effect of different treatments against cucurbit fruit fly in bottle gourd on the basis of healthy fruits and fruit infestation by weight at mid fruiting stage

Treatments	Weight (kg) of		% fruit infestation
	Healthy fruits/plot	Infested fruits/plot	
T_1	5.83 c	4.50 c	43.56 c
T_2	7.70 b	4.00 c	34.19 d
T_3	9.70 a	3.30 d	25.38 e
T_4	7.80 b	5.86 b	42.93 c
T_5	4.80 c	5.36 b	52.79 b
T_6	3.20 d	7.80 a	70.91 a
$LSD_{(0.05)}$	1.07	0.55	4.41
CV%	9.06	5.89	5.47

In a column, means with same letter(s) are not significantly different by LSD at 5% level of significance.

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

4.4.4Weight of healthy fruits/plot at early fruiting stage (sponge gourd)

The effect of different treatment on production of number healthy fruits/plot at early fruiting stage of sponge gourd has been shown in Table 10. The highest amount of healthy fruits/plot (5.19 kg) was harvested from T_3(Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a alternative sprays), followed by 4.10 kg in T_2(Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays) , 4.00 in T_1(Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval) which has significance difference.

Table 10: Effect of different treatments against cucurbit fruit fly in bottle gourd on the basis of healthy fruits and fruit infestation by weight at late fruiting stage

Treatments	Weight (kg) of		% fruit infestation
	Healthy fruits/plot	Infested fruits/plot	
T_1	8.90 c	2.90 d	24.57 d
T_2	10.70 b	4.20 b	28.19 c
T_3	13.40 a	2.60 d	16.25 e
T_4	9.20 c	4.50 b	32.85 b
T_5	8.40 c	3.70 c	30.58 bc
T_6	4.80 d	5.53 a	53.55 a
$LSD_{(0.05)}$	0.90	0.41	3.74
CV%	5.36	5.79	6.75

In a column, means with same letter(s) are not significantly different by LSD at 5% level of significance.

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

The lowest number of healthy fruits/plot (2.23 kg) was harvested from T_6 (untreated Control plot) treatment, followed by (3.30 kg) was harvested from T_5 (Neem oil @ 4ml/Liter of water sprayed at 10days interval), and 3.55 kg was harvested from T_4 (Cue-lure traps+ hand picking at 10 days interval) have significant difference among them the lowest percent of fruit infestation by weight 18.01% was found in T_1 which is significantly different from other and highest percent of fruit infestation by weight 46.87% was found in T_6.

Table 11: Effect of different treatments against cucurbit fruit fly in Sponge gourd on the basis of healthy fruits and fruit infestation by weight at early fruiting stage

Treatments	Weight (kg) of		% fruit infestation
	Healthy fruits/plot	Infested fruits/plot	
T_1	4.00 b	1.41 bc	26.06 c
T_2	4.10 b	1.59 b	27.94 b
T_3	5.19 a	1.14 d	18.01 d
T_4	3.55 c	1.30 c	26.8 b
T_5	3.30 c	1.29 c	28.08 b
T_6	2.23 d	1.97 a	46.87 a
$LSD_{(0.05)}$	0.32	0.23	3.31
CV%	4.82	8.55	6.39

In a column, means with same letter(s) are not significantly different by LSD at 5% level of significance.

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

4.4.5 Weight of healthy fruits/plot at mid fruiting stage (sponge gourd)

The highest amount of healthy fruits/plot (4.23 kg) was harvested from T_3(Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a alternative sprays) which is significantly different from other, followed by 3.15 kg was harvested from T_2 (Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays) treatment 2.58 kg from T_1(Cue-lure traps+ Neem oil @ 4ml/Liter of water sprayed at 10 days interval) which have significance difference (Table 12). The lowest number of healthy fruits/plot (1.11 kg) was harvested from T_6 (Control plot), followed by (2.03 kg) was harvested from T_5 (Neem oil @ 4ml/Liter of water sprayed at 10days interval), and 2.03 kg was harvested from T_4 (Cue-lure traps + hand picking at

10 days interval). The lowest percent of fruit infestation by weight 23.77 % was found in T_1 which is significantly different from other and highest percent of fruit infestation by weight 65.14 % was found in T_6 (Table 12).

Table 12: Effect of different treatments against cucurbit fruit fly in Sponge gourd on the basis of healthy fruits and fruit infestation by weight at mid fruiting stage

Treatments	Weight (kg) of		% fruit infestation
	Healthy fruits/plot	Infested fruits/plot	
T_1	2.58 c	1.45 c	35.98 c
T_2	3.15 b	1.74 b	35.58 c
T_3	4.23 a	1.32 d	23.77 d
T_4	2.06 d	1.76 b	46.17 b
T_5	2.03 d	1.80 b	47.01 b
T_6	1.11 e	2.08 a	65.14 a
$LSD_{(0.05)}$	0.45	0.24	4.12
CV%	9.96	7.55	5.44

In a column, means with same letter(s) are not significantly different by LSD at 5% level of significance.

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

4.4.6 Weight of healthy fruits/plot at late fruiting stage (sponge gourd)

The effect of different treatment on production of number healthy fruits/plot at early fruiting stage of sponge gourd has been shown in Table 13. The highest amount of healthy fruits/plot (4.35 kg) was harvested from T_2 (Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays) which is significantly different from other. The intermediate amount of healthy fruits/plot (4.02 kg) was recorded from T_1 (Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval) ,followed by 4.20 kg from T_3 (Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a

alternative sprays) The lowest number of healthy fruits/plot (1.92 kg) was harvested from T_6 (Control plot), followed by (2.97 kg) was harvested from T_4 (Cue-lure traps+ hand picking at 10 days interval),followed by 3.35 kg from T_5 (Neem oil @ 4ml/Liter of water sprayed at 10days interval). The lowest percent of fruit infestation by weight 20.01 % was found in T_1 which is significantly different from other and highest percent of fruit infestation by weight 48.39 % was found in T_6.

Table 13: Effect of different treatments against cucurbit fruit fly in Sponge gourd on the basis of healthy fruits and fruit infestation by weight at late fruiting stage

Treatments	Weight (kg) of		% fruit infestation
	Healthy fruits/plot	Infested fruits/plot	
T_1	4.02 ab	1.50 b	27.15 d
T_2	4.35 a	1.74 a	28.57 c
T_3	4.20 a	1.05 c	20.01 e
T_4	2.97 c	1.55 b	34.27 b
T_5	3.35 bc	1.51 b	31.07 bc
T_6	1.92 d	1.80 a	48.39 a
$LSD_{(0.05)}$	0.67	0.18	3.31
CV%	10.74	6.80	5.84

In a column, means with same letter(s) are not significantly different by LSD at 5% level of significance.

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

4.5.1 Effect of different treatment on percent increase of healthy fruit by weight over control (bottle gourd)

In Figure 4, It is showed that highest percent increase of healthy fruit (201.40%) was found in T_3 at early stage which was significantly different

from all other .The second highest percent increase of healthy fruits (125.00%) was found T_2 which have significant difference than other. At early fruiting stage lowest percent increase of healthy fruits (59.73%) was found in T_1 followed by 95.83% and 97.92% increase of healthy fruits was found in T_4 and T_5 have significant difference among them. In mid fruiting stage T_3 also gave the highest percent increase of healthy fruit (203.13%) which is significantly different from other (Figure 4). The second highest percent increase of healthy fruits (143.75%) was found in T_4.

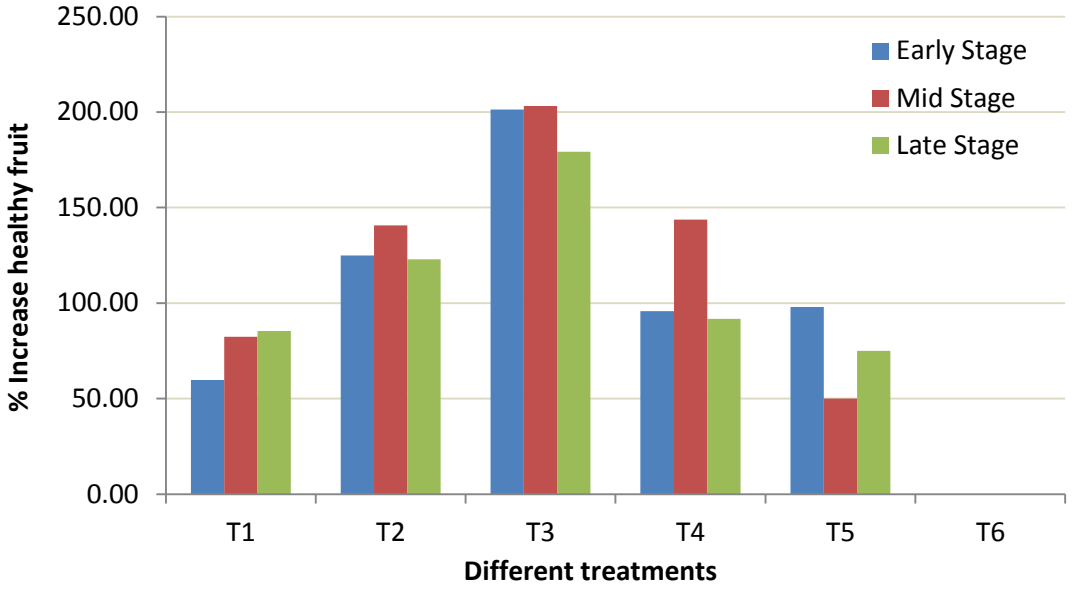


Figure 4. Effect of different treatments on percent (%) increase of healthy fruits of Bottle gourd by weight

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

Followed by 140.63% increase of healthy fruit was found in T_2 have no significant difference between them. The lowest percent increase of healthy fruits (50%) was found in T_5, followed by 82.29% in T_1 which are statically similar. The highest percent increase of healthy fruit (179.17%) was found in T_3 at late stage which is significantly different from other. The second highest percent increase of healthy fruits(122.92%) was found T_2,followed by 91.67 % increase of healthy fruit was found in T_4 have significance fruits (75%)

followed by 85.42% increase of healthy fruit was found in T_1 have no significant difference between them.

4.5.2 Effect of different treatment on percent increase of healthy fruit by weight over control (sponge gourd)

The Figure 5 showed that the highest percent increase of healthy fruit (131.70%) was found in T_3 at early stage which was significantly different from all other treatments. The second highest percent increase of healthy fruits (83.04%) was found in T_2. followed by 78.57% percent increase of healthy fruits was found in T_1.

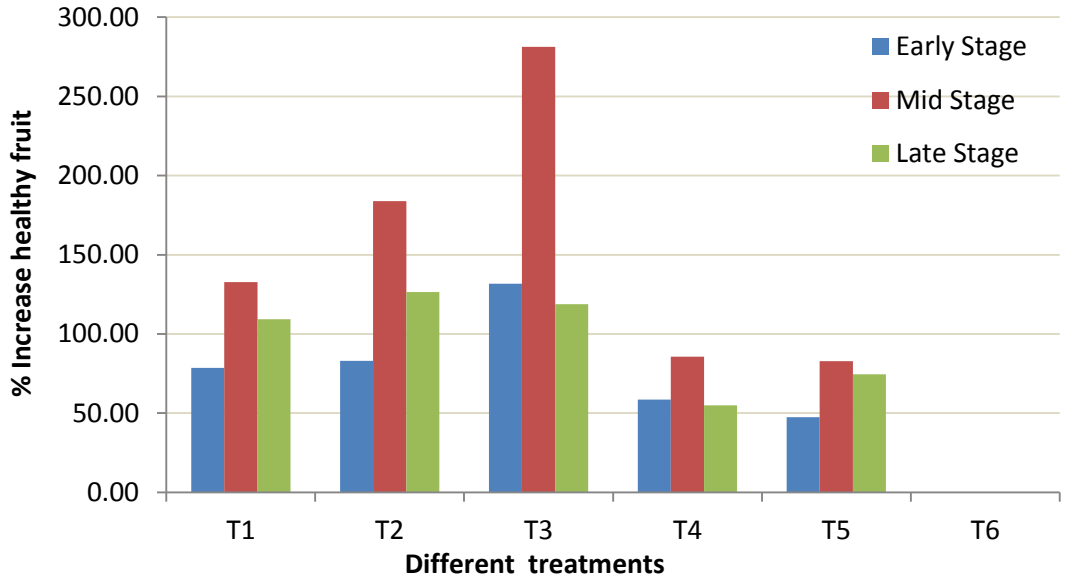


Figure 5. Effect of different treatments on percent (%) increase of healthy fruits of Sponge gourd by weight

\

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

At early fruiting stage lowest percent increase of healthy fruits (47.47%) was found in T_5 followed by 78.57% from T_1. In case of mid fruiting stage T_3 also gave the highest percent increase of healthy fruit (281.38%). The second highest percent increase of healthy fruits (183.78%) was found in T_2, followed by 132.73% increase of healthy fruits was observed in T_1. The

lowest percent increase of healthy fruits (82.88%) was found in T_5, followed by 85.59% increase of healthy fruits was found in T_4. Similarly, the table (Figure 5) showed that the highest percent increase of healthy fruit (118.75%) was found in T_3 at late stage which is significantly different from other. The intermediate percent increase of healthy fruits (126.56%) was found from T_1 followed by 109.38% was found in T_2. In contrast T_5 gave the lowest percent increase of healthy fruits (74.48%).

4.6.1 Yield of healthy fruits/plot during total cropping season (bottle gourd)

From the Table 14 it was observed that the highest weight of healthy fruits/plot (37.57 kg) was obtained from treatment T_3 (Cue-lure traps+ Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays) , which was significantly different

Table 14: Effect of different treatments on total yield of healthy fruit through total growing season of Bottle gourd

Treatments	Yield/plot (kg)	Yield/ha (t ha^{-1})	% increase
T_1	23.4 d	26.06 d	83.26 d
T_2	29.2 b	32.44 b	128.13 b
T_3	37.57 a	41.74 a	193.53 a
T_4	26.4 c	29.33 c	106.26 c
T_5	22.7 d	25.22 d	77.36 e
T_6	12.8 e	14.22 e	0.00
$LSD_{(0.05)}$	1.28	1.50	5.23
CV %	4.79	5.94	5.96

In a column, means with same letter(s) are not significantly different by LSD at 5% level of significance.

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

from other (Table 14) total yield per hector (41.74 t ha^{-1}),followed by 29.2 kg from T_2 (Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays) total yield per hector (32.44 t ha^{-1}), and 26.4 kg in T_4 (Cue-lure traps + hand picking at 10 days interval) and (29.33 t ha^{-1}) , 22.7 kg was found in T_5(Neem oil @ 4ml/Liter of water sprayed at 10 days interval) total yield per hector (25.22 t ha^{-1}), which were statically dissimilar . Intermediate weight of healthy fruits/plot (23.4 kg) result was obtained from T_1 (Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval) total yield per hector (26.06 t ha^{-1}). The figure also showed that the lowest total weight of healthy fruits/plot (12.8 kg) observed in T_6 (Untreated control) total yield per hector (14.22 t ha^{-1}) which was significantly different from other.

4.6.2 Yield of healthy fruits/plot during total cropping season (sponge gourd)

Similar results were found for sponge gourd from the Table 15. It was observed that the highest weight of healthy fruits/plot (13.62 kg) was obtained from treatment T_3 (Cue-lure traps+ Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays) , which was significantly different from other(Table 15) total yield per hector (15.14 t ha^{-1}),followed by 11.6 kg from T_2 (Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays) total yield per hector (12.89 t ha^{-1}), and 9.81 kg was found on T_1 (Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval) total yield per hector (10.93 t ha^{-1}). 8.58 kg in T_4 (Cue-lure traps + hand picking at 10 days interval) and (9.54 t ha^{-1}), Intermediate weight of healthy fruits/plot (23.4 kg) result was obtained from 8.68 kg was found in T_5 (Neem oil @ 4ml/Liter of water sprayed at 7 days interval) total yield per hector (9.65 t ha^{-1}), which were statically dissimilar. The table 15 also showed that the lowest total weight of healthy fruits/plot (5.27 kg) observed in

T_6 (Untreated control) total yield per hector (**5.86 t ha^{-1}**) which is significantly different from other (Table 15).

Table 15: Effect of different treatments on total yield of healthy fruit through total growing season of Bottle gourd

Treatments	Yield/plot (kg)	Yield/ha (t ha^{-1})	% increase
T_1	9.81 c	10.93 c	86.64 c
T_2	11.6 b	12.89 b	119.97 b
T_3	13.62 a	15.14 a	158.36 a
T_4	8.58 d	9.54 d	62.80 d
T_5	8.68 d	9.65 d	64.68 d
T_6	5.27 e	5.86 e	0.00 e
$LSD_{(0.05)}$	1.01	1.08	15.26
CV %	5.82	8.59	8.57

In a column, means with same letter(s) are not significantly different by LSD at 5% level of significance.

T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2= Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4 = Cue-lure traps + hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 7 days interval,T_6 = Untreated control.

The result of the present study agree with the findings of (Budhathoki *et al.*, 1993) they mention neem derivatives repel insect pests of cucurbits and Anon. (2002-2003) who mentioned that cue-lure pheromone effecting 40% to 65% reduction in fruit fly infestation and damage to the fruits and producing 2-4 times higher yields.

CHAPTER V
SUMMARY AND CONCLUSION

A field experiment was conducted at Sher-e-Bangla Agriculture University farm to find out effect of different treatment for management of cucurbit fruit fly, *Bactrocera cucurbitae* during March to October 2015. The treatments of the experiment were T_1= Cue-lure traps + Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_2 = Cue-lure traps + Sevin 85wp @ 2g/Liter + Ripcords 10EC @ 1ml as a alternative sprays,T_3= Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays,T_4= Cue-lure traps+ hand picking at 10 days interval,T_5 = Neem oil @ 4ml/Liter of water sprayed at 10 days interval,T_6=Untreated control. The experiment was laid out in Randomized Block Design (RCBD) with three replications. The whole reproductive period of bottle gourd and sponge gourd was divided into three stages viz., early, mid and late fruiting stage . Data were collected on number of fruits/plot and weight of fruits/plot at early, mid and late fruiting stage, total yield and presence of cucurbit fruit fly at different days after sowing (DAS). Healthy fruits/plot, infested fruits/plot, % of fruits infestation , % increase of fruits and % decrease of fruit at each of the fruiting stage of bottle gourd and sponge gourd. Result showed that at early fruiting stage of bottle gourd, the highest number of healthy fruits/plot (9.33), lowest number of infested fruits/plot (2.00), lowest level of fruit infestation (17.65%) and the highest percent increase of healthy fruit (211.11%) by number were achieved from T_3 (Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays).conversly, lowest number of healthy fruits/plot(3.00), highest number of infested fruits/plot(4.21) and highest level fruit infestation by number (58.59%) was achieved from T_6 (Untreated control). Similarly at early fruiting stage of sponge gourd ,the highest number of healthy fruits/plot (14.00), lowest number of infested fruits/plot (7.33), lowest level of fruit infestation by number (19.23%) and highest percent increase of healthy fruit

(94.90%) by number were achieved from T_3 (Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays). In contrast lowest number of healthy fruits/plot (7.33), highest number of infested fruits/plot (6.00) and highest percent fruit infestation by number (45.00%) were achieved from sponge gourd on T_6 (Untreated control). Again the result showed that at mid fruiting stage of bottle gourd, the highest number of healthy fruits/plot (5.33) , lowest number of infested fruits/plot (2.00) , lowest level of fruit infestation (27.27%), highest percent increase of healthy fruit (166.67%) by number were achieved from T_3 (Cue-lure traps + Neem oil @ 4ml/Liter + Ripcords 10EC @ 1ml/Liter as a alternative sprays) .In contrast the lowest number of healthy fruits/plot (2.00), highest number of infested fruit/plot (5.00) and highest level of fruit infestation by number (71.43%) were achieved from T_6 (Untreated control) . Similarly, at mid fruiting stage of sponge gourd the highest number of healthy fruits/plot (11.00) ,lowest number of infested fruits/plot(4.00),lowest level of infestation (26.67),highest percent increase of fruit (266.67%) were achieved from T_3(Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays) . In contrast the lowest number of healthy fruits/plot (3.00), highest number of infested fruit/plot (6.00) and highest level of fruit infestation by number (66.67%) were achieved from T_6 (Untreated control). At late fruiting stage of bottle gourd the highest number of healthy fruits/plot (8.66), lowest number of infested fruits/plot (2.00) and lowest level of fruit infestation (18.75%), highest percent increase of healthy fruit(220%) by number were achieved from T_3 (Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays).On the other hand, lowest number of healthy fruits/plot (3.00), highest number of infested fruits/plot (4.00) and highest level of fruit infestation by number (57.14%) were achieved from T_6 (Untreated control). Similarly , at late fruiting stage of sponge gourd highest number of healthy fruits/plot (13.00), lowest number of infested fruits/plot (3.00) and lowest level of fruit infestation (18.75%), highest percent increase of healthy fruit(180%) by

number were achieved from T_3 (Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays) . conversly, lowest number of healthy fruits/plot (6.67), highest number of infested fruits/plot (5.00) and highest level of fruit infestation by number (42.86%) were achieved from T_6 (Untreated control).On bottle gourd the total highest number of healthy fruits/plot (10.75) and total highest percent increase of yield over control by number (230.75%) were achieved from T_3 (Cue-lure traps+ Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays .Similarly, in sponge gourd total highest number of healthy fruits/plot (12.25), and total highest percent increase of yield over control by number (96%) were achieved from T_3 (Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays. Among the different treatments on bottle gourd the total highest weight of healthy fruits/plot (37.57 kg) was achieved from T_3 (Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays).Similarly, among the different treatments of sponge gourd, total highest weight of healthy fruits/plot (13.62 kg) was achieved from T_3 (Cue-lure traps + Neem oil @ 4ml/Litre + Ripcords 10EC @ 1ml/Liter as a alternative sprays) . Total number of adult fruit fly captured on bottle gourd was (138), and total number of adult fruit fly captured on sponge gourd was (89). The overall study revealed that on both bottle gourd and sponge gourd the highest performance were achieved from Cue-lure traps combined with Neem oil @ 4ml/Liter and Ripcords 10EC @ 1ml/Liter as a alternative sprays (T_3).Cue-lure traps combined with Sevin 85wp @ 2g/Liter and and Ripcords 10EC @ 1ml/Liter as a alternative sprays (T_2) showed the second highest performance.

CONCLUSION

Considering above discussion the present study revealed that

- Cue-lure traps combined with neem oil @ 4ml/Liter and Ripcord 10EC @ 1ml/Liter as a alternative spray (T_3) showed the highest performance on controlling cucurbit fruit fly on bottle gourd and sponge gourd.
- Cue-lure traps combined with Sevin 85wp @ 2g/Liter and Ripcord 10EC @ 1ml/Liter as a alternative spray (T_2) showed the second highest performance on bottle gourd and sponge gourd .
- Intermediate level of performance on bottle gourd was found from Neem oil @ 4ml/Liter of water sprayed at 10 days interval (T_5).

So in conclusion it can be said that Cue-lure traps combined with neem oil @ 4ml/Liter and Ripcord 10EC @ 1ml/Liter as a alternative spray at 10 days interval could be effectively utilized on bottle gourd and sponge gourd for the management of cucurbit fruit fly in summer season.

RECOMANDATION

From this study it may be recommended that cue-lure traps combined with Neem oil @ 4ml/Liter and Ripcords 10EC @ 1ml/Liter as a alternative sprays spraying at 10 days interval can be used successfully for reducing the infestation of cucurbit fruit fly. However, further study of this experiment is needed in different locations of Bangladesh for accuracy of the results obtained from the present experiment.

CHAPTER VI
REFERENCES

Agarwal, M.I., Sharma, D.D. and Rahman, O. (1987). Melon fruit fly and its control . *Indian Hort.* **32**(2): 10-11.

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.

Akhtaruzzaman, M., Alam, M.Z. and Sardar, M.A. (2000). Efficacy of different bait sprays for suppressing fruit fly on cucumber. Bulletin of the Institute of Tropical Agriculture, Kyushu University. **23**: 15-26.

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

Atwal, A. S. (1993). Agricultural Pests of India and South East Asia. Kalyani Puhl., New Delhi, Ludhiana. 189p.

Alam, M.Z. (1966). Shasha Kumrar Machipoka (In Bangla). East Pakistan Agril. Res. Inst. and Agril. Infor. Serv., Dacca. 7 p.

Amin, M.R. (1995). Effect of some indigenous materials and pesticides in controlling fruit fly *Bactrocera cncurbitae* Coquillet on cucumber. M. S. Thesis. Department of Entomology, Institute of Postgraduate Studies in Agriculture, Gazipur, Bangladesh. p. 56.

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. p. 17.

Anonymous, (1993). Research and development of vegetable crops. Paper presented in the workshop on research and development of vegetable crops, held on march 9-10, 1993 at IPSA, Gazipur, Bangladesh. Pp. 1-7.

Anonymous. (2002-2003). Technical Bulletin, USAID funded integrated pest management collaborative research support programme (IPM CRSP), Bangladesh Agricultural Research Institute, Gazipur, Bangladesh. p.9.

Anonymous.(2001). Research and development of vegetables crops. Paper presented in the workshop on research and development of vegetable crops; held on March 9-10, 2001 at IPSA, Gazipur, Bangladesh. Pp 1-7.

BBS.(2007). Statistical Year Book of Bangladesh 2002.Bangladesh Bureau of Statistics (BBS). Planning Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.144p

Butani, D.K and Jotwani M.G. (1984). Insects in Vegetables. Periodical Expert Book Agency. Vivek-vihar, Delhi, India. 69p.

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.

Batra, H.N. (1968). Biology and bionomics of Dacus (Zeugodacus) hageni Meijer (*Dacus caudatus* Fabr.). *Indian J. Agric.* Sci. **38**: 1015-1020.

Butterworth, J.H. and Morgan. E.D. (1968). Isolation of substance that suppress feeding in locusts. *Annu. Rev. Entomol*. **2:** 23-24.

Calcagno, G.E., Manso, F. and Vilardi, J.C. (2002). Comparison of mating performance of medfly (Diptera: Tephritidae) genetic sexing and wild type strains: field cage and video recording experiments. *Florida Entomol.* **85**: 41-45.

Collins, S.R., Weldon, C.W., Banos, C. and Taylor, P.W. (2009). Optimizing irradiation dose for sterility induction and quality of *Bactrocera tryoni*. *J. Econ .Entomol*.**102** (5): 17-18.

Chiristenson, L.D. and Foote, R.H. (1960). Biology of fruit flies. *Annu. Rev. Entomol.* **5**:171-192.

Chelliah, S. (1970). Host influence on the development of melon fly, *Dacus cucurbitae*Coquillett. *Indian J. Entomol.* **32**: 381-383.

Chawla, S.S. (1966). Some critical observations on the biology of melon fly, *Dacus cucurbitae* Coquillett (Diptera: Tephritidae). *Res. Bull. Punjab Unv*. **17**: 105-109.

Chattopadhyay, S.B. (1991). Principles and Procedures of Plant Protection. 3rdEdition Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India. p. 584.

Cork.A. and Basu, S.K. (1992). Control of the yellow stem borer, *Scirpophaga incertulus* by mating disruption with a PVC resin formulation of the sex pheromone of *Chilo suppressalis* (Lepidoptera: Pyralidae) in India. Bull. *Entomol.Res*. **86** p: 1-9.

Cheng, H.H. and Struble, D.L. (1982). Field evaluation of black light and sex attractants traps for monitoring seasonal distribution of the dark sided cutworm (Lepidoptera: Noctuidae) in Ontario. *Canadian Entomologist*. **114**: 1121-1125.

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.

Fang, M.N. (1989). A non-pesticide method for the control of melon fly. Special publication. Taichung District Agricultural Improvement Station, Taiwan. **16**:193-205.

Gapud, V.P. (1993). Insect and mite pests of plant crops in Bangladesh and their natural enemies. A consultancy report financed by USAID. Organized by BARC, Dhaka, Bangladesh. 265p.

Gillani, W.A., Bashir, T. and Ilyas, M. (2002). Studies on population dynamics of fruit flies (Diptera:Tephritidae) in guava and nectrin orchards in Islamabad. *Pakistan J. Biol. Sci.* **5(**4): 452-454.

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, D. and Verma, A.K. (1995). Host specific demographic studies of the melon fruit fly, *Dacus cucurbitae* Coquillett (Diptera: Tephritidae). *J. Insect Sci*. **8**: 87-89.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. (2nd Ed). IRRI (International Rice Research Institute) and John Wiley and Sons, New York. p. 680.

Gupta, D. (1992). Population fluctuations of the maggots of fruit flies infesting cucurbitaceous crops. *Advances Plant Science*. **5(**2): 518-523.

GCYD, Mandal C.K (2000). Integrated management of fruit fly (Bactrocera cucurbitae) on bitter gourd (Momordicha charantia L.) during the summer of 1998/99. *IAAS Res. Rep.* 1995-2000: 171-175.

Hameed, S.F., Suri, S.M. and Kashyap, N.P. (1980). Toxicity and persistence of residues of some organophosphorus insecticides applied for the control of *Bactrocera cucurbitae* Coq. On fruits of cucumber. *Indian J. Agri. Sci.* **50**(1): 73-77.

Heppner, J.B. (1989). Larvae of Fruit Flies. V. *Dacus cucurbitae* (Melon Fly) (Diptera: Tephritidae). Fla. Dept. Agric. and Consumer Services, Division of Plant Industry. Entomology Circular No. 315. p. 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.

Islam. M.N. (1994). Trapping of the male pulse beetle, *Callosobruchus chinensis* (L.) (Coleoptera: Bruchidae), in the laboratory using crude extract of female sex pheromone. *Bangladesh. J. Entomol*. **4** (1&2): 1-8.

IPM CRSP, (2004). Technical Bulletin, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh

Islam, M. A. (1999). Integrated pest (Insects) management of vegetables. Consultancy, report, 18 November 1998 to17 May 1999.AVRDC-USAID Bangladesh project, Horticulture Research center, BARI, Gazipur-1701.

Jackson, C.G., Long, J.P. and Klungness, L.M. (1998). Depth of pupation in four species of fruit flies (Diptera: Tephritidae) in sand with and without moisture. *J. Econ. Entomol*. **91**: 138-142.

Jacob J, Leela NK, Sreekumar KM, Anesh RY, Heema M (2007). Phyto-toxicity of leaf extracts of multipurpose tree against insect pests in bitter gourd (Momordica charantia) and brinjal (Solanum melongena). Allelopathy J. 20(2):1-2.

Janjua, M.A. (1948). The biology of *Dacus* (strumeta) *ferrugeneus* (Trypetidae: Diptera) in Baluchistan. *Indian J. Entom*. **10**:55-59.

Jiaiswal, J.D., Gurung, T.B. and Pandey, R.R. (1997). Findings of melon fruit fly control survey and its integrated management, 1996/97. Working Paper Lumle Agricultural Research Centre.No. 97-53. 12 p.

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.

Katsoyannos, B.I., Kouloussis, N.A. and Carey, J.R. (1998). Seasonal and annual occurrence of Mediterranean fruit flies (Diptera: Tephritidae) on Chios island, Greece: differences between two neighboring citrus orchards. *Ann. Entomol. Soc . America.* **91**: 43-51.

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

Keck, C.B. (1951). Effect of temperature on development and activity of the melon fly. *J. Econ. Entomol*. **44**: 1001-1002.

Khatiwada B, Pokhrel B.P. (2004). Botanical pesticides 'Jholmal' for organic agriculture. Ecocentre Tech. Bull. 1(2): pp. 1-2.

Koul, V.K. and Bhagat, K.C. (1994). Biology of melon fruit fly, *Bactrocera (Dacus) cucurbitae* Coquillett (Diptera: Tephritidae) on bottle gourd. *Pest Manage. Econ. Zool.* **2**: 123-125.

Khan, L., Haq, M.U., Mohsin, A.U. and Inayat-Tullah, C. (1993). Biology and behavior of melon fruit fly, *Dacus cucurbitae* Coq. (Diptera: Tephritidae). *Pakistan J. Zool*. **25**: 203-208.

Lee, H.S. (1972). A study on the ecology of melon flies. Plant Protec. Bull., Taiwan. **14**:175-182.

Marwat, N.K. and Baloch, U.K. (1986). Methyl eugenol, a male fruit fly sex- attractant.*Pakistan J. Agric. Res*. **7**: 234.

Messenger, P.S. and Flitters, N.E. (1958). Effect of constant temperature environments on the egg stage of three species of Hawaiian fruit flies . *Ann. Entomol. Soc. America.* **51**: 109-119.

Mukharjee, S., Tithi, D.A. Bachchu, A.A., Ara, R. and Amin, M.R. (2007). Life history and management of cucurbit fruit fly *Bactocera cucurbitae* on sweet gourd. *J. Sci. Technol.* **5**: 17-27.

Miyatake, T. (1995). Two-way artificial selection for developmental period in *Bactrocera cucurbitae* (Diptera: Tephritidae). *Ann. Entomol. Soc. America*. **88:**848-855.

Miyatake, T. (1996). Comparison of adult life history traits in lines artificially selected for long and short larval and pupal developmental periods in the melon fly, *Bactrocera cucurbitae* (Diptera: Tephritidae). *Appl. Entomol. Zool.* **31**: 335-343.

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. Houndmilis, Basingstok Hampshire and London. pp 263-326.

Nasiruddin, M. and Karim, M.A. (1992). Evaluation of potential control measures for fruit fly, *Bactrocera (Dacus) cucurbitae* in snake gourd. *Bangladesh J. Entomol*.**2(**1and 2**)**: 31-34.

Nair, M.R.G. (1986). Insects and Mites of Crops in India. Publication and Information Division, Indian Council of Agricultural Research, New Delhi. Pp. 162-169.

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

Nayar, K.K., Ananthakrishnan, T.N. and David, B.V. (1989). General and Applied Entomology. Tata McGraw-Hill Publishing Co. Ltd., New Delhi. p. 2

Neupane, F.P. (2000). Integrated management of vegetable insects . CEAPRED, Bakhundol, Lalitpur, Nepal. p. 172.

Pawar, D.B., Jony, M.B. and Sonone, H.N. (1984). Chemical control of red pumpkin beetle and fruit fly of musk melon by modern insecticides . S*outh Indian Hort*..**32**(5): 317-318.

Ramphall and Gill, H.S. (1990). Demand and supply of vegetable and pulse in South Asia, In: Vegetable Research and Development in South Asia. S. Shanmugasundaram (ed), Proc.Workshop held at Islamabad, Pakistan on 24-29 September, 1990. AVRDC Publication No. 90.331, AVRDC, Tainan, Taiwan.

Rashid, M. (1993). Vegetables Science (Sabji Bighan) (in Bengali), Bangla Academy, Dhaka. 33-254 p.

Renjhan,P.L. (1949) On the morphology of the immature stages of *Dacus (Strumeta)cucurbitae* Coq. (the melon fruit fly) with notes on its biology. *Indian J. Entomol*.**11**: 83–100.

Ravindranath, K.and Pillai, K.S. (1986). Control of fruit fly of bitter gourd using synthetic pyrethroids. Entomol. **11**(4): 269-272.

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.

Sapkota, R. (2009). Damage assessment and field management of cucurbit fruit fly (*Bactrocera cucurbitae* Coquillett) in squash during spring summer season of mid hill Nepal. Thesis, M. Sc. Ag., Tribhuvan University/IAAS, Rampur, Nepal.

Smith, E.S.C. (1992). Fruit flies in Home Garden. Agnote-Darwin. p. 425.

Singh, R.R. and Srivastava, B.G. (1985). Alcohol extract of neem (*Azadiraclrta indica* A. Juss.) seed oil as oviposition deterrent *for Dacus cucurbitae* Coq. *Indian J. Entomol*. **45**(4): 497-498.

Stark, J.D., Vargas, R.I. and Thalman, R.K. (1990). Azadirachtin: effect on metamorphosis, longevity and reproduction of three tephritid fly species (Diptera: Tcphritidae). *J. Econ. Entomol*. **83**(4): 2168-2174.

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.

Singh, J.P. (1983). Crop Protection in the Tropics. Vikas Publishing House Pvt. Ltd., New Delhi. 213p.

Singh S, Singh R.P. (1998). Neem (Azadirachta indica) seed kernel extracts and Azadirachtin as oviposition deterrents against the melon fly (B. cucurbitae) and oriental fruit fly (B. dorsalis). Phytoparasitica. 26(3): pp. 1-7.

Steiner, L.F., Mitchell, W.C. and Ohinata, K. (1988). Fruit fly control with poisoned bait sprays in Hawaii. *USDA Agri. Res. Serv*. Pp 1-5.

Tikkannen, O.P., Niemela, P. and Keranen, J. (2000). Growth and development of a generalist insect herbivore, Operophtera brumata on original and alternatives host plants. *Oecologia*. **122**: 529-536.

Tanaka, A., Shimada, H. 1978. Fluctuation in number of the melon fly males, *Dacus cucurbitae* Coquillelt (Diptera: Tephritidae) caught in traps at different habitats on Kikai lands Proceedings of the Association for Plant Protect ion of Kyushu, Japan. **24**: pp. 122-124.

Uddin, M.J. (1996). Development of suitable package(s) of IPM components for the management of selected insect pests of cucumber. M.S.

Thesis, Institute of Postgraduate Studies in Agriculture, Gazipur, Bangladesh. 72p.

UNDP-FAO.(1988) . Land Resources Apprasial of Bangladesh for Agricultural Development. Report to Agro-ecological regions of Bangladesh. UNDP-FAO, BGD/81/035 Technical Report **2.**570 pp.

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.

Vargas, R.I., Walsh, W.A., Kanehira, D., Jang, E.B. and Armstrong, J.W. (1997). Demography of four Hawaiian fruit flies (Diptera: Tephritidae) reared at five constant temperatures. *Ann. Entomol. Soc. America*. **90**: 162-168.

Vargas, R.I., Stark, J.D. and Nishida, T. (1992). Ecological framework for integrated pest management of fruit flies in papaya orchards. In: Ooi PAC, Lim GS, Teng PS editors. Proceedings of the third International Conference on Plant Protection in the Tropics 20-23 March 1990. Malaysian Plant Protection Society, Genting Highlands, Kuala Lumpur, Malaysia. Pp. 64-69.

Wadud, M.A., Hossain, M.A. and Islam, M.S. (2005). Sensitivity of the Melon fly*Bactrocera cucurbitae* (Coq.) pupae to Gamma Radiation. *Nucl. Sci. Applic.***14**(2): 119-122.

Weldon, C.W., Banos, C. and Taylo, P.W. (2008). Effects of irradiation dose rate on quality and sterility of Queensland fruit flies, *Bactrocera tryoni* (Froggatt). *J. Appl. Entomol.* **132**: 398–405.

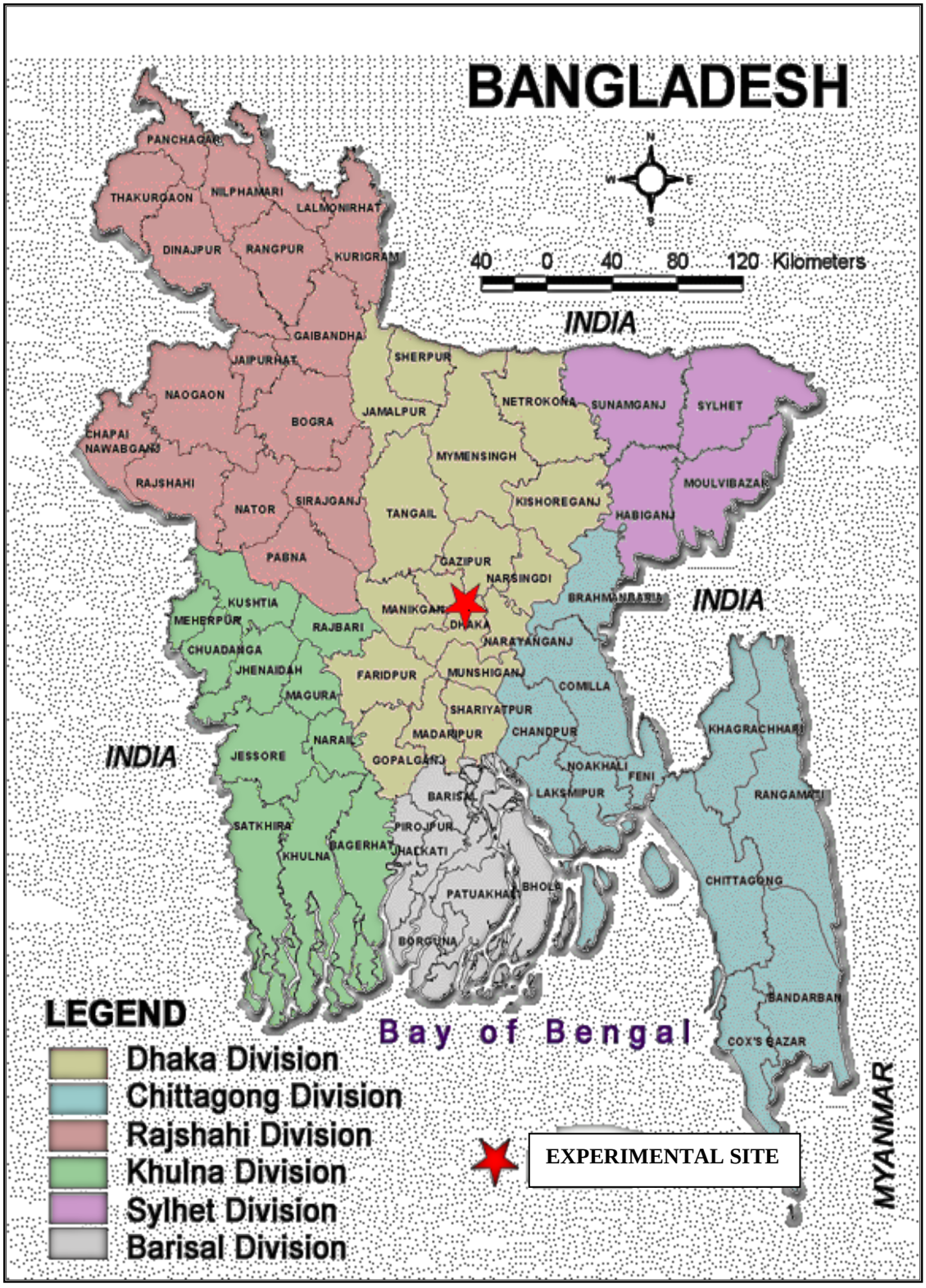
York, A. (1992). Pest of cucurbit crops: Marrow, pumpkin, squash, melon and cucumber.M: Vegetable Crop Pests. Mckinlay, R.G. (ed.). McMillan Press. Houndmills, Basingstoke, Hampshire and London . p. 139.

YubakDhoj G.C. and Mandal, C.K. (2000). Integrated management of fruit fly (*Bactrocera cucurbitae*) on bitter gourd (*Momordicha charantia)* during the summer of 1998/99. IAAS Research Reports (1995-2000): 171-175.

Yang, P.J., Carey, J.R. and Dowell, R.V. (1994). Tephritid fruit flies in China: Historical background and current status. *Pan-Pacific Entomologist* . **70**: 159-167.

APPENDICES

Appendix I. Experimental site at Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.



Appendix II : Monthly average air temperature, relative humidity, rainfall during the cropping period (May to October, 2015)

Month	Monthly average air temperature ($°c$)		Monthly average relative humidity (%)	Monthly average rainfall (mm)
	Maximum	Minimum		
May,2015	35.00	25.21	70	220
Jun,2015	32	25	83	305
July,2015	31	27	84	310
August,2015	30	26	84	300
Septembor,2015	30	25	80	150
Octobor,2015	29.18	18.26	78	120

Source: Bangladesh Meteorological Department (Climate Division), Agargaon , Dhaka–1207.

Appendix III : Physical characteristics and chemical composition of soil of the experimental plot.

Soil Characteristics	**Analytical results**
Agrological Zone	Madhupur Tract
$_{P}H$	5.47 – 5.63
Organic matter	0.82
Total N (%)	0.43
Available phosphorous	22 ppm
Exchangeable K	0.42 meq / 100 g soil

Source: Soil Research Development Institute (SRDI), Dhaka.