



## Insect growth regulators and their potential in reducing body weight of bean aphid, *Aphis craccivora* (Koch.)

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### Abstract

In the present study, experiments were conducted in the laboratory to evaluate the potentiality of some promising insect growth regulators (IGRs) viz. Buprofezin (Award 40 SC), Lufenuron (Heron 5 EC) and Pyriproxyfen (Pyrifen 10.8 EC) on the weight reduction of bean aphid, *Aphis craccivora* (Koch). Each of the IGRs was tested in three different concentrations (0.5, 1.0 and 1.5 ml/L) following three application methods namely direct (topical), indirect (leaf-dip) and combined (topical+ leaf-dip). Weight changes data were recorded at 3 and 7 days after treatment (DAT). All the selected IGRs were found effective against bean aphid in the laboratory condition. Weight change of bean aphid was clearly dose, time and method dependent. Significant level of weight reduction was observed at 3DAT from all application methods but maximum weight reduction was found at 7 DAT. Highest weight reduction was recorded from the concentration 1.5 ml/L which was followed by 1.0 ml/L and 0.50 ml/L respectively. It was also observed that combined application method was found highly effective than topical and leaf-dip method regarding weight reduction.

**Keywords:** buprofezin, lufenuron, pyriproxyfen, *Aphis craccivora*, weight reduction

### 1. Introduction

Country bean, *Lablab purpureus* (L) is one of the major winter vegetable crops grown in all over Bangladesh (Haq, 1986) [8]. In Bangladesh, bean is considered as cheap and readily available source of protein; therefore, it has a great demand to all people. Apart from proteins, it contains appreciable amount of vitamins, calcium, phosphate and sodium. In spite of being a prospective crop, high incidence of insect pests results in low yield and poor quality of country bean. Farmers of Bangladesh face significant yield loss of country bean in every year due to severe attack of various insect pests. The yield loss in country bean due to insect pests is reported to be about 12-30% (Hossain, 1990) [9]. Country bean is infested by nine different insect species and one species of mite. For example, major insect pests of common bean are aphids, pod borer, epilachna beetle, stem maggot etc. Among these insects, bean aphid, *Aphis craccivora* Koch. and *Aphis medicaginis* are major constraints of country bean production which inflict a destructive damage throughout the country (Alam, 1969) [2]. *A. craccivora* (Koch.) (Aphididae: Hemiptera) is a serious sucking pest of different legume vegetables which does approximately 40-50% of the damage (Chaudhury, 2001) [3]. Various control strategies such as biological, chemical, cultural methods have been evaluated against this pest. Conventionally, farmers are using various types of synthetic chemical insecticides to control bean aphid that creates several problems in agro-ecosystem and development of high level of resistance (Ahmed, 1995) [1]. Therefore, there is a need of developing other strategies like biorational-based control methods which targets the insect during the specific time of damage. It has been trying since last few years to overcome resistance problems using target based

molecules than broad-spectrum insecticides.

Insect growth regulators (IGRs) might be potential alternatives of conventional insecticides to control bean aphids. Insect Growth Regulators (IGRs) are natural and synthetic analogs capable of interfering with the processes of growth, development, moulting and metamorphosis of the target pest. The mode of action of IGR is not central nervous system-oriented but kills insects potentially through cessation of moulting process (Chaudhury, 2001) [3]. Insect growth regulators (IGRs) viz. Buprofezin, Lufenuron and Pyriproxyfen are found as potential alternatives of broad-spectrum insecticides against lepidopteran and hemipteran insects (Follas *et al.*, 1994; Khatun *et al.*, 2017; Smith, 1995) [6, 13, 14]. However, no information is available yet on the potentiality of Buprofezin, Lufenuron and Pyriproxyfen on the weight change of bean aphid, *Aphis craccivora*. The present investigation was, therefore, planned to evaluate the potentiality of Buprofezin, Lufenuron and Pyriproxyfen on weight reduction under laboratory conditions.

### 2. Experimental methods

The effects of some insect growth regulators like Buprofezin (Award 40 SC), Lufenuron (Heron 5 EC) and Pyriproxyfen (Pyrifen 10.8 EC) were evaluated against bean aphid, *Aphis craccivora* (Koch.) in the Laboratory of the Department of Entomology, Bangladesh Agricultural University, Mymensingh from July, 2017 to March, 2018.

#### 2.1 Collection of bean aphid

For laboratory bioassay, bean aphids were collected from the Entomology Field Laboratory, Bangladesh Agricultural University, Mymensingh. Country bean plants were raised in the field for mass-production of aphids and care was

taken to keep these plants from any insecticidal contamination or drift residues. Severely infested twigs of bean by *A. craccivora* were carefully cut from the plant and kept with small twigs in a large petridish cautiously. The petridish was then covered so that the aphids could not escape from there and brought to the laboratory. Then bean aphids were kept in the laboratory at room temperature and used for IGR testing on that day. For every experiment, fresh and alive aphids were collected from the field laboratory for conducting experiments.

## 2.2 Specifications of selected insect growth regulators

Three doses of Buprofezin (Award 40 SC), Lufenuron (Heron 5 EC) and Pyriproxyfen (Pyrifen 10.8 EC) @ 0.5, 1.0 & 1.5 ml/L were provided as treatments. Each treatment was replicated thrice and ten insects were used for each replication.

## 2.3 Treatment application methods

Treatments were applied through three application methods viz. topical or direct, leaf-dip or indirect and combined (direct + indirect).

### 2.3.1 Direct/ Topical application

In this method, bean aphids were directly treated (using micropipette) with different concentrations of selected IGRs. The treated insects were then transferred on the untreated country bean leaves using fine camel hair brush and finally placed in petridishes.

### 2.3.2 Indirect/Leaf-dip method

In this method, country bean leaves were dipped into different concentrations of selected IGRs for few seconds. Then dipped leaves were taken out from the solution and dried on tissues. Then untreated insects were transferred on the treated country bean leaves using fine camel hair brush and finally placed in petridishes.

### 2.3.3 Combined (topical + leaf-dip) method

In this method, both aphids and country bean leaves were treated with different concentrations of selected IGRs. After that treated leaves were transferred in petridishes. Then, treated aphids were carefully transferred on treated country bean leaves.

## 2.4 Data collection

▪ % Weight reduction was recorded at 3 and 7 DAT  
The percentage of weight reduction of aphid compared to control was calculated using the following formula:

$$\% \text{ Weight reduction} = (\text{Po}-\text{Pr})/\text{Po} \times 100$$

Where,

Po=Mean of weight of a single aphid in control condition

Pr= Mean of weight of a single aphid in treated condition

## 2.5 Statistical Analysis

The recorded data were compiled and tabulated for statistical analysis. Analysis of variance (ANOVA) was

done with the help of computer software WASP 2.0. The mean differences among the treatments were adjudged with Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD).

## 3. Results

### 3.1 Potentiality of Award 40 SC on weight reduction of bean aphid through different application methods

#### 3.1.1 Direct effect of Award 40 SC on the weight reduction of bean aphid

Buprofezin is one of the important IGRs that has effect on the growth & development of insect. Weight reduction due to direct application of different concentrations of Award 40 SC was shown in Table-1A. As the insects were treated with Award 40 SC it was being accumulated in the insect body and ultimately hampered growth. Results indicated that the percentage of weight reduction over control of aphids increased steadily with the increase of time and also with the concentration of Buprofezin. At 3 DAT, 29.77% weight reduction was recorded over control when aphids were treated with 1.5 ml/L which was followed by 1.0 ml/L (27.48%) and 0.50 ml/L (25.19%) respectively. At 7 DAT, weight reduction was further occurred than 3 DAT. 40.55% weight reduction was found over control @ 1.5 ml/L which was followed by 1.0 ml/L (37.76%) and 0.50 ml/L (37.09%) respectively.

#### 3.1.2 Indirect effect of Award 40 SC on the weight reduction of bean aphid

Weight reduction due to indirect application of different concentrations of Award 40 SC has shown in Table-1B. As country bean leaves were treated with Award 40 SC, when insects fed on the treated leaves it was being accumulated in the insect body and ultimately hampered growth. Similar trend but more weight reduction was occurred in indirect application method than direct application method. At 3 DAT, 31.29% weight reduction over control was recorded when bean leaves were treated with 1.5 ml/L which was followed by 1.0 ml/L (30.53%) and 0.50 ml/L (26.72%) respectively. Weight of bean aphids was further reduced at 7 DAT where 43.36% weight reduction was recorded @1.5 ml/L that was followed by rest of the concentrations.

#### 3.1.3 Combined effect of Award 40 SC on the weight reduction of bean aphid

Like as direct and indirect application method, similar trend was found in case of combined application method (Table-1C) but reduction was stronger than rest of the two application methods. At 7 DAT, the highest reduction was recorded that was followed by 3 DAT. On the other hand, weight reduction was found concentration-dependent. At 3 DAT, 33.58% weight reduction over control was recorded when both aphids and bean leaves were treated with 1.5 ml/L which was followed by 1.0 ml/L (32.06%) and 0.50 ml/L (29.01%) respectively. At 7 DAT, 46.85% weight reduction over control was found from 1.5 ml/L which was followed by 1.0 ml/L (41.96%) and 0.50 ml/L (41.26%) respectively.

**Table 1:** Mean weight of bean aphid, *Aphis craccivora* at different time interval following treated with different concentrations of Award 40 SC through different application methods.

**[A] Direct application method**

Treatments	Mean weight of <i>A. craccivora</i>				
	Pre-treated weight (mg)	3 DAT		7 DAT	
		Weight (mg/aphid)	% weight reduction over control	Weight (mg/aphid)	% weight reduction over control
Award 40 SC @ 0.5 ml/L	1.100	0.98b	25.19	0.89b	37.09
Award 40 SC @ 1.0 ml/L	1.147	0.95b	27.48	0.80b	37.76
Award 40 SC @ 1.5 ml/L	1.17	0.92b	29.77	0.84b	40.55
Control	1.07	1.31a		1.42a	
Level of significance	NS	*		**	
CV (%)	3.67	5.67		5.89	

**[B] Indirect application method**

Treatments	Mean weight of <i>A. Craccivora</i>				
	Pre-treated weight (mg)	3 DAT		7 DAT	
		Weight (mg/aphid)	% weight reduction over control	Weight (mg/aphid)	% weight reduction over control
Award 40 SC @ 0.5 ml/L	1.04	0.96b	26.72	0.88b	38.46
Award 40 SC @ 1.0 ml/L	1.00	0.91b	30.53	0.85b	40.56
Award 40 SC @ 1.5 ml/L	0.94	0.90b	31.29	0.81b	43.36
Control	1.06	1.31a		1.43a	
Level of significance	NS	**		**	
CV (%)	4.55	6.77		7.88	

**[C] Combined application method**

Treatments	Mean weight of <i>A. craccivora</i>				
	Pre-treated weight (mg)	3 DAT		7 DAT	
		Weight (mg/aphid)	% weight reduction over control	Weight (mg/aphid)	% weight reduction over control
Award 40 SC @ 0.5 ml/L	1.05	0.92b	29.01	0.84b	41.26
Award 40 SC @ 1.0 ml/L	1.10	0.88b	32.06	0.83b	41.96
Award 40 SC @ 1.5 ml/L	1.13	0.87b	33.58	0.76b	46.85
Control	1.06	1.31a		1.43a	
Level of significance	NS	**		**	
CV (%)	4.12	6.23		7.90	

In a column, means followed by different letters are significantly different, DAT = Days after Treatment, \* = Significant at 5% level of probability, \*\* = Significant at 1% level of probability, NS = Not significant.

**3.2 Potentiality of Heron 5 EC on the weight reduction of bean aphid through different application methods**

**3.2.1 Direct effect of Heron 5 EC on the weight reduction of bean aphid**

Like Buprofezin, direct or topical application of different concentrations of Heron 5 EC on aphids caused a significant weight reduction (Table 2A, P<0.01). Weight data was collected at 3 and 7 DAT. The effect was found dose and time dependent. At 3 DAT, 26.96% weight reduction over control was recorded when aphids were topically treated with 1.5 ml/L which was followed by 1.0 ml/L (20.00%) and 0.50 ml/L (16.52%) respectively. At 7 DAT, the highest percentage of weight reduction over control was found from 1.5 ml/L (37.01%) which was followed by 1.0 ml/L (30.71%) and 0.50 ml/L (26.77%) respectively.

**3.2.2 Indirect effect of Heron 5 EC on the weight reduction of bean aphid**

In this method, Heron 5 EC treated bean leaves were provided for insect feeding. Aphid's weight was significantly reduced when aphid fed Heron 5 EC treated leaves (P<0.01, Table 2B). Results indicated that the percentage of weight reduction of treated aphids over control increased

Steadily with the increase of time and also with the concentration of Heron 5 EC. At 3 DAT, highest percentages of weight reduction over control was recorded 31.30% when aphids were treated with 1.5 ml/L which was followed by 1.0 ml/L (26.09%) and 0.50 ml/L (22.61%) respectively. AT 7 DAT, the highest 44.88% weight reduction was found from 1.5 ml/L which was followed by 1.0 ml/L (30.71%) and 0.50 ml/L (29.13%) respectively.

**3.2.3 Combined effect of Heron 5 EC on the weight reduction of bean aphid**

Weight of aphid was further reduced when both aphid and bean leaves were treated with Heron 5 EC (Table 2C). The weight was significantly affected by concentrations also. Results indicated that the percentage of weight reduction over control of aphids increased clearly with the increase of time and also with the concentration of Heron 5 EC. At 3 DAT, the highest percentages of weight reduction was recorded 37.39% when aphids were treated with 1.5 ml/L which was followed by 1.0 ml/L (31.30%) and 0.50 ml/L (30.43%) respectively. Similarly, at 7 DAT the highest % weight reduction over control was found from 1.5 ml/L (46.00%) which was followed by 1.0 ml/L (40.94%) and 0.50 ml/L (33.07%) respectively.

**Table 2:** Mean weight of bean aphid, *Aphis craccivora* at different time interval following treated with different concentrations of Heron 5 EC through different application methods.**[A] Direct application method**

Treatments	Mean weight of <i>A. Craccivora</i>				
	Pre-treated weight (mg)	3 DAT		7 DAT	
		Weight (mg/aphid)	% weight reduction over control	Weight (mg/aphid)	% weight reduction over control
Heron 5 EC @ 0.5 ml/L	1.01	0.96b	16.52	0.93b	26.77
Heron 5 EC @ 1.0 ml/L	1.02	0.92bc	20.00	0.88b	30.71
Heron 5 EC @ 1.5 ml/L	0.64	0.84c	26.96	0.80c	37.01
Control	0.97	1.15 a		1.27a	
Level of significance	NS	**		**	
CV (%)	6.67	5.09		6.27	

**[B] Indirect application method**

Treatments	Mean weight of <i>A. Craccivora</i>				
	Pre-treated weight (mg)	3 DAT		7 DAT	
		Weight (mg/aphid)	% weight reduction over control	Weight (mg/aphid)	% weight reduction over control
Heron 5 EC@ 0.5 ml/L	0.99	0.89b	22.61	0.90b	29.13
Heron 5 EC@ 1.0 ml/L	0.93	0.85b	26.09	0.88b	30.71
Heron 5 EC@ 1.5 ml/L	0.98	0.79c	31.30	0.70c	44.88
Control	0.97	1.15a		1.27a	
Level of significance	NS	**		**	
CV (%)	3.33	5.11		5.89	

**[C] Combined application method**

Treatments	Mean weight of <i>A. Craccivora</i>				
	Pre-treated weight (mg)	3 DAT		7 DAT	
		Weight (mg/aphid)	% weight reduction over control	Weight (mg/aphid)	% weight reduction over control
Heron 5 EC@ 0.5 ml/L	0.93	0.80b	30.43	0.85b	33.07
Heron 5 EC@ 1.0 ml/L	0.99	0.79b	31.30	0.75c	40.94
Heron 5 EC@ 1.5 ml/L	0.95	0.72c	37.39	0.62d	51.18
Control	0.97	1.15a		1.27a	
Level of significance	NS	**		**	
CV (%)	3.44	5.03		6.20	

In a column, means followed by different letters are significantly different, DAT = Days after Treatment, \*\* = Significant at 1% level of probability, NS = Not significant.

### 3.3 Potentiality of Pyrifen 10.8 EC on weight reduction of bean aphid through different application methods

#### 3.3.1 Direct effect of Pyrifen 10.8 EC on the weight reduction of bean aphid

Pyriproxyfen is one of the important IGRs that acts as juvenile hormone analogue which prevents the development of insect. Weight reduction due to direct application of different concentrations of Pyrifen 10.8 EC has been shown in Table 3A. Results indicated that the percentage of weight reduction over control of aphids increased with increase of time and also with the concentration of Pyriproxyfen. At 3 DAT, 25.42% weight reduction over control was recorded when aphids were treated with 1.5 ml/L which was followed by 1.0 ml/L (25.42%) and 0.50 ml/L (15.25%) respectively. At 7 DAT, the highest percentage of weight reduction over control was found from 1.5 ml/L (45.45%) which was followed by 1.0 ml/L (43.18%) and 0.50 ml/L (28.03%) respectively.

#### 3.3.2 Indirect effect of Pyrifen 10.8 EC on the weight reduction of bean aphid

Like as direct application method, similar result was found from indirect method. The growth and development was significantly affected by different concentrations of Pyrifen 10.8 EC by reducing body weight of aphid ( $P < 0.01$ , Table

3B). Initially weight reduction was comparatively slower but with increasing time maximum reduction was observed. Table 3B clearly showed that the percentage of weight reduction over control of aphids increased with the increase of time and also with the concentration of Pyriproxyfen. About 23.73% weight was reduced over control @ 1.5 ml/L of Pyrifen 10.8 EC that was followed by 1.0 ml/L (23.73%) and 0.50 ml/L (22.03%) respectively. On the other hand, the highest reduction was found at 7 DAT with the concentration of 1.5 ml/L (40.91%) that was significantly followed by 1.0 ml/L (39.39%) and 0.50 ml/L (34.09%) respectively. This method was found comparatively less effective than direct or combined application method.

#### 3.3.3 Combined effect of Pyrifen 10.8 EC on the weight reduction of bean aphid

Among three application methods, the combined method was found better than rest of the two application methods (Table 3C). The rate of weight reduction was profoundly affected by concentration as well as time. The highest reduction was observed at 7 DAT that was followed by 3 DAT. According to the table 3C, about 46.97% weight reduction was found when both aphids and bean leaves were treated with Pyrifen 10.8 EC @ 1.5 ml/L that was closely followed by 1.0 ml/L (45.45%). Almost half reduction was

recorded from the rate of 0.5 ml/L and it was found comparatively ineffective. At 3DAT, 33.89% weight reduction over

Control was recorded when aphids were treated with 1.5 ml/L which was followed by 1.0 ml/L (27.96%) and 0.50 ml/L (17.79%) respectively.

**Table 3:** Mean weight of bean aphid, *Aphis craccivora* at different time interval following treated with different concentrations of Pyrifen 10.8 EC through different application methods.

**[A] Direct application method**

Treatments	Mean weight of <i>A. Craccivora</i>				
	Pre-treated weight (mg)	3 DAT		7 DAT	
		Weight (mg/aphid)	% weight reduction over control	Weight (mg/aphid)	% weight reduction over control
Pyrifen@ 0.5 ml/L	1.10	1.00b	15.25	0.95b	28.03
Pyrifen@ 1.0 ml/L	1.07	0.88bc	25.42	0.75c	43.18
Pyrifen@ 1.5 ml/L	0.94	0.82c	30.51	0.72c	45.45
Control	0.97	1.18a		1.32a	
Level of significance	NS	**		**	
CV (%)	3.89	5.89		6.22	

**[B] Indirect application method**

Treatments	Mean weight of <i>A. Craccivora</i>				
	Pre-treated weight (mg)	3 DAT		7 DAT	
		Weight (mg/aphid)	% weight reduction over control	Weight (mg/aphid)	% weight reduction over control
Pyrifen@ 0.5 ml/L	0.94	0.92b	22.03	0.87b	34.09
Pyrifen@ 1.0 ml/L	0.97	0.90b	23.73	0.80b	39.39
Pyrifen@ 1.5 ml/L	1.00	0.89b	24.58	0.78b	40.91
Control	0.97	1.18a		1.32a	
Level of significance	NS	**		**	
CV (%)	3.78	5.39		7.31	

**[C] Combined application method**

Treatments	Mean weight of <i>A. Craccivora</i>				
	Pre-treated weight (mg)	3 DAT		7 DAT	
		Weight (mg/aphid)	% weight reduction over control	Weight (mg/aphid)	% weight reduction over control
Pyrifen@ 0.5 ml/L	1.04	0.97b	17.79	0.95b	28.03
Pyrifen@ 1.0 ml/L	1.03	0.85bc	27.96	0.72c	45.45
Pyrifen@ 1.5 ml/L	0.98	0.78c	33.89	0.70c	46.97
Control	0.97	1.18a		1.32a	
Level of significance	NS	**		**	
CV (%)	4.01	5.39		5.98	

In a column, means followed by different letters are significantly different, DAT = Days after Treatment, \*\* = Significant at 1% level of probability, NS = Not significant.

**4. Discussion**

In the present laboratory study, it has been observed that Buprofezin (Award 40 SC), Lufenuron (Heron 5 EC) and Pyriproxyfen (Pyrifen 10.8 EC) worked as potent insect growth regulators (IGRs) against bean aphid to reduce body weight. These findings also confirmed that all the selected IGRs were found to be effective as contact as well as stomach action because significant weight reduction was found both in direct (contact) and indirect (leaf feeding) application methods. It was also observed that among three application methods, combined method was found much potential than rest of the two methods i.e. maximum moulting disruption occurred when IGRs molecules worked inside the insect body by two pathways- cuticle and metabolic. On the other hand, individual application was not much stronger to inhibit moulting process and thereby comparatively lower weight reduction was found in case of direct or indirect method. Moreover, it was also found that higher concentration is needed to inhibit the moulting process than lower one.

It has been found that the effect of selected IGRs on weight

change was dose and method dependent. Results obtained from the previous findings shows that Buprofezin (Award 40 SC) was found to be very effective in reducing weight of *Spodoptera litura* pupae by arresting the growth and development. The highest percent of weight reduction (26.05%), length & width inhibition (19.85% & 18.29%) was recorded from 600 ppm followed by 400 and 200 ppm respectively through combined application method. The 2<sup>nd</sup> best application method was leaf-dip which was followed by topical method. It was also observed from the laboratory study that larval weight of brinjal shoot and fruit borer has significantly reduced at 3 and 7 DAT when 2<sup>nd</sup> instar larvae were treated with Award 40 SC @ 600 ppm (Das and Islam, 2014; Khatun *et al.*, 2017a, 2017b) <sup>[4, 12, 13]</sup>.

Some recent studies has reported that Buprofezin (Award 40 SC) worked as the most effective IGR against aphid offering the lowest aphid population (1.56/top10 cm central twig) at 7 days after treatment (DAT) (Dutta *et al.*, 2016; Vadja and Kalasariya, 2015) <sup>[5, 15]</sup>. Similarly, it has been found that higher dose of Lufenuron is highly effective against different sucking and borer pests than lower doses while

combined application method showed the highest potentiality than rest of the application methods (Gogi *et al.*, 2006; Islam *et al.*, 2015) [7, 10]. Moreover, Pyriproxyfen is currently used for the control of sucking insect pests. Pyriproxyfen causes sterility in most aphids exposed to dosages exceeding 1 ppm and reduced aphid longevity of reproductively mature aphids. A field study indicates that Pyriproxyfen affects aphid population structure and may have potential in managing aphid outbreaks. Modifying aphid population structure and growth through the use of juvenoids such as Pyriproxyfen may prove to be an effective proactive approach to pest control without adversely impacting beneficial organisms or causing pest resurgence (Kerns and Stewart, 2003) [11].

## 5. Conclusion

From the present laboratory findings, it can be concluded that Buprofezin (Award 40 SC), Lufenuron (Heron 5 EC) and Pyriproxyfen (Pyrifen 10.8 EC) are highly potential in reducing body weight of bean aphid by inhibiting moulting activities. Significant reduction of growth and development of bean aphid through IGRs is positively co-related with higher mortality as well as less reproduction capability. Hence, further investigations are needed in the field condition to justify present laboratory findings.

## 6. Acknowledgement

This study was supported by a research grant from NATP-2/PIU-BARC sub-project (Project ID: 400) to Dr. Gopal Das.

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