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RESEARCH PAPER

Damage Status, Feeding Preferences and Control of Hog-plum Beetle with *Photorhabdus temperata*

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ABSTRACT

Experiments were conducted related to damage status, feeding preferences and control of hog-plum beetle, *Podontia 14-punctata* with a symbiotic bacterium, *Photorhabdus temperata*, in different locations of patuakhali district, Patuakhali science and Technology University (PSTU) campus and Entomology laboratory. *Podontia 14-punctata* is one of the most leaves damaging pest in southern part of Bangladesh. To evaluate the damage status a survey was conducted in twenty one villages under seven different upazillas of patuakhali district. Six hundred thirty plants of different ages (0-20 years) were observed. In this survey (58.33±2.12) percent plants and (45.67±1.68) percent leaflets were infested. In respect of ages highest plant infestation 76% was found in 16-20 years plants followed by 11-15 years (59%), 0-5 years (57%) and lowest infestation of plant was 6-10 years (56%). To determine feeding preferences leaves of four varieties namely, Baromashi, Bilati, Local I and Local II were tested against 3rd instar larvae of *Podontia 14-punctata.* Among these four varieties, Local I was most susceptible variety. 85.57% leaflets was consumed in local I variety followed by Baromashi (80.42%), Local II (65.14%) and Bilati (59.19%) respectively in field condition. Highest leaflets consumed in the variety of Local I (88.88%) and was lowest in the variety of Bilati (55.55%) in laboratory condition. To control *Podontia 14-punctata* three different concentrations (0%, 1% and 10%) of symbiotic culture medium of *Photorhabdus temperata* (PT) were used. Using 10% PT, 100% and 85% mortality were observed after 96 hours in 1st and 2nd instars larvae of *Podontia 14-punctata* respectively.

Key words: Amra Beetle, symbiotic bacteria, management strategy

Introduction

Bangladesh is a land with different delicious fruits. Hog-plum is one of the minor but very popular fruit (*Spondias cythera*) in Bangladesh locally known as "amra. This fruit is grown all over the country but mostly preferred that are grown in Barisal district due to its good quality. It is rich source of vitamin-C and carotene (Mondal and Amin, 1990). The fruit hog–plum is consumed mostly in green stage and is also used as pickle (Ahmed, 1969). It is also reported to be used as fodder in different parts of India like Asham, Madhya Pradesh, Punjab and Uttar Pradesh (Singh, 1982).

The fourteen spotted leaf beetle, *Podontia 14-punctata* belongs to the family chrysomelidae under the Order Coleoptera is an important pest of hogplum. Both larvae and adult beetles feed on the leaves of hog-plum (Beeson, 1941). Initially they feed on the young succulent leaflets. During severe infestation the larvae devour the old leaves, tender part of stems and even the green barks of the plants (Howladar 1993). Limited report reveals that in case of heavy infestation all leaves of the young trees are eaten up except midribs and subsequently cause the trees defoliated. The damage due to the pest was severe during the period when the tree is in full foliage (Mondal, 1975). The insect causes damage about 96 percent of the leaves of hog-plum. Average infestation of the leaves was 50 percent. The beetles completely defoliate the tree and cause stunting of growth of the tree. During off season the insect pupate in the soil in hibernating condition.

Still we are totally dependent on chemical pesticides to control these insect pests which may create several problems, like pesticide resistance, pest resurgence, and disruption of natural balance with other chemical hazards. However, we have some microbial agents which are very safe to our ecosystem can be used in pest control program. Symbiotic bacteria of entomopatho genic nematodes entomopathogenic nematodes from

the families Steinernematidae and Heterorhab ditidae have proven to be the most effective as biological control organisms against more than 200 insect species can play an important role in pest's reduction. *Photorhabdus temperata* under the family Steinernematidae can be used effectively to control soil borne insect pests. Several groups of toxins of *Photorhabdus* spp. play an important role in insect pathogenesis such as toxin complexes (Tcs), the make caterpillar floppy toxins (Mcf), the *Photorhabdus* insect related proteins (Pir) and the *Photorhabdus* virulent cassettes (PVC) (Rodou et al., 2010).

Toxin complexes with Tca, Tcb, Tcc and Tcd multisubunits are most abundant and highly lethal in both oral and injectable application. Tca acts on insect midgut, causing blebbing of endothelium and finally cell lysis (Blackburn et al, 1998). Two Mcf induce death of by making apoptosis of both epithelial and phagocytic cells within midgut (Dowling et al., 2007). This toxin makes enable the bacteria for multiple insect species (Rodou et al., 2010). *Photorhabdus* spp. have PirA and PirB toxin that can work together showing injectable insecticidal toxicity (ffrench-Constant et al., 2007). PirB toxin is similar with Bt cry toxin and have the potential to use as alternate of Bt toxin (Ahantarig et al., 2009). Recently identified toxin is *Photorhabdus* virulence cassettes that showed antifeeding activity (Yang et al., 2006; Rodou et al., 2010).

The present research work was conducted to know the damage status, feeding preferences and the efficacy of a symbiotic bacteria of entmopathgenic nematode, *Photorhabdus temperata* against *Podontia-14 punctata*.

Materials and Methods

These experiments were conducted in the laboratory of Entomology and the surrounding area of Patuakhali Science and Technology University. The survey was conducted at different upazilla in patuakhali, Bangladesh, July 2017 to June 2018 to know the damage status of hog-plum beetle. Different varieties were collected to observe feeding preferences and management of *Podontia 14-punctata* by the application of *Photorhabdus temperata.* The laboratory experiment was carried out under normal room temperature (32 ±2C) and relative humidity (85 ± 5%) with a 14 ± 2:10±2 light and dark cycle (L:D).

Conduct a survey

This survey was conducted in the 21 villages of 7 upazilla in the patuakhali district. These village are Shreerampur, Dumki, Jalisha, Auliapur, Morichbunia, Gerakhali, Masuakhali, Laxmipur, Charhosnabad, Subidkhali, Vidakhali, Andhua, Islampur, Shantipur, Gamuribunia, Birpasha, Kanokdia, Madanpur, Gajalia, Chiknikandi, Dakua inrespect of Dumki, Patuakhali Sadar, Dashmina, Mirzagonj, Kalapara, Baufhal and Galachipa upazilla. The incidence of the insect attack was different level in these villages. The insect attack may vary from different ages of the plant. The incidence of the insect mostly noticed at middle to old age plant very severely. Old age (16-20) years plant are mostly attack by this insect. Mostly infested leaves in middle age plant (6-10 and 11-15) yrs plant. In each village, 30 plants were observed and totally 630 plants were observed.

Nature of damage

Damage caused by the larvae of hog-plum was closely observed at the time of the study period. The place of infestation from the newly flashed leaves, then gradually older leaves and later on the whole plants become defoliated.

Planting hogplum plant:

Four varieties were collected to determine the feeding preferences. These varieties are namely Local I, Local II, Baromashi and Bilati. These varieties were planted at patuakhali science and technology university campus. Local I, Local II, Bilati and Baromashi were collected from Dumki, PSTU Horticulture germplasm and Pirojpur district. Twelve plants under four different varieties were planted in November 2017.

Collection and rearing of larvae

Insect larvae were collected from surroundings of patuakhali science and technology university and near to different village of Dumki upazilla. The insect larvae were rearing with some immature fresh leaves. For testing varietal resistance and mortality 1st and 2nd instars larvae were collected and rearing with immature fresh leaves.

Preparation of solution

For mortality testing, PT solutions were collected from Korea and diluted with water and 0%, 1%, and 10% solution were prepared in the laboratory and preserved. These solutions were sprayed on the leaves and larvae were released on these leaves.

Analysis of Data

The data were obtained during the experiment were statistically analyzed by using Sigma plot software in computer (version 8). The means of different parameters were separated by Duncan's Multiple Range Test (DMRT). MS Excel was used for graphical representation.

Results and Discussion

Damage status

To determine the incidence of Hog plum beetle, a survey was conducted during the observation period August 2017 to June, 2018 with twenty one villages under seven upazilla in Patuakhali district. Six hundred thirty plants of different ages were observed in this survey. On an average (58.33±2.12) plants and (45.67±1.68) percent leaf were infested in this locality (Table 1). In respect of ages highest plant infestation was found in 16-20 years plants (76%) followed by 11-15 years (59%), 0-5 years (57%) and 6-10 years (56%) respectively (Table 2).

In case of leaf infestation, highest leaf infestation was found in 6-11 years plants (47%), followed by 6-10 years (45%), 0-5 years (40%) and lowest infestation of leaves were found in 16-20 years plants (36%) (Table 2). Howladar (1993) reported that both larvae and adults fed on young succulent leaflets. During severe infestation

the larvae devour the old leaves, tender parts of stems and even the green barks of the plants. Mondal (1975) also reported that the larval population of *Podontia 14-punctata* was comparatively greater than that of the adult beetles and the insect appeared in large numbers during the month from May to June.

Feeding preference

To evaluate feeding preferences, 3rd instars larvae of *Podontia 14- punctata* were introduced on the leaves of four different varieties namely, Baromashi, Bilati, Local I and Local II in both field and laboratory conditions. The 3rd instars larvae prefer most the leaves of local I variety followed by Baromashi, Local II and Bilati respectively. In field condition, Highest leaflet infestation was found in the variety of Local II (85.57%) followed by Baromashi (80.42%), Local II (65.14%) and Bilati (59.19%) respectively (Table 3).

Table 1. Damage status of hogplum plants by hugplum beetle at different villages of Patuakhali district.

Upzila	Villages	No. of plant observed	% infested plant	% leaf infestation
Dumki	Shreerampur	30	80	65
	Dumki	30	70	58
	Jalisha	30	60	51
Patuakhali Sadar	Auliapur	30	76	39
	Morichbunia	30	53	42
	Gerakhali	30	60	48
Dashmina	Masuakhali	30	50	52
	Laxmipur	30	53	47
	Charhosnabad	30	66	45
Mirzagonj	Subidkhalui	30	43	40
	Vidakhali	30	56	38
	Andhua	30	60	42
Kalapara	Islampur	30	50	36
	Shantipur	30	46	37
	Gamuribunia	30	63	40
Baufal	Birpasha	30	50	48
	Kanokdia	30	50	57
	Madanpur	30	50	50
Galachipa	Gajali	30	66	40
	Chiknikandi	30	60	43
	Dakua	30	63	41
	Total	630	58.33±2.12	45.67±1.68

Table 2. Percent infestation of plants and leaves in different ages of hog plum by *Podontia 14-punctata*

Age range	No. of plant observed	% plant infested	% infested leaves
0-5	68	57	40
6-10	365	56	45
11-15	184	59	47
16-20	13	76	36

Table 3. Percent Leaflet damage on different varieties of hog plum by 3rd instars larvae of *Podontia* 14- *punctata* in field condition.

Varieties	Total no. of leaflets	No. of leaflets infested	% leaflet damage
Baromashi	366.66	300.00	80.42
Bilati	196	101.67	59.19
Local I	470.0	64.29	85.57
Local II	703.33	460.00	65.14
CV	18.69	24.81	19.81
CD	162.56	156.78	-

In laboratory condition, this experiment showed similar results with field condition. In three days observation, highest leaflet infestation was found in the variety of Local-I (88.88%) followed by Baromashi (77.77%), Local-II (70.37%) and lowest infestation was found in the variety of Bilati (55.56%) (Table 4). Percent damage caused by *Podontia*-14 *punctata* was significant at 5% level. In this observation it was fund that all varieties were susceptible to the attack of *Podontia* -14 *punctata.* In respect of feeding preferences the varietal sequences were Local I > Baromashi > Local II > Bilati respectively. Local I variety was most susceptible to Hog plum beetle; it may be due to varietal specific trait.

Table 4. Feeding preference of hog-plum varieties by *Podontia -14 punctata* in laboratory condition.

Variety	No. of leaflets provides	Mean no. of leaflets consumed	% leaflets consumed
Baromashi	18	14 b	77.77 b
Bilati	18	10 c	55.56 c
Local -I	18	16 a	88.88 a
Local-II	18	12.66 b	70.37 b
CV	-	6.93	6.93
CD (0.05)	-	1.719	9.54

Howladar (1993) reported that the young leaves (15-21 days old) of hog-plum trees were superior as food for the larvae of *P. punctata* than older leaves (90-97 days old).

Mortality test

To control *Podontia* 14-*punctata*, *Photorhabdus temperata* (PT) bacterium solution was diluted with water and 0%, 1% and 10% PT concentration were prepared and tested against 1st and 2nd instars larvae of hogplum beetle. It was found mortality of Hog plum beetle increased with the increase of exposure time. Using 1% PT, 53% and 47% mortality was achieved in 1st and 2nd instars larvae after 96 h, while 100% and 85% mortality was recorded using 10% PT in similar exposure time (Figure 1-2). Howladar (1993) observed four larval instars of *P. 14- punctata*. The author also stated that the mortality was highest in the first two larval instar fed on the old leaves, tender stems or green barks. Rodou et al., 2010 stated that several groups of toxins of *Photorhabdus* spp. play an important role in insect pathogenesis such as toxin complexes (Tcs), the make caterpillar floppy toxins (Mcf), the *Photorhabdus* insect related proteins (Pir) and the *Photorhabdus* virulent cassettes (PVC). Blackburn et al. (1998) described Toxin complexes with Tca, Tcb, Tcc and Tcd multisubunits are most abundant and highly lethal in both oral and injectable application. Tca acts on insect midgut, causing blebbing of endothelium and finally cell lysis. Dowling et al., 2007 observed two Mcf induce death of by making apoptosis of both epithelial and phagocytic cells within midgut. ffrench-Constant et al. (2007) explained *Photorhabdus* spp. have PirA and PirB toxin that can work together showing injectable insecticidal toxicity.

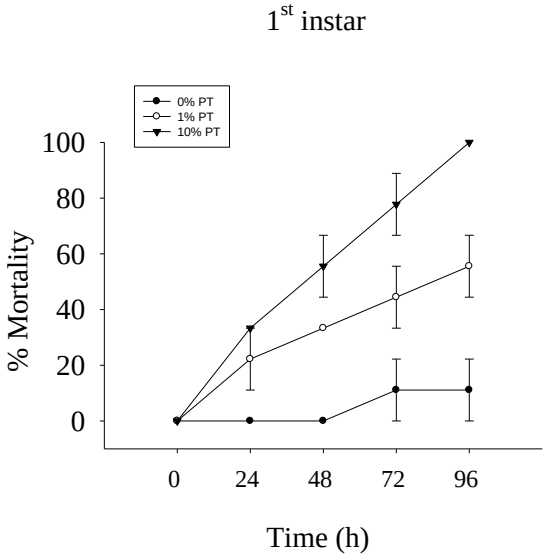

Figure1. Effects of *Photorhabdus temperata* on 1st instar larvae of *Podontia* 14-*punctata*. Leaves of hog plum were dipped in 0 %, 1% and 10% *P. temperata* solution directly for 20 sec. followed by drying 10 minutes at room temperature. The mortality of hogplum beetle was observed at every 24 hours. Each point represents mean ± SE with three replications.

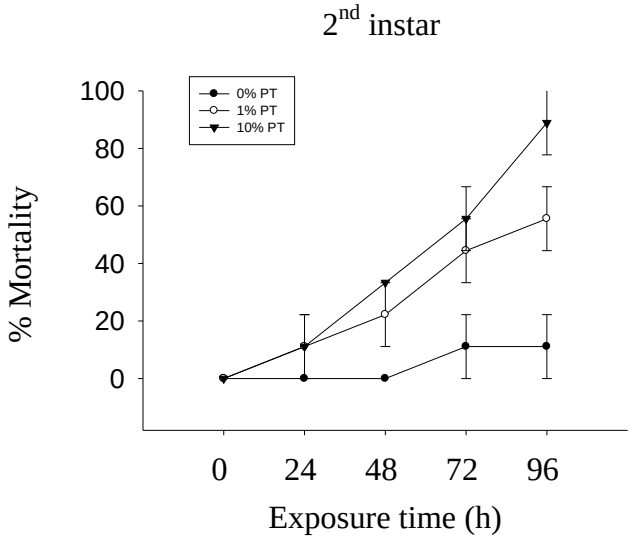

Figure 2. Effects of *Photorhabdus temperata* on 2nd instars larvae of *Podontia* 14-*punctata*. Leaves of hog plum were dipped in 0 %, 1% and 10% *P. temperata* solution directly for 20 sec. followed by drying 10 minutes at room temperature. The mortality of hogplum beetle was observed at every 24 hours. Each point represents mean ± SE with three replications.

Conclusion

In fine it can be said that hog plum beetle is a serious leaf eating beetle in this locality. Hog plum beetle larvae prefer the leaves of local varieties compared to others. Ist, and 2rd instars larvae can be controlled using cell culture of symbiotic bacteria *Photorhabdus temperata*, which are safe to people, property and the environment.

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