J. Bangladesh Agril. Univ. 8(1): 23–28, 2010 **ISSN 1810-3030**

Evaluation of some management practices for the suppression of cucurbit fruit fly in bitter gourd

M. Wasim Akram, M. M. Rahman and R. Ali
Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka-1207

Abstract

The experiment was conducted at Sher-e-Bangla Agricultural University farm, Dhaka, Bangladesh during the period from March to June 2007 with seven treatments viz; T_1: Hand picking of infested fruits of bitter gourd at 7 days interval; T_2: Neem seed kernel at 5 gm/l of water at 5 days interval +T_1; T_3: Spray of shobicron 425EC @ 2ml/l of water at 7 days interval + T_1; T_4: Micronutrient-Zn @ 6.72kg/ha; T_5: Micronutrient-B @ 1.96kg/ha; T_6: Micronutrient Zn + B and T_7: Untreated control.. The lowest fruit infestation (13.78%) by weight was recorded from the treatment T_2, while the highest (46.09%) fruit infestation by weight was recorded from T_7 untreated control. The highest (85.00) number of fruits per plot was recorded for T_2 treated plots while the lowest (61.00) number of fruits per plot was recorded from the untreated control T_7. The application of neem seed kernel at 5 days interval + hand picking of infested fruits in T_2 treated plots gave the highest yield (12.88 t/ha) while it was lowest (10.02 t/ha) in T_7 untreated control plots. The combined application of micronutrients was more effective in T_6 than the single application of micronutrients in T_4 and T_5 respectively. The results of economic analysis of bitter gourd showed that the highest benefit cost ratio (9.44) was estimated for T_6 treatment and the lowest (1.06) benefit cost ration for T_3 treatment. Among the different treatments neem seed kernel at 5 days interval + hand picking of infested fruits in T_2 treated plots was more effective than the insecticide Shobicron 425 EC at 7 days interval + hand picking of infested fruits followed by the T_6 treated plots in combination of micronutrients Zn +B.

Keywords: Cucurbit fruit fly, Bitter gourd, Various management practices

Introduction

Bitter gourd is an important fast growing cucurbitaceous vegetable covering an area of 5,502 hectare with a total production of 20,470 tons in Bangladesh (Anon., 2004). It is considered one having medicinal properties and with a compound named 'Charantin' present in the bitter gourd is useful to reduce blood sugar for diabetic patients (Dhillon *et al*, 2005). It is also rich in vitamins and carbohydrates. The production of bitter gourd is hindered due to several factors like disease and insect pests. Many insects viz., red pumpkin beetles, epilachna beetle, and melon fruit fly are the major constraints to the successful production of bitter gourd. For cucurbits, especially for bitter gourd the melon fruit fly *Bactrocera cucurbitae (Coquillett)* damage is the major limiting factor in obtaining high yield (Rabindranath and Pillai, 1986). *Bactrocera cucurbitae* is dominant in all the locations of Bangladesh followed by *Bactrocera tau* and *Dacus ciliatus* (Akhtaruzzaman et al, 1999). Among 15 cucurbits, fruit fly prefer bitter gourd, the extent of losses varies between 30 to 100%, depending on the cucurbit species and the season (Anon., 2004). It prefers to infest young, green, soft-skinned fruits. It inserts the eggs 2 to 4 mm deep in the fruit tissues, and the maggots feed inside the fruit. Pupation occurs in the soil at 0.5 to 15 cm below the soil surface depending on the nature and type of soil **(**Dhillon *et al.*, 2005**)**. Now a day's farmers in Bangladesh solely rely on the use of toxic insecticides to control the pest in bitter gourd. In some areas, farmers spend about 25% of the cultivation cost in bitter gourd production only to buy toxic pesticides (Anon., 2004). In a research, the residues of pesticide in bitter gourd were found next to brinjal, which was the cause of export reduction of vegetables because of serious concern of the importing countries (Quasem, 2003). Moreover, repeated use of toxic insecticides has created a hazardous situation for the environment as well as health of the farmers and consumers. Therefore, it is desirable to explore alternative methods of control, and develop a control strategy for effective, cheap and environment friendly management of fruit fry. Use of plant extract for pest control is however a recent approach and it has drawn the special attention of the researchers all over the world. Cultural methods such as crop fertilization can affect susceptibility of plants to insect pests by altering plant tissue nutrient levels. Micronutrients are essential plant mineral nutrients taken up and utilized by crops in very small quantities. They include copper (Cu), zinc (Zn), boron (B), iron (Fe), manganese (Mn), molybdenum (Mo) and chlorine (Cl). Micronutrients are naturally occurring elements and use of these elements is environmentally safe and highly desirable. The deficiency of Zn and B are severe in soil of Bangladesh especially in low land and water logging condition. Boron deficiencies were found in well drained, sandy and soils with low water holding capacity (Farid *et al.*, 2003). Zinc affects enzyme systems that regulate various metabolic activities like protein synthesis, formation of chlorophyll, transformation of carbohydrates and regulation of the consumption of sugar in the plant. Moreover they play important role in seed and grain formation, maturation date, height of plant, if present in sufficient quantities in the leaf, acts like anti freeze in citrus, tomatoes and other crops (Horn and Wimmer, 2006). Considering the above mentioned factors, a research program was undertaken with the following objectives: to evaluate the effectiveness of management practices against bitter gourd fruit fly; to determine the role of micronutrients in controlling the fruit fly in bitter gourd and to estimate the benefit-cost ratio.

Materials and Methods

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period of March to June 2007. The seedlings of 25 days old were transplanted in the well prepared field on 23th April 2007. The size of each experimental plot was 2m × 2m with an inter plot distance of 0.5 m. Two pits of 30 cm ×30 cm × 20 cm sizes each was dug in each plot at a distance of 1m between pits. The experiment was laid out at randomized complete block design (RCBD) with three replications. Cowdung and other chemical fertilizers were applied as recommended by Rashid (1993) for bitter gourd. Cowdung, urea, TSP and MP were applied @ 10 t/ha, 150 kg, 125 kg and 100 kg per hectare respectively. The total cowdung, two third of TSP and one third of urea were applied as basal dose during land preparation. The rest of the TSP and half of MP were applied in the pits seven days before transplanting of seedling. The remaining portions of urea and MP were top dressed after each three flush of flowering and fruiting in two equal splits. The experiment consists of seven treatments such as T_1: Hand picking of infested fruits and flowers at 7 days interval; T_2: Neem seed kernel @ 5g/litre of water at 5 days interval + T_1 ; T_3: Shobicron 425 EC(Profenofos Q+Cypermethrin) 2 ml/litre of water at 7 days interval +T_1; T_4: Micronutrient-Zn (6.72 kg/litre of water); T_5: Micronutrient-B (1.96 kg/litre of water); T_6: Micronutrient Zn + B; T_7: Untreated control. First application of micronutrients was done as top dress on April 24, 2007 after one day of transplanting and second application of the treatment was done on 23 May 2007 after second harvest following the top dress method. The plots of the untreated control were left without any application of micronutrients. Treatments were applied at 7 days interval for controlling the pest. Data on fruit infestation was taken at fruit initiation, early, mid and late fruiting stages according to Amin (1995) and Uddin (1996).

$$\%\text{Fruit infestation by weight} = \frac{\text{Weight of infested fruits (g)}}{\text{TWeight of total fruits (g)}}$$

Fruit yield was measured by adding the total harvest attaining from all harvest in individual plot and converted into per hectare yield.

The benefit cost ratio (BCR) was calculated by utilizing the following formula:

$$\text{Benefit cost ratio} = \frac{\text{Adjusted net return}}{\text{Total management cost}}$$

The data obtained for different characters were statistically analyzed to find out the significant difference among the treatments. The analysis of variance was performed by using MSTAT Program. The significance of the difference among the treatment combination means was tested by DMRT (Duncan's Multiple Range Test) at 5% level of probability (Gomez and Gomez, 1984).

Results and Discussion

At early fruiting stage, the lowest (12.85%) fruit infestation by weight was recorded from the treatment T_2 which was statistically similar (13.26% and 13.74%) with the treatments T_6 and T_3, respectively. On the other hand the highest (43.68%) fruit infestation by weight was recorded from T_7 i.e. untreated control plots which were followed (30.08%) by T_1 treatment. Sole application of micronutrient Zn + B for the treatments T_4 and T_5 comparing with the untreated control and treatments T_2 and T_3 performed intermediate level of fruit infestation by weight and the value was 19.85% and 25.22%, respectively. At mid fruiting stage, the lowest (15.02%) fruit infestation by weight was recorded from the treatment T_2 which was statistically similar (16.85% and 17.11%) with T_3 and T_6 treatment, respectively. On the other hand, the highest (48.36%) fruit infestation by weight was recorded from T_7 treatment which was followed (34.77%) by T_1 treatment. At late fruiting stage, the lowest (17.22%) fruit infestation by weight was recorded from the treatment T_2 which was statistically identical (19.08% and 19.55%) with T_6 and T_3 treatment, respectively. On the other hand, the highest (52.63%) fruit infestation by weight was recorded from the treatment T_7 which was followed by T_1 (38.58%) treatment. Application of micronutrient Zn and B alone for the treatment T_4 (26.93%) and T_5 (31.74%) had moderate level of fruit infestation by weight. From the above findings, it was observed that inclusion of hand picking with the treatments increased its effectiveness. Similarly, Nasiruddin and Karim (1992) reported that the hand picking was less effective but it was necessary that the female fruit fly lay eggs and the larvae hatch inside the fruit, it become essential to look for the available measures in the field sanitation. Cruz (1996) evaluate different insecticide along or in mixture with micronutrients (Boron, Zinc and Molybdenum) as seed treatments for the control of maize pests and he found that the average maize yield from treated plot varied from 818 to 1414 Kg/ha, greater than the yield obtained from the control plots. In an average fruiting infestation for entire fruiting stage minimum (13.78%) fruit infestation by weight was recorded for the treatment T_2 which was closely followed (15.38% and 15.44%) by the treatmentT_6 and T_3, respectively.

Table 1. Effect of various pest management practices on fruit infestation (%) by weight at different fruiting stages

Treatments	Fruit infestation (%) by weight at				Reduction over control (%)
	Early stage	Mid stage	Late stage	Average	
T_1	30.08 b	34.77 b	38.58 b	31.94 b	30.70
T_2	12.85 e	15.02 e	17.22 e	13.78 e	70.10
T_3	13.74 e	16.85 e	19.55 e	15.44 e	66.50
T_4	19.85 d	22.85 d	26.93 d	21.37 d	53.63
T_5	25.22 c	29.94 c	31.74 c	26.56 c	42.37
T_6	13.26 e	17.11 e	19.08 e	15.38 e	66.63
T_7	43.68 a	48.36 a	52.63 a	46.09 a	--
$LSD_{(0.05)}$	4.633	3.769	2.671	1.987	--
CV(%)	11.49	8.02	5.11	4.58	--

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 3 plants per treatment

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

T_1: Hand picking of infested fruit of bitter gourd at 7 days interval
T_2: Neem seed kernel @ 5gm/l of water at 5 days interval + T_1
T_3: Shobicron 425 EC @ 2ml/l of water at 7 days interval + T_1
T_4: Micronutrient-Zn @ 6.72kg/ha
T_5: Micronutrient-B @ 1.96kg/ha
T_6: Micronutrient Zn + B
T_7: Untreated control

On the other hand the maximum (46.09%) fruit infestation by weight was recorded for T_7 treatment which was closely followed (31.94%) by T_1 treatment. Application of micronutrient-Zn and micronutrient-B was solely for the treatment T_4 and T_5 comparing with the untreated control. The reason for this might be the prevalence of hindrance free activities of the fruit fly in untreated plots. As a result, the damage in majority of infested fruits incurred by larval activity inside the fruit might reach the extreme level leading to rotting of the fruits (Uddin, 1996).

Fruit infestations by weight reduction over control for different treatments were calculated and recorded different values for different treatments. Maximum (70.10%) reduction over control was found from the treatment T_2 and the minimum (30.70%) reduction over control was found from T_1. Treatments T_4 and T_5 gave reduction over control 53.63% and 42.37% by weight under the present trial. The minimum (61.00) number of fruits per plot was recorded for the treatment T_7 as untreated control condition which was closely followed (68.00) by T_1 treatment as hand picking. On the other hand the maximum (85.00) number of fruits per plot was recorded for T_2 as application of neem seed kernel at 5 days interval + hand picking which was statistically identical (81.00) by T_3 treatment as spray of shobicron at 7 days interval + hand picking were done for controlling fruit fly. Sole application of micronutrient-Zn and micronutrient-B for the treatment T_4 (75.00/plot) and T_5 (71.00/plot) gave medium number of fruits (Table 2). Number of fruits per plot increased over control for different treatments. Maximum (39.34%) increase over control was recorded from the treatment T_2 and the minimum (11.48%) increase over control was recorded from the treatment T_1. The minimum (128.36 g) weight of individual fruit was recorded for the treatment T_7 as untreated control condition which was closely followed (141.88 g) by T_1 treatment as hand picking. On the other hand the maximum (172.35 g) weight of individual fruit was recorded for T_2 as application of neem seed kernel at 5 days interval + hand picking which was statistically identical (168.30 g) by T_3 treatment as spray of shobicron at 7 days interval + hand picking were done for controlling fruit fly. Sole application of micronutrient-Zn and B was treated for the treatments T_4 and T_5 comparing with the untreated control. Treatments T_2 and T_3 gave intermediate level of weight of individual fruit weight and the weight was 151.21 g and 147.22 g, respectively (Table 2).

Table 2. Effect of various pest management practices on number of fruits, weight of individual fruit and increase over control

Treatment	Number of fruits per plot	Increase over control	Weight of individual fruit (g)	Increase over control
T_1	68.00 c	11.48	141.88 bc	10.53
T_2	85.00 a	39.34	172.35 a	34.27
T_3	81.00 a	32.79	168.30 a	31.12
T_4	75.00 b	22.95	151.21 b	17.80
T_5	71.00 bc	16.39	147.22 b	14.69
T_6	82.00 a	34.43	166.62 a	29.81
T_7	61.00 d	--	128.36 c	--
$LSD_{(0.05)}$	5.337	--	13.77	--
CV(%)	4.02	--	7.04	--

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 3 plants per treatment

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

Maximum (34.27%) increase over control was recorded from the treatment T_2 and the minimum (10.53%) was recorded from T_1. At early fruiting stage, the highest (2030.93 g) yield per plot was recorded from the treatment T_2 which was statistically similar (2007.00 g and 2000.00 g) with the treatmetnsT_3 and T_6, respectively (Table 3). On the other hand, the lowest (1676.00 g) yield per plot was recorded from T_7 treatment which was statistically similar (1804.90 g) with T_1 treatment. Comparing with the untreated control, sole application of micronutrient Zn and B for the treatments T_4 and T_5 had intermediate level of fruit yield per plot and the yield was 1944.90 g and 1871.37 g, respectively. At mid fruiting stage, the highest (2245.32 g) yield per plot was recorded from the treatment T_2 which was statistically identical (2215.48 g and 2214.00 g) with T_6 and T_3 treatments, respectively. On the other hand, the lowest (1810.56 g) yield per plot was recorded from T_7 which was followed (1944.90 g) by T_1 treatment. Sole application of micronutrient-Zn and B for the treatments T_4 (2108.66 g/plot) and T_5 (2003.68 g/plot) had intermediate level of fruit yield per plot. At late fruiting stage, the lowest (2022.72 g) yield per plot was recorded for the treatment T_2 which was statistically similar (1969.36 g and 1953.88 g) with T_3 and T_6 treatment, respectively. On the other hand, the lowest (1456.50 g) yield per plot was recorded from T_7

treatment which was followed (1601.48 g) by T_1 treatment. Sole application of micronutrient-Zn and B for the treatments T_4 and T_5 comparing with the untreated control and treatments T_2 and T_3 performed intermediate level of fruit yield per plot at late fruiting stage and the yield was 1843.10 g/plot and 1705.38 g/plot, respectively. Yield per plot was calculated by adding different harvest and the maximum (7.73 kg) yield per plot was recorded for the treatment T_2 which was statistically similar (7.59 kg and 7.58 kg) with treatments T_3 and T_6, respectively. On the other hand, the minimum (6.01 kg) yield per plot was recorded for T_7 which was closely followed (6.55 kg) by T_1. Sole application of micronutrients-Zn and B for the treatments T_4 (7.26 kg/plot) and T_5 (6.86 kg/plot) performed intermediate yield of fruit per plot. Fruit yield per plot increased over control for different treatments which were calculated and recorded.

Table 3. Effect of various pest management practices on fruit yield per plot at different fruiting stage and increase over control in bitter gourd

Treatments	Fruit yield (g/plot) at the stage of				Yield (kg/plot)	Increase over control (%)
	Initiation	Early	Mid	Late		
T_1	1201.10 b	1804.90 bc	1944.90 cd	1601.48 de	6.55 d	8.99
T_2	1430.72 a	2030.93 a	2245.32 a	2022.72 a	7.73 a	28.62
T_3	1405.84 a	2000.00 a	2214.00 a	1969.36 ab	7.59 a	26.29
T_4	1362.50 a	1944.90 ab	2108.66 ab	1843.10 bc	7.26 b	20.80
T_5	1276.56 b	1871.37 ab	2003.68 bc	1705.38 cd	6.86 c	14.14
T_6	1400.00 a	2007.00 a	2215.48 a	1953.88 ab	7.58 a	26.12
T_7	1069.48 c	1676.00 c	1810.56 d	1456.50 e	6.01 e	--
$LSD_{(0.05)}$	80.98	158.5	141.1	146.6	0.239	--
CV(%)	9.48	4.68	7.82	8.58	11.91	--

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 3 plants per treatment

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

Maximum (28.62%) increase over control was recorded from the treatment T_2 and the minimum (8.99%) increase over control was recorded from T_1. Treatments T_4 and T_5 gave reduction over control 20.80% and 14.14% yields per plot under the present trial. From the above findings it was observed that including the management practice hand picking of infested fruits with neem seed kernel or spraying of insecticide shobicron was found more effective in controlling fruit fly. Zinc affects enzyme systems that regulate various metabolic activities like protein synthesis, formation of chlorophyll, transformation of carbohydrates and regulation of the sugar consumption in the plant. Moreover they played important role in flowering maturation date, plant height, if present in sufficient quantities in the leaf, acts like anti freeze in citrus, tomatoes and other crops and ultimately resulting was highest yield (Horn and Wimmer, 2003). Singh and Singh (1998) evaluated neem (*Azadirachta indica)* seed kernel extract at 1.25-20% and pure azadirachtin at 1.25-10 ppm as oviposition deterrents to *Bactrocera cucurbitae* on pumpkin and they reported that neem seed kernal extract deterred oviposition by *B. cucurbitae* at all the concentration. Atwal (1993) suggested mechanical control measures in farmer's fields as normal practice for effective control against this pest in India and the treatment hand picking and burning had considerably lowered the infestation (average 34.08% when compared with untreated control plot (average 58.39%). In this study the untreated control did not have pest management cost, but rest of the components needed variable pest management costs. The component (T_1) hand picking was done only involved labors cost; treatment (T_2), neem seed kernel at 5 days intervals + hand picking include neem kernel cost and mixture preparation; Component (T_3) Spray of shobicron 7 days interval + hand picking this treatment also includes the cost pesticides and other treatments include the cost of Zn and B. The analysis was done in order to find out the most profitable management practices based on cost and benefit of various components. The results of economic analysis of bitter gourd showed that the highest net benefit of Tk. 247,600 ha^{-1} was obtained in T_6 treatment component followed by the second highest Tk. 237,000 ha^{-1} in T_4 (Table 6). The highest benefit cost ratio (9.44) was estimated for T_6 treatment and the lowest (1.06) benefit cost ration for T_3 treatment under the trial. The benefit cost ratio (BCR) calculated for each of the treatment component revealed that the BCR of the treatment T_4 was (7.32) and the in the treatment component T_5 (4.64) which was followed by the treatments T_2 (1.60) and treatment T_1 (1.25), respectively (Table 4). Highest BCR was found in the treatment T_6 may be due to the less management cost compared to the other treatment components and highest yield. Thus, it might be concluded that judicious use of insecticides in combination with micronutrients as well as hand picking of infested fruits would be best for bitter gourd cultivation at farmers' level.

Table 4. Benefit cost ratio of bittergourd using various management practices

Treatments	Cost of pest Management (Tk.)	Yield (t/ha)	Gross return (Tk.)	Net Return (Tk.)	Adjusted net return (Tk.)	Benefit cost ratio
T_1	8000	10.92	218400	210400	10000	1.25
T_2	22000	12.88	257600	235600	35200	1.60
T_3	25500	12.65	253000	227500	27100	1.06
T_4	5000	12.10	242000	237000	36600	7.32
T_5	5000	11.43	228600	223600	23200	4.64
T_6	5000	12.63	252600	247600	47200	9.44
T_7	0	10.02	200400	200400	--	--

References

Akhtaruzzaman, M, Alam, M.Z. and Ali-Sardar, M.M. 1999. Suppressing fruit fly infestation by bagging cucumber at different days after anthesis. *Bangladesh J. Entomol.* **9**: 103-112.

Amin, M.R. 1995. Effect of some indigenous materials and pesticides in controlling fruit fly *Bactrocera cucurbitae Coquillet* in Cucumber. M. S. Thesis. Department of Entomology, Institute of Postgraduate Studies in Agriculture, Gazipur, Bangladesh. P. 56

Anonymous. 2004. Integrated management of cucurbit fruit fly, *Bactrocera cucurbitae* Coquillett in Bangladesh. *IPM CRSP Bangladesh site technical bulletin no. 1.*

Atwal, A.S. 1993. Agricultural Pests of India and South East Asia. Kalyani Publ. New Delhi, Ludhiana, pp. 189-190.

Cruz, I. 1996. Effect of seed treatment of maize with insecticides on grain yield. EMBRAPA/CNPMS, Caixa Postal. **151**, 35701-970.

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

Farid, A.T.M., Mojibur, R. and Sheel, N.C. 2003. Deficiency symptoms of micronutrients and its remedy, Soil Science Division, Bangladesh Agricultural Research Institute, Joydebvpur, Gazipur.

Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedure for Agricultural Research (2nd edn.). Int. Rice Res. Inst., A Willey Int. Sci., Pub., pp. 28-192.

Horn, C. and Wimmer, E.A. 2003. A transgene-based, embryo-specific lethality system for insect pest management. *Nature Biotechnology*. **21**: 64-70.

Mishra, P.N. and Singh, M.P. 1999. Studies on the ovicidal action of diflubenzuron on the eggs of *Dacus* (*Bactrocera*) *cucurbitae Coq*. damaging cucumber. *Annals of Plant Protection Science.* **7**: 94-6.

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

Quasem, M.A. 2003. Exports of fresh horticultural crops from Bangladesh: problems and prospects. Dhaka: Bangladesh Institute of Development Studies. pp. 65.

Rabindranath, K. And Pillai, K.S. 1986. Control of fruit fly of bitter gourd using synthetic pyrethroids. *Entomon*. **11**: 269-272.

Rashid, M.A. 1993. Sabji Biggan. Bangla Accademi, Dhaka, Bangladesh. pp. 234-269.

Singh, S. and Singh, R.P. 1998. Neem seed kernel extracts and azadirachtin as oviposition deterrents against the melon fly (*Bactrocera cucurbitae*) and the oriental fruit fly. Div. of Ent. Indian Agri. Res. Ins. (IARI) New Delhi.

Uddin, M.J. 1996. Development of suitable package(s) of IPM components for the management of selected insect pests of cucumber. M.S. Thesis. Department of Entomology, Institute of Postgraduate Studies in Agriculture, Gazipur, Bangladesh.