EVALUATION OF SOME ECO-FRIENDLY MANAGEMENT PRACTICES AGAINST CUCURBIT FRUIT FLY ON RIDGE GOURD

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CERTIFICATE

This is to certify that the Thesis entitled, " **EVALUATION OF SOME ECO-FRIENDLY MANAGEMENT PRACTICES AGAINST CUCURBIT FRUIT FLY ON RIDGE GOURD."** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in the partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M.S.) IN ENTOMOLOGY,** embodies the result of a piece of bona fide research work carried out by **MD. AMINUL HAQUE BHUYAN** bearing Roll No. 955, Registration No. 00955 under my supervision and guidance. No part of the Thesis has been submitted for any other degree or diploma.

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

Dr. Md. Razzab Ali
Research Supervisor
Advisory Committee

Dated:

Place: Dhaka, Bangladesh


Dedicated TO
MY
Beloved Parents

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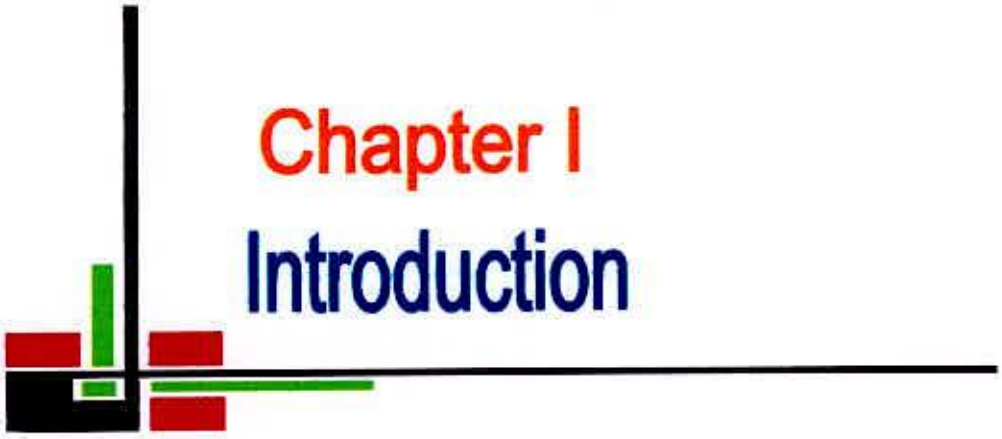
EVALUATION OF SOME ECO-FRIENDLY MANAGEMENT PRACTICES AGAINST CUCURBIT FRUIT FLY ON RIDGE GOURD

By

MD. AMINUL HAQUE BHUYAN

ABSTRACT

To evaluate the comparative effectiveness of some eco-friendly management practices against fruit fly on ridge gourd an experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh during March to July 2007. The experiment, consisting six different eco-friendly management practices and an untreated control measures, was laid out in Randomized block design (RCBD) with 3 replications. Considering the early, mid, late fruiting stages and mean through out the cropping season of ridge gourd, T_5 (spraying of neem oil @ 3% at 7 days interval) performed as best in reducing percent fruit infestation by number (77.75%, 74.02%, 63.67% and 71.23%, respectively) and weight (73.87%, 71.48%, 62.47% and 69.41%, respectively). The highest fruit yield (17.18 t/ha) was also recorded in neem oil treated plot (T_5) and the lowest yield (13.62 t/ha) was recorded in untreated control (T_7). The length, girth and single fruit weight were significantly and positively correlated with the yield of ridge gourd. The highest (5.78) benefit cost ratio (BCR) was calculated in neem oil treated plot (T_5) and the lowest BCR (2.16) in T_1 (hand picking and destruction of infested fruits from the plot at 7 days interval). Considering the national demand and environmental safely point of view, T_5 (spraying of neem oil @ 3 % at 7 days interval) was the most effective management practices applied against fruit fly infesting ridge gourd.



Chapter I

Introduction

CHAPTER I

INTRODUCTION

Bangladesh has a serious deficiency in vegetables. In Bangladesh, the vegetables are not equally produced quantitatively throughout the year. Of the total production, less than 25% is produced during Kharif season and more than 75% in Rabi season (Anon. 1993). The vegetable production in the country is very low in summer. In this season the major vegetable grown are cucurbits. Therefore, during this lack period, cucurbitaceous vegetables play an important role to supplement this shortage (Rashid 1993). Among different cucurbitS, ridge gourd is a fast growing warm seasonal climbing vegetable crop. In Bangladesh, the rate of production of ridge gourd is 10-15 ton/ha (Rashid *et al.* 2006). Unfortunately cucurbits are infested by a number of insect pests, which are considered being the significant obstacles for its economic production. Among them, cucurbit fruit fly, *Bactrocera cucurbitae* is the major pest responsible for considerable damage of cucurbits (Butani and Jotwani 1984). It is also the key pest of cucurbits of many Asian countries including Bangladesh (Alam 1969, Butani and Jotwani 1984). The adults are flower loving but their larvae are herbivorous particularly cucurbit fruits and continue to plague humankind (Kapoor 1993).

The quantitative and qualitative damages due to this pest cause great economic losses to cucurbit vegetable growers almost all over the world. The cucurbit vegetables, which are affected by this noxious pest, are ridge gourd, sweet gourd, sponge gourd, bottle gourd, bitter gourd, snake gourd, melon, water melon, cucumber, teasel gourd as well as other wild cucurbits (Alam 1965, Mckinlay *et al.* 1992). Besides, 70-100 non-cucurbitaceous fruits and vegetables are also attacked by this pest. According to Kabir *et al.* (1991), the rate of infestation in cucurbits varies from 19-77% depending

upon the crops in Bangladesh. Only in sweet gourd, the infestation ranges from 60-75% and that in flowers of sweet gourd and bottle gourd is 42-77 %. Sometimes 50% of entire fruit crop is destroyed in India (Kapoor 1993).

The control of this pest seems to be very difficult. Several management practices are adopted in different parts of the world to control this pest. It has been reported that the direct foliar application of insecticides are not effective to suppress this pest (Williamson 1989). Although various chemicals were tried as cover spray against fruit flies in India, there is not a single chemical so far been successfully reduced the damage at an economically low level (Kapoor 1993). Sometimes farmers are applying insecticides without considering its negatives effect. The insecticidal prophylactic measures are highly risky from the residual point of view and development of resistance, resurgence and hazard to human health, wild life and environment, resulting in disruption of natural control system in the crop field. Considering these problems in mind alternative method(s) of fruit fly management was sought.

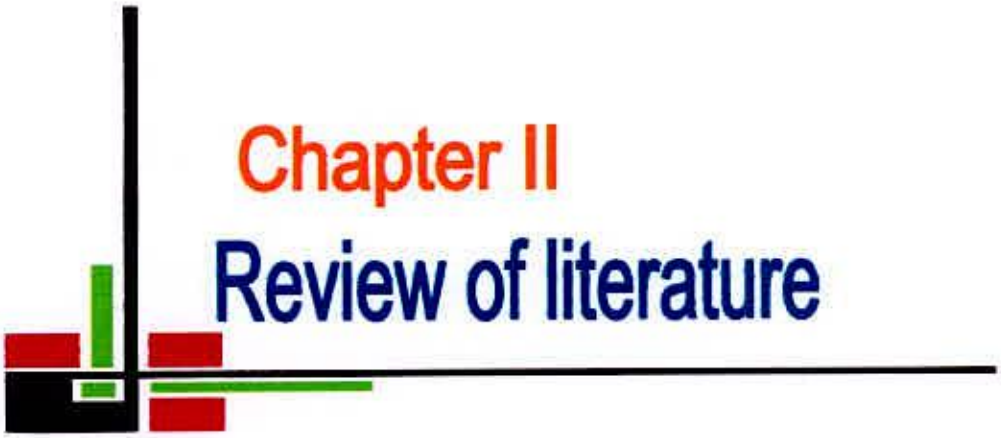
It is therefore, extremely important to devise means to reduce the extent of damage due to these flies without adversely affecting the agro-ecosystem. A cluster of methods have been developed and suggested by Kapoor (1993) to control this pest using various mechanical, physical and cultural controls consisting of field sanitation, infested fruit picking, bagging of fruits, ploughing of soils etc. are very effective control measures against cucurbit fruit fly (Agarwal *et at.* 1987, Smith 1992, Kapoor 1993, Akhteruzzamzn 1999). Collection and destruction of infested fruits with the larvae inside helped population reduction of fruit flies (Nasiruddin and Karim 1992). Covering of fruits by polythene bag is an effective control of fruit fly in teasel gourd. The lowest fruit fly incidence in teasel gourd occurred in bagging fruits (4.2 %), while the highest (39.38 %) was recorded in the fruits of control plots (Anon 1988).

Nasiruddin and Karim (1992) found that 61.92% reduction of infestation over control by spraying Dipterex 80 SP in snake gourd. Bait spray (Steiner *et al.*, 1988), trapping with chemical attractant (Qureshi *et al.* 1981) were undertaken to control fruit fly on various crops. Different types of attractants (Tanaka *et al.* 1978), cucurbit fruit fly traps (Nasiruddin and Karim 1992) and repellants of plant extracts (Sing and Srivastava 1985) were utilized against this pest with variable success.

Objectives

Considering the above discussions, the present study was undertaken on the basis of following objectives:

- To determine the level of infestation by cucurbit fruit fly on ridge gourd
- To explore the effectiveness of different environment friendly management practices against cucurbit fruit fly on ridge gourd and
- To assess the economics of different management practices against cucurbit fruit fly.



Chapter II

Review of literature

CHAPTER II

REVIEW OF LITERATURE

Cucurbit fruit fly, *Bactrocera cucurbitae* and *B. dorsalis* (previously known as *Dacus cucurbitae* and *D. dorsalis,* respectively) is the most serious and destructive insect pest of cucurbit fruits and vegetables and causes great yield reduction. The literatures on the packages of integrated pest management using several non-hazardous components to combat this pest are very sporadic and scanty. For the purpose of this study, the most relevant information's are given below under the following sub-headings:

Origin and distribution of fruit fly

Fruit fly is considered to be the native of oriental, probably India and South East Asia and it was first discovered in the Yacyama Island of Japan in 1919 (Anon. 1987). However, the fruit fly is widely distributed in India, Bangladesh, Pakistan, Myanmar, Nepal, Malaysia, China, Philippines, Formosa (Taiwan), Japan, Indonesia, East Africa, Australia and Hawaiian Island (Alam 1965, Atwal 1993). It is also a serious pest in Mediterranean region (Andrewartha and Birch 1960). Although, this pest is widely distributed, but it does not occur in the UK, central Europe and continental USA (McKinlay *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 including New Guinea, Soloman and Bismark Islands, Australia, Mauritius, East Africa, Kenya and Tanzania.

Fruit flies are distributed almost everywhere in the world and infest a large number of host plants. The distribution of a particular species is limited perhaps due to physical, climatic and gross vegetational factors, but most likely due to host specificity. Such

species may become widely distributed when their host plants are widespread, either naturally or cultivation by man (Kapoor 1993). Two of the world's most damaging tephritids, *B. dorsalis* and *B. cucurbitae* are widely distributed in Malaysia and other South East Asian countries (Vijaysegaran 1987). Gapud (1993) has cited references of five species of fruit fly in Bangladesh, e.g., *B. brevistylus* (melon fruit fly), *Dacus (Zeugodacus) caudatus* (fruit fly), *D. (Strumeta) cucurbitae* (melon fly), *D. (Bactrocera) dorsalis* Hendel (mango fruit fly) and *D. (Chaetlodacus) zonatus* (zonata fruit fly). According to Akhtaruzzaman (1999), *B. cucurbitae, B. tau* and *D. ciliatus* have been currently identified in Bangladesh of which *D. ciliatus* is a new record. *B. cucurbitae* is dominant in all the locations of Bangladesh followed by *B. tau* and *D. ciliatus.*

Host range of fruit fly

Many fruit fly species do serious damage to vegetables, oil-seeds, fruits and ornamental plants. Batra (1953) 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 the hosts. Lawrence (1950) recorded that cucurbit vegetables are the most favorite host of *B. cucurbitae.* 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 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 cucurbits as well as 70-100 non-cucurbitaceous vegetables and fruits are the host of fruit fly. In Bangladesh, Alam (1962) 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 for both *B. cucurbitae* and *B. tau.* Among flowers, the rate of infestation was greater in sweet gourd but the intensity was higher in bottle gourd (Kabir *et al.* 1991).

According to Mathew *et al.* (1999), *B. cucurbitae* infesting vines of cucumber and bitter gourd and the first report in cowpea pods. *Brassica caulorapa* (*Brassica oleracca* var.*gongylodes)* was confirmed as a food plant of *B. cucurbitae* (Ranganath *et al.* 1999). *B. cucurbitae* was recently recorded infesting tomato in South Andaman, Andaman and Nicobar Islands, India (Ranganath and Veenakumari 1996).

White and Elson-Harris (1994) stated that many of the host recorded might be based on casual observations of adults resting on plants or caught in traps set in non-host plant species. Based on the extensive surveys carried out in Asia and Hawaii, plants belonging to the family Cucurbitaceae are preferred host (Allwood *et al.* 1999). The males pollinate the flowers and acquire the floral essence and store it in the pheromone glands to attract con-specific females (Hong and Nishida 2000).

Melon fruit fly infestation was recorded at 3-day intervals from the initiation of fruiting until the last picking. Among the cucurbits, long melon [*Cucumis melo*] was the most preferred host by the melon fruit fly, followed by round gourd [*Citrullus lanatus* var. *fistulosus*] and ridge gourd [*Luffa acutangula*]. Pumpkin [*Cucurbita moschata*] was the least preferred host, followed by bottle ground [*Lagenaria siceraria*] and mateera (local cultivar of *Citrullus lanatus*). Cucumber [*Cucumis sativus*], sponge gourd [*Luffa acutangula*] and bitter gourd [*Momordica charantia*] were moderately preferred crops (Jakhar and Pareek 2005).

Thirteen cucurbit crops were screened for their resistance to the fruit fly (*B. cucurbitae*) during the summer and rainy seasons of 2001 and 2002, in Varanasi, Uttar Pradesh, India. None of the cucurbits were found free from pest attack during both seasons. However, significant differences were observed in the degree of infestation among cucurbits. Damage during the summer season of 2001 and 2002 was maximum in bitter gourd (26.11 and 31.96%) and minimum in pumpkin (2.78 and 1.39%). Similarly, damage during the rainy season of 2001 and 2002 was maximum in bitter gourd (46.8 and 45.3%) and minimum in pumpkin (7.4 and 11.1%). Bitter gourd, followed by bottle gourd, was the most preferred host of *B. cucurbitae* (Nath and Bhushan 2006).

Nature of damage of fruit fly

According to Janjua (1948), the nature of infestation of fruit fly varies with the kinds of fruits. Shah *et al.* (1948) 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 or 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 young leaves or stems of the host plants. After that a fluid substance oozes out, which transform into a brown resinous deposits. After hatching the larvae feed into pulpy tissues and make tunnels in fruits causing direct damage. They also indirectly damage the fruits by contaminating it with frass and accelerate rotting of fruit by pathogenic infection. Infested fruits if not rotten, become deformed and hardly which make it unfit for consumption. The fly also attacks flowers and the infested flowers often become juicier and drop from the stalk at slight jerk (Kabir *et al.* 1991).

According to Kapoor (1993), some flies make mines and a few form galls on different parts of the plants. Singh (1985) reviewed 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. The cracks on fruits serve as the predisposing factor to cause pathogenic infection resulting in decomposition of fruits.

Maggots feed inside the fruits, but some times, also feed on flowers, and stems. Generally, the females prefer to lay the eggs in soft tender fruit tissues by piercing them with the ovipositor. A watery fluid oozes from the puncture, which becomes slightly concave with seepage of fluid and transforms into a brown resinous deposit. Sometimes pseudo-punctures (punctures without eggs) have also been observed on the fruit skin. This reduces the market value of the fruit. In Hawaii, pumpkin and squash are heavily damaged even before fruit set. The eggs are laid into unopened flowers, and the larvae successfully develop in the taproots, stems, and leaf stalks (Weems and Heppner 2001). The vinegar fly, *Drosophilla melanogaster* has also been observed to lay eggs on the fruits infested by melon fly, and acts as a scavenger (Dhillon *et al.* 2005).

Rate of infestation and yield loss by fruit fly

Borah and Dutta (1997) studied the infestation of Tephritids on the cucurbits in Assam, India and obtained the highest fruit fly infestation rate in snake gourd (62.02%). Larger proportion of marketable fruits was obtained from ash gourd in Kharif 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 *D. cucurbitae (B. cucurbitae)* and *D. tau* on cucurbits in India during 1986-87 and recorded that 80% infestation on cucumber and bottle gourd in July-August and 60% 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. Among these vegetables the intensity of fruit fly infestation was numerically the highest in sweet gourd (32.5-± 3.9) and the lowest in sponge gourd (14.7 ± 4.0).

According to the reports of Bangladesh Agricultural Research Institute (BARI), rate of fruit fly infestation were 22.48, 41.88 and 67.01% for snake gourd, bitter gourd and musk melon, respectively (Anon 1988). Experiment revealed that fruit flies attack melon and teasel gourd within 1 to 11 and 3 to 11 days after fruit setting when the average fruit size ranged from 1.38 x 0.78 cm to 3.53 x 2.07 cm and 2.13 x 1.18cm to 4.98 x 3.1 cm, respectively (Anon 1988). Maximum infestation (26.67%) in melon occurred in the 4th day after fruit setting when average fruit size was 2.03 x 1.08 cm. In teasel gourd, it was 19.28% on 8th day after fruit setting when average fruit size was 4.57 x 2.91 cm (Anon., 1988). Amin (1995) and Uddin (1996) observed 42.08 and 45.14% fruit fly infestation in cucumber, respectively.

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 fruit 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 the infestation often reaches up to 100%. Other cucurbit might also be infested 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 S 655738.

Fruit infestation by melon fruit fly in bitter gourd has been reported to vary from 41 to 89% (Gupta and Verma 1978, Rabindranath and Pillai 1986). The melon fruit fly has

been reported to infest 95% of bitter gourd fruits in Papua New Guinea, and 90% snake gourd and 60 to 87% pumpkin fruits in Solomon Islands (Hollingsworth *et al.* 1997). Singh *et al.* (2000) reported 31.27% damage on bitter gourd and 28.55% on watermelon in India. But no work has been done about the level of infestation and yield loss caused by fruit fly on ridge gourd in Bangladesh.

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. Yao and Lee (1978) observed that populations of oriental fruit fly were higher in the ripening season of any fruit in Taiwan. Nasiruddin (1991) observed that the incidence of fruit flies was the highest in February and the lowest in September. Kapoor (1993) reviewed that the fruit fly *B. cucurbitae* Coquillett and *B. zonata* Saunders are active throughout the year except for a short period from December to mid February due to excessive cold when they hide under the leaves of guava, citrus fruits and mangoes etc. Narayan and Batra (1960) reported that most of the fruit fly species are more or less active at temperatures ranging between 12°C - 15°C and become inactive below 10°C. Cucurbit fruit fly 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 rapidly 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 adult of melon fly, *B. cucurbitae* over winter in 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.

Life history of fruit fly

The adult fly *(B. cucurbitae)* is about 8 mm in body length; reddish brown in color with yellow stripes on its dorsal thorax and has brown spots along the veins otherwise clear wings. In late ours of the day, the female flies lay eggs on the tender fruits. The eggs lay by *B. cucurbitae* inside the fruit, which are creamy, white in color; oblong; banana shaped and is about 1.3 mm in length (Anon 1987). Eggs are normally inserted under the skin of the fruits, vegetables, nuts or fleshy parts of plants, stems or flowers where they are protected from sun (Feron *et al.* 1958). The maggots feed inside just after hatching from the eggs. The creamy white maggot gradually becomes darker as it matures. The length of mature larvae is about12 mm. The full grown larvae come out of the bores and make a loop holding the last abdominal segment by mouth hook and drop forcedly on the soil by releasing their mouth hook for pupation. This phenomenon takes place usually in the early morning between 6:00 am to 9:00 am. The most of the full grown larvae penetrate the soil rapidly and pupate under the soil surface. The larval period is 4-7 days, varying with temperature, nutritional condition, larval rearing density etc. (Anon 1987). Pupation formation may require as little as one hour and complete within the puparium by less than 48 hours (Christenson and Foot 1960). The larvae spend 4^{lh} instar in the puparium formed by the exuviae of the 3rd instar and subsequently become pupae. The puparium is 4.8 to 6.0 mm in length. At 23-25°C, the pupal stage lasts for 8-12 days. At 27°C, the mean

pupal period for *B. dorsalis* and *Ceratitis capitata* (Wiedemann) is 10 days and that for *B. cucurbitae* is 9 days (Mitchell *et al.* 1965).

Mating between the adult melon fruit flies generally takes place at about dusk and lasts for about an hour or more (Narayan and Batra 1960). Mating starts in the evening and continues till dawn. Melon flies may mate every 4-5 days. Females found to lay eggs up to 7-10 days. Eggs are laid @ 7-10 per female per day. A female melon fly can lay a total of 800-900 eggs during her life span with approximately 50% fertility (Vargas *et al.* 1984). According to Janjua (1948), the pre-oviposition period of *D. (Strumeta) ferrugeneus* is two to five days but it may range from ten to fifteen days or longer in varying conditions of climate and diet. In another report of Butani and Jotwani (1984) indicates that the pre-oviposition periods of melon fly lasts for 9-12 days. A single life cycle is completed in 10 to 18 days but it takes 12 to 13 weeks in winter. Adult longevity is 2 to 5 months; females live longer than males. Generally, males die soon after fertilizing the females, whereas, females die after completing egg lying. Nair (1986) reported that the flies, which emerge in the morning hours, oviposit for four days in autumn and nine to thirty days in winter. Adults begin to copulate 9-12 days after emergence and the longevity of adult fly is one to five months in the laboratory and under the optimum condition, the length of one generation is around one month (Anon 1987).

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°C, respectively. 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 (Samalo *et al.* 1991). High temperatures, long period of sunshine and plantation activates influence the *B. cucurbitae* abundance in the Northeastern Taiwan

(Lee *et al.*, 1992). Development from egg to adult stage takes 13 days at 29°C in Solomon Islands (Hollingsworth *et al.* 1997). There are 8 to 10 generations in a year (White and Elson-Harris 1994, Weems and Heppner 2001).

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 pest, there is not a single such method which has so far been successfully reduced the damage of fruit fly. This perhaps, is mainly due to the polyphagous 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-headings:

A. Cultural control

Cultural methods of pest control aim at either reducing insect population or inoculum potential of pathogens or preventing damages due to pests, either encouraging a healthy growth of plants or circumventing the attack by changing various agronomic practices (Chattopadhay 1991). The importance of these methods lies on the basic fact that usually comparatively little additional expenditure-capital or recurring, or effort is involved except in adjustment in the cropping system. The cultural practices used for controlling fruit flies were described under few headings.

a. Field sanitation

Field sanitation is an essential prerequisite to reduce insect population or defer the possibilities of the appearances of epiphytotics (Reddy and Joshi 2004). Measures adopted destruction and eradication of crop residues, stubbles, affected plants or plants parts, weeds, alternate host, collateral host etc. (Chattopadhay 1991). Once the eggs are laid by female fruit fly and the larvae hatched inside the fruit, it becomes essential to look for the available measures to reduce their damage on fruit. One of

safer measure is the filed sanitation (Nasiruddin and Karim 1992). In this method, the infested fruits on the plant or fallen on die ground should be collected and buried deep into the soil or cooked and fed to animals (Kapoor 1993). Agarwal *et al.* (1987) mentioned that proper sanitation is essential for controlling fruit fly. Good sanitation practices are recommended in the urban areas of the northern territory of Australia for controlling *B. aquilonis* and *B. jarvisi* on fruits and vegetables at home garden (Smith 1992). Sanitation, wild host destruction are widely used in USA for controlling Mediterranean fruit fly *Ceratilis capitata* (Mitchell and Saul 1990).

The most effective method in melon fruit fly management uses primary component-field sanitation. To break the reproduction cycle and population increase, growers need to remove all un-harvested fruits or stubbles from a field by completely burning them deep into the soil. Burying damaged fruits 0.46 m deep in the soil prevents adult fly eclosion and reduces population increase (Klungness *et al.* 2005).

b. Hand picking of infested fruits

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, mango, guava, peach, etc. and many tissue borers of plants (Mitchell and Saul 1990, Chattopadhay 1991).

B. Physical Control

Sometimes attempts were made to control insects by the physical manipulation of environment or employment of physical sources.

a. Bagging of fruits

Sometimes each and every fruit is covered by a paper or polythene bag to block the contact of flies with the fruit thereby protecting from oviposition by the fruit fly. This is quite useful when the fruits are within the reach and the number of fruits to be

covered is less. This is a tedious task for big commercial orchards (Kapoor 1993). Simple bagging procedures without considering the days after anthesis and period of retaining the bags were conducted by few authors. Bagging bitter gourd in Taiwan at the stage of 3-4cm fruit length and sponge gourd at 5-6 cm length with two layers of paper bags every after 2-3 days against *B. cucurbitae* increased yield by 40-58 percent compared to control (Fang, 1982). Amin (1995) obtained significantly lowest fruit fly infestation (4.61%) in bagged cucumber compared to other chemical and botanical control measures. Bagging of cucumber with perforated polythene bags at immature stage significantly reduced the fruit fly infestation (Uddin *et al.* 1998 and Akhterruzzaman 1999). Covering of teasel gourd by polythene bag reduced the fruit fly infestation substantially (Anon. 1988).

b. Wire netting

Fine wire netting surrounding the small orchard was found effective in not only saving the fruit from the attack of fruit flies but also protect the fruit crops against their vertebrate pests like squirrels, rats, birds etc (Kapoor 1993).

C. Bait sprays:

The dacine fruit flies have long been recognized to be susceptible to attractants. The breakthrough to principle was achieved around the fifties when protein lures were discovered. Protein hydrolysate insecticide formulations are now used against various dacine fruit fly species (Kapoor 1993). Presently the poison baits used for various *Dacus* species are 20g Malathion 50 percent or 50ml of Diazinon plus 200g of molasses in 2 liter of water kept in Hot containers or applying the bait spray containing Malathion 0.05 percent plus 1 percent sugar/molasses or 0.025 percent of protein hydrolysate (20ml of malathion 50Ec and 200g of sugar/ molasses in 20 liter of water) or spraying plants with 500g molasses plus 50g malathion in 50 liter of

water or 0.025 percent Fenitrothion plus 0.5 percent molasses. This is repeated at weekly intervals were the fruit fly infestation is serious (Kapoor 1993). Agarwal *et al.* (1987) achieved very good results for fruit fly (*D. cucurbitae*) management by spraying the plants with 500g molasses and 50g malathion in 50 liter water at 7 days intervals. In Hawaii, poison bait containing malathion and protein hydrolysate gave better results in fruit fly management program (Steiner *et al.* 1988).

Baiting (with malathion in protein bait sprays) is a good method for the control of *B. aquilonis* and *B. jarvisi* on fruits and vegetables in home gardens in the north territory of Australia (Smith 1992). Bait spray (1.0g Depterex 80SP and 100g of molasses per liter of water) on snake gourd against fruit fly (*B. cucurbitae*) showed 8.50 percent infestation compared to 22.48 percent in control (Nasiruddin and Karim 1990). It is advisable to spray the lower surface of leaves as these flies have the habit of resting there. The flies are attracted to sugar solution and are killed while trying to feed on them. The time of repeated applications is adjusted in such a way that it is less than the required time for the sexual maturation of newly emerged adult flies. This is useful for efficient destruction of the population as a whole, rather than only the individuals (Kapoor 1993).

D. Use of attractants and repellents

Trapping with the use of olfactory lures constitutes an important aspect of biotechnical methods for the management of fruit fly population, detection, seasonal occurrence and collection for taxonomic purposes (Iwahashi 1972; Tanaka *et al.* 1978 and Kapoor 1993). Since the traps lead to minimal environmental pollution, a lot of emphasis has been laid over the pest decades to develop more effective traps. A successful suppression programme has been reported from Pakistan were mass trapping with methyl eugenol, from 1977 to 1979, reduced the infestation of *B. zonata*

below economic injury levels (Qureshi *et al.* 1981). Mahmood and Mohyuddin (1986) reported that the maximum mango fruit infestation was 1-3 percent in the orchard, where methyl eugenol was used compared with 30-35 percent in orchard, where traps were not used. Similarly, *D. dorsalis* was eradicated from the island of Rota by male annihilation using methyl eugenol as attractant (Steiner *et al.* 1965). But the finding of Mitchell *et al.* (1985) regarding methyl eugenol was controversial. They mentioned that a widely used lure methyl eugenol is a liver carcinogenic agent; therefore an attempt was undertaken by the Department of Entomology, University of Hawaii at Manoa, Honolulu, USA to replace this chemical. There components were selected on the basis of laboratory and preliminary field evaluation as promising replacements of this chemical. They are 3, 4-Dimethoxy-propylbenzene, 3, 4 Dimethoxyethoxy-benzene and 3, 4 Dimethoxy-methoxymethyl-benzene. Like Pakistan, Bangladesh Agricultural Research Institute has also developed a simple and cheaper method of poison bait trap which showed 31.18 to 95.07 percent reduction of fruit fly infestation in cucurbit fruits as compared to those in untreated plots (Nasiruddin and Karim 1991). The bait material was prepared by adding 0.5g of Dipterex 80SP/Cekufon 80SP with 100g sweet gourd mass and 100 ml water. The was kept in a small earthen pot supported by three split bamboo sticks at the center of the plot at a height of 50cm above ground level. Another earthen plate was placed 20 cm above the bait container which protected the bait material from sun and rain. The mash was changed at an interval of four days but the insecticide was added to the bait material every alternate day.

In a study, 15.34 and 15.36 percent fruit fly infestation in bitter gourd was observed in baited and bait sprayed plots, respectively and was significantly lower than that obtained in control plots (36.55%) (Anon.1990). Nasiruddin and Karim (1992)

reported a lower rate of infestation in snake gourd (6.47%) when treated with bait spray (Dipterex 80SP + molasses) compared to those of control (22.48%).

The attractant may be effective to kill the captured flies in the traps as reported by several authors. One percent methyl eugenol plus 0.5 percent malathion or 0.1 percent Carbaryl (Lakshmann *et al.* 1973) or 0.1 percent methyl eugenol plus 0.25 percent malathion (Bagle and Prasad 1983) have been used for trapping the oriental fruit fly, *B. zonata*. Lall and Singh (1969) used palm juice/ sugar / dried mango juice / oil of citronella mixed with 10 percent Diazinon as bait for trapping *B. cucurbitae*. A formulation of 85 percent methyl eugenol mixed with 10 percent sugar and 5 percent naled has also been found useful for trapping *B. zonata* and *B. dorsalis* (Kappor 1993). Cunningham and Suda (1985) used Min-U-Gel 400 as a thickening agent for formulation of the lure, methyl eugenol mixed with malathion applied to guava leaves in buckets for the annihilation of *B. dorsalis*.

Research efforts during the last decade have culminated in the development of an effective trapping method for the control of *B. oleae* in Greece (Haniotakis *et al.* 1991). The method combines a food attractant, a phagostimulant, a male sex pheromone, a female aggregation pheromone with additional arrestant and aphrodisiac properties and a hygroscopic substance on an insecticide treated wood board. The method eliminated an average of 4 (3-5) insecticide sprays required per season for the control of this pest. Reduced pesticide use by 99 percent per treatment and is being introduced gradually by the Greek Ministry of Agriculture to replace the use of bait or cover sprays that have been used for decades.

Neem derivatives have been demonstrated as repellents, antifeedants, growth inhibitors and chemosterilant (Butterworth and Morgan 1968, Leuschner 1972, Steets 1976). Singh and Srivastava (1985) found that alcohol extract of neem oil,

Azadirachta indica (5%) reduced oviposilion of *B. cucurbitae* on bitter gourd completely and its 20 per cent concentration was highly effective to inhibit oviposition of *B. zonata* on guava. Stark *et at.* (1990) studied the effect of Azadiractin on metamorphosis, longevity and reproduction of *Ceratitis capitata* (Wiedemann), *B. cucurbitae* and *B. dorsatis.*

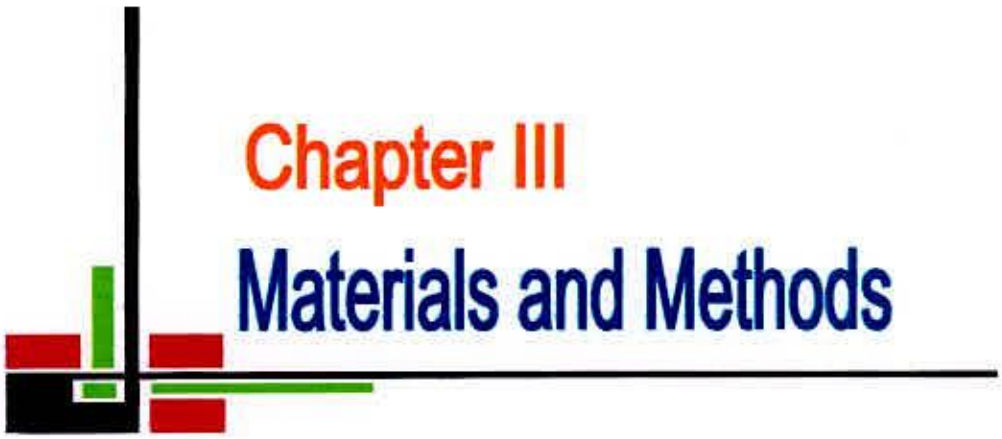
E. Use of color ribbons

Hill (1983) reported aphids and some other plant bugs are attracted to yellow colors; this is possibly because most aphids feed either on young or senescent leaves, presumably because these are the plant parts where active transport of food material occurs. The young leaves are photosynthesizing rapidly and the sugars formed are transported away in the phloem system to be stored as starch grains in older leaves, tubers, etc. As leaves become senescent, the stored starch is reconverted into soluble sugars for transportation prior to leave dehison. Senescent leaves are usually yellowish in color and young foliage is often a pale yellowish-green. So the attraction of aphids to yellow colors seems fairly obvious, but why so many flies (especially Anthomyiidae) and some moths are similarly attracted to yellow is not obvious.

Conversely, many flying insects are repelled by blue colors and by reflective material. This has been exploited by using strips of aluminium foil, or metalicized plastic, between the rows and around the periphery of the crop, the result being that fewer flying aphids and other insects settle in the crop than would otherwise. Thus, reflecting stripe also result in crops having far less aphid-borne virus disease.

Atwal and Dhaliwal (1999) suggested using red light in the monsoon to keep away most of insects, and to keep the fields well lit with white light at night to protect against certain insects has been quite effective. Light reflection by alluminium foil is effective against aphids.

An experiment was conducted by Rahman (2001) to evaluate the efficacy of silver color ribbons as the management approaches for suppressing fruit fly infestation on bitter gourd and revealed that the treatment effect on overall fruit infestation by number was lowest (27.59%) to comprising hand picking of infested fruits plus bait spray with malathion 57 EC and molasses and that was numerically followed by silver color ribbon, hand picking of infested fruits plus bait trap.



Chapter III

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

The present study was conducted to evaluate the comparative effectiveness of some eco-friendly management practices applied against fruit fly infesting ridge gourd in the experimental field of Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh during March to July, 2007. The treatments and their application procedures adopted in this study are discussed below:

Treatments

T_1 = Hand picking and destruction of infested fruits from the plot at 7 days interval

T_2 = Bagging of tender fruit by porous polythene bag at 3 days after anthesis and left for 5 days

T_3 = Bait spray prepared with molasses and malathion in the proportion of 1 : 0.01 : 100 (25 g of molasses, 2.5 ml of malathion 57 EC and 2.5 litre of water) and replace the bait by newly made one at 7 days interval

T_4 = Use of attractants (bait traps) comprising Cekufon 80 SP (0.5g) mixed with 100g of sweet gourd mash and 100 ml water) and replace the trap at 7 days interval

T_5 = Spraying of neem oil @ 3% [75 ml neem oil and 1 ml trix (liquid detergent) mixed with 2.5 liters of water) at 7 days interval

T_6 = Use of silver color ribbon between the rows and around the periphery of the plot

T_7 = Untreated control.

Climate of the experimental area

The experimental area was characterized by subtropical rainfall during the month of May to September (Anon. 1988) and scattered rainfall during the rest of the year (Appendix I).

Soil of the experimental field

Soil of the study site (Appendix II) was silty clay loam in texture belonging to series. The area represents the Agro-Ecological Zone of Madhupur tract (AEZ-28) with pH 5.8-6.5, CEC-25.28 (Haider *et al.* 2001). .

Land preparation

The soil was well prepared and good tilth for commercial crop production. The target land was divided into 21 equal plots (3 m × 2 m) with plot to plot distance of 1.0 m and block to block 1.0 m. The field layout and design of the experiment were done immediately after land preparation.

Manure and fertilizer

Recommended fertilizers were applied at the rate of 500 kg urea, 400 kg triple super phosphate (TSP) and 20 kg muriate of potash (MP) per hectare (Rashid 1993) as source of nitrogen, phosphorus and potassium, respectively. Moreover, well-decomposed cowdung (CD) was also applied at the rate of 10 ton/ha to the field at the time of land preparation.

Design of experiment and layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The whole area of experimental field was divided into 3 blocks and each block was again divided into seven unit plots. The size of the unit plot was 3.0 m ×2.0 m. The block to block and plot to plot distance was 1.0 m and 1.0 m, respectively.

Raising seedlings

Seeds of hybrid ridge gourd variety were collected from the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. The seeds were sown in polythene bag containing 50% well decomposed cow dung and 50% sandy loam soil. A single seedling of 20 day old was transplanted in each pit of the experimental plots. Thus there were 126 plants in the field with 18 plants per treatment.

Cultural practices

After transplanting the seedlings, a light irrigation was applied and necessary shade was provided for 2 to 3 days by using banana pseudostem. Damaged seedlings were replaced by new ones from the stock. Propping of each plant using bamboo sticks (1.83 m height) was provided to facilitate creeping of the plants. Bamboo sticks tied with galvanized iron wire running 1.68 m above ground from one end to the other of each plot fixed with two additional bamboo pillars located at each end. This would provide extra support to avoid lodging of the plants.

Supplemental irrigation was applied at an interval of 7-8 days. Hand picking and destructions were done in each plot for controlling aphid and red pumpkin beetle before flowering. After flowering some red pumpkin beetles were found particularly in the untreated plots and also controlled by hand picking. Weeding and mulching in the plots were also done.

Treatment application

The treatments used under the present study are elucidated as follows:

Hand picking of infested fruits

Regular visual checking of infested fruits of each plot was done at 7 days interval and the infested fruits of the relevant plots were picked up and their numbers were recorded. Then collected infested fruits were cut to separate out the edible portion and

non-edible portion of the fruit and weighted separately to find out the percent edible portion of the infested fruits. This procedure was continued from early to late fruiting stage.

Bagging of tender fruits by porous polythene bag

Ridge gourd is a cross-pollinated crop and both the male and female flowers are generally open in the morning and are fertilized naturally by cross pollination (Rashid 1993). In the morning (8.0 A.M to 9:30 A.M), the hand pollinated and naturally pollinated flowers were checked and recorded the pre-treatment infestation data and then covered the tender fruit at 3 days after anthesis of flowers by transparent polythene bag having a few holes made with an ordinary pin. The size of the bag (30cm x 15cm) used was large enough not only to allow future growth of the fruit but also to allow sufficient sunlight to reach the fruits. A few tiny holes were made at the bottom of the bag to allow the rain water (if any) to be drained off. Drainage is essential to avoid the growth of fungus or mould on fruits. The mouth of the bag was closed by jams clip at the peduncle of a fruit. In this way almost all the tender fruits were covered. These bags were left for 5 days and then removed. This bagging operation was completed in the early morning before the beginning of frequent visit by the fruit fly to prevent their oviposition. At harvestable stage, the bagged fruits were collected and the post-treatment infestation data were recorded along with other fruits harvested from other treatments. These operations were undertaken continuously throughout the reproductive stages of plant with the appearance of new fruits until the last economic harvest. This bagging had probably acted as physical barrier against gravid females ready for oviposition.

Bait spray prepared with molasses and malathion

The bait was prepared by mixing molasses and malathion 57 EC with water in the proportion of 1: 0.1: 100. For the purpose of this study the bait spray was prepared by mixing 25g of molasses, 2.5ml of malathion 57 EC and 2.51 litre of water. This bait spray was applied uniformly on the selected plots and obtained complete coverage. The molasses attracted the fruit flies and malathion 57 EC acted contact poison. Caution was taken to avoid drift in other treated and control plots. The bait spray was applied at 7 days interval.

Use of poison bait trap

The poison bait trap was consisted of 0.5g Cekufon 80 SP (trichlorfon), mixed with 100 g of sweet gourd mash and 100 ml water. The bait was kept in a small earthen pot placed within a three splitted bamboo sticks, 50 cm above the ground (Plate 1). An earthen cover plate was placed 20 cm above the bait container to protect the bait material from sun and rain. One such traps were placed at the center of each selected plot. The number of adult fruit flies (male and female) trapped in those bait traps were recorded daily in the morning. The old bait materials were changed at an interval of 7 days and fresh ones were placed there for further use.

Spraying of neem oil

Neem oil was collected from Siddique Bazar, Dhaka. The required spray volume was prepared by mixing 75 ml neem oil (3%), 1 ml trix (liquid detergent as mixing agent) with 2.5 litres of water. The detergent was used to break the surface tension of water and to help the solubility of neem oil in water. This preparation may have repelling and antifeedant actions against fruit fly. The mixture was sprayed at 7 days interval selected plots.

Plate 1. Setting of bait trap for fruit fly on earthen pot

Use of colour ribbon

The silver color ribbon collected from local market used between the rows and around the periphery of the plot. These ribbons reflect the light to deter the fruit flies from the selected plots. As a result, fruits remain uninfested by the flies.

Untreated control

The randomly selected three plots were kept untreated, where no treatment was used.

Data collection and calculation

The data were recorded on the number of fruits harvested at three reproductive stages of plant, viz., early, mid and late fruiting stages. At early fruiting stage three harvests were made. During mid fruiting stage two harvests were undertaken. After the final application, only one harvest was done.

In the experiment the effectiveness of each treatment was evaluated on the basis of some pre-selected parameters. The following parameters were considered during data collection before and after treatment application at four reproductive stages as described. Number and weight of the healthy fruit (HF) and infested fruit (IF), infestation rate of fruit fly on ridge gourd and reduction of fruit weight due to fruit fly infestation. Infestation of fruit and fruit weight reduction were calculated in percent using the following formulae:

$$\% \text{ Fruit infestation} = \frac{\text{Number of IF}}{\text{Number of HF - Number of IF}} \times 100$$

$$\%\text{Weight reduction} = \frac{\text{Weight of HF - Weight of IF}}{\text{Weight of HF}} \times 100$$

Economic analysis of the treatments

Economic analysis in terms of benefit cost ratio (BCR) was analyzed on the basis of total expenditure of the respective management practices along with the total return from that particular treatment. In this study BCR was analyzed for one hectare of land. For this analysis following parameters were considered:

Treatment wise management cost/variable cost

This cost was calculated by adding all costs incurred for labours and inputs for each management treatment including untreated control during the entire cropping season. The plot yield (kg/plot) of each treatment was converted into ton/ha yield.

Gross Return (GR): The yield in terms of money that was measured by multiplying the total yield by the unit price of ridge gourd (Tk 20/kg).

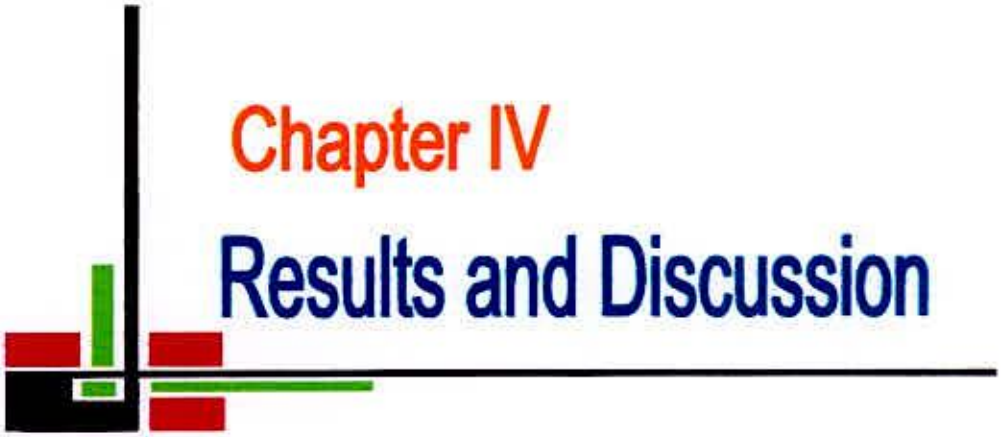
Net Return (NR): The NR was calculated by subtracting treatment wise management cost from gross return.

Adjusted Net Return (ANR): The ANR was determined by subtracting the net return for a particular management treatment from the net return with control plot. Finally, BCR for each management treatment was calculated by using the following formula described by Elias and Karim (1984):

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Adjusted net return}}{\text{Total management cost}}$$

Statistical analysis

Data were analyzed by MSTAT-C software. The Duncan's Multiple Range Test (DMRT) was used to separate the means and determine the level of significance. The correlation studies were also done to make the relationship among different parameters.



Chapter IV

Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

The present study was conducted to evaluate the effectiveness of some selected eco-friendly management practices applied against cucurbit fruit fly on ridge gourd. The analysis of variance (ANOVA) of the data on fruit infestation and different yield contributing characters are given in Appendix III-VIII. The results have been presented and discussed with interpretations under the following sub-headings:

4.1 Effect of management practices on fruit bearing status at early fruiting stage

4.1.1 Effect on number of ridge gourd

The number of healthy fruit at early fruiting stage for the selected management practices showed a statistically significant difference (Appendix III). The highest number of healthy fruit per plot (13.89) was recorded in T_5 (spraying of neem oil @ 3% at 7 days interval) (Plate 2). Which was statistically identical with T_2 (bagging of tender fruit by porous polythene bag at 3 days after anthesis and left for 5 days) and T_3 (bait spray consisting molasses and malathion mixing with water in the proportion of 1 : 0.1 : 100, respectively at 7 days interval) (Table 1). On the other hand, the lowest (9.22) number of healthy fruit was recorded in T_7 (untreated control) (Plate 3). This was statistically identical with T_1 (hand picking and destruction of infested fruit), T_6 (use of silver color ribbon) and T_4 (use of bait trap as attractant consisting Cekufon 80 SP + ripe sweet gourd + water at 7 days interval).

Statistically significant variation was also recorded in terms of number of infested fruit per plot at early fruiting stage during the management practices applied against fruit fly on ridge gourd (Appendix III). The highest number of infested fruit (1.44) was recorded in T_7, which was statistically similar with T_1.

Plate 2. T_5 treated plot bearing maximum number of healthy ridge gourd

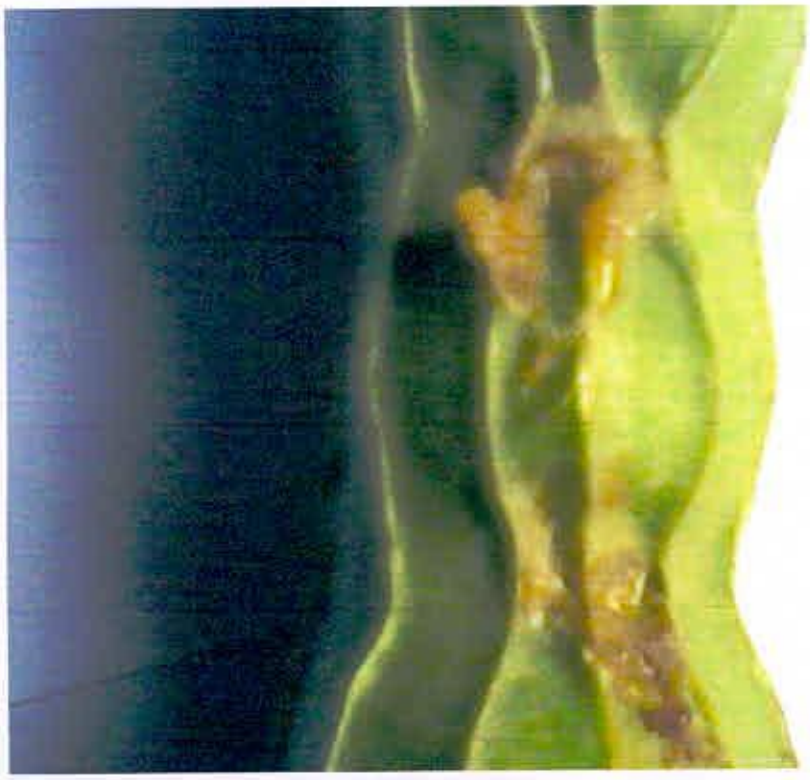


Plate 3. Severely infested ridge gourd produced in untreated control (T_7) plot

Table 1. Effect of different management practices on fruit infestation caused by fruit fly on ridge gourd at early fruiting stage

Treatments	Ridge gourd by number/plot				Ridge gourd by weight (g)			
	Healthy	Infested	% infestation	Infestation reduction over control (%)	Healthy	Infested	% infestation	Infestation reduction over control (%)
T_1	9.33 c	1.11 ab	10.60 ab	21.89	1093.63d	134.07b	10.91b	22.73
T_2	13.00 a	0.56 c	4.04 de	70.23	1558.21a	72.80cd	4.43 de	68.63
T_3	12.33ab	0.67 bc	5.07 cde	62.64	1458.81ab	85.51cd	5.50 de	61.05
T_4	11.00bc	0.78 bc	6.66 cd	50.92	1314.45bc	95.39bd	6.82 cd	51.70
T_5	13.89 a	0.44 c	3.02 e	77.75	1654.50a	64.03 d	3.69 e	73.87
T_6	10.11 c	0.89 bc	8.10 bc	40.31	1196.32cd	111.09c	8.52 c	39.66
T_7	9.22 c	1.44 a	13.57 a	--	1019.83 d	167.59a	14.12 a	--
LSD (.05)	1.90	0.42	3.21	--	203.9	37.66	2.355	--
CV (%)	9.48	27.92	24.73	--	8.63	20.28	17.17	--

In a column, means having similar letter(s) are statistically identical at 0.05 level of probability

T_1 = Hand picking and destruction of infested fruits from the plot at 7 days interval,

T_2 = Bagging of tender fruit by porous polythene bag at 3 days after anthesis and left for 5 days,

T_3 = Bait spray prepared with molasses and malathion in the proportion of 1 : 0.01 : 100 (25 g of molasses, 2.5 ml of malathion 57 EC and 2.5 litre of water) and replace the bait at 7 days interval,

T_4 = Use of attractants (bait traps) comprising Cekufon 80 SP (0.5g) mixed with 100g of sweet gourd mash and 100 ml water) and replace the trap at 7 days interval,

T_5 = Spraying of neem oil @ 3% [75 ml neem oil and 1 ml trix (liquid detergent) mixed with 2.5 liters of water) at 7 days interval,

T_6 = Use of silver color ribbon between the rows and around the periphery of the plot and

T_7 = Untreated control.

On the other hand, the lowest number of infested fruit (0.44) was recorded in T_5, which was statistically identical with T_2 (0.56), T_3 (0.67), T_4 (0.78) and T_6 (0.89) (Table 1). The highest percentage of infested fruit by number (13.57%) was recorded in T_7, which was statistically identical with T_1 (10.60%). While, the lowest percentage of infested fruit by number (3.02%) was recorded in T_5 (Table 1), which was statistically similar with T_2 (4.04%) and T_3 (5.07%) followed by T_4 (6.66%). This was also followed by T_6 (8.10%).

Ridge gourd fruit infestation percentage reduction over control by number was estimated for different management practices and the highest value (77.75%) was recorded for T_5 and the lowest value (21.89%) from T_1 (Table 1). As result, the order of effectiveness of different management practices in reducing percent fruit infestation over control is $T_5 > T_2 > T_3 > T_4 > T_6 > T_1 > T_7$.

From the above findings it is revealed that spraying of neem oil @ 3% at 7 days interval performed best in producing the maximum healthy fruit by producing the minimum infested fruit by number followed by bagging of tender fruits by porous polythene bag at 3 days after anthesis left for 5 days, while in control treatment the situation was reverse under the trial followed by hand picking and destruction of the infested fruit at 7 days interval. According to the reports of Bangladesh Agricultural Research Institute (BARI), the rates of fruit fly infestation were 22.48, 41.88 and 67.01 % for snake gourd, bitter gourd and musk melon, 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%).

4.1.2 Effect on weight of ridge gourd

More or less similar trends of results were also observed and the highest weight (1654.50 g) of healthy fruit per plot was recorded in T_5, which was statistically identical with T_2 (1558.21 g) and T_3 (1458.81 g) followed by T_4 (1314.45g) (Table 1). But the lowest (1019.83 g) weight of healthy fruit was recorded in T_7 (untreated control), which was statistically identical with T_1 (1093.63 g) and T_6 (1196.32 g).

The highest weight (167.59 g) of infested fruit was recorded in T_7 (untreated control), which was statistically similar with T_1 (134.07 g) followed by T_6 (111.09g), T_4 (95.39g). On the other hand, the lowest weight of infested fruit (64.03 g) was recorded in T_5, which was statistically identical (72.80 g and 85.51 g) with T_2 and T_3, respectively.

The highest percentage of infested fruit by weight (14.12%) was recorded in T_7, which was statistically different from all other treatments. This was closely followed (10.91%) by T_1, followed by T_6 (8.52%). But the lowest percentage of infested fruit by weight (3.69%) was recorded in T_5, which was statistically similar (4.43%, 5.50% and 6.82%) with T_2, T_3 and T_4. Ridge gourd fruit infestation percentage reduction over control by weight was estimated for different management practices and the highest value (73.87%) was recorded for T_5 and the lowest value (22.73%) from T_1. As result, the order of effectiveness of different management practices in reducing percent fruit infestation by weight over control is $T_5 > T_2 > T_3 > T_4 > T_6 > T_1 > T_7$.

From the above findings it is also revealed that spraying of neem oil @ 3% at 7 days interval performed best in producing maximum healthy fruit by reducing the fruit fly infestation by weight followed by bagging of tender fruits by porous polythene bag at 3 days after anthesis and left for 5 days, while in untreated control (T_7) treatment

ranked at the bottom followed by hand picking and destruction of the infested fruit from the plot at 7 days interval (T_1).

4.2 Effect of management practices on fruit bearing status at mid fruiting stage

4.2.1 Effect on number of ridge gourd

Number of healthy fruit at mid fruiting stage in controlling fruit fly on ridge gourd showed a statistically significant difference (Appendix IV) and more or less similar trends of results were also observed as found in early fruiting stage. The highest number of healthy fruit per plot (21.00) was recorded in T_5 (spraying of neem oil at 7 days interval) (Table 2). This was statistically similar (19.11 and 18.67) with T_2 and T_3. On the other hand, the lowest (12.44) number of healthy fruit was recorded in T_7 (untreated control). This was statistically identical (14.22, 16.22 and 18.67) with T_1, T_6 and T_4. Statistically significant variation was also recorded in terms of number of infested fruit per plot at mid fruiting stage during the management practices applied against fruit fly on ridge gourd (Appendix IV). The highest number of infested fruit (2.33) was recorded in T_7, which was statistically similar (1.89) with T_1. On the other hand, the lowest number of infested fruit (0.89) was recorded in T_5, which was statistically identical with T_2 (1.11), T_3 (1.33), T_4 (1.44) and T_6 (1.67) (Table 2). The highest percentage of infested fruit by number (15.86%) was recorded in T_7, which was statistically identical with T_1 (11.73%). But the lowest percentage of infested fruit by number (4.12%) was recorded in T_5 (Table 2), which was statistically identical with T_2 (5.50%) and T_3 (6.62%) followed by T6 (9.44%).

The reduction of percent fruit infestation over control by number was estimated for different management practices. The highest reduction over control (74.02%) was recorded in T_5 and the lowest reduction (26.04%) in T_1 (Table 2). As a result, the

order of effectiveness of different management practices in reducing percent fruit infestation over control is $T_5 > T_2 > T_3 > T_4 > T_6 > T_1 > T_7$.

Table 2. Effect of different management practices on fruit infestation caused by fruit fly on ridge gourd at mid fruiting stage

Treatments	Ridge gourd by number				Ridge gourd by weight (g)			
	Healthy	Infested	% infestation	Infestation reduction over control (%)	Healthy	Infested	% infestation	Infestation reduction over control (%)
T_1	14.22 de	1.89 b	11.73b	26.04	1564.41d	220.17b	12.36 b	23.70
T_2	19.11ab	1.11de	5.50 de	65.32	2129.89b	133.03 de	5.87 ef	63.77
T_3	18.67abc	1.33 cd	6.62 d	58.26	2058.99b	163.50 cd	7.33 de	54.75
T_4	17.55 bc	1.44 cd	7.60 cd	52.08	1925.41bc	173.97 c	8.28 cd	48.89
T_5	21.00 a	0.89 e	4.12 e	74.02	2363.80 a	114.23 e	4.62 f	71.48
T_6	16.22 cd	1.67 bc	9.44 c	40.48	1786.12cd	187.90bc	9.60 c	40.74
T_7	12.44 e	2.33 a	15.86 a	--	1331.87 e	256.70 a	16.20 a	--
LSD (05)	2.63	0.36	2.12	--	229.0	32.97	1.79	--
CV (%)	8.70	13.25	13.7	--	6.85	10.38	10.96	--

In a column, means having similar letter(s) are statistically identical at 0.05 level of probability

T_1 = Hand picking and destruction of infested fruits from the plot at 7 days interval,

T_2 = Bagging of tender fruit by porous polythene bag at 3 days after anthesis and left for 5 days,

T_3 = Bait spray prepared with molasses and malathion in the proportion of 1 : 0.01 : 100 (25 g of molasses, 2.5 ml of malathion 57 EC and 2.5 litre of water) and replace the bait at 7 days interval,

T_4 = Use of attractants (bait traps) comprising Cekufon 80 SP (0.5g) mixed with l00g of sweet gourd mash and 100 ml water) and replace the trap at 7 days interval,

T_5 = Spraying of neem oil @ 3% [75 ml neem oil and 1 ml trix (liquid detergent) mixed with 2.5 liters of water) at 7 days interval,

T_6 = Use of silver color ribbon between the rows and around the periphery of the plot and

T_7 = Untreated control.

From the above findings it is revealed that T_5 (spraying of neem oil @ 3% at 7 days interval) performed best in producing the maximum healthy fruit by producing the minimum infested fruit by number followed by T_2 (bagging of tender fruits by porous polythene bag at 3 days after anthesis left for 5 days). While in T_7 (untreated control), the situation is reverse under the trial followed by T_1 (hand picking and destruction of the infested fruit at 7 days interval).

4.2.2 Effect on weight of ridge gourd

Considering the effectiveness of different management practices on weight of ridge gourd during the management of fruit fly, more or less similar trends of results were also observed as found in the effect on the number of ridge gourd. The highest weight of healthy fruit per plant (2363.80 g) was recorded in T_5, which was statistically identical (2129.89 g and 2058.99 g) with T_2 and T_3, respectively followed by T_4 (1925.41g). But it was lowest (1331.87g) in T_7 (untreated control). This was statistically identical (1564.41 g and 1786.12g) with T_1 and T_6, respectively. Similarly, the highest weight of infested fruit (256.70 g) was recorded in T_7, which was statistically similar (220.17 g) with T_1 followed by T_6 (187.90g) and T_4 (173.97g). On the other hand, it was lowest (114.23 g) in T_5, which was statistically identical (133.03 g and 163.50g) with T_2 and T_3 (Table 2). The highest percentage of infested fruit by weight (16.20%) was also recorded in T_7. This was statistically different from all other treatments followed by T_1 (12.36%) and T6 (9.60%). But it was lowest (4.62%) in T_5, which was statistically similar (5.87%, 7.33% and 8.28%) with T_2, T_3 and T_4, respectively (Table 2)

Considering the percent reduction of fruit infestation over control by weight, the highest reduction (71.48%) was recorded in T_5 and it was lowest (23.70%) in T_1 (Table 2). As result, the order of effectiveness of different management practices in

reducing percent fruit infestation by weight over control is $T_5 > T_2 > T_3 > T_4 > T_6 > T_1 > T_7$.

From the above findings it is also revealed that T_5 (spraying of neem oil @ 3% at 7 days interval) performed best in producing maximum healthy fruit by reducing the fruit fly infestation by weight followed by T_2 (bagging of tender fruits by porous polythene bag at 3 days after anthesis and left for 5 days). But T_7 (untreated control) ranked at bottom followed by T_1 (hand picking and destruction of the infested fruit from the plot at 7 days interval). Singh *et al.* (2000) reported 31.27% damage on bitter gourd and 28.55% on watermelon in India.

4.3 Effect of management practices on fruit bearing status at late fruiting stage

4.3.1 Effect on number of ridge gourd

Number of healthy fruit at late fruiting stage in controlling fruit fly on ridge gourd showed a statistically significant difference (Appendix V) and more or less similar trends of results were also observed as found in early and mid fruiting stage. The highest number of healthy fruit per plot (15.56) was recorded in T_5 (spraying of neem oil @ 3% at 7 days interval) (Table 3). This was statistically similar (14.11 and 13.22) with T_2 (bagging of tender fruit by porous polythene bag at 3 days after anthesis and left for 5 days) and T_3 (bait spray consisting molasses and malathion at 7 days interval), respectively (Table 3). On the other hand, the lowest (10.89) number of healthy fruit was recorded in T_7 (untreated control). This was statistically identical (11.33, 12.11 and 12.89) with T_1 (hand picking and destruction of infested fruit) and T_6 (use of silver color ribbon) and T_4 (use of bait trap as attractant consisting Cekufon 80 SP + ripe sweet gourd + water). Similarly, the highest number of infested fruit (2.44) was recorded in T_7, which was statistically similar (2.00) with T_1. On the other

hand, the lowest number of infested fruit (1.11) was recorded in T_5. It was statistically similar with T_2 (1.33), T_3 (1.44), T_4 (1.56) and T_6 (1.78) (Table 3). The highest percentage of infested fruit by number (18.33%) was recorded in T_7, which was statistically identical with T1 (15.07%). But the lowest percentage of infested fruit by number (6.66%) was recorded in T_5 (Table 3). It was statistically similar with T_2 (8.63%), T_3 (9.87%), T_4 (10.89%) and T_6 (12.80%) (Table 3).

Table 3. Effect of different management practices on fruit infestation caused by fruit fly on ridge gourd at late fruiting stage

Treatments	Ridge gourd by number				Ridge gourd by weight (g)			
	Healthy	Infested	% infestation	Infestation reduction over control (%)	Healthy	Infested	% infestation	Infestation reduction over control (%)
T_1	11.33 de	2.00 b	15.07 b	17.79	1076.83de	202.10ab	15.84 b	15.92
T_2	14.11ab	1.33 de	8.63 de	52.92	1336.48ab	138.20cd	9.39 de	50.16
T_3	13.22 bc	1.44cde	9.87 cd	46.15	1251.38bc	145.83cd	10.45 d	44.53
T_4	12.89bcd	1.56 cd	10.89 cd	40.59	1220.85bcd	155.43 c	11.38cd	39.60
T_5	15.56 a	1.11 e	6.66 e	63.67	1488.73 a	113.58 d	7.07 e	62.47
T_6	12.11cde	1.78 bc	12.80 bc	30.17	1147.32cde	177.00bc	13.35bc	29.14
T_7	10.89 e	2.44 a	18.33 a	--	1034.15 e	239.90a	18.84 a	--
LSD (.05)	1.635	0.386	2.927	--	154.8	38.04	2.692	--
CV (%)	7.14	12.98	14.00	--	7.12	12.77	12.27	--

In a column, means having similar letter(s) are statistically identical at 0.05 level of probability

T_1 = Hand picking and destruction of infested fruits from the plot at 7 days interval,

T_2 = Bagging of tender fruit by porous polythene bag at 3 days after anthesis and left for 5 days,

T_3 = Bait spray prepared with molasses and malathion in the proportion of 1 : 0.01 : 100 (25 g of molasses, 2.5 ml of malathion 57 EC and 2.5 litre of water) and replace the bait at 7 days interval,

T_4 = Use of attractants (bait traps) comprising Cekufon 80 SP (0.5g) mixed with 100g of sweet gourd mash and 100 ml water) and replace the trap at 7 days interval,

T_5 = Spraying of neem oil @ 3% [75 ml neem oil and 1 ml trix (liquid detergent) mixed with 2.5 liters of water) at 7 days interval,

T_6 = Use of silver color ribbon between the rows and around the periphery of the plot and

T_7 = Untreated control.

The reduction of percent fruit infestation over control by number was estimated for different management practices and the highest reduction (63.67%) was recorded in T_5 and it was lowest (17.79%) in T_1 (Table 3). As a result, the order of effectiveness of different management practices in reducing percent fruit infestation over control is $T_5 > T_2 > T_3 > T_4 > T_6 > T_1 > T_7$.

From the above findings it is revealed that T_5 (spraying of neem oil @ 3% at 7 days interval) performed best in producing the maximum healthy fruit by producing the minimum infested fruit by number followed by T_2 (bagging of tender fruits by porous polythene bag at 3 days after anthesis left for 5 days), while in T_7 (untreated control) was the lowest followed by T_1 (hand picking of the infested fruit and destruction of infested fruit at 7 days interval). 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%).

4.3.2 Effect on weight of ridge gourd

Considering the effectiveness of different management practices on weight of ridge gourd during the management of fruit fly, more or less similar trends of results were also observed as found in the effect on the number of ridge gourd. The highest weight of healthy fruit per plot (1488.73 g) was recorded in T_5, which was statistically identical (1336.48 g and 1251.38 g) with T_2 and T3, respectively followed by T4 (1220.85g) (Table 3). But the lowest (1034.15 g) weight of healthy fruit was recorded in T_7 (untreated control), which was statistically identical (1076.83 g and 1147.32g) with T_1 and T6, respectively.

The highest weight of infested fruit (239.90 g) was recorded in T_7, which was statistically similar (202.10 g) with T_1 followed by T_6 (177.00g), T4 (155.43g). On the

other hand, the lowest weight of infested fruit (113.58 g) was recorded in T_5, which was statistically identical (138.20 g and 145.83 g) with T_2 and T_3, respectively.

The highest percentage of infested fruit by weight (18.84%) was recorded in T_7, which was statistically different from all other treatments. This was closely followed (15.84%) by T_1, followed by T6 (13.35%). But the lowest percentage of infested fruit by weight (7.07%) was recorded in T_5, which was statistically similar with 9.39%, 10.45% and 11.38% that were recorded in T_2, T_3, and T_4, respectively.

In case of percent gourd fruit infestation reduction over control by weight, the highest reduction (62.47%) was recorded in T_5 and it was lowest (15.92%) in T_1. As a result, the order of effectiveness of different management practices in reducing percent fruit infestation by weight over control is $T_5 > T_2 > T_3 > T_4 > T_6 > T_1 > T_7$.

From the above findings it is also revealed that T_5 (spraying of neem oil @ 3% at 7 days interval) performed best in producing maximum healthy fruit by reducing the fruit fly infestation by weight followed by T_2 (bagging of tender fruits by porous polythene bag at 3 days after anthesis and left for 5 days), while in T_7 (untreated control) ranked at bottom followed by T_1 (hand picking and destruction of the infested fruit from the plot at 7 days interval).

4.4 Effect of management practices on fruit bearing status throughout the growing season of ridge gourd during March to July, 2007

Statistical variations (Appendix VI) among different management practices were also observed in respect of number of healthy and infested fruits and percent fruit infestation by number and weight throughout the growing season during the management of fruit fly on ridge gourd (Table 4).

4.4.1 Effect on number of ridge gourd

In case of number of healthy fruit per plot, the highest number (50.45) was recorded in T_5 (Table 4). This was statistically similar (46.22 and 44.22) with T_2 and T_3, respectively. On the other hand, the lowest number (32.55) of healthy fruit was recorded in T_7 (untreated control). This was statistically identical (34.89, 41.44 and 38.44) with T_1, T_6 and T_4. Similarly, the highest number of infested fruit (6.22) was recorded in T_7, which was statistically similar (5.00) with T_1. It was lowest (2.44) in T_5, which was statistically identical T_2 (3.00), T_3 (3.44), T_4 (3.78) and T_6 (4.34).

In case of percent fruit infestation, the highest percentage of infested fruit by number (16.06%) was recorded in T_7, which was statistically identical with T_1 (12.54%). While it was lowest (4.62%) in T_5, which was statistically similar with T_2 (6.09%) and T_3 (7.18%) followed by T_4 (8.38%). This was also followed by T6 (10.15%).

Considering the percent fruit infestation reduction over control, the highest reduction (71.23%) was recorded in T_5, while it was lowest (21.92%) in T_1. As a result, the order of effectiveness of different management practices in reducing percent fruit infestation over control is $T_5 > T_2 > T_3 > T_4 > T_6 > T_1 > T_7$.

Table 4. Effect of different management practices on fruit infestation caused by fruit fly on ridge gourd through out the growing period of ridge gourd during March-July, 2007

Treatments	Ridge gourd by number				Ridge gourd by weight (g)			
	Healthy	Infested	% infestation	Infestation reduction over control (%)	Healthy	Infested	% infestation	Infestation reduction over control (%)
T_1	34.89 ef	5.00 b	12.54 b	21.92	3734.88 e	556.33 b	12.97 b	20.96
T_2	46.22 b	3.00 ef	6.09 ef	62.08	5024.58 b	344.03 ef	6.40 ef	61.00
T_3	44.22bc	3.44 de	7.18 de	55.29	4769.19bc	394.84de	7.62 de	53.56
T_4	41.44cd	3.78 cd	8.38 d	47.82	4460.71cd	424.79cd	8.72 d	46.86
T_5	50.45 a	2.44 f	4.62 f	71.23	5507.03 a	291.84 f	5.02 f	69.41
T_6	38.44de	4.34 bc	10.15 c	36.80	4129.76 d	475.99 c	10.34 c	36.99
T_7	32.55 f	6.22 a	16.06 a	--	3385.85 e	664.19 a	16.41 a	--
LSD (.05)	3.933	0.720	1.680	--	366.4	76.00	1.401	--
CV (%)	5.37	10.05	10.17	--	4.65	9.49	8.17	--

In a column, means having similar letter(s) are statistically identical at 0.05 level of probability

T_1 = Hand picking and destruction of infested fruits from the plot at 7 days interval,

T_2 = Bagging of tender fruit by porous polythene bag at 3 days after anthesis and left for 5 days,

T_3 = Bait spray prepared with molasses and malathion in the proportion of 1 : 0.01 : 100 (25 g of molasses, 2.5 ml of malathion 57 EC and 2.5 litre of water) and replace the bait at 7 days interval,

T_4 = Use of attractants (bait traps) comprising Cekufon 80 SP (0.5g) mixed with 100g of sweet gourd mash and 100 ml water) and replace the trap at 7 days interval,

T_5 = Spraying of neem oil @ 3% [75 ml neem oil and 1 ml trix (liquid detergent) mixed with 2.5 liters of water) at 7 days interval,

T_6 = Use of silver color ribbon between the rows and around the periphery of the plot and

T_7 = Untreated control.

From the above findings it is also revealed that T_5 (spraying of neem oil @ 3% at 7 days interval) performed best in producing the maximum healthy fruit and minimum infested fruit by number followed by T_2 (bagging of tender fruits by porous polythene bag at 3 days after left for 5 days), while T_7 (untreated control) ranked at bottom followed by T_1 (hand picking and destruction of the infested fruit at 7 days interval). Nasiruddin and Karim (1992) was also reported about similar results and they stated that a lower rate of infestation in snake gourd (6.47%) when treated with bait spray (Dipterex 80SP + Molasses) compared to those of control (22.48%).

4.4.2 Effect on weight of ridge gourd

In case of effectiveness of different management practices applied against fruit fly on ridge gourd, more or less similar trends of result were also observed in respect of effect on weight of ridge gourd and the highest weight of healthy fruit per plot (5507.03 g) was recorded in T_5 (Table 4). This was statistically identical (5024.58 g and 4769.19g) with T_2 and T3, respectively followed by T_4 (4460.71g. But the lowest (3385.85 g) weight of healthy fruit was recorded in T_7 (untreated control), which was statistically identical (3734.88 g and 4129.76g) with T_1 and T_6. Similarly, the highest weight of infested fruit (664.19 g) was recorded in T_7, which was statistically similar (556.33 g) with T_1 followed by T_6 (475.99g), T_4 (424.79g). On the other hand, the lowest weight of infested fruit (291.84 g) was recorded in T_5, which was statistically identical (344.03 g and 394.84g) with T_2 and T_3, respectively. The highest percentage of infested fruit by weight (16.41%) was also recorded in T_7, which was statistically different from all other treatments. But the lowest percentage of infested fruit in weight (5.02%) was recorded in T_5, which was statistically similar (6.40%, 7.62% and 8.72%) with T_2, T_3 and T_4, respectively.

Considering the percent reduction of fruit infestation over control by weight, the highest reduction (69.41%) was observed in T_5 and the lowest reduction (20.96%) was observed in T_1. As a result, the order of effectiveness of different management practices in reducing percent fruit infestation over control is $T_5 > T_2 > T_3 > T_4 > T_6 > T_1 > T_7$.

From the above findings it is revealed that T_5 (spraying of neem oil @ 3% at 7 days interval) performed best in producing maximum healthy fruit by reducing the fruit fly infestation by weight followed by T_2 (bagging of tender fruits by porous polythene bag at 3 days after anthesis and left for 5 days). While T_7 (untreated control) ranked at bottom followed by T_1 (hand picking and destruction of the infested fruit from the plot at 7 days interval). Almost similar results were also reported by Kapoor (1993) and he stated that simple bagging procedures without considering the days after anthesis and period of retaining the bags were conducted by few authors. Amin (1995) also obtained significantly lowest fruit fly infestation (4.61%) in bagged cucumber compared to other chemical and botanical control measures.

4.5. Effect of different management practices on yield attributes of ridge gourd

Statistically significant differences were observed in terms of length and girth of both healthy and infested fruits (Appendix VII), single fruit weight, edible and non-edible portion of the infested fruits (Appendix VIII), when applied different management practices against fruit fly infesting ridge gourd.

4.5.1. Effect on length of ridge gourd

The maximum length of healthy fruit (43.38 cm) was found in T_5, which was statistically similar (40.62 cm and 39.57 cm) with T_2 and T_3 (Table 5). On the other

hand, the minimum length of healthy fruit (27.17 cm) was recorded in T_7, which was statistically identical (30.13 cm and 32.53 cm) with T_1 and T_6, respectively. In case of percent length increase over control, the highest percent length increase (59.66%) of healthy fruit over control was estimated was recorded for T_5 and the lowest length increase (10.89%) was recorded in T_1.

Table 5. Effect of different management practices on fruit length of ridge gourd during the management of fruit fly

Treatments	Length of fruit (cm)			
	Healthy		Infested	
	Length (cm)	Increase over control (%)	Length (cm)	Increase over control (%)
T_1	30.13 c	10.89	25.92 c	3.14
T_2	40.62 a	49.50	34.18 a	36.01
T_3	39.57 a	45.64	33.12 ab	31.79
T_4	37.43 ab	37.76	29.17 bc	16.08
T_5	43.38 a	59.66	35.58 a	41.58
T_6	32.53 bc	19.73	29.50 bc	17.39
T_7	27.17 c	--	25.13 c	--
$LSD_{(0.05)}$	6.213	--	4.070	--
CV(%)	9.75	--	7.53	--

In a column, means having similar letter(s) are statistically identical at 0.05 level of probability

T_1 = Hand picking and destruction of infested fruits from the plot at 7 days interval,

T_2 = Bagging of tender fruit by porous polythene bag at 3 days after anthesis and left for 5 days,

T_3 = Bait spray prepared with molasses and malathion in the proportion of 1 : 0.01 : 100 (25 g of molasses, 2.5 ml of malathion 57 EC and 2.5 litre of water) and replace the bait at 7 days interval,

T_4 = Use of attractants (bait traps) comprising Cekufon 80 SP (0.5g) mixed with 100g of sweet gourd mash and 100 ml water) and replace the trap at 7 days interval,

T_5 = Spraying of neem oil @ 3% [75 ml neem oil and 1 ml trix (liquid detergent) mixed with 2.5 liters of water) at 7 days interval,

T_6 = Use of silver color ribbon between the rows and around the periphery of the plot and

T_7 = Untreated control.

From the above findings it is also revealed that T_5 (spraying of neem oil @ 3% at 7 days interval) gave the maximum length of healthy fruit followed by T_2 (bagging of tender fruits by porous polythene bag at 3 days after anthesis and left for 5 days), while T_7 (untreated control) produced the minimum length of healthy fruit followed by T_1 (hand picking and destruction of the infested fruit). From the correlation studies it was also revealed that the length of fruit increased with the decrease of infestation level. Probably fruit infestation hinders the normal growth of ridge gourd fruit.

4.5.2. Effect on the length of infested fruit

The maximum length of infested fruit (35.58 cm) was recorded in T_5, which was statistically similar (34.18 cm and 33.12 cm) with T_2 and T_3 followed by T_4 (29.17 cm) (Table 5). On the other hand, the minimum length of infested fruit (25.13 cm) was recorded in T_7 , which was statistically identical (25.92 cm, 29.17 cm and 29.50 cm) with T_1, T_4 and T_6. The percent length of infested fruit increase over control was also estimated and it was highest (41.58%) in T_5 and lowest (3.14%) in T_1.

From the above findings it is revealed that T_5 (spraying of neem oil @ 3% at 7 days interval) gave the maximum length of infested fruit followed by T_2 (bagging of tender fruits by porous polythene bag at 3 days after anthesis and left for 5 days). While T_7 (untreated control) produced minimum length of infested fruit followed by T_1 (hand picking and destruction of the infested fruit). This might be due to the minimum fruit infestation by fruit fly in T_5, T_2 and T_1, respectively.

4.5.3. Effect on the girth of healthy fruit

The maximum girth of healthy fruit (5.48 cm) was recorded in T_5, which was statistically similar (5.18 cm and 5.05 cm) with T_2 and T_3 followed by T_4 (4.69 cm). (Table 6). On the other hand, the minimum girth of healthy fruit (3.44 cm) was

recorded in T_7, which was statistically identical (3.80 cm and 4.04 cm) with T_1 and T_6, respectively. Considering the percent increase of girth of healthy fruit over control, highest girth increase (59.30%) was recorded in T_5 and the lowest increase (10.47%) was recorded in T_1.

Table 6. Effect of different management practices on fruit girth of ridge gourd during the management of fruit fly

Treatments	Girth of fruit (cm)			
	Healthy		Infested	
	Girth (cm)	Increase over control (%)	Girth (cm)	Increase over control (%)
T_1	3.80 bc	10.47	3.12 de	2.97
T_2	5.18 a	50.58	4.12 ab	35.97
T_3	5.05 a	46.80	4.02 abc	32.67
T_4	4.69 ab	36.34	3.54 cde	16.83
T_5	5.48 a	59.30	4.25 a	40.26
T_6	4.04 bc	17.44	3.62 bcd	19.47
T_7	3.44 c	--	3.03 e	--
$LSD_{(.05)}$	0.873	--	0.540	--
CV(%)	5.46	--	7.33	--

In a column, means having similar letter(s) are statistically identical at 0.05 level of probability

T_1 = Hand picking and destruction of infested fruits from the plot at 7 days interval,

T_2 = Bagging of tender fruit by porous polythene bag at 3 days after anthesis and left for 5 days,

T_3 = Bait spray prepared with molasses and malathion in the proportion of 1 : 0.01 : 100 (25 g of molasses, 2.5 ml of malathion 57 EC and 2.5 litre of water) and replace the bait at 7 days interval,

T_4 = Use of attractants (bait traps) comprising Cekufon 80 SP (0.5g) mixed with 100g of sweet gourd mash and 100 ml water) and replace the trap at 7 days interval,

T_5 = Spraying of neem oil @ 3% [75 ml neem oil and 1 ml trix (liquid detergent) mixed with 2.5 liters of water) at 7 days interval,

T_6 = Use of silver color ribbon between the rows and around the periphery of the plot and

T_7 = Untreated control.

From the above findings it is revealed that T_5 (spraying of neem oil @ 3% at 7 days interval) gave the maximum breadth of healthy fruit followed by T_2 (bagging of tender fruits by porous polythene bag at 3 days after anthesis and left for 5 days). While T_7 (untreated control) produced the minimum girth of healthy fruit followed by T_1 (hand picking and destruction of the infested fruit).

4.5.4. Effect on girth of infested fruit

The maximum girth of infested fruit (4.25 cm) was recorded in T_5, which was statistically similar (4.12 cm and 4.02 cm) with T_2 and T_3 (Table 6). On the other hand, the minimum girth of infested fruit (25.13 cm) was recorded in T_7, which was statistically identical (25.92 cm and 3.54 cm) with T_1 and T_4, respectively. In case of percent girth increase over control, the highest increase (40.26%) was recorded in T_5 and the lowest increase (2.97%) was recorded from T_1.

From the above findings it is revealed that T_5 (spraying of neem oil @ 3% at 7 days interval) gave the maximum girth of infested fruit followed by T_2 (bagging of tender fruits by porous polythene bag at 3 days after anthesis and left for 5 days), while in T_7 (untreated control) gave the minimum girth of infested fruit followed by T_1 (hand picking and destruction of the infested fruit) under the present trial. This might be due to the minimum infestation of fruit for T_5, T_2 and T_1, respectively.

4.5.5. Effect on single fruit weight

The maximum single fruit weight (109.16 cm) was recorded in T_5, which was statistically similar with other treatment except T_7 (untreated control), which produced minimum single fruit weight (104.02 g) (Table 7). In case of percent increase of single fruit weight over control, the highest increase (4.94%) was recorded in T_5 and the lowest increase (2.91%) was recorded from T_1.

Table 7. Effect of different management practices on single fruit weight of ridge gourd during the management of fruit fly

Treatments	Single fruit weight (g)	
	Weight (g/fruit)	Increase over control (%)
T_1	107.05 a	2.91
T_2	108.71 a	4.51
T_3	107.85 a	3.68
T_4	107.64 a	3.48
T_5	109.16 a	4.94
T_6	107.43 a	3.28
T_7	104.02 b	--
$LSD_{(0.05)}$	2.185	--
CV(%)	5.22	--

In a column, means having similar letter(s) are statistically identical at 0.05 level of probability

T_1 = Hand picking and destruction of infested fruits from the plot at 7 days interval,

T_2 = Bagging of tender fruit by porous polythene bag at 3 days after anthesis and left for 5 days,

T_3 = Bait spray prepared with molasses and malathion in the proportion of 1 : 0.01 : 100 (25 g of molasses, 2.5 ml of malathion 57 EC and 2.5 litre of water) and replace the bait at 7 days interval,

T_4 = Use of attractants (bait traps) comprising Cekufon 80 SP (0.5g) mixed with 100g of sweet gourd mash and 100 ml water) and replace the trap at 7 days interval,

T_5 = Spraying of neem oil @ 3% [75 ml neem oil and 1 ml trix (liquid detergent) mixed with 2.5 liters of water) at 7 days interval,

T_6 = Use of silver color ribbon between the rows and around the periphery of the plot and

T_7 = Untreated control.

From the above findings it is revealed that T_5 (spraying of neem oil @ 3% at 7 days interval) gave the maximum single fruit weight followed by T_2 (bagging of tender fruits by porous polythene bag at 3 days after anthesis and left for 5 days), while T_7 (untreated control) produced minimum single fruit weight followed by T_1 (hand picking and destruction of the infested fruit).

4.6. Effect of different management practices on the yield of ridge gourd

Different management practices showed a statistically significant difference in terms of yield (kg per plot and ton per hectare) (Appendix VIII).

4.6.1. Effect on yield (kg/plot) of ridge gourd

The highest yield per plot (10.31 kg) was recorded in T_5, which was statistically similar (10.09 kg and 9.63 kg) with T_2 (bagging of tender fruit by porous polythene bag at 3 days after anthesis and left for 5 days) and T_3 (Bait spray consisting molasses and malathion at 7 days interval) (Table 8). But the lowest (8.17 kg) was recorded in T_7 (untreated control), which was statistically identical (8.53 kg) with T_1 (hand picking and destruction of infested fruit) followed by T_6 (9.01kg) (use of silver color ribbon) (Table 8). Similarly, in case of percent yield increase over control, the highest yield increase (26.19%) was recorded in T_5, while it was lowest (4.41%) in T_1. From the above findings it is also revealed that T_5 (spraying of neem oil @ 3% at 7 days interval) gave the maximum yield per plot followed by T_2 (bagging of tender fruits by porous polythene bag at 3 days after anthesis and left for 5 days), while T_7 (untreated control) produced minimum yield per plot followed by T_1 (hand picking and destruction of the infested fruit).

Table 8. Effect of different management practices on the yield of ridge gourd during the management of fruit fly

Treatments	Yield of fruit			
	Yield per plot (kg)	Increase over control (%)	Yield per hectare (ton)	Increase over control (%)
T_1	8.53 de	4.41	14.22 de	4.41
T_2	10.09 ab	23.50	16.82 ab	23.49
T_3	9.63 abc	17.87	16.05 abc	17.84
T_4	9.29 bcd	13.71	15.48 bcd	13.66
T_5	10.31 a	26.19	17.18 a	26.14
T_6	9.01 cde	10.28	15.02 cde	10.28
T_7	8.17 e	--	13.62 e	--
$LSD_{(0.05)}$	0.872	--	1.453	--
CV(%)	5.27	--	5.27	--

In a column, means having similar letter(s) are statistically identical at 0.05 level of probability

T_1 = Hand picking and destruction of infested fruits from the plot at 7 days interval,

T_2 = Bagging of tender fruit by porous polythene bag at 3 days after anthesis and left for 5 days,

T_3 = Bait spray prepared with molasses and malathion in the proportion of 1 : 0.01 : 100 (25 g of molasses, 2.5 ml of malathion 57 EC and 2.5 litre of water) and replace the bait at 7 days interval,

T_4 = Use of attractants (bait traps) comprising Cekufon 80 SP (0.5g) mixed with 100g of sweet gourd mash and 100 ml water) and replace the trap at 7 days interval,

T_5 = Spraying of neem oil @ 3% [75 ml neem oil and 1 ml trix (liquid detergent) mixed with 2.5 liters of water) at 7 days interval,

T_6 = Use of silver color ribbon between the rows and around the periphery of the plot and

T_7 = Untreated control.

4.6.2. Effect on yield (ton/ha) of ridge gourd

Considering the yield of ridge gourd in ton/ha, the highest yield (17.18 ton/ha) was recorded in T_5, which was statistically similar (16.82 ton/ha and 16.05 ton/ha) with T_2 and T_3 (Table 8). But the lowest yield (13.62 ton/ha) was recorded in T_7 (untreated control), which was statistically identical (14.22 ton/ha) with T_1. In case of percent yield (ton/ha) increase over control, the highest yield increase (26.14%) was recorded in T_5 and the lowest yield increase (4.41%) was recorded in T_1.

From the above findings it is revealed that T_5 (spraying of neem oil @ 3 % at 7 days interval) gave the maximum yield (ton/ha) followed by T_2 (bagging of tender fruits by porous polythene bag at 3 days after anthesis and left for 5 days), while T_7 (untreated control) produced minimum yield (ton/ha) followed by T_1 (hand picking and destruction of the infested fruit).

4.7. Effect of yield attributes on the yield of ridge gourd during the management of fruit fly

Significant relationships were observed among different yield attributes of ridge gourd due to different management practices applied against fruit fly infesting ridge gourd (Figure 1 - Figure 4).

4.7.1. Relationship between fruit length and yield of ridge gourd

Correlation study was done to establish the relationship between the fruit length and yield (ton/ha) of ridge gourd during the management of fruit fly. From the study it was revealed that significant correlation was observed between the parameters (Figure 1). It was evident from the Figure 1 that the equation $y = 0.215x + 7.7809$ gave a good fit to the data, and the co-efficient of determination ($R^2 = 0.967$) showed that, fitted regression line had a significant regression co-efficient. From these relations it can be

concluded that yield of ridge gourd was strongly as well as positively correlated with the length of fruits of ridge gourd, i.e., the yield increased with the increase of length of fruit in different management practices in controlling fruit fly in ridge gourd.

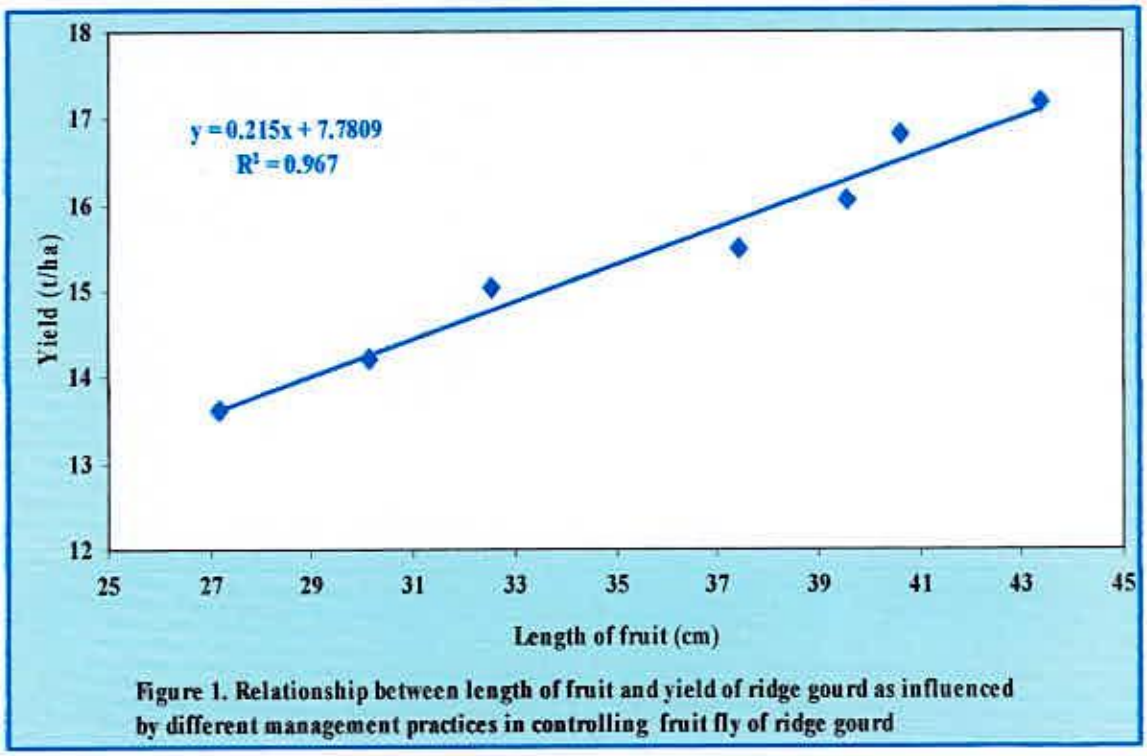


Figure 1. Relationship between length of fruit and yield of ridge gourd as influenced by different management practices in controlling fruit fly of ridge gourd

4.7.2. Relationship between girth of fruit and yield of ridge gourd

Correlation study was done to establish the relationship between the girth of fruit and yield (t/ha) of ridge gourd during the management of fruit fly (Figure 2). It was evident from the Figure 2 that the regression equation $y = 1.6625x + 7.9602$ gave a good fit to the data, and the co-efficient of determination ($R^2 = 0.9641$) showed that, fitted regression line had a significant regression co-efficient. From the relationship it can be concluded that girth of ridge gourd fruit was strongly as well as positively correlated to the yield of ridge gourd, i.e., the yield increased with the increase of the girth of fruit in different management practices in controlling fruit fly in ridge gourd.

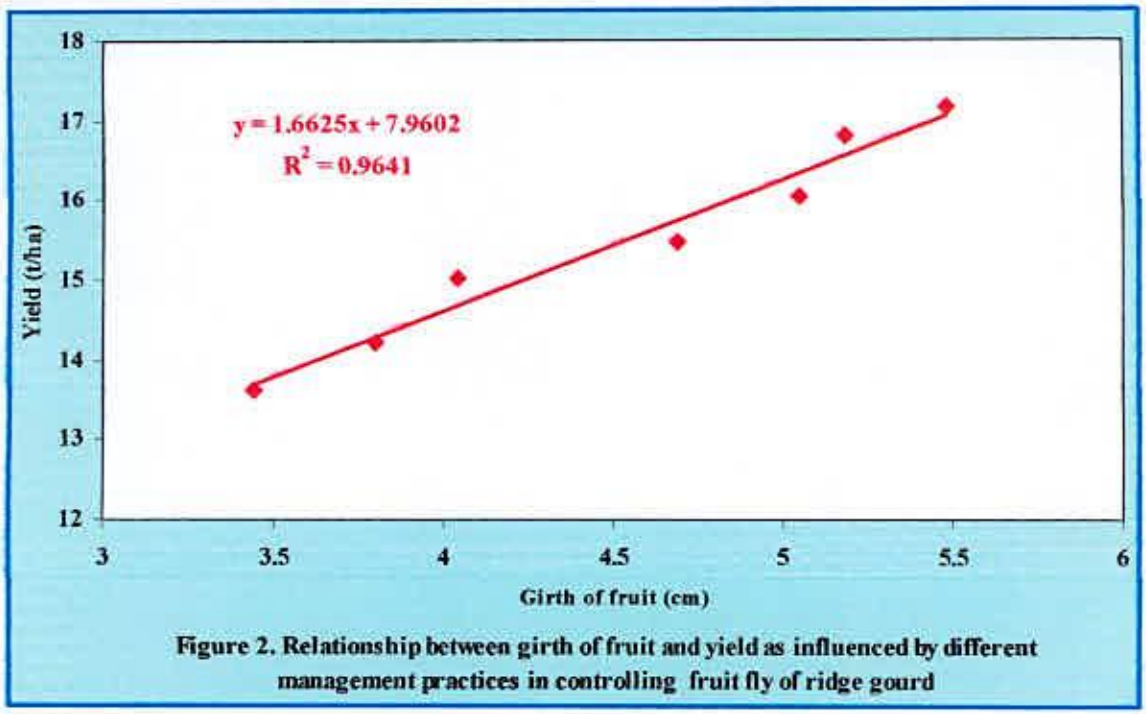


Figure 2. Relationship between girth of fruit and yield as influenced by different management practices in controlling fruit fly of ridge gourd

4.7.3. Relationship between single fruit weight and yield of ridge gourd

Correlation study was done to establish the relationship between the single fruit weight and yield (t/ha) of ridge gourd during the management of fruit fly. From the study it was revealed that significant correlation was observed between the parameters (Figure 3). It was evident from the Figure 3 that the regression equation $y = 0.705x - 60.237$ gave a good fit to the data, and the value of the co-efficient of determination ($R^2 = 0.8044$) showed that, fitted regression line had a significant regression co-efficient. From the relationship it can be concluded that single fruit weight was strongly as well as positively correlated to the yield of ridge gourd, i.e., the yield increased with the increase of the single fruit weight in different management practices in controlling fruit fly in ridge gourd.

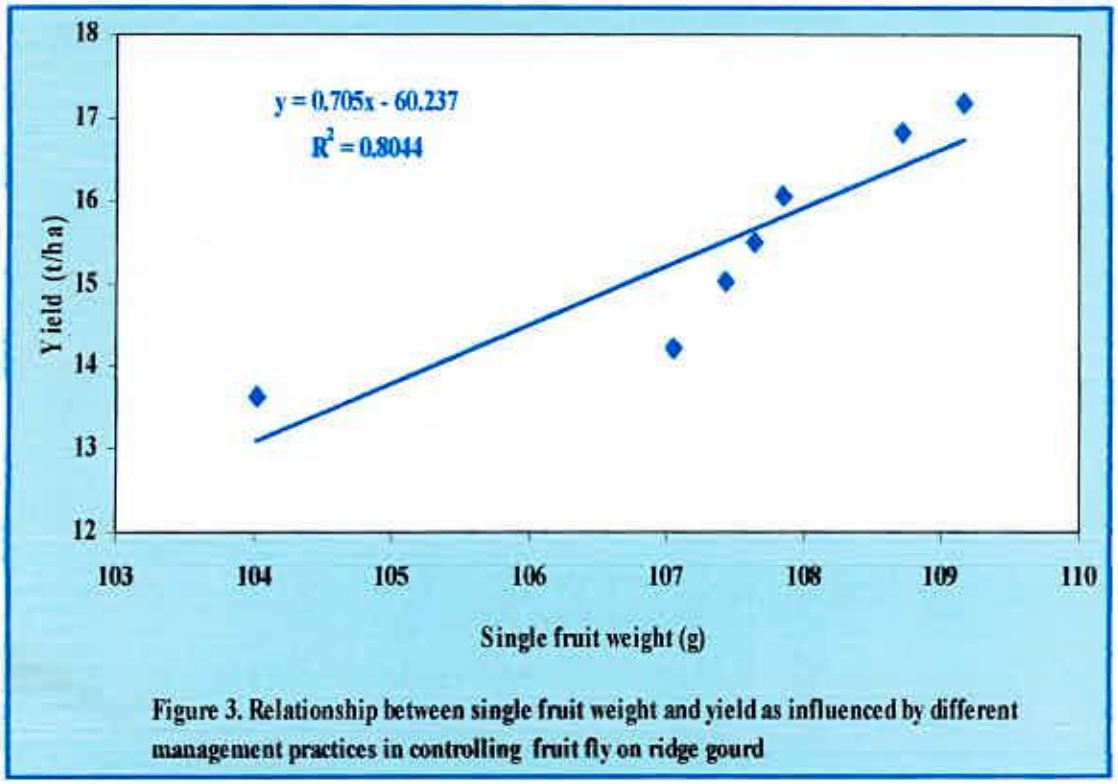


Figure 3. Relationship between single fruit weight and yield as influenced by different management practices in controlling fruit fly on ridge gourd

4.8. Economic analysis of different management practices applied against fruit fly infesting ridge gourd

In the present study the plot of untreated control (T_7) did not require any pest management cost, but rest of the treatments needed different amount of management costs for controlling fruit fly infesting ridge gourd (Table 9). All these costs were calculated per hectare basis. The component T_1 (hand picking and destruction of the infested fruit) was done only involved labors cost; T_2 (bagging of tender fruit by porous polythene bag at 3 days after anthesis and left for 5 days) involved cost for polythene bags as well as labor cost; T_3 (bait spray consisting molasses and malathion at 7 days interval) included the cost of molasses and malathion and also labor cost; T_4 involved costs for Cekufon, ripe sweet gourd and earthen pot as well as labor cost; component T_5 involved in the cost of neem oil, trix (mixing agent) and labor and T_6 involved the cost of silver color ribbon and labor.

The analysis was done in order to find out the most profitable management practices based on cost and benefit of various components. The highest benefit cost ratio (5.78) was estimated for T_5 and the lowest (2.16) benefit cost ration for T_1 under the trial.

Table 9. Economic analysis of different management practices applied against fruit fly infesting ridge gourd

Treatments	Cost of pest Management (Tk.)	Yield (t/ha	Gross return (Tk.)	Net Return (Tk.)	Adjusted net return (Tk.)	Benefit cost ratio
T_1	3800	14.22	284400	280600	8200	2.16
T_2	12500	16.82	336400	323900	51500	4.12
T_3	14200	16.05	321000	306800	34400	2.42
T_4	10500	15.48	309600	299100	26700	2.54
T_5	10500	17.18	343600	333100	60700	5.78
T_6	6200	15.02	300400	294200	21800	3.52
T_7	0	13.62	272400	272400	0	--

T_1 = Hand picking and destruction of infested fruits from the plot at 7 days interval,

T_2 = Bagging of tender fruit by porous polythene bag at 3 days after anthesis and left for 5 days,

T_3 = Bait spray prepared with molasses and malathion in the proportion of 1 : 0.01 : 100 (25 g of molasses, 2.5 ml of malathion 57 EC and 2.5 litre of water) and replace the bait at 7 days interval,

T_4 = Use of attractants (bait traps) comprising Cekufon 80 SP (0.5g) mixed with 100g of sweet gourd mash and 100 ml water) and replace the trap at 7 days interval,

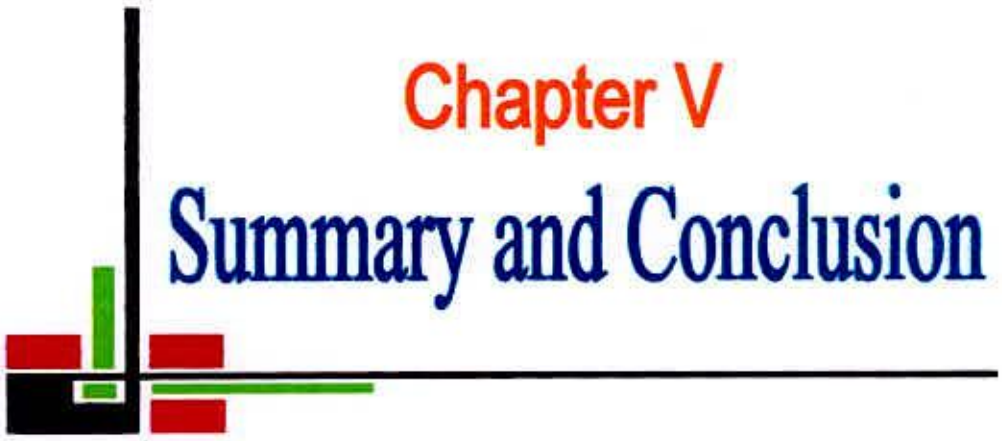
T_5 = Spraying of neem oil @ 3% [75 ml neem oil and 1 ml trix (liquid detergent) mixed with 2.5 liters of water) at 7 days interval,

T_6 = Use of silver color ribbon between the rows and around the periphery of the plot and

T_7 = Untreated control.

Market price of ridge gourd @ Tk. 20 per kg

The benefit cost ratio (BCR) calculated for each of the treatment component revealed that the BCR of T_5 was (5.78) the highest followed by T_2 (4.12). This was also followed by the T_6 (3.52) and T_4 (2.54), respectively (Table 9). The highest BCR was found in the T_5 may be due to the less management cost as well as highest yield compared to the other treatment. 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.



Chapter V

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

The present study was conducted to evaluate the comparative effectiveness of different eco-friendly management practices to suppress the level of infestation by fruit fly on ridge gourd in the experimental field of Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh during March to July 2007. Six different eco-friendly management practices were evaluated including untreated control. Data on fruit infestation by number and weight and yield contributing characters and yield were recorded including benefit cost ratio (BCR) of different management practices applied against fruit fly on ridge gourd.

Considering the effect of different management practices in reducing the level of infestation by fruit fly on ridge gourd, at early harvesting stage of ridge gourd, the highest percentage of infested fruit by number (13.57%) was recorded in T_7 and the lowest percentage of infested fruit by number (3.02%) was recorded in T_5. Similarly, the highest percentage of infested fruit by weight (14.12%) was recorded in T_7, while the lowest percentage of infested fruit by weight (3.69%) was recorded in T_5. Considering the mid harvesting stage of ridge gourd, the highest percentage of infested fruit by number (15.86%) was recorded in T_7 and the lowest percentage of infested fruit by number (4.12%) was recorded in T_5. Similarly, the highest percentage of infested fruit by weight (16.20%) was recorded in T_7, while the lowest percentage of infested fruit by weight (4.62%) was recorded in T_5. In case of late harvesting stage, the highest

percentage of infested fruit by number (18.33%) was recorded in T_7 and the lowest percentage of infested fruit by number (6.66%) was recorded in T_5. Similarly, the highest percentage of infested fruit by weight (18.84%) was recorded in T_7, while the lowest percentage of infested fruit by weight (7.07%) was recorded in T_5. Considering the total growing season of ridge gourd, the highest percentage of infested fruit by number (16.06%) was also recorded in T_7 and the lowest percentage of infested fruit by number (4.62%) was recorded in T_5. Similarly, the highest percent of infested fruit by weight (16.41%) was recorded in T_7, while the lowest percentage of infested fruit by weight (5.02%) was recorded in T_5.

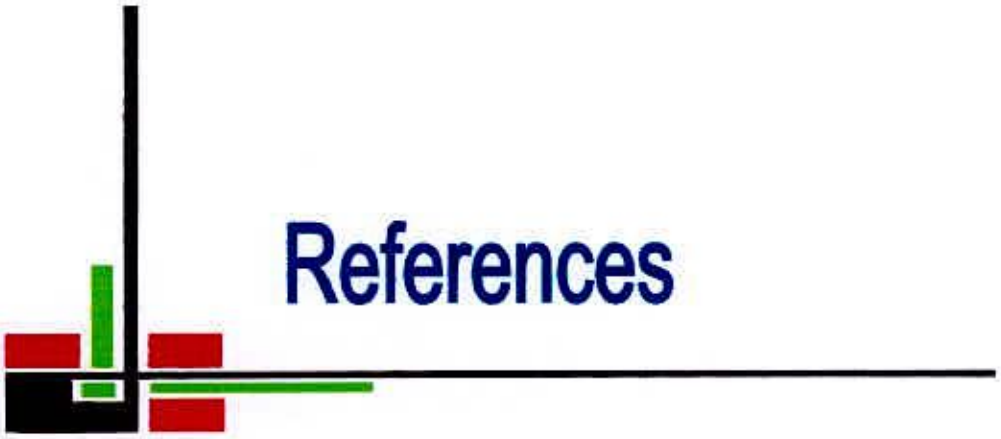
Considering the effect of different management practices on yield attributes of ridge gourd during the management of fruit fly on ridge gourd, the highest length of healthy fruit (43.38 cm) was found in T_5 and the lowest length of healthy fruit (27.17 cm) was recorded in T_7. The highest length of infested fruit (35.58 cm) was recorded in T_5 and the lowest length of infested fruit (25.13 cm) was recorded in T_7. The highest girth of healthy fruit (5.48 cm) was recorded in T_5 and the lowest girth of healthy fruit (3.44 cm) was recorded in T_7. The highest girth of infested fruit (4.25 cm) was recorded in T_5 and the lowest girth of infested fruit (25.13 cm) was recorded in T_7. The highest single fruit weight (109.16 cm) was recorded in T_5 and T_7 (untreated control) produced the lowest single fruit weight (104.02 g) of ridge gourd.

In case of effectiveness of different management practices on yield of ridge gourd during the management of fruit fly on ridge gourd, the highest yield

(10.31 kg/plot) was recorded in T_5 and the lowest (8.17 kg/plot) was recorded in T_7. The highest yield (ton/ha) (17.18 t/ha) was recorded in T_5 and the lowest (13.62 t/ha) was recorded in T_7.

In case of relationships between yield attributes and yield of ridge gourd as influenced by different management practices applied against fruit fly infesting ridge gourd, the length (r = 0.967), girth (r = 0.9641), single fruit weight (r = 0.8044) of the fruit strongly as well as positively correlated to the yield of ridge gourd, i.e., yield of ridge gourd increased with the increase of the length (cm), girth (cm), single fruit weight (g) of the fruit.

From the economic analysis of different management practices applied against fruit fly infesting ridge gourd, the highest (5.78) benefit cost ratio (BCR) was estimated for T_5 (spraying of neem oil @ 3% at 7 days interval) and the lowest (2.16) BCR was calculated in T_1 (hand picking and destruction of infested fruit) under the trial. In economic and environmental safety point of view T_5 was the most effective in reducing the level of infestation by fruit fly as well as by increasing the yield and yield contributing characters of the ridge gourd.



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CHAPTER VI

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Appendices

CHAPTER VII

APPENDICES

Appendix I. Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from March to July 2007

Month	Air temperature (°C)			RH (%)	Total rainfall (mm)
	Maximum	Minimum	Mean		
March 2007	31.25	21.55	26.40	74.65	35
April 2007	32.98	23.72	28.35	88.24	65
May 2007	34.00	24.65	34.33	79.55	155
June 2007	33.85	26.15	30.0	69.05	184
July 2007	34.20	24.50	29.35	89.5	281

Source : Dhaka Meteorological Center

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

Mechanical analysis

Constituents	Percent
Sand	32.45
Silt	61.35
Clay	6.10
Textural class	Silty loam

Chemical analysis

Soil properties	Amount
Soil Ph	6.15
Organic carbon (%)	1.32
Total nitrogen (%)	0.075
Available P (ppm)	19.5
Exchangeable K (%)	0.2

Source: Soil Resource Development Institute (SRDI)

Appendix III. Analysis of variance of the data on fruit per plot by number and weight as influenced by different control measures in controlling fruit fly on ridge gourd at early fruiting stage

Source of variation	Degrees of freedom	Mean square					
		Ridge gourd by number			Ridge gourd by weight (g)		
		Healthy	Infested	% infestation	Healthy	Infested	% infestation
Replication	2	0.020	0.006	1.039	11.454	23.847	0.389
Treatment	6	10.167**	0.355**	42.624**	172064.893**	3992.578**	42.291**
Error	12	1.142	0.055	3.254	13141.162	448.075	1.753

**: Significant at 0.05 level of probability

Appendix IV. Analysis of variance of the data on fruit per plot by number and weight as influenced by different control measures in controlling fruit fly on ridge gourd at mid fruiting stage

Source of variation	Degrees of freedom	Mean square					
		Ridge gourd by number			Ridge gourd by weight (g)		
		Healthy	Infested	% infestation	Healthy	Infested	% infestation
Replication	2	2.935	0.015	0.284	25702.200	79.494	0.026
Treatment	6	26.319**	0.711**	48.884**	369732.497**	7191.343**	47.784**
Error	12	2.194	0.041	1.430	16575	343.533	1.012

**: Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data on fruit per plot by number and weight as influenced by different control measures in controlling fruit fly on ridge gourd at late fruiting stage

Source of variation	Degrees of freedom	Mean square					
		Ridge gourd by number			Ridge gourd by weight (g)		
		Healthy	Infested	% infestation	Healthy	Infested	% infestation
Replication	2	0.590	0.017	0.883	4540.303	137.299	0.886
Treatment	6	7.881**	0.606**	47.690**	73527.633**	5455.202**	48.239**
Error	12	0.845	0.047	2.707	7573.818	457.331	2.289

**: Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data on fruit per plot by number and weight as influenced by different control measures in controlling fruit fly on ridge gourd throughout the growing period during March to July, 2007

Source of variation	Degrees of freedom	Mean square					
		Ridge gourd by number			Ridge gourd by weight (g)		
		Healthy	Infested	% infestation	Healthy	Infested	% infestation
Replication	2	1.220	0.068	0.137	9078.384	582.944	0.116
Treatment	6	121.066**	4.905**	47.204**	1646552.969**	48891.980**	47.054**
Error	12	4.887	0.164	0.892	42409.315	1825.127	0.620

**: Significant at 0.05 level of probability

Appendix VII. Analysis of variance of the data on length and girth of healthy and infested fruit per plot as influenced by different management practices applied against fruit fly on ridge gourd

Source of variation	Degrees of freedom	Mean square			
		Length		Girth	
		Healthy	Infested	Healthy	Infested
Replication	2	0.989	2.979	1.051	0.015
Treatment	6	107.436**	49.364**	12.458**	2.458
Error	12	12.196	5.235	4.256	2.156

**: Significant at 0.01 level of probability

Appendix VIII. Analysis of variance of the data on yield contributing characters and yield of ridge gourd as influenced by different management practices applied against fruit fly on ridge gourd throughout the growing period

Source of variation	Degrees of freedom	Mean square				
		Single fruit weight	Edible portion	Non edible portion	Yield per plot	Yield per hectare
		0.125	12.154	1.254	0.127	0.352
Treatment	6	1.254**	125.846**	3.459**	1.848**	5.135**
Error	12	0.125	3.458	0.258	0.240	0.667

**: Significant at 0.01 level of probability