EVALUATION OF THE HOST PREFERENCE OF CUCURBIT FRUIT FLY AGAINST DIFFERENT COMBINATIONS OF HYBRID CUCURBITS

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CERTIFICATE

This is to certify that the thesis entitled, **"*Evaluation of the host preference of cucurbit fruit fly against different combination of hybrid cucurbits*"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in the partial fulfilment 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 ***Sanjit mandal*, Registration No. *09-03604*** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed during the course of this investigation has been duly acknowledged and style of this thesis have been approved and recommended for submission.

Dated- June, 2015
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ABSTRACT

The study was conducted at the central Farm of Sher-e-Bangla Agricultural university, Dhaka to find out the evaluation of the host preference of cucurbit fruit fly against different hybrid cucurbit due to March to July, 2014. The experiment consisted of one factors as follows: T_1 : Snake gourd + Bitter gorud + Wax gourd, T_2 : Snake gourd, T_3 : Snake gourd + Bitter gorud, T_4 : Bitter gorud, T_5 : Bitter gorud + wax gourd, T_6 : Snake gourd + Wax gourd and T_7 : Wax gourd. The single factor experiment was laid out in Randomized Complete Block Design with three replications. The highest number of bores per fruit (12.00), number of maggot per infested fruit (19.00) was recorded from T_1 treatment and the lowest (2.00 and 4.00, respectively) was found in T_4 treatment. The maximum percentage of infestation (48.00, 68.00 and 88.00%, respectively) was recorded from T_2 treatment and minimum (12.00, 32.00 and 52.00 %, respectively) was recorded from T_4 treatment at early, mid and late fruiting stage. The lowest weight of healthy and infested fruit ratio (1:0.62) was recorded from T_4 treatment. The overall result revealed that among three cucurbits, snake gourd are more susceptible and highly preferred host to fruit fly and faced significantly severe damage compared to others. On the contrary, bitter gourd as less susceptible and less preferred host for fruit fly with significantly lower damage inflicted. On the other hand, most of the parameters bitter gourd and wax gourd combination of cropping was suitable against cucurbit fruit fly.

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LIST OF ACCRONYMS AND ABBREVIATIONS

AEZ	Agro-Ecological Zone
Agric.	Agriculture
Agril.	Agricultural
Anon.	Anonymous
As	Arsenic
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BCF	Bio Concentration Factors
cm	Centi-meter
cm^2	Square centi-meter
CV	Coefficient of Variance
DAP	Days After Planting
Dev.	Devlopment
DMRT	Duncan's Multiple Range Test
Environ.	Environmental
et al.	And others
Expt.	Experimental
FAO	Food and Agriculture Organization
g	Gram (s)
$hill^{-1}$	Per hill
i.e.	*id est* (L), that is
j.	Journal
kg	Kilogram (s)
mg	Milligram
m^2	Meter squares
M.S	Master of Science
Res.	Research
SAU	Sher-e-Bangla Agricultural University
Sci.	Science
SE	Standard Error
$t\ ha^{-1}$	Ton per hectare
TSS	Total Soluble Solids
UNDP	United Nations Development Programme
viz	Namely
WHO	World Health Organization
%	Percentage

CHAPTER I

INTRODUCTION

Vegetable are cheaper source of vitamin and minerals which is essential for sound health. But in our country the vegetables are not equally produced quantitatively throughout the year. The major vegetables grown in the summer are cucurbits and they play a prime role to the supplement this shortage during the lag period (Rashid, 1993). Cucurbit crops occupy about 66 % of the vegetable lands producing only 11% of total vegetables (Nasiruddin *et al.*, 2004).

Among different cucurbits bitter gourd, snake gourd and wax gourd is a fast growing warm seasonal climbing vegetables crops. Area covered by bitter gourd was 5502 hectare with a total production of 20470 tons (BBS, 2013). In 2012-2013 cropping year 114 thousand metric tons of wax gourd produced in Bangladesh (BBS, 2014). In Bangladesh, the rate of production of snake gourd is 10-15 ton/ha (Rashid *et al.*, 2006).

Unfortunately cucurbits are infested by a number of insect pest which are considered being the significantly obstacles for its economic production. Among them, cucurbits fruit fly, *Bactrocera cucurbitae* is the major pest responsible for considerable damage of cucurbits (Alam, 1969). The adult are flower loving but their larvae are herbivorous particularly cucurbit fruit and continue to plague humankind (Kapoor, 1993). Fruit fly commonly known as melon fruit fly is the major constrain for satisfactory production. Fruit fly reduces the yield as well as quality of the cucurbit fruit. The melon fruit fly is distributed widely in temperate, tropical and sub-tropical regions of the world. Two species of cucurbit fruit fly viz., *Bactrocera cucurbitae* and *Dacus caudatus* have been found in Bangladesh (Alam, 1964). The

Bactrocera cucurbitae is dominant in all the locations of Bangladesh followed by *Dacus caudatus* (Akhtaruzzam *et al.*, 1999).

Fruit infestation by melon fruit fly in bitter gourd has been reported to very from 41% to 89% (Lall and Sinha, 1959), 90% snake gourd and 60% to 87% was gourd in Solomon island. Like any other cucurbit crops, bitter gourd, snake gourd and wax gourd are severely affected by melon fruit fly. Melon fruit fly damages this cucurbits in three ways: i) Oviposition injury by the female on fruits and vegetative parts, ii) larval feeding damage on ovaries and fruit pulp and iii) Decomposition of fruit fly damaged fruit tissue by invading saprophytic micro organism. Therefore, effective crop management of fruit fly is very important for successful cultivation and export of cucurbits.

The utilization of pre-harvest management practices is important to reduce direct losses and to increase efficacy of post-harvest quarantine treatments. Since the discovery of the melon fly in Hawaii a number of methods have been employed in attempts to reduce or prevent damage by this pest. These include: 1) mechanical control, 2) cultural control, 3) biological control and 4) chemical control (Dhillon *et al.*, 2005). Keeping in view the importance of the pest and crop, melon fruit fly management could be done using local area management and wide area management. The melon fruit fly can successfully be managed over a local area by bagging fruits, field sanitation, protein baits, cue lure traps, growing fruit fly resistant genotypes, augmentation of biocontrol agents and soft insecticides. In the Commonwealth of the Northern Mariana Islands, it was detected in 1943 and eradicated by sterile insect release in 1963 (Steiner *et al.*, 1965 and Mitchell, 1980), but re-established from the neighboring Guam in 1981 (Wong *et al.*, 1989).

Objectives of the research work:

i) To measure the extent of damage of bitter gourd, snake gourd and wax gourd caused by the cucurbit fruit fly at different fruiting stages.

ii) To determine the individual and combined effect of crop cultivation against the infestation of cucurbit fruit fly in yield

iii) To determine the total crop loss caused by fruit fly in individual and combined cultivated crop plot.z

CHAPET II

REVIEW OF LITERATURES

Fruit fly are most serious and destructive insects pest of cucurbit fruit vegetables and play a vital role on their yield reduction. The incidence of these pests occurs almost relevant information pertaining to origin, distribution, biology and seasonal abundance, host range, host preference, nature of damage of these pest and yield loss due to their attack and management of fruit fly are given below:

2.1 Origin and distribution of fruit fly

Fruit fly is considered to be the native of oriental origin, probably India and South east Asia and it was first discovered in the Yaeyama Island of Jappan in 1919 (Anon, 1987). However, fruit fly is widely distributed in India, Bnagladesh, Pakistan, Myammar, Nepal, Malaysia, Chian, Formosa, Japan, Indonesia, East Africa, Australia and Hawaiian Island (Alam, 1965 and Atwal, 1993). The fruit fly is also a serious pest in Mediterranean region (Andrewartha and Birch, 1960) but not yet been recorded in UK, Central Europe and USA (Micknlay, 1992). Gapud (1993) reviewed five species of fruit fly in Bangladesh e.g., *Bactrocera brevistylus* (melon fruit fly), *Dacus caudatus* (fruit fly), *D. cucurbitae* (melon fly), *D. tau* (mango fruit fly) and *D. zonatus* (zonata fruit fly). Other species like *Bactrocera Cucurbitae* and *D. tau* have been currently identified in Bangladesh (Akhtaruzzaman *et al.*, 1999).

2.2 Host Range

Melon fruit fly damages over 81 plant species. Based on the extensive surveys carried out in Asia and Hawaii, plants belonging to the family

Cucurbitaceae are preferred most (Allwood *et al.*, 1999). Doharey (1983) reported that it infests over 70 host plants, amongst which, fruits of bitter gurd (*Momordica charantia*), muskmelon (*Cucumis melo*), snap melon (*Cucumis melo* var. momordica) and snake gourd (*Trichosanthes asguina* and *T. cucumeria*) are the most preferred hosts. However, White and Harris (1994) stated that many of the host records might be based on casual observations of adults resting on plants or caught in traps set in non-host plant species. In the Hawaiian Islands, melon fruit fly has been observed feeding on the flowers of the sunflower, Chinease bananas and the juice exuding from sweet corn. Under induced oviposition, McBride and Tanda (1949) reported that broccoli (*Brassica oleracea* var. capitata) tangerine (*Citrus reticulata*) and longan (*Euphoria longan*) are doubtful hosts of *B. cucurbitae*. The melon fly has a mutually beneficial association with the Orchid, Bulbophyllum patens which produce zingerone.

More than 150 species of plants, including cucurbits, tomatoes, and many other vegetables have been recorded as hosts of the melon fly. Preferred hosts include cantaloupe, water melon, pumpkin, squash, gourd, cucumber, tomato, string bean and cowpea.

Occasional hosts include oil-seed, vegetables such as eggplant, orange, papaya, mango, peach, fig, guava, loquat, plum peach, pear, fig, apple, quince, persimon, banana, pomegranate, jujube, tomato, sweet lime, chillies, jackfruit, carambola, papaya, avocado, bread fruit, coffees, berries, passion fruit, star apple, Spanish pepper, cherries, blackberry, cape gooseberry, grapes, mulberry etc. Wild hosts include passion-flower, *passiflora* sp.; balsam apple, *Diplocyclos palmatus*; colocynth, *Cucumis trigonus*; and two gerera of *cucurbits Sicyos* sp. and Chinese cucumber, *Momordica* spp.

Melon flies have more that 80 hosts. They are major pests of beans, bittermelon, Chinese wax gourd, cucumbers, edible gourds, eggplant, green beans, hyotan, luffa, melons, peppers, pumpkins, squashes, togan, tomatoes, watermelon and zucchini (Weems and Hoppner 2001).

Batra (1953) listed as many as 70 hosts of fruit fly species, whereas, Christenson and Foote (1960) reported more than 80 kinds of fruits and vegetables as the hosts. Kapoor (1993) reported that more than one hundred vegetables and fruits are attacked by Bactrocera sp. Atwal (1993) and Micknlay (1992) reported that cucurbits as well as 70-100 non-cucurbitaceous vegetables and fruits are the host of fruit fly. Tomato, green pepper, papaya, cauliflower, mango, guava, citrus, pear, fig and peaches were also infested by fruit fly (Anon., 1987 and Atwal, 1993). In Bangladesh, Alam (1962) reported ten cucurbit vegetables as the host of fruit fly. Kabir *et al.* (1991) found that 16 species of plants act as the host of fruit flies among which sweet gourd was the most preffered host of both *B. cucurbitae* and *B. tau*.

2.3 Nature of Damage

The damage to crops caused by melon flies result from 1) ovipositon in fruit and soft tissues of vegetative parts of hosts 2) feeding by the larvae and 3) decomposition of plant due to invading secondary microorganisms (Ronald, 2003).

Larval feeding in fruits is the most damaging. Damage usually consists of breakdown of tissues and internal rotting associated with maggot infestation, but this varies with the type of fruit attacked (Steiner, 1957). Infested young fruit becomes distorted and drop, mature attacked fruits develop a water soaked appearance. The larval tunnels provide entry points for bacteria and fungi that cause the fruit rot. When only a few larvae develop, damage consists of an unsightly appearance and reduced marketability because of the egg laying punctures or tissue break down due to the decay (Steiner, 1957).

On papaya, the oriental fruit fly is the primary pest in Hawaii. The other fruit flies, the Mediterranean fruit fly and the melon fly, are infrequently found in papaya. The *solanaceous* fruit fly, *Dacus latifrons* (Hendel), does not attack papaya (Liquido and Cunningham, 1990). Infestation rates in papaya by fruit flies increases with ripeness of the fruit (Liquido and Cunningham, 1990).

On banana cultivars ‘Brazilizn’, ‘Valery’ and William’s, oriental fruit fly eggs and larvae develop in fruit at the later stages of ripeness only. Banana is not a host for the oriental fruit fly when the bananas are unripe. Unripe bananas up to 3 to 4 days post harvest are also free of fruit flies (Armstrong *et al.*, 1983).

Perhaps no insect pest other than fruit fly can cause so severe damage of orchard or vegetable crops. Indeed the external damage varies from host to host although the pattern of the damage inside the pulp is similar (Janjua, 1984 and Narayanan and Batra, 1960). Generally speaking, the adult female lays eggs just below the epidermal or sometimes a little deeper in the pulp and or sometimes on young leaves or steps of the host plants. The insertion of the ovipositor causes hounds on the fruit or vegetables in the form of punctures, which appear like dark spots on the fruits. In freshly punctured specimens, the fluid that exuded collects in the form of a droplet which later dries up and appears like brown resinous deposit (Shah *et al.*, 1948; Narayanan and Batra, 1960 and York, 1992). After hatching, the larvae feed into pulpy tissue and make tunnels in fruit causing direct damage. They also indirectly damage the fruits by contaminating with frays and accelerate rotting of fruits by pathogenic infection. Infested fruits If not rotten, become deformed and hardy which make it unfit for consumption. The infested flowers often become more juicy and drop from the stalk at a single jerk (Kabir *et al.*, 1991).

The fruit fly adults are flower loving and feed on plants saps, fruit juices, nectars, yeasts, fungi, bird dropping and several other natural sources of food as well as honey dew (Dteiner and Mitchel, 1968). Some flies also make mines and a few from galls on different parts of the plants (Kapoor, 1993).

Singh (1983) pointed out that, the maggots bore and feed inside the fruits causing sunken discolored patches, distortion and open cracks. Affected fruits prematurely ripe and drop from the plants. Cracks on fruits serve as the predisposing factor to cause pathogenic infection resulting in decomposition of fruits.

2.4 Life Cycle

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 8.1^0 C (Keck, 1951). The lower and upper developmental thresholds for eggs were 11.4 and 36.4^0C (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

32.2^0 C and the relative humidity ranges between 60 to 70%. Fukai (1938) reported the survival of adults for a year at room temperature if fed on fruit juices. In general, its life cycle lasts from 21 to 179 days (Fukai, 1938; Narayanan and Batra, 1960). Development from egg to adult stage takes 13 days at 29^0C in Solomon Islands (Hollingsworth *et al.,* 1997). High temperature, long period of sunshine, and plantation activity influence the B. cucurbitae abundance in the North-eastern Taiwan (Lee *et al*., 1992). Bhatia and Mahto (1969) reported that the life cycle is completed in 36.3, 23.6, 11.2 and 12.5 days at 15, 20, 27.5 and 30^0C, respectively. There are 8 to 10 generations in a year (White and Harris, 1994; Weems and Heppner, 2001).

2.5 Biology and Life History Startegies

There are four stages in the life cycle of the fruit fly: egg, larva, pupa and adult. The life cycle from egg to adult requires 14-27 days (Nasirudding *et al.*, 2004).

2.5.1 Eggs

The eggs of the melon fly are slender, white and measure 1.3 mm in length and 0.4 mm breadth. Eggs often are white, cyclindrical and slightly curved. Eggs as laid singly or in clusters of four or ten eggs. Eggs are embedded in the flower or fruit tissue vertically. The number of eggs lay by a female varies from 42-58. The Incubation period varies from 18 hours in the summer to 3-4 days in the winter (Nasiruddin *et al.*, 2004).

2.5.2 Larvae

Eggs hatch in 2 to 4 days. The larva has two molts, during which the cuticle, mouth hooks and spiracles are shaded. The fruit fly has three instars. First instar larvae, commonly called young maggots. The young maggot is white, translucent and measured 1.5 mm × 0.3 mm. Second instars larvae yellowish due to accumulation of reverse materials in the form of fat and hence opaque. The full grown maggot is 8-9 mm long and 1.5 mm broad across the posterior end. The fully developed larva of third instars has a habit of jumping a short distance to find suitable substrate for pupation (Alam, 1992). The larval period last for 7-14 days with each stage lasting 2 or more days. Heppner (1989) gave detailed description of larvae. Duration of larval development is strongly affected by host.

2.5.3 Maggot

Maggot at 1.27 cm to 58.42 cm deep in the soil depending upon the nature of the soil. The maggot is barrel shaped, light brown or pale in color. The maggot is 11 segmented. The maggot is about 5 to 6 mm in length and varies in color from dull red or brownish yellow to dull white, according to host. The maggot period is 5-8 days is the summer season and about three weeks in the winter months (Nasiruddin *et al.*, 2004).

2.5.4 Adults

The adult fruit fly, *Bacrtocera cucurbitae* is 6 to 8 mm in length. Distinctive characteristics of the adult are the wing pattern, long third antennal segment, the dorsum of the thorax reddish yellow with light yellow markings and withut black markings, and the head yellowish with black spots. Adults may live more than a year. Adults feed primarily upon juices of host plants, nectar and honeydew secreted by various kinds of insects. There may be as many as eight to 10 generations a year (Steiner, 1957).

Adult melon flies *Bactrocera cucurbitae* are slightly larger than houseflies. The head and eyes are dark brown. Their bodies are yellowish brown with a yellow stop above the base of the first pair of legs. A yellow stripe, with curved lines on either side is present down the center of the back. The tip of the body furthermost from the head is yellow. Wings are patterned with a thick brown band extending along the leading edge, ending in a larger brown spot at the tip. Another thin band extends from the wing base just inside the trailing edge of each wing. A brown spot occurs near the wing margin. Abdomens are reddish yellow with darker bands on the second and third segments. Legs are yellowish (Steiner, 1957).

Oviposition occurs about 10 days after emergence and continues at intervals. One female may deposit up to 1,000 eggs, although 300 eggs are estimated in natural conditions. Females prefer to oviposit in new plant such as young seedlings, growing tips, and developing ovaries of all cucurbits except young cucumbers. Ripe fruits are preferred; green fruits are sometimes used. Because of their high egg laying capacity and mobility, each female is capable of destroying large numbers of fruit in her lifespan. Adults generally live for 10 months to a year (Steiner, 1957).

Development from egg to adult under summer requires from 12 to 28 days, depending on the individual, host and weather conditions. The developmental periods may be extended considerably by cool weather. The length of the stages in the Philippine Islands, at an average temperature of 30^0C was 1.73 days for eggs, 4 to 9 days, by exposing specimens to low temperatures. In the Phillipines the pre-oviposition period lalted 7 to 26 days and the oviposition period 39 to 95 days. Eggs generally are laid in young fruit, although they are laid also in succulent stems of many host plants, in cavities made with the help of a sharp ovipositor. Only ripe fruit of some hosts are attacked. Pupation normally occurs in the soil, usually beneath the host of the fruit fly species. They are more or less active at temperatures ranging between 12^0-15^0C and become inactive below 10^0 C (Narayanan and Batra, 1960).

The adults of olive fruit fly, Dacus (*B. oleae*) are present throughout the year, but there is a peak in the autumn (normally October), sometimes followed by another peak in the spring (Delario and Prota, 1988).

Mating between the adult melon fruit flies generally takes place at about dusk and lasts for an hour or more (Narayanan and Batra, 1960). But according to Vargas *et al.* (1984), mating of melon fly starts in the evening and continue till down. They studied the life history and demographic parameter of three laboratory reared cucurbits fruit flies. Janjua (1948) reported that pro-oviposition period of *D. ferrugeneus* is two to five days but it may range from ten to fifteen days or longer or varying conditions of climate and diet. In another report of Butani and Jotwani (1984) indicates that the pre-oviposition period of melon fly lasts for 9-12 days.

Janjua (1948) reported that the female fly *D. ferrugeneus* laid eggs in the late hour of the day, in small clusters just undeneath the skin of the fruit, 1-4 mm deep in the rind. Tactile bristles on the ovipositor assist the fly to discriminate between hard and soft surfaces for oviposition. As soon as a suitable spot on the surface is located it bends its abdomen at a right angle to the long axis of the body and moves the distal needle–like structure of the ovipositor and proximal tube push deeper and deeper until its disappears entirely and the eggs are then deposited. After the act of oviposition the ovipositor is withdrawn leaving a puncture behind. The complete act of oviposition takes sometimes about five minutes.

The eggs laid by *B. cucurbitae* are creamy white, oblong, banana shaped and are about 1.3 mm in length (Anon., 1987). Each cluster of eggs laid by a single female contains between 2-15 eggs depending upon the rexture and quality of the pulp available in each kind of fruit. On an average about 50 eggs are laid, but under favorable conditions a single fly may lay as many as

170-200 eggs in a period of one month. The incubation period of the eggs is two or three days during March and April and 24-36 hours throughout the summer months. It may be prolonged up to ten days in winter. But under laboratory condition (27^0-28^0C), this period is only 27 hours. The young maggot is white, translucent and measures 1.5 mm × 0.3 mm. The full grown maggot is 8-9 mm long and 1.5 mm broad across the posterior end. The fully developed larva of third instars has a habit of jumping a short distance 7.50-10 cm to find a suitable substrate for penetration. Larval period is 4-7 days varying with temperature, nutrition, density etc. The pupa is cylindrical in shape and is 4-5 mm long and 2 mm broad. The color varies from dull deep reddish yellow to ochraceous. The pupal stage lasts for 8-12 days at 23 -25^0C and 9 days at 27^0C. Adults begin to copulate 9-12 days after emergence (Anon., 1987).

The well developed adult of *B. ferrugeneus* Fab, is stout and a little bigger that the ordinary house fly and measures 14 mm across the wing and 7 mm in maximum length. The male fly is slightly smaller than female. The fly is generally brown or dark brownish black arranged in varying pattern (Narayanan and Batra, 1960).

2.6 Yield Loss

Cucurbits are infested by several insects which are considered to be the significant obstacle for its economic production. Amont them, fruit fly is the serious pest responsible for considerable damage of cucurbits (Alam, 1969; Butani and Jatwai, 1984). In reality, this is very difficult to correctly appraise the extent of damage by the pest except in a generalize term (Narayanan and Batra, 1960).

This is not only due to the complexity of the problem but also to interplay of other factors like the variety of the fruits grown, the resistance offered by these varieties to the attack by flies, the influence of environmental factors particularly climatic conditions and lastly the fluctuating market value. All these make it difficult to asses the damage caused and average loss to the farmers from year to year (Narayanan and Batra, 1960). Yet, information of this aspect of the problem is necessary if only to prove the effectiveness of the control methods adopted.

According to the reports of Bangladesh Agricultural Research Institute (BARI), fruit fly infestations were 39-69, 35-58, 30-54 percent for sweet gourd, cucumber and ash gourd, respectively (Anon., 1988). Kabir *et al.* (1991) reported that yield losses due to fruit fly infestation varies in different fruits and vegetables and it is minimum in cucumber (19.19) and maximum in sweet gourd (69.96%). Amin (1995) observed 42.08 percent fruit fly infestation in cucumber and this value was 45.14 percent as reported by Uddin (1966). The damage caused by fruit fly is the most serious in melon after the shower in monsoon when the infestation often reaches up to 100 percent. Other cucurbit may also be infested and infestation may go up to 50 percent.

In any case, it can be safely stated that the damage caused by these flies to fruits as well as vegetables in India is alarming (Narayanan and Batra, 1960) and this is also true for Bangladesh. Almost every vegetable and fruit growers must have experienced every year that it is almost impossible to get infestation free fruits and vegetables. It can, however, be stated without any contradiction that the horticultural industry suffers most from the depredations of the pests.

2.7 Seasonal Abundance

The seasonal abundance or population dynamics study of an insect is very important as it offers a distinct idea about the trend of its population build up at different times of the year which in turn helped to develop a forecasting system for setting an effective management strategy (Anon., 1988). Generally the abundance of insect populaton 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 (Narayanan and Batra, 1960). In places where there is a clear cut winter, it enters into hibernation in the papal stage from the first week of November up to about the beginning of April in the plains and June in the hills. If however, the season is early or late, the hibernation may be even in March or May as the case may be (Narayanan and Batra, 1960).

Cucurbit fruit fly normally increases their multiplication when the temperature goes below 15^0C and relative humidity varies from 60-70 percent (Alam, 1966).

The peak population of fruit fly in India is attained during rainy months of July and August and cold months of January and February (Nair, 1986). The fly population is generally low during dry weather and increases rapidly with adequate rainfall (Butani and Jotwani, 1984). Tanaka *et al.* (1978) reported that population of fruit fly in Japan was increased in autumn and decreased in winter. The adults of melon fruit fly *D. cucurbitae* overwinter in November to December and the fly is the most active in July to August (Agarwal *et al.*, 1987).

The bionomic of fruit fly *D. ferrugeneus* Fab. Was studied in India (Janjua, 1948). According to bionomics, the fruit fly is not severe in the beginning of the summer but soon several broods complete their life cycle in quick succession resulting the population increase. This species coursed in guava during March, while passed in peach, wild fig and brinjal during April and

May. It is lived in mango, peach and pear in July. The peak of its attack is reached from August to October. During this period the flies mostly breed in guava. In winter i.e. from November onward, the host supply runs short and therefore, the damage to individual fruits is rather severe. Guava and citrus are the main hosts in the winter months. The broods of flies generally overlap. The adults are long lived and may life for four months in the field.

Yao and Lee (1978) observed that the population of oriental fruit fly, *B. dorsalis*, in guava is higher at the ripening stage and also pointed out that this is true for all the fruit fly species. In 1995, Amin also observed the highest population incidence at the ripening stage of cucumber. In another study of Bangladesh, Nasiruddin (1991) showed that the incidence of fruit flies in cucurbit was highest in February and lowest in September.

2.8 Management of Fruit Fly

The utilization of pre-harvest management practices is important to reduce direct losses and to increase efficacy of post-harvest quarantine treatments. Since the discovery of the melon fly in Hawaii a number of methods have been employed in attempts to reduce or prevent damage by this pest. These include: 1) mechanical control, 2) cultural control, 3) biological control and 4) chemical control (Dhillon *et al.*, 2005). Keeping in view the importance of the pest and crop, melon fruit fly management could be done using local area management and wide area management. The melon fruit fly can successfully be managed over a local area by bagging fruits, field sanitation, protein baits, cue lure traps, growing fruit fly resistant genotypes, augmentation of biocontrol agents and soft insecticides. The wide area management program involved the coordination of different characteristics of an insect eradication program (including local area options) over an entire area within a defensible perimeter and subsequently protected against reinvasion by quarantine controls. Although, the sterile insect technique has been successfully used in wide area approaches, this approach needs to use more sophisticated and powerful technologies in eradication programs such as insect transgenesis and geographical information systems, which could be deployed over a wide area. In the Commonwealth of the Northern Mariana Islands, it was detected in 1943 and eradicated by sterile insect release in 1963 (Steiner *et al.*, 1965 and Mitchell, 1980), but re-established from the neighboring Guam in 1981 (Wong *et al.*, 1989). It was detected in Nauru in 1982 and eradicated in 1999 by male annihilation and protein bait spraying, but was re-introduced in 2001 (Hollingsworth and Allwood, 2002). Although it is found in Hawaii, it is absent from the continental United States (Weems and Heppner, 2001).

CHAPTER III

MATERIALS AND METHODS

This chapter deals with the materials and methods that were used in the present experiment. It includes short description of location of the experimental plot, characteristic of soil, climate, materials of the experiment, raising of seedlings, treatments, layout and design, land preparation, manuring and fertilizing, transplanting, intercultural operations, harvesting, collection of data and statistical analysis which are given below under the above said headings:

3.1 Location of the experimental field

The experiment work was conducted in the central farms of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from March, 2014 to July, 2014. The location of the site was 23.714°N Latitude and 90.335° E Longitude with the elevation of 8.2 meter from the sea level (Anon, 1989) and presented in Appendex I.

3.2 Characteristics of the soil experiment field

The experimental plot belongs to the Modhupur Tract which was under the Agro Ecological Zone-28. The analytical data of the soil, collected from the experimental area were determined in SRDI, Soil Testing Laboratory, Khamarbari, Dhaka and presented in Appendix II.

3.3 Climate of the experimental site

The experimental site is situated in subtropical zone, the macro climate is characterized by heavy rainfall during the months from April to September (Kharif season) and scantly rainfall during the rest month of the year (Rabi season). Information regarding average monthly the maximum and minimum temperature, rainfall and relative humidity and sunshine hour as recorded by the weather yard, Bangladesh Meteorological Department (Climate Division), Agargaon, during the period of study has been presented in Appendix III.

3.4 Plant materials used

The different cucurbit seeds used in the experiment was snake gourd, bitter gourd and wax gourd. Seeds were collected from Bangladesh Agricultural Research Institute (BARI) and Siddik Bazar, Dhaka.

3.5 Raising and transplanting of Seedlings

The seeds were sown in polythene bag (15 cm × 10 cm) containing 50 % well decomposed cowdung and 50% sandy loam soil. Seeds of snake gourd, bitter gourd and wax gourd were sown on 4 March, 2014 in polythene bag. 30 days old seedling was transplanted in each of the 12 pits of the experimental plots. Each plot was provided with three cucurbit vegetables planted in a sequence circular fashion.

3.6 Treatments of the experiment

The experiment was consisted of the following combination of cucurbit vegetables which were considered as an individual treatment:

T_1 = Snake gourd + Bitter gourd + Wax gourd

T_2 = Snake gourd

T_3 = Snake gourd + Bitter gourd

T_4 = Bitter gourd

T_5 = Bitter gourd + wax gourd

T_6 = Snake gourd + Wax gourd

T_7 = Wax gourd

3.7 Layout and design of the experiment

The one factor experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications. An area of 25 m x 25 m was divided into three equal blocks. Each block consisted of 7 plots where 7 treatments were assigned randomly as per design of the experiment. There were 21 unit plots altogether in the experiment. The size of the plot was 5 m x 5 m. Block to block distance was 1 m and plot to plot 0.5m.

3.8 Cultivation procedure

3.8.1 Land preparation

The selected plot was fallow at the time of period of land preparation which was opened on 02 April, 2014 with the help of the power tiller and then it was kept open to sun for seven days prior to further ploughing, cross ploughing followed by laddering. The weeds and stubbles were removed after each laddering. Simultaneously the clods were broken and the soil was made into good tilth for transplanting.

3.8.2 Application of manures

Farmyard manure (FYM), Urea, TSP, MOP and Gypsum were applied @ 10 ton, 200, 150, 120 and 22 kg/ha, respectively (BARI krishi projukti hatboi, 2005). The FYM was applied after opening the land. The total amount of TSP, ½ MP and full gypsum were applied at the final land preparation. Total urea and ½ MP were applied in two installments. The first instalments were applied at thirty days after transplanting; second installments were applied 45 days after transplanting as top dressing. The fertilizer was thoroughly mixed with the soil.

3.8.3 Gap filling

Very few seedlings were damaged after transplanting and such seedling were replaced by new seedlings from the same stock planted earlier on the border of the experimental plots. The seedlings were transplanted with a mass of root attached with soil ball to avoid transplanting shock.

3.8.4 Intercultural operations

The seedlings were kept under careful observation. Light watering was done every morning and afternoon following transplanting and was continued for 6 days for early and well establishment of the seedlings. Weeding and other intercultural operations were done as and when required. Earthing up was done on both sides of rows after 30 days of transplanting, using the soil from the space between the rows.

3.9 Data collection

For evaluation of target parameters different types of data were recorded for fruit fly infestation attacking those cucurbit vegetables. Details of the data recording producers are explained under the following sub-heading.

3.9.1 Number of bore(s) per fruit

The fruits which reached marketable size, were harvested and observed for infestation by fruit fly. Bore(s) were counted in each infested fruit on different cucurbits. Mean number of bore(s) was calculated from the sum of bores divided by total number of infested fruits. A total of 7 harvests were done during the whole cropping season.

3.9.2 Fruit infested by fruit fly per plant

The number of fruit infested per plant in growing season at their early, mid and late stages during the period from 10 May to 20 July, 2014 was recorded. This was calculated from total number of fruits infested in the plot divided by total number of plants in the plot. Finally the mean number of fruit infested per plant was calculated.

3.9.3 Age of infested fruit

Infestation due to fruit fly on fruits of different cucurbits was observed carefully. The age of infested fruit was recorded from the date of initiations of fruits. The average age of the infested fruits attacked by the fruit fly were calculated on the basis of date recorded during 10-20 May, 2014. To confirm the day of attack, necessary dissection was done and looked for the presence of the maggot and its size.

3.9.4 Healthy and damaged fruits weight

All the infested fruits were stored in the laboratory to measure the health and damaged fruit by number and by weight per plot.

3.9.5 Percent weight reduction per fruit due to fruit fly infestation

Weight reduction due to fruit fly infestation at early, mid and late fruiting stages was calculated by the following formula:

$$\% \text{ weight reduction per fruit} = \frac{Weight\ of\ health\ fruit - Weigh\ of\ infested\ fruit}{Weight\ of\ healthy\ fruit} \times 100$$

3.9.6 Numbers of fruit fly pupae per fruit

Five several infested fruits of more or less uniform size of those cucurbit vegetables were kept on the sand in a separated net cage (30 cm × 20 cm) till pupation. From the number of pupae obtained from the sand the average number of pupae per fruit was determined.

3.10 Statistical analysis

The data obtained for different characters were statistically analyzed to find out the significance of the difference for gibberellic acid and zinc nutrient on yield and yield contributing characters of cucurbit. The mean values of all the recorded characters were evaluated and analysis of variance was performed by the 'F' (variance ratio) test. The significance of the difference among the treatment combinations of means was estimated by Least Significant Different Test (LSD) at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULT AND DISCUSSION

This chapter comprises of the presentation and discussion of the results obtained from the present study. The results have been presented, discussed and possible interpretations were given in tabular and graphical forms under separate headings as follows:

4.1 Number of bore (s) per infested fruit

The results of mean number of bore(s) per fruit due to fruit fly infestation on different cucurbits are presented in Table 1. The table reveals that the highest number of bore(s) was (12.00) found in T_1 with a range of 8–15, which was significantly different from all other transplanted cucurbit combination(s) as a treatment. The second highest number of bores (10.00) was recorded in T_2 with a range of 6–12 and this was significantly different from those of T_3 to T_7. However, the lowest number of bores (2.00) was recorded in T_4.

Literatures on the intensity of infestation due to fruit fly attack in cucurbit vegetables are scanty. But one study undertaken by Patel and Patel (1998) can be referred here. They reported significantly higher number of punctures (25–40) made by *Daces ciliates* in the little gourd, which was followed by the cucumber (13.52) and bitter gourd (9.50). Ridge gourd fruits were not preferred by fruit fly for oviposition, and the fruits were completely free from any puncture. Bottle gourd and smooth gourd were less preferred. The results of the present study with the lowest number of bores in cucumber and the highest number in sweet gourd might have some relevance with the results obtained by Patel and Patel (1998).

Table 1. Effect of mixed cropping against the infestation of fruit fly on different cucurbit vegetables during April to July, 2014

Treatments	Range of bores per fruit	*Mean number of bores per fruit
T_1	8–15	12.00 a
T_2	6–12	10.00 b
T_3	2–7	6.00 d
T_4	0–3	2.00 e
T_5	3–7	5.00 d
T_6	6–10	8.00 c
T_7	3–8	5.00 d
$LSD_{(0.05)}$	—	1.60
CV (%)	—	11.45

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

*Mean of 3 replications

Note: T_1 – Snake gourd + Bitter gourd + Wax gourd

T_2 – Snake gourd

T_3 - Snake gourd + Bitter gourd

T_4 - Bitter gourd

T_5 - Bitter gourd + wax gourd

T_6 - Snake gourd + Wax gourd

T_7 - Wax gourd

4.2 Numbers of fruit fly maggot per fruit

Mean number of maggot obtained from fruit fly infested fruits reared in the laboratory from cucurbits combination(s) are presented in Table 2. The table revealed that the highest number of maggot (19.00) was obtained from fruit fly infested T_1 (per fruit) with a range of 14 to 21, which was significantly different from all other cucurbit treatments. The second highest number of maggot (16.00) per fruit was obtained from infested T_2 with a range of 12 to 19, which was also significantly similar with T_7 with a range of 13 to 19. However, the lowest number of maggot (4.00) per fruit was obtained from fruit fly infested T_4 with a range of 2 to 7.

Table 2. Effect of mixed cropping against of fruit fly maggot per infested fruits of different cucurbits

Treatments	Range of maggot	*Mean number of maggot per infested fruit
T_1	14–21	19.00 a
T_2	12–19	16.00 b
T_3	5–10	7.00 d
T_4	2–7	4.00 e
T_5	7–11	9.00 cd
T_6	8–13	11.00 c
T_7	13–19	16.00 b
$LSD_{(0.05)}$	—	2.36
CV (%)	—	6.65

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

*Mean of 3 replications

Note: T_1 – Snake gourd + Bitter gourd + Wax gourd

T_2 – Snake gourd

T_3 - Snake gourd + Bitter gourd

T_4 - Bitter gourd

T_5 - Bitter gourd + wax gourd

T_6 - Snake gourd + Wax gourd

T_7 - Wax gourd

4.3 Age of infested fruits

The results on average age of different infested cucurbit fruits were shown in Table 3. The maximum age of infested fruit (9.00 day) was recorded in T_4 with a range of 5–13. This was significantly different from all other cucurbits in the plot. The second highest (7.00 day) of such age was recorded in T_2 with a range of 5–9. The lowest age (3.00 day) attractive to fruit fly was found in T_7 with a range of 1–5 and this was statistically different from all other treatments.

Very few literatures are available for this kind of study but many workers gave the opinion that soft (less rind hardness), tender and young fruits are more vulnerable to be attacked by fruit fly. Nat (1966) reported the vulnerable age of some selected lines of bottle gourd and found that the average age of damaged fruit ranged from the 1–2 days in Pisa S.P. Long to 4 days in NB 23.

Table 3. Effect of mixed cropping on average age of infested fruits of different cucurbits during the growing period from May to June, 2014

Treatments	Range of infested fruits age (day)	*Average age of infested fruit (day)
T_1	3–8	5.00 d
T_2	5–9	7.00 b
T_3	3–9	5.00 d
T_4	5–13	9.00 a
T_5	2–7	5.00 d
T_6	3–9	6.00 c
T_7	1–5	3.00 e
$LSD_{(0.05)}$	—	1.00
CV (%)	—	6.61

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

*Mean of 3 replications

Note: T_1 – Snake gourd + Bitter gourd + Wax gourd

T_2 – Snake gourd

T_3 - Snake gourd + Bitter gourd

T_4 - Bitter gourd

T_5 - Bitter gourd + wax gourd

T_6 - Snake gourd + Wax gourd

T_7 - Wax gourd

Table 4. Incidence of fruit fly infestation on different cucurbit fruit vegetables observed at early fruiting stage

Treatments	Total fruits observed(no.)	Infested fruit(no.)	% of infestation
T_1	25	8.00 d	32.00 d
T_2	25	12.00 a	48.00 a
T_3	25	9.00 c	36.00 c
T_4	25	3.00 f	12.00 f
T_5	25	7.00 e	28.00 e
T_6	25	9.00 c	36.00 c
T_7	25	10.00 b	40.00 b
$LSD_{(0.05)}$	—	0.67	2.67
CV (%)	—	4.56	4.56

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

Note: T_1 – Snake gourd + Bitter gourd + Wax gourd

T_2 – Snake gourd

T_3 - Snake gourd + Bitter gourd

T_4 - Bitter gourd

T_5 - Bitter gourd + wax gourd

T_6 - Snake gourd + Wax gourd

T_7 - Wax gourd

4.4 Fruit infestation by fruit fly per plant at early fruiting stage

The percent of fruit fly infested fruit at early fruiting stage of different cucurbit hosts are shown in Table 4. It reveals that at early fruiting stage the highest number of infested fruit was (12.00) recorded from T_2 plant followed by T_7 (10.00). Significantly the highest percent of fruit infested per plant (48.00 %) caused by fruit fly was obtained in T_2 while the lowest was observed in T_4 (12.00 %) (Table 4). Healthy fruit was highest in T_4 (88.00 %) followed by T_5 (72.00 %). The lowest healthy fruit was observed in T_2 (52.00%) at early fruiting stage (Figure 1).

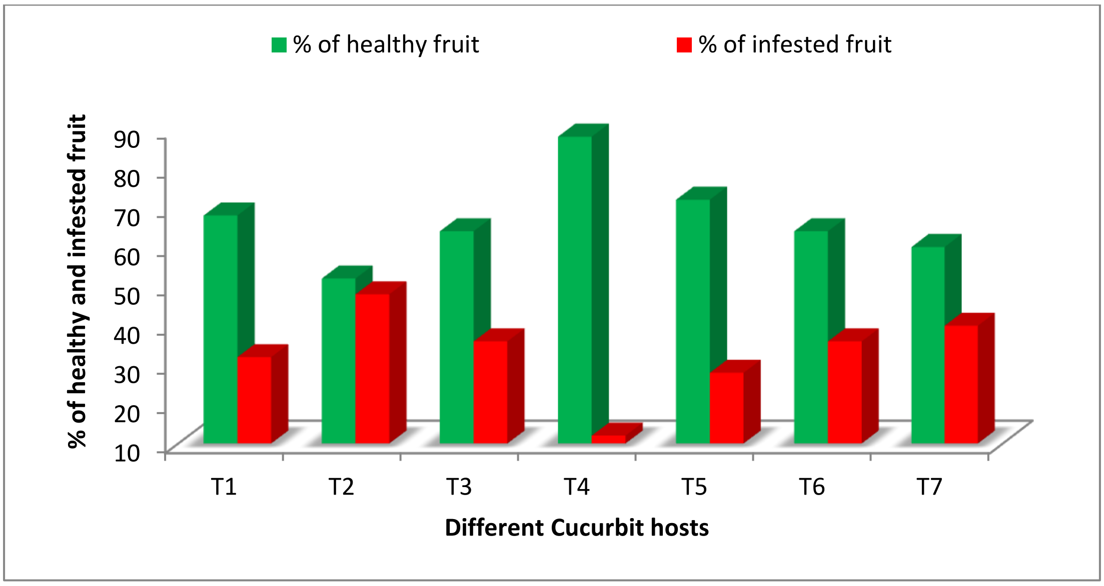

Figure 1. Percentage of healthy and infested fruit at early fruiting stage due to attack of fruit fly on different cucurbits

Note: T_1 – Snake gourd + Bitter gourd + Wax gourd

T_2 – Snake gourd

T_3 - Snake gourd + Bitter gourd

T_4 - Bitter gourd

T_5 - Bitter gourd + wax gourd

T_6 - Snake gourd + Wax gourd

T_7 - Wax gourd

Table 5. Incidence of fruit fly infestation on different cucurbit fruit vegetables observed at mid fruiting stage

Treatments	Total fruits observed	Infested fruit	% of infestation
T_1	25	12.00 d	48.00 d
T_2	25	17.00 a	68.00 a
T_3	25	13.00 c	52.00 c
T_4	25	8.000 e	32.00 e
T_5	25	12.00 d	48.00 d
T_6	25	13.00 c	52.00 c
T_7	25	15.00 b	60.00 b
$LSD_{(0.05)}$	—	0.87	3.47
CV (%)	—	3.80	3.80

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

Note: T_1 – Snake gourd + Bitter gourd + Wax gourd

T_2 – Snake gourd

T_3 - Snake gourd + Bitter gourd

T_4 - Bitter gourd

T_5 - Bitter gourd + wax gourd

T_6 - Snake gourd + Wax gourd

T_7 - Wax gourd

4.5 Fruit infestation by fruit fly per plant at mid fruiting stage

The percent of fruit fly infested fruit at mid fruiting stage of different cucurbit hosts are shown in Table 5. It reveals that at mid fruiting stage the highest number of infested fruit was (17.00) recorded from T_2 plant followed by T_7 (15.00). Significantly the highest percent of fruit infested per plant (68.00 %) caused by fruit fly was obtained in T_2 while the lowest was observed in T_4 (32.00 %) (Table 5). Healthy fruit was highest in T_4 (68.00 %) followed by $T_5$and T_1(52.00 %). The lowest healthy fruit was observed in T_2 (32.00 %) at mid fruiting stage (Figure 2).

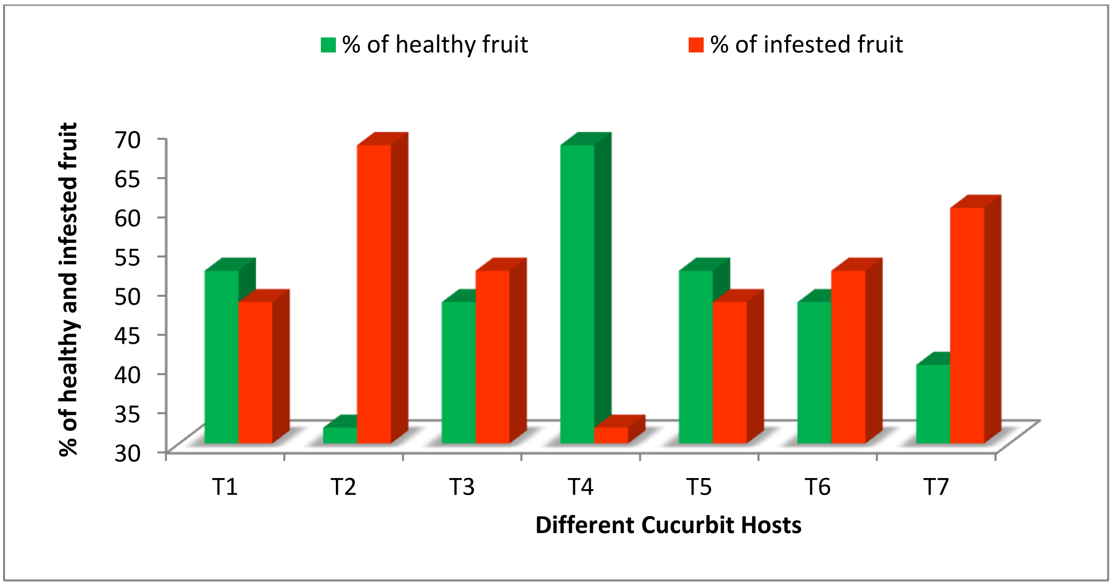

Figure 2. Percentage of healthy and infested fruit at mid fruiting stage due to attack of fruit fly on different cucurbits

Note: T_1 – Snake gourd + Bitter gourd + Wax gourd

T_2 – Snake gourd

T_3 - Snake gourd + Bitter gourd

T_4 - Bitter gourd

T_5 - Bitter gourd + wax gourd

T_6 - Snake gourd + Wax gourd

T_7 - Wax gourd

4.6 Fruit infestation by fruit fly per plant at late fruiting stage

The percent of fruit fly infested fruit at late fruiting stage of different cucurbit hosts are shown in Table 6. It reveals that at late fruiting stage the highest number of infested fruit was (22.00) recorded from T_2 plant followed by T_7 (18.00). Significantly the highest percent of fruit infested per plant (88.00 %) caused by fruit fly was obtained in T_2 while the lowest was observed in T_4 (52.00 %) (Table 6). Healthy fruit was highest in T_4 (48.00 %) followed by T_5 (40.00 %). The lowest healthy fruit was observed in T_2 (12.00 %) at late fruiting stage (Figure 3).

Very little work has been done on the host preference of fruit fly attacking different cucurbit vegetables. Begum (2002) reported that, the maximum number of infested fruits shown in sweet gourd while it was the lowest in cucumber. Sponge gourd showed intermediate level of infested fruit per plant. Among various cucurbit vegetable fruits the rate of infestation was the minimum in cucumber (19.2+2.3%) and maximum in sweet gourd (70.0 +5.0%) (Kabir *et al.*, 1991). In the study maximum numbers of infested fruits were recorded also in sweet gourd while it was the lowest in cucumber.

Table 6. Incidence of fruit fly infestation on different cucurbit fruit vegetables observed at late fruiting stage

Treatments	Total fruits observed	Infested fruit	% of infestation
T_1	25	16.00 c	64.00 c
T_2	25	22.00 a	88.00 a
T_3	25	16.00 c	64.00 c
T_4	25	13.00 d	52.00 d
T_5	25	15.00 c	60.00 c
T_6	25	16.00 c	64.00 c
T_7	25	18.00 b	72.00 b
$LSD_{(0.05)}$	—	1.34	5.38
CV (%)	—	7.56	7.56

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

Note: T_1 – Snake gourd + Bitter gourd + Wax gourd

T_2 – Snake gourd

T_3 - Snake gourd + Bitter gourd

T_4 - Bitter gourd

T_5 - Bitter gourd + wax gourd

T_6 - Snake gourd + Wax gourd

T_7 - Wax gourd

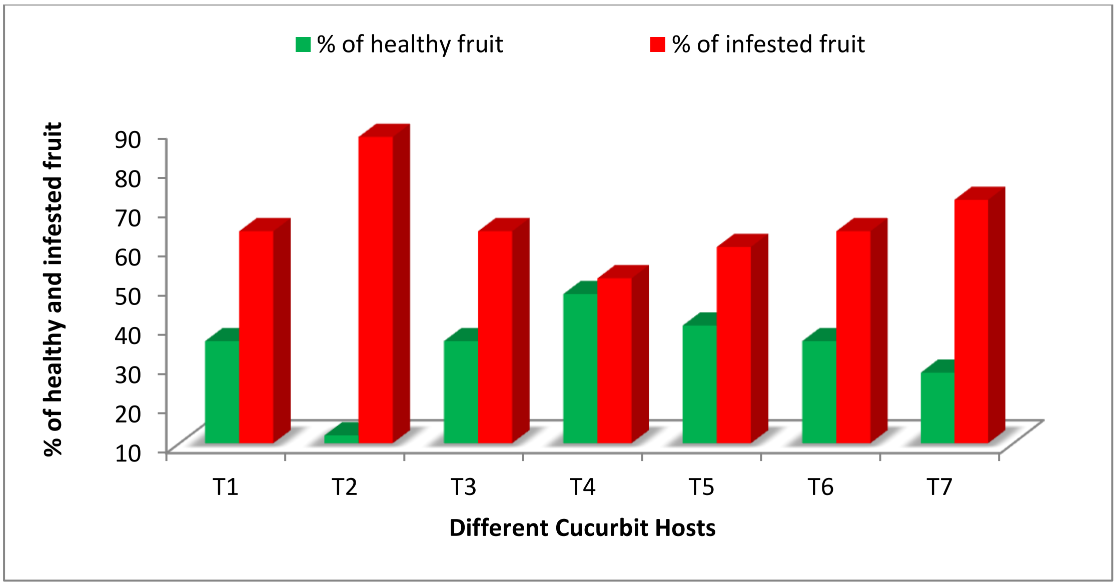

Figure 3. Percentage of healthy and infested fruit at late fruiting stage due to attack of fruit fly on different cucurbits

Note: T_1 – Snake gourd + Bitter gourd + Wax gourd

T_2 – Snake gourd

T_3 - Snake gourd + Bitter gourd

T_4 - Bitter gourd

T_5 - Bitter gourd + wax gourd

T_6 - Snake gourd + Wax gourd

T_7 - Wax gourd

4.7 Healthy and damaged portion of the infested fruits at early fruiting stage

The results on weight of healthy and damaged portion of the infested fruits of different cucurbits hosts at early fruiting stage are shown in Table 7. This Table reveals that the highest weight of healthy portion (627.00 g) of infested fruit was found in T_1 which was significantly different from all other cucurbits.

On the other hand the highest weight of damaged portion (1527.00 g) of fruit was separated from the infested T_7. The quantity was significantly higher than all other infested cucurbit fruits. The second highest weight of damage portion (1305.00 g) was separated from infested T_1.

The lowest damage portion (348.00 g) was recorded from the infested T_4 which was significantly different from all other cucurbits. The highest ratio of healthy and damage (1: 6.47) was found in T_7 followed by T_6 (1: 3.45), T_2 (1: 3.25), T_1 (1: 2.08), T_5 (1: 1.68), T_3 (1: 1.48) and T_4 (1: 0.62).

Table 7. Weight of healthy and infested fruit of cucurbit due to attack of fruit fly

Treatments	Weight of healthy fruit (g)	Weight of infested fruit (g)	Ratio
T_1	627.00 a	1305.00 b	1 : 2.08
T_2	396.00 d	1285.00 c	1 : 3.25
T_3	493.00 c	729.00 f	1 : 1.48
T_4	564.00 b	348.00 g	1 : 0.62
T_5	493.00 c	829.00 e	1 : 1.68
T_6	346.00 e	1195.00 d	1 : 3.45
T_7	236.00 f	1527.00 a	1 : 6.47
$LSD_{(0.05)}$	18.15	25.88	—
CV (%)	12.26	8.32	—

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

Note: T_1 – Snake gourd + Bitter gourd + Wax gourd

T_2 – Snake gourd

T_3 - Snake gourd + Bitter gourd

T_4 - Bitter gourd

T_5 - Bitter gourd + wax gourd

T_6 - Snake gourd + Wax gourd

T_7 - Wax gourd

CHAPTER V

SUMMARY AND CONCLUSION

The present study was undertaken in the field of the Department of Entomology, Sher-e-Bangla Agriculture University, Dhaka, Bangladesh during the period March to July, 2014 to study the evolution of the host preference of cucurbit fruit fly against different hybrid cucurbits.

The highest number of bore(s) were (12.00) found in T_1 with a range of 8–15, which was significantly different from all other cucurbits. The second highest number of bores (10.00) was recorded in T_2 with a range of 6–12 and this was significantly different from those of T_3 to T_7. However, the lowest number of bores (2.00) was recorded in T_4.

The highest number of maggot (19.00) was obtained from fruit fly infested T_1 (per fruit) with a range of 14 to 21, which was significantly different from all other cucurbit treatments. The second highest number of maggot (16.00) per fruit was obtained from infested T_2 with a range of 12 to 19, which was also significantly similar with T_7 with a range of 13 to 19. However, the lowest number of maggot (4.00) per fruit was obtained from fruit fly infested T_4 with a range of 2 to 7.

The maximum age of infested fruit (9.00 day) was recorded in T_4 with a range of 5–13. This was significantly different from all other cucurbits in the plot. The second highest (7.00 day) of such age was recorded in T_2 with a range of 5–9. The lowest age (3.00 day) attractive to fruit fly was found in T_7 with a range of 1–5 and this was statistically different from all other treatments.

At early fruiting stage the highest number of infested fruit (12.00) was recorded from T_2 plant followed by T_7 (10.00). Significantly the highest percent of fruit infested per plant (48.00 %) caused by fruit fly was obtained in

T_2 while the lowest was observed in T_4 (12.00 %). Healthy fruit was highest in T_4 (88.00 %) followed by T_5 (72.00 %). The lowest healthy fruit was observed in T_2 (52.00 %) at early fruiting stage.

At mid fruiting stage the highest number of infested fruit was (17.00) recorded from T_2 plant followed by T_7 (15.00). Significantly the highest percent of fruit infested per plant (68.00 %) caused by fruit fly was obtained in T_2 while the lowest was observed in T_4 (32.00 %). Healthy fruit was highest in T_4 (68.00 %) followed by T_5 and T_1 (52.00 %). The lowest healthy fruit was observed in T_2 (32.00 %) at mid fruiting stage.

At late fruiting stage the highest number of infested fruit was (22.00) recorded from T_2 plant followed by T_7 (18.00). Significantly the highest percent of fruit infested per plant (88.00 %) caused by fruit fly was obtained in T_2 while the lowest was observed in T_4 (52.00 %). Healthy fruit was highest in T_4 (48.00 %) followed by T_5 (40.00 %). The lowest healthy fruit was observed in T_2 (12.00 %) at late fruiting stage.

The highest weight of healthy portion (627.00 g) of infested fruit was found in T_1 which was significantly different from all other cucurbits. On the other hand the highest weight of damaged portion (1527.00 g) of fruit was separated from the infested T_7. The quantity was significantly higher than all other infested cucurbit fruits. The second highest weight of damage portion (1305.00 g) was separated from infested T_1. The lowest damage portion (348.00 g) was recorded from the infested T_4 which was significantly different from all other cucurbits. The highest ratio of healthy and damage (1: 6.47) was found in T_7 followed by T_6 (1: 3.45), T_2 (1: 3.25), T_1 (1: 2.08), T_5 (1: 1.68), T_3 (1: 1.48) and T_4 (1: 0.62).

Conclusion

The following conclusions may be drawn from the findings of the studies:

i) Among the cucurbits vegetables viz., snake gourd, bitter gourd and wax gourd is identified as the most susceptible and highly preferred host to fruit fly which significantly severe damage compared to other.

ii) Three days old, young and tender bitter gourd fruit is the most preferred to fruit fly compared to other cucurbits host.

iii) The overall result revealed that among three cucurbits, snake gourd are more susceptible and highly preferred host to fruit fly and faced significantly severe damage compared to others.

iv) On the contrary, bitter gourd as less susceptible and less preferred host for fruit fly with significantly lower damage inflicted.

v) In combination of mixed cropping, most of the parameters bitter gourd and wax gourd combination was suitable against cucurbit fruit fly.

vi) In the early and mid fruiting stage, the combination of snake gourd, bitter gourd, wax gourd and bitter gourd, wax gourd was given second best result but late fruiting stage, bitter gourd and wax gourd combination was best against cucurbit fruit fly.

Recommendation

Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. The present research work was carried out at the Sher-e-Bangla Agriculture University, Dhaka and one season only;

2. Further trail of this research work in different locations with another variety of the country is needed to justify the result for common farmers;

3. Such study may be conducted in different agro-ecological zones (AEZ) and seasons of Bangladesh for exploitation of regional adaptability and other performances;

4. Some other cucurbit crops may be included in future program for more confirmation of the results

5. All of the cucurbit crops of Bangladesh may be included single and two, three or more other combinations in future program.

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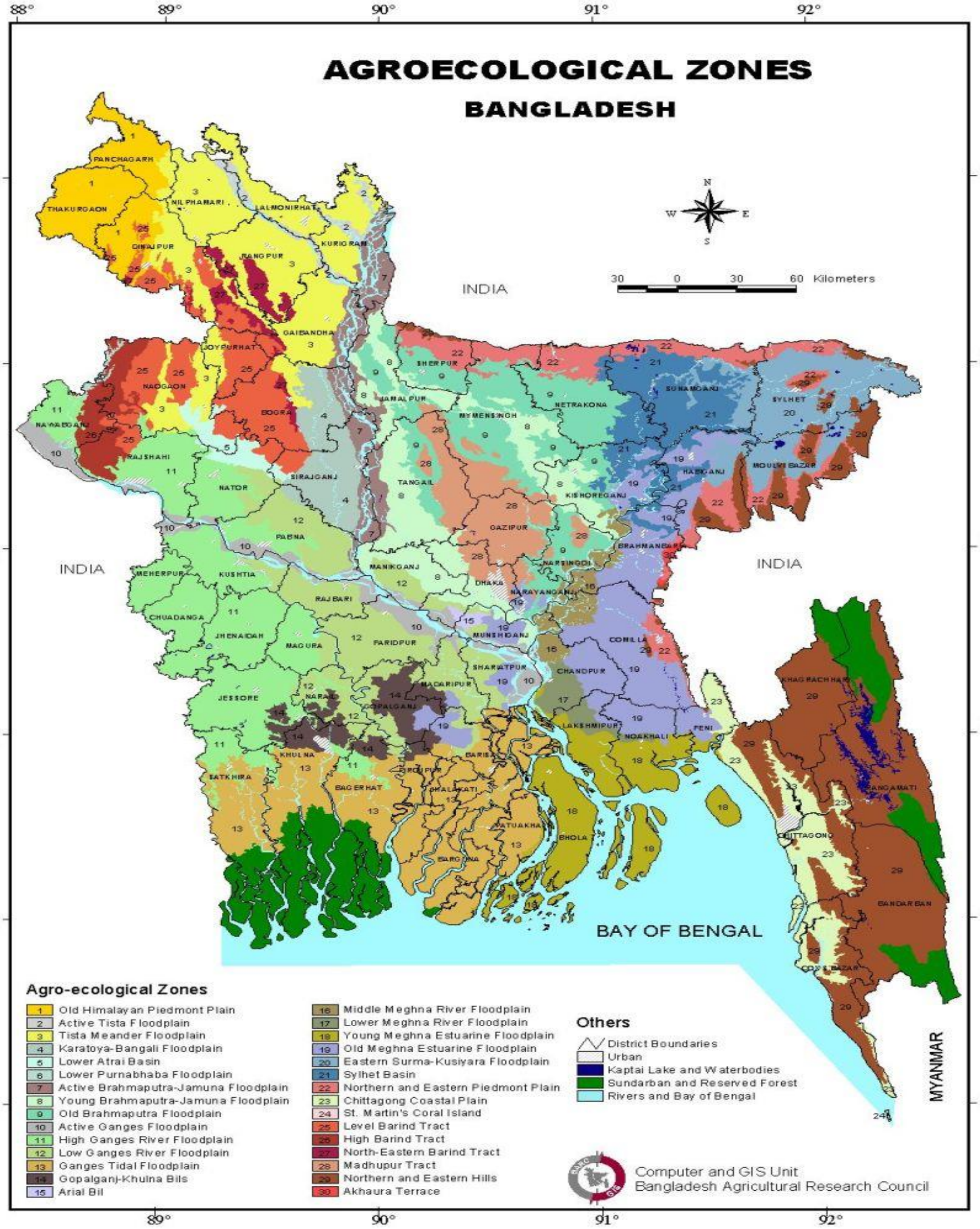
APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh



Appendix II. Monthly average record of air temperature, rainfall, relative humidity and Sunshine of the experimental site during the period from March 2014 to July 2014.

Month	Air temperature (°c)		Relative humidity (%)	Total rainfall (mm)	Sunshine (hr)
	Maximum	Minimum			
March, 2014	32.5	20.4	64	65.8	5.2
April, 2014	33.7	23.6	69	165.3	4.9
May, 2014	26.4	14.1	69	212.8	5.5
June, 2014	25.4	12.7	68	267.7	5.6
July, 2014	28.1	15.5	68	258.9	5.5

Source: Bangladesh Meteorological Department (Climate & Weather Division) Agargoan, Dhaka - 1212

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

Soil characteristics	Analytical results
Agrological Zone	Madhupur Tract
P^H	6.00 – 6.63
Organic matter	0.84
Total N (%)	0.46
Available phosphorous	21 ppm
Exchangeable K	0.41 meq / 100 g soil

Source: Soil Resource and Development Institute (SRDI), Dhaka

Appendix IV: Error mean square values for number of bore, number of pupae, weight loss percentage, age of infested fruit and number of infested fruit

Source of variation	Degrees of freedom	Number of bore	Number of pupae	Weight loss %	Age of infested fruit	Number of infested fruit
Replication	2	0.003	0.016	0.054	0.200	0.083
Treatment	6	1.130**	3.123*	1.238*	1.033*	9.744**
Error	12	0.083	0.078	0.123	0.057	0.046

*Significant at 5% level of probability ** Significant at 1% level of probability

PLATE

Plate 1. Wax gourd fruit infested by fruit fly at early fruiting stage

Plate 2. Wax gourd fruit infested by fruit fly at late fruiting stage

Plate 3. Snake gourd fruit infested by fruit fly at late fruiting stage

Plate 4. Healthy fruit of snake gourd

Plate 5. Bitter gourd fruit infested by maggot at early fruiting stage

Plate 6. Bitter gourd fruit infested by fruit fly at late fruiting stage