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FEEDING, GROWTH AND CHEMICAL CONTROL OF HOG-PLUM BEETLE (*Podontia 14-punctata*)

Mousumi Khatun[1], Mohammad Mahir Uddin[1*], Md. Azizul Haque[1] and Mohammad Saidur Rhaman[2]

[1]Department of Entomology and [2]Department of Seed Science and Technology, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

***Corresponding author:** Mohammad Mahir Uddin; E-mail: mahirbau@yahoo.com

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Experiments were conducted to study the feeding, growth and chemical control of hog-plum beetle (*Podontia 14-punctata*) in the laboratory and in the field. It was found that larval leaf consumption gradually increased with the increase of age of larva. Mean leaf consumption per larva was 0.28g, 0.86g and 1.70g after 24, 72 and 144 hrs, respectively. Growth pattern of larva was depended on the rate of leaf consumption. The average body weight of larvae was increased with time and per larva was recorded as 0.06g, 0.19g and 0.45g after 24, 72 and 144 hrs of leaf consumption. Daily leaf consumption was higher in adults than larvae. Mean leaf consumption per adult was 0.24g, 0.91g and 1.87g after 24, 72 and 144 hrs, respectively. Mortality of larvae and adults against four chemical insecticides viz. Altima 40WG, Belt 24WG, Libsen 45SC and Limper 10EC were observed both in the laboratory and field. All the treatments had a significant effect on mortality percentage of larva and adult in comparison to control. The highest mortality percentage of the larva (86.67) and adult (80.00) were observed in the case of Limper 10EC at 72 hrs after spraying. However, there was no significant difference observed in efficacy among Limper 10EC, Belt 24WG and Libsen 45SC. In field, percentage of leaf protection over control after 1st spray was the highest (37.95) in Limper 10EC and the lowest (20.86) in Altima 40WG treated plants. The results of laboratory and field trials revealed that Limper 10EC might be recommended for effective control of *P. 14-punctata*.

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INTRODUCTION

Bangladesh is a small country enjoys generally a sub-tropical monsoon climate. A tropical location, lush greenery, moisture rich loamy soil and production friendly climate,all these make Bangladesh one of the notable growers of a vast range of fruits. In 2009-10, about 133000 acres land was used for permanent fruit production (BBS, 2011). Hog-plum (*Spondias cytherea*) is also known as “Amra” has been considered as major fruit for its availability in Bangladesh although it was a minor fruit. Now it is one of the popular fruit in Bangladesh. Hog-plum, a natural source of vitamin C, contains even more vitamin C than more costly fruit orange. Hence, most of the country people are not able to buy oranges where hog-plum could be a very good alternative source of vitamin C. In addition to Vit. C, it has also been reported as a rich source of carotene (Mondal and Amin, 1990). The fruit hog-plum is consumed mostly in green stage and is also used as jam, jelly, pickles etc (Ahmed, 1969). It is reported that hog-plum leaf used as fodder in different parts of India like Asham, Madhya Pradesh, Punjab and Uttar Pradesh (Singh, 1982). The production of hog-plum is greatly reduced by infestation of many insect pests. Hog-plum beetle or fourteen spotted leaf beetle, *Podontia 14-punctata* L. (Chrysomelidae: Coleoptera) is an important pest among them. Both the larvae and adults feed on the leaf of hog-plum and the insect causes damage up to 96 percent of the leaf of hog-plum (Uddin and Khan, 2015). Average infestation of the leaves is 50 percent and sometimes resulted complete defoliation of trees. This beetle causes serious damage to the crop from March to August with two generations in a year (Mondal, 1975). When the hog-plum trees acquire full-foliar stage in the spring, the beetles are found to appear immediately.

In Bangladesh, the beetles appear in April, abundant during July to September and disappear in October (Khan, 2016). The peak period of defoliation is found in August and September (Beeson, 1941; Baksha, 1997; Deka and Kalita, 2002). The limited report reveals that in the case of heavy infestation all leaves of the young trees are eaten up except midribs and subsequently cause the trees defoliated. During severe infestation, the larvae devour the old leaves, tender parts of stems and even the green barks of the plants (Howlader, 1993). Their attack resulting in retarded growth of the plant and reduce the fruit yield (Mondal, 1975). During off season the insect pupates in the soil in hibernating condition.

Hog-plum beetle is a destructive pest in hog-plum and damage hog-plum plant severely in Bangladesh. At present suitable control measure against this pest is not available in the country. People usually spray any insecticide to control this insect pest. But there is no recommended insecticide with optimum doses of application for controlling this pest yet. The choice of effective insecticide and dose (s) are important approach necessary for developing acceptable IPM package against this pest. For suppressing this pest and other beetle and weevil pests, some authors tested a few number of chemical insecticides (Hoffmann et al., 2000; Elzen et al., 2000; Singh et al., 1989), of them Malathion was found to be effective against these pests. But indiscriminate use of broad spectrum insecticide causes various problems in fruit cultivation. So it is necessary to identify the appropriate insecticide with proper doses which might be helpful to develop an IPM package for managing this devastating pest which ultimately will help in controlling this pest and the increase of productivity of hog-plum in our country. To control this pest, it is also necessary to know its feeding behavior and larval growth pattern. In view of above perspectives, the present research was therefore, conducted to study the feeding behavior, larval growth and finally to develop a suitable management strategy including some new generation chemical insecticides for the hog-plum beetle.

MATERIALS AND METHODS

Several experiments on feeding, growth and chemical control of hog-plum beetle, *Podontia 14-punctata* were carried out in the laboratory of Entomology Department and Germplasm Centre, Bangladesh Agricultural University (BAU), Mymensingh during June 2014 to July 2015.The laboratory experiment was carried out at normal room temperature (32 ± 0C) and relative humidity using completely randomized design (CRD). The field experiment was laid out in a randomized complete block design (RCBD) with 5 treatments and 3 replications. Treatments of different doses of chemical insecticides were T1 =Altima plus (Emamectin benzoate + Thiomethaoxam) 40WG @ 0.02%, T2 = Belt (Flubendiamide) 24 WG @ 0.04 %, T3 = Limper (Cypermethrin) 10EC @ 0.1%, T4 = Libsen (Spinosad) 45SC @ 0.1%, T5 = control. These treatments were used both in laboratory and field condition. Each treatment was replicated 3 times.

Protocol for laboratory trial

Leaf consumption by larva and adult

The leaf consumption of larvae and adult of *P. 14-punctata* was measured in terms of consumed leaf weight (g). In the case of larvae, eight Petri dishes were used to determine leaf consumption. Three grubs of 2nd and 3rd instars were released in each Petri dish. In the case of adult four Petri dishes were used. Five adults were released in each Petri dish. Water soaked cotton was supplied in Petri dishes to moisten the leaves in both cases. In both cases, fresh leaf was provided by replacing old one. Before replacing old one the weight of fresh leaves and old leaves were measured.

Growth of larva

The growth of larvae was measured in terms of weight gained by larvae. Eight Petri dishes were used. Three larvae were supplied in each Petri dish. Fresh leaves were provided daily by replacing old leaves. The weight of larvae was measured daily by electronic balance before and after release in the Petri dish. Finally the weight (g) increase per day was calculated.

Mortality of larva and adult

Three fresh leaflets were dipped into the different insecticide solutions and then single leaflet was placed into each Petri dish. Altima plus 40WG, Libsen 45SC, Belt 24WG and Limper 10EC were applied @ 0.02%, 0.1%, 0.04% and 0.1%, respectively. Each treatment was replicated in three times. In each petridish, 10 adults or 10 larvae were released. This procedure was continued up to three days and mean percentage mortality was calculated.

Protocol for field trial

The hog-plum plants of BAU Germplasm Centre, Bangladesh Agricultural University, Mymensingh. For field trial, beetle infested small trees were randomly selected. Pretreatment data was recorded on the following parameters, the number of adults, the number of larvae, the number of total leaflet and number of infested leaflet per twig. Altima plus 40WG, Libsen 45SC, Belt 24WG and Limper 10EC were applied @ 0.02%, 0.1%, 0.04% and 0.1%, respectively. Appropriate doses of insecticides were prepared by adding required amount of water. Spraying was done by a hand sprayer. A total of two sprayings were given during experimental period. Spraying was done within 9.00 to 11.00 AM to avoid bright sun shine and drift caused by strong wind.

Statistical analysis of data

The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was done with the help of computer package MSTAT. The mean differences among the treatments were adjusted with Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD) when necessary.

RESULTS AND DISCUSSION

Trial for laboratory condition

Leaf consumption by larva of *P. 14-punctata*

The result indicated that mean leaf consumption after 24hrs of leaf supply by three larvae was 0.83±0.07g. At 24 hrs after leaf supply in the Petri dish 0.28g leaf was consumed by per larva and it attained 1.70g at 144 hrs (Table 1). The results revealed that the rate of leaflet consumption increased with the increase in age of larvae due to increase in the size of the larvae which need enough food for voracious and random feeding on leaves. The results of the present study are supported by Uddin and Khan (2014) who reported that 2nd instar larva of *P. 14- punctata* had consumed 0.204 ± 0.001 g leaflet of hog-plum after 24 hrs where it was 0.877 ± 0.003 g for 3rd instar larva.

Table 1. Leaf consumption of larva of *P. 14-punctata* at different time intervals

Sl. No.	Leaf consumption (g) at different time intervals by 3 larvae					
	24 hrs	48 hrs	72 hrs	96 hrs	120 hrs	144 hrs
1	0.9	1.7	2.8	3.6	4.5	5.2
2	0.7	1.6	2.7	3.5	4.3	5.3
3	0.8	1.6	2.1	3	3.9	5.1
4	1.1	1.9	3.0	3.5	4.5	4.9
5	0.4	1.3	1.9	2.7	3.6	4.2
6	1.0	1.8	2.5	3.4	4.4	5.1
7	0.9	2.0	2.9	3.5	4.9	5.6
8	0.9	1.9	2.8	3.4	4.5	5.4
Mean	0.83	1.71	2.58	3.33	4.32	5.10
SE(±)	0.07	0.12	0.15	0.09	0.09	0.08
Food eaten/larva	0.28	0.57	0.86	1.11	1.44	1.70

Body weight of larva of *P. 14-punctata*

After 24hrs mean body weight of three larvae was 0.18g. Body weight of a single larva was 0.06g after 24 hrs in laboratory condition. It was observed that body weight of a larva after 72 hrs was 0.19g and it proved that by consumption of leaf their body weight was increased. After 144 hrs a larva gained 0.45g weight (Table 2). Uddin and Khan (2014) reported that 3rd & 4th instar larvae of *P. 14-punctata* had consumed more leaflet than 1st & 2nd instar larvae. It might be concluded that with the increase of age their feeding rate also increased and the older larvae fed more than younger one.

Table 2. Body weight (g) of larva of *P. 14-punctata* at different time intervals

Sl. No.	Body weight of 3 larvae (g) at different time intervals					
	24 hrs	48 hrs	72 hrs	96 hrs	120 hrs	144 hrs
1	0.3	0.6	0.9	1.1	1.3	1.6
2	0.3	0.4	0.5	0.8	1.1	1.5
3	0.2	0.3	0.4	0.7	1.0	1.3
4	0.1	0.6	0.9	1.1	1.3	1.7
5	0.2	0.2	0.3	0.4	0.7	1.0
6	0.2	0.5	0.8	1.1	1.4	1.6
7	0.1	0.15	0.25	0.45	0.7	0.9
8	0.1	0.3	0.6	0.7	0.9	1.2
Mean	0.18	0.38	0.58	0.79	1.05	1.35
SE(±)	0.02	0.06	0.09	0.1	0.09	0.10
Body wt./larva	0.06	0.13	0.19	0.26	0.35	0.45

Leaf consumption by adult beetle of *P. 14-punctata*

Consumption of hog-plum leaf by *P. 14-punctata* adults after 24 hrs up to 144 hrs is presented in Table 3. The leaflet consumption by five adults ranged from 0.5 g to 10.1 g, within 24 hrs to 144 hrs. The leaflet consumption by five adults ranged from 0.5 g to 1.6 g, with an average of 1.2±0.24 g after 24 hrs. The results of the present study were similar to the findings of Uddin and Khan (2014). They reported that male adult of *P. 14- punctata* had consumed 0.25 ± 0.006 g leaflet of hog-plum after 24 hrs the female adult had consumed 0.58±0.015 g leaflet.

Table 3. Amount of food eaten by adult of *P. 14-punctata* at different time intervals

Sl. No.	Leaf consumption (g) by 5 adults at different time intervals					
	24 hrs	48 hrs	72 hrs	96 hrs	120 hrs	144 hrs
1	1.4	3.6	4.6	6	7.2	9.1
2	1.6	4.6	6.1	7.3	8.7	10.3
3	1.3	3.1	3.5	5.3	6.5	9.1
4	0.5	1.1	4	6.2	6.8	8.9
Mean	1.2	3.1	4.55	6.2	7.3	9.35
SE(±)	0.24	0.73	0.56	0.41	0.49	0.32
Food eaten/adult	0.24	0.62	0.91	1.24	1.46	1.87

Mortality of larva

The results (Table 4) showed that the mean larval mortality percentage after 72hrs ranged from 16.67 to 86.67%. The highest mortality% after 72 hrs were recorded where the treatment was T3= Limper 10EC which was statistically similar to treatments T2 and T4. The lowest mean mortality was in T5= untreated control. The findings of the present research were almost similar to the findings of Hosen (2009) on mortality percentage of *P. 14-punctata* larvae in the laboratory condition.

Table 4. Mortality of larvae of hog-plum beetle in the laboratory at different time intervals

Treatments	Mean number of released larvae /Petri dish	Mean number of dead larvae			Mean mortality (%) after 72 hrs
		24 hrs	48 hrs	72 hrs	
Altima plus 40WG	10	3.00b	4.00b	5.33b	53.33b
Belt 24WG	10	6.00a	7.33a	8.00a	80.00a
Limper 10EC	10	6.00a	7.66a	8.66a	86.67a
Libsen 45SC	10	6.00a	7.33a	7.66a	76.67a
Untreated Control	10	0.33c	1.00c	1.66c	16.67c
$LSD_{0.05}$	-	1.28	1.56	1.14	12.18
SE (±)	-	0.39	0.47	0.35	3.74
Level of significance	-	**	**	**	**
CV (%)	-	16.01	15.12	9.66	10.33

Means in the same column indicate significant differences at 1% level of probability

Mortality of adult

The adult mortality result of the experiments after 24 hrs, 48 hrs and 72 hrs of spraying of four insecticides with different concentration is presented in Table 5. The highest mean mortality percentage after 72hrs were recorded where the treatment was T3= Limper 10EC which was statistically similar to treatments T2 and T4. The lowest mean mortality was in T5= untreated control. The findings of the present research were almost similar to the findings of Hosen (2009) on mortality percentage of *P. 14-punctata* larvae in the laboratory condition.

Table 5. Mortality of adult of hog-plum beetle in the laboratory

Treatments	Mean no. of adults released/ Petri dish	Mean number of dead adults			Mean mortality (%) after 72 hrs
		24 hrs	48 hrs	72 hrs	
Altima plus 40WG	10	2.33b	3.33c	4.00b	40.00b
Belt 24WG	10	4.67a	5.67b	7.00a	70.00a
Limper 10EC	10	6.00a	7.00a	8.00a	80.00a
Libsen 45SC	10	5.00a	5.67b	6.67a	66.67a
Control	10	0.00c	0.00d	0.66c	6.67c
$LSD_{0.05}$	-	1.35	1.24	1.42	14.17
SE (±)	-	0.415	0.380	0.435	4.35
Level of significance	-	**	**	**	**
CV (%)	-	19.97	15.19	11.64	14.29

Means in the same column indicate significant differences at 1% level of probability

Trial for field condition

Effectiveness of selected insecticides on percent leaflet infestation by *P. 14-punctata*

The percentage of leaflet infestation was significantly reduced when hog-plum plants were treated with four chemical insecticides. Altima plus, Belt, Limper and Libsen were evaluated against the leaflet infestation caused by *P. 14-punctata* (Table 6). The data clearly showed that all the chemical insecticides had significant ($P<0.01$) effect on the reduction of percent leaflet infestation compared to the control. The lowest percentage of leaflet infestation was observed on Limper (48.23%) and Belt (51.80%) treated plants after 120 hrs of spraying.

Table 6. Percentage of leaflet infestation after insecticide spraying at different time intervals

Treatments	Pre-treatment (%) leaflet infestation	% leaflet infestation at different time intervals of spraying					Cumulative mean (%) leaflet infestation
		24 hrs	48 hrs	72 hrs	96 hrs	120 hrs	
Altima plus 40WG	54.16ab	56.52b	58.92b	60.40b	61.62b	63.65b	60.22b
Belt 24WG	49.50b	49.68bc	50.11bc	50.45c	51.32c	51.80c	50.67c
Limper 10EC	46.40b	46.50c	46.85 c	47.12c	47.38c	48.23c	47.22c
Libsen 45SC	51.08b	51.47bc	51.96bc	52.34bc	52.83bc	53.03c	52.32bc
Control	62.50a	67.79a	72.14a	75.96a	80.55a	84.06a	76.10a
$LSD_{0.05}$	8.87	8.31	8.60	8.90	8.94	8.42	8.56
SE (±)	2.71	2.55	2.64	2.73	2.74	2.58	2.63
Level of significance	*	**	**	**	**	**	**
CV (%)	8.93	8.12	8.16	8.26	8.09	7.44	7.94

Means in the same column indicate significant differences at 1% level of probability

These findings could be linked with Hosen (2009) who reported that when Siperin 10EC (Limper 10EC) was tested against *P. 14-punctata*, it was found most effective among the treatments. The results of their experiment indicated that the application of Siperin 10EC was found most effective in reducing the damage extent.

Mortality of larva

The result of the field experiments showed that the mean mortality percentage after 120 hrs, the highest mortality percentage 90.77 was found in Limper. The mortality percentage was 52.62, 82.39 and 73.58 for the treatments Altima plus, Belt and Libsen, respectively (Fig. 1). The lowest mortality was found in Altima plus and it was 52.62 %. There were significant differences among the treatments. There was no mortality observed in control treatment. Uddin and Khan (2015) found that two treatments Superior 505 EC (Chlorpyriphos + Cypermethrin) @ 0.75 ml L^{-1} of water and Superior 505 EC (Chlorpyriphos + Cypermethrin) @ 1.0 ml L^{-1} of water were most effective in mortality of all larval instars under field condition.

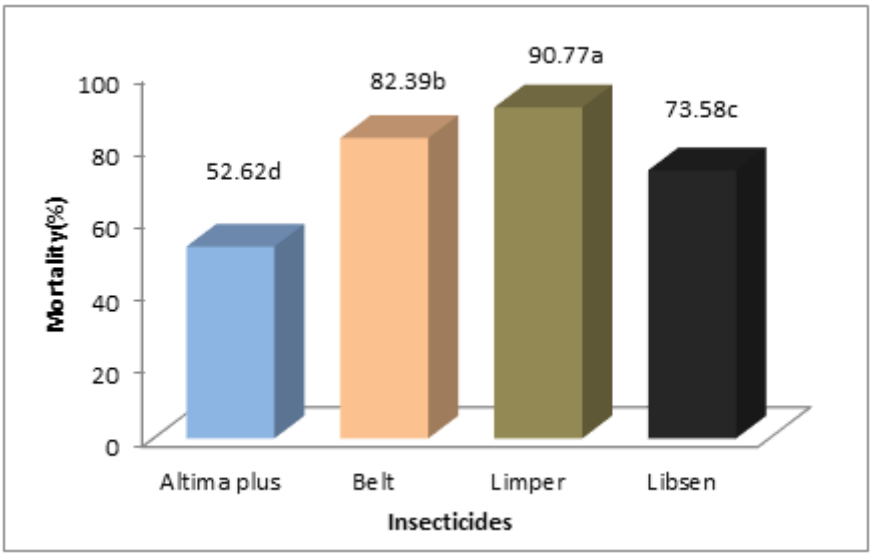

Figure 1. Mortality percentage of larvae in field condition after 120 hrs

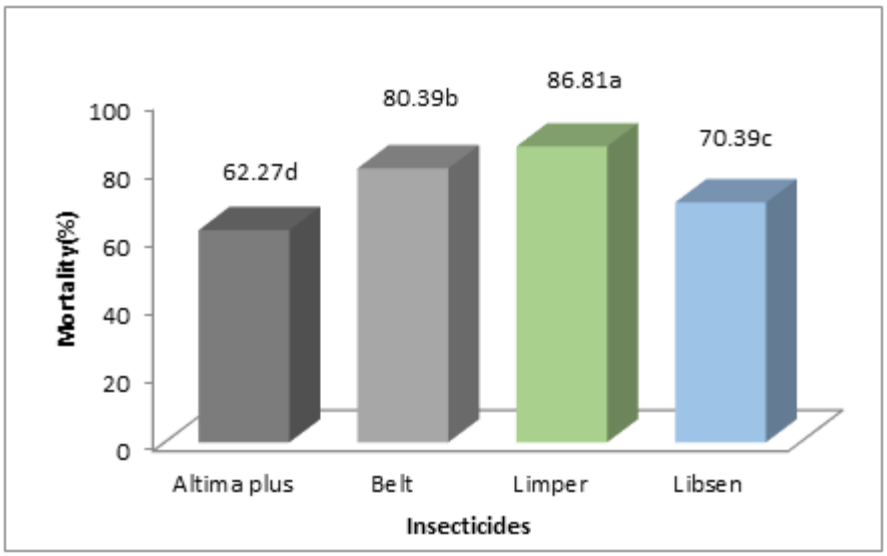

Figure 2. Mortality percentage of adult in field condition after 120 hrs

Mortality of adult

Mortality percentage after 120 hrs was highest at Limper which was 86.81. On the other hand, lowest mortality percentage was found 62.27 in the treatment of Altima plus. Belt and Libsen showed mortality percentage 80.39 and 70.39, respectively (Fig. 2). There were significant differences among the

treatments. There was no mortality observed in control treatment. Uddin and Khan (2015) reported that the highest mortality was found in the adult stage of hog-plum beetle after 24 hrs at superior 505 EC (Chlorpyriphos + Cypermethrin) in field trials.

CONCLUSION

From the results, it may be concluded that leaf consumption increased with the increase of larval age. Larval weight also increased by consumption of leaves. Adult beetle consumed more leaf than the larva and rate of leaf consumption was increased day by day. Finally, the results of the effectiveness of insecticides were almost similar. Based on the results it might be concluded that among four insecticides Limper 10EC was most effective in mortality and in reducing the extent of leaf damage. The rank of the efficacy of four chemical insecticides tested against hog-plum beetle was: Limper > Belt >Libsen> Altima.

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