

Bio-efficacy of buprofezin, a potent chitin synthesis inhibitor on the mortality, weight reduction and wing deformation of mango hopper, *Idioscopus clypealis* (Leth.)

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Abstract:

Experiment on “Bio-efficacy of Buprofezn on mango hopper, Idioscopus clypealis (Leth.)” was conducted in the IPM laboratory, Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh during April, 2015 to April, 2016 with the aim to generate necessary information of mango hopper, a serious insect pest of mango. Different concentrations of Award 40 SC (Buprofezin) were applied through topical, leaf-dip and combination (topical + leaf-dip)

methods on the 2nd instar nymphs of mango hopper and three parameters viz. mortality, weight reduction and wing deformation were observed at 1, 3, 5 and 7 DAT (days after treatment) application. No significant level of mortality was found at 1 DAT but increased significantly by day 3, reached to the peak level by day 5, and persisted at least up to day 7. Approximately 87% mortality was found from the combination method which was followed by the leaf-dip (78.33%) and topical (72.00%) methods, respectively at 5 DAT with the concentration of 1.00 ml/L. In case of nymphal weight reduction, the maximum was found from the combination method (83.35%) which was followed by the leaf-dip (81.12%) and topical (39.08%) methods, respectively with the concentration of 1.00 ml/L. Again, the highest percentage of wing deformation was found at 7 DAT with the concentration of 1.00 ml/L from the combination method (80.97%) which was followed by the leaf-dip (71.67%) and topical (61.67%) methods, respectively. Moreover, nymphal mortality, weight reduction and wing deformation were clearly concentration and time dependent.

Key words: Buprofezin, wing deformation, *Idioscopus clypealis*, weight reduction, mortality.

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most common, important and popular fruits in Bangladesh. Among all the mango pests, hopper (*Idioscopus clypealis* Leth.) is considered to be the most serious and widespread pest. Large numbers of nymphs and adult hoppers puncture and suck sap out of the tender parts of the plants, thereby reducing their vigour (Rahman and Kuldeep, 2007; Varshneya and Rana, 2008).

The present prevalent control methods are purely based on chemicals especially synthetic insecticides causing several problems such as disrupting natural enemy complexes, development of insecticide resistance, secondary pest outbreak,

pest resurgence, and environmental pollution. But, there are some natural and synthetic analogs which are capable of interfering with the processes of growth, development, moulting and metamorphosis of target pests are called “Insect Growth Regulator” (IGRs).

Buprofezin is an eco-friendly biopesticide and an insect growth regulator, especially a chitin synthesis inhibitor (CSI). It has both contact and vapor phase activity. It inhibits incorporation of 3H-glucosamin into chitin (Uchida *et al.*, 1987). Moreover, Buprofezin has multiple effects on the target pests like reduction of fecundity, egg hatchability, egg sterility, production of abnormal larvae and pupae (Ragaei and Sabry, 2011, Sontakke *et al.*, 2013).

However, this research work on mango hopper would provide significant information to protect the mango flower and fruit from attack of the pest and thereby will increase the yields. Hence, the experiment was planned to evaluate the efficacy of Buprofezin on the mortality, weight reduction and wing deformation of mango hopper under laboratory condition.

MATERIALS AND METHODS

The efficacy of Buprofezin on mango hopper (*I. clypealis* Leth.) was conducted in the IPM laboratory of Entomology Department, Bangladesh Agricultural University, Mymensingh during April, 2015-April, 2016 by treating with different concentrations of Award 40 SC in different application methods.

I. Rearing of mango hopper

Though the pest, mango hopper breeds during spring, different stages of mango hoppers such as 1st instar nymph, 2nd instar nymph, 3rd instar nymph, 4th instar nymph and 5th instar nymph were collected and immediately released on 35-40 days

old mango tree previously grown in the earthen pot kept inside rearing cages. Nymphs for morphological examinations were fixed overnight for KAAD and AAD solutions. Field collected adult hoppers kept in rearing jars started mating immediately when the female was provided with the male.

II. Specifications and Methods of treatment application

Three concentrations of Buprofezin (Award 40 SC, Square Pharmaceuticals Ltd.) viz. 0.50, 0.75 and 1.00 ml/L were provided as treatments. Each treatment was replicated thrice and twenty nymphs were used for each replication. The treatments were applied in three different methods. Topical method where different concentrations of Award 40 SC were directly applied on the nymphs and transferred on the untreated mango leaves kept in the petridishes. In leaf-dip method mango leaves were treated with different concentrations of Award 40 SC and then treated leaves were dried for few minutes. After that, untreated nymphs were placed on treated leaves and changes were observed. Again, in Combination (topical + leaf-dip) method both nymphs and mango leaves were treated with different concentrations of Award 40 SC. The treated nymphs were then transferred on previously treated mango leaves.

III. Data collection and Analysis

Data on the mortality was observed at 1, 3, 5 and 7 days after treatment (DAT) application. Nymphal weight was measured at 3, 5 and 7 days after treatment (DAT) application and wing deformation observed at 3, 5 and 7 days after treatment (DAT) application. Analysis of variance (ANOVA) was done with the help of computer package MSTAT-C. The mean differences among the treatments were adjusted with Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD), if necessary.

The percentage of mortality was also calculated using the following formula;

$$\% \text{ Mortality} = (\text{Po}/\text{Pr}) \times 100$$

Where,

Po = Number of dead nymphs due to treatment application

Pr = Total number of treated/untreated nymphs

RESULTS AND DISCUSSION

Different concentrations of Award 40 SC (Buprofezin) viz. 0.50, 0.75 and 1.00 ml/L were applied through different application methods like topical (direct), leaf-dip (indirect) and combination (topical + leaf-dip) methods.

1.1 Effects of different concentrations of Award 40 SC (Buprofezin) on nymphal mortality of *Idioscopus clypealis* in topical application method

The mortality of mango hopper nymphs was significantly increased when the nymphs were directly treated with different concentrations of Award 40 SC ($P < 0.01$, Table 1). The action of Award 40 SC was found too slow i.e. no significant level of mortality was observed at 1 day after treatment (DAT). The significant level of mortality was found at 3 DAT and the mortality was reached at the highest level at 5 DAT which persisted at least up to 7 DAT. At 5 DAT, the highest percentage of mortality was obtained from 1.00 ml/L (72.00%) which was followed by 0.75 ml/L (60.33%) and 0.50 ml/L (43.33%) of Award 40 SC, respectively and the lowest percentage mortality (6.67%) was recorded from the water treated control (Table 1). At 7 DAT, the mortality level was increased slightly compared to 5 DAT and there had no significant differences between 5 and 7 DAT based on mortality. Asai *et al.* (1985) also observed that the nymphs treated with 50

ppm of Buprofezin began to die after 84 hr and none of them emerged (100% mortality).

Table 1. Efficacy of different concentrations of Award 40 SC (Buprofezin) on the mortality of *Idioscopus clypealis* nymphs at different time intervals through topical application method

Treatments	Mean percent of nymphal mortality			
	1 DAT	3 DAT	5 DAT	7 DAT
Award 40 SC @ 0.50 ml/L	2.52	18.10c	43.33c	46.67c
Award 40 SC @ 0.75 ml/L	2.90	22.40b	60.33b	64.67b
Award 40 SC @ 1.00 ml/L	3.80	26.30a	72.00a	78.33a
Water treated control	2.34	4.78d	6.67d	8.00d
Significance level	NS	P<0.01	P<0.01	P<0.01

In a column, means of similar letter (s) do not differ significantly as per DMRT.

DAT = Days after Treatment, NS= Not Significant

1.2 Efficacy of different concentrations of Award 40 SC (Buprofezin) on weight reduction of *Idioscopus clypealis* in topical application method

The weight of the mango hopper nymphs gradually decreased when nymphs were directly treated with different concentrations of Award 40 SC ($P < 0.01$, Table 2). Among the different concentrations of Award 40 SC, the lowest mean nymphal weight was obtained from 1.00 ml/L (4.22 mg/nymph) which was followed by 0.75 ml/L (5.20 mg/nymph) and both these concentrations had significant effect on nymphal weight. However, mean nymphal weight in case of the lowest concentration of Award 40 SC was statistically insignificant with the water treated control nymphs (6.170 vs. 6.927 mg/nymph, respectively). More clearly, the maximum weight reduction of nymphs (39.08%) was observed from 1.00 ml/L of Award 40 SC which was followed by 0.75 ml/L (24.93%) and 0.50 ml/L (10.93%), respectively as compared to the nymphs of water treated control.

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Table 2. Efficacy of different concentrations of Award 40 SC (Buprofezin) on the weight reduction of *Idioscopus clypealis* nymphs at different time intervals through topical application method.

Treatments	Pre-treated weight (mg/nymph)	Weight change after treatment application (mg/nymph)			Cumulative mean weight (mg/nymph)	%Reduction over control
		3 DAT	5 DAT	7 DAT		
Award 40 SC @ 0.50 ml/L	0.50	3.883a	6.240b	8.387a	6.17a	10.93%
Award 40 SC @ 0.75 ml/L	0.55	3.207b	5.200c	7.193b	5.20b	24.93%
Award 40 SC @ 1.00 ml/L	0.50	1.990c	4.227d	6.443b	4.22c	39.08%
Water treated control	0.52	4.160a	7.247a	9.373a	6.927a
Significance level	NS	P<0.01	P<0.01	P<0.01	P<0.01	

In a column, means of similar letter (s) do not differ significantly as per DMRT.

DAT = Days after Treatment, NS= Not Significant

1.3 Efficacy of different concentrations of Award 40 SC (Buprofezin) on wing deformation of *Idioscopus clypealis* in topical application method

The effects of different concentrations of Award 40 SC when applied topically on the deformation of wings of mango hoppers has been shown in the table 3 (P<0.01). The results clearly revealed that Award 40 SC was moderately effective against mango hopper and the effect was clearly concentration dependent. No wing deformation was found at 3 days after treatment application (DAT), the significant effect was found at 5 DAT (P<0.01) which was consistent up to day 7 (P<0.01). At 7 DAT, the maximum percentage of wing deformation was recorded from 1.00 ml/L (61.67%) which was followed by 0.75 ml/L (47.00%) and 0.50 ml/L (36.63%) of Award 40 SC, respectively. The lowest percentage of wing deformation (11.67%) was found from the water treated control (Table 3). Asai *et al.* (1985) and Gu *et al.* (1993) proved that Buprofezin has significant effects on the physiology of moulting and the feeding behavior of economically injurious insects.

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Table 3. Efficacy of different concentrations of Award 40 SC (Buprofezin) on the wing deformation of *Idioscopus clypealis* at different time intervals through topical application method

Treatments	Mean percent of wing deformation		
	3 DAT	5 DAT	7 DAT
Award 40 SC @ 0.50 ml/L	0.00	15.67c	36.63c
Award 40 SC @ 0.75 ml/L	0.00	21.03b	47.00b
Award 40 SC @ 1.00 ml/L	0.00	27.33a	61.67a
Water treated control	0.00	6.67d	11.67d
Significance level	NS	P<0.01	P<0.01

In a column, means of similar letter (s) do not differ significantly as per DMRT.
 DAT = Days after Treatment, NS= Not Significant

2.1 Efficacy of different concentrations of Award 40 SC (Buprofezin) on the mortality of *Idioscopus clypealis* in leaf-dip application method

The mortality of mango hopper nymphs was significantly increased compared to water treated control through leaf-dip method (P<0.01, Table 4).

Table 4. Efficacy of different concentrations of Award 40 SC (Buprofezin) on the mortality of *Idioscopus clypealis* nymphs at different time intervals through leaf-dip application method

Treatments	Mean percent of nymphal mortality			
	1 DAT	3 DAT	5 DAT	7 DAT
Award 40 SC @ 0.50 ml/L	1.19	21.67c	49.33c	53.00c
Award 40 SC @ 0.75 ml/L	2.74	33.33b	67.58b	73.33b
Award 40 SC @ 1.00 ml/L	3.19	45.33a	78.33a	85.00a
Water treated control	1.56	6.50d	8.67d	9.12d
Significance level	NS	P<0.01	P<0.01	P<0.01

In a column, means of similar letter (s) do not differ significantly as per DMRT.
 DAT = Days after Treatment, NS= Not Significant

In this method, mango leaves were treated with different concentrations of Award 40 SC and then untreated mango hopper nymphs were released on treated leaves. Like as topical method, no significant level of mortality was observed at 1 DAT which further confirmed that Award 40 SC has no any acute action. The mortality level was increased gradually which was reached the significant level by day 3 compared to that of water

treated control. The highest level of mortality was observed at 5 DAT which was persisted at least up to 7 DAT. At 5 DAT, about 78.33% mortality was recorded when mango leaves were treated with 1.00 ml/L of Award 40 SC which was followed by 0.75 ml/L (67.58%) and 0.50 ml/L (49.33%), respectively and the lowest percentage of mortality (8.67%) was recorded from the water treated control (Table 4). At 7 DAT, the mortality was insignificantly increased in comparison with that of 5 DAT. Liu and Chen (2000) observed that Buprofezin at the higher concentrations (500 and 1,000 mg a.i./liter) reduced survival rates 17-47% and prolonged the overall development from first instars to adult emergence.

2.2 Efficacy of different concentrations of Award 40 SC (Buprofezin) on the weight reduction of *Idioscopus clypealis* in leaf-dip application method

Award 40 SC had concentration dependent effects on the reduction of nymphal weight ($P < 0.01$, Table 5). The weight of nymphs was gradually decreased with increasing the concentration level and time duration. Among the different concentrations of Award 40 SC, the lowest mean nymphal weight was obtained from 1.00 ml/L (1.224 mg/nymph) which was followed by 0.75 ml/L (3.031 mg/nymph) and 0.50 ml/L (5.35 mg/nymph), respectively. Here, mean nymphal weight in case of all the concentrations of Award 40 SC was significantly different as compared to the nymphs of water treated control. The maximum mean weight of nymphs (6.484 mg/nymph) was found in water treated control. Interestingly, the lowest concentration of Award 40 SC (0.50 ml/L) had significant effect on the nymphal weight in this leaf-dip application method while topical application method had insignificant effect. The maximum reduction in nymphal weight was observed at 7 DAT. About 81% weight reduction was found when nymphs were fed treated mango leaves with 1.00 ml/L concentration of Award 40

SC which was followed by 0.75 ml/L (53.25%) and 0.50 ml/L (17.49%), respectively as compared to the nymphs of water treated control. Ragaei and Ragaei and Sabry (2011) found that Buprofezin was very effective against the fourth instar larvae of the cotton leafworm.

Table 5. Efficacy of different concentrations of Award 40 SC (Buprofezin) on the weight reduction of *Idioscopus clypealis* nymphs at different time intervals through leaf-dip application method

Treatments	Pre-treated weight (mg/nymph)	Weight change after treatment application (mg/nymph)			Cumulative mean weight (mg/nymph)	%Reduction over control
		3 DAT	5 DAT	7 DAT		
Award 40 SC @ 0.50 ml/L	0.55	4.03b	5.337b	6.683a	5.35b	17.49%
Award 40 SC @ 0.75 ml/L	0.51	1.903c	3.027c	4.163b	3.031c	53.25%
Award 40 SC @ 1.00 ml/L	0.46	0.587d	1.217d	1.87c	1.224d	81.12%
Water treated control	0.49	5.143a	6.47a	7.84a	6.484a
Significance level	NS	P<0.01	P<0.01	P<0.01	P<0.01	

In a column, means of similar letter (s) do not differ significantly as per DMRT.

DAT = Days after Treatment, NS= Not Significant

2.3 Efficacy of different concentrations of Award 40 SC (Buprofezin) on the wing deformation of *Idioscopus clypealis* in leaf-dip application method

Significant wing deformation was found when the untreated nymphs were provided on Award 40 SC treated mango leaves (P<0.01, Table 6). It was observed that the leaf-dip method was comparatively more effective than topical application method regarding wing deformation percentages. The trend of Award 40 SC effect was similar with that of topical application method. At 7 DAT, the maximum, 71.67% wing deformation was recorded from 1.00 ml/L which was followed by 0.75 ml/L (60.00%) and 0.50 ml/L (50.00%) of Award 40 SC, respectively. The lowest percentage of wing deformation (10.67%) was recorded from the water treated control where the untreated nymphs were simply placed on the untreated mango leaves.

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Table 6. Efficacy of different concentrations of Award 40 SC (Buprofezin) on the wing deformation of *Idioscopus clypealis* at different time intervals through leaf-dip application method

Treatments	Mean percent of wing deformation		
	3 DAT	5 DAT	7 DAT
Award 40 SC @ 0.50 ml/L	0.00	20.47c	50.00c
Award 40 SC @ 0.75 ml/L	0.00	31.18b	60.00b
Award 40 SC @ 1.00 ml/L	0.00	43.38a	71.67a
Water treated control	0.00	4.78d	10.67d
Significance level	NS	P<0.01	P<0.01

In a column, means of similar letter (s) do not differ significantly as per DMRT.
 DAT = Days after Treatment, NS= Not Significant

3.1 Efficacy of different concentrations of Award 40 SC (Buprofezin) on the mortality of *Idioscopus clypealis* in combination (topical+leaf-dip) application method

The highest level of mortality was found when both the mango leaves and mango hopper nymphs were treated with different concentrations of Award 40 SC compared to the individual application method ($P<0.01$, Table 7). No significant level of mortality was observed at 1 DAT which further confirmed that Award 40 SC has no any acute action on the mortality of mango hopper nymphs. At 3 DAT, the mortality level was increased significantly in comparison with that of control which was reached at the peak level at 5 DAT and persisted at least up to 7 DAT. Approximately 86% nymphs were died at 5 DAT when both the leaves and mango hopper nymphs were treated with 1.00 ml/L of Award 40 SC which was followed by 0.75 ml/L (75.33%) and 0.50 ml/L (56.33%), respectively and the lowest mortality (6.67%) was recorded from the water treated control (Table 7). The mortality was persisted up to day 7 and there had no significant differences between 7 and 5 DAT which raises the possibility that maximum mortality of mango hopper nymphs can be achieved within 5 days of treatment application. Smith (1995) showed that Buprofezin caused significant larval mortality and reduced egg production in scale-feeding coccinellid, *Chilocorus circumdatus* Gyll.

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Table 7. Efficacy of different concentrations of Award 40 SC (Buprofezin) on the mortality of *Idioscopus clypealis* nymphs at different time intervals through combination (topical + leaf-dip) application method

Treatments	Mean percent of nymphal mortality			
	1 DAT	3 DAT	5 DAT	7 DAT
Award 40 SC @ 0.50 ml/L	2.52	24.47c	56.33c	62.33c
Award 40 SC @ 0.75 ml/L	3.75	34.81b	75.33b	82.00b
Award 40 SC @ 1.00 ml/L	4.26	47.33a	86.67a	91.67a
Water treated control	2.34	4.78d	6.67d	8.17d
Significance level	NS	P<0.01	P<0.01	P<0.01

In a column, means of similar letter (s) do not differ significantly as per DMRT.

DAT = Days after Treatment, NS= Not Significant

3.2 Efficacy of different concentrations of Award 40 SC (Buprofezin) on the weight reduction of *Idioscopus clypealis* in combination (topical+leaf-dip) application method

Award 40 SC had significant and concentration dependent effects on the reduction of nymphal weight when both the leaves and nymphs were treated with different concentrations of Award 40 SC (P<0.01, Table 8).

Table 8. Efficacy of different concentrations of Award 40 SC (Buprofezin) on the weight reduction of *Idioscopus clypealis* nymphs at different time intervals through combination (topical + leaf-dip) application method.

Treatments	Pre-treated weight (mg/nymph)	Weight change after treatment application (mg/nymph)			Cumulative mean weight (mg/nymph)	%Reduction over control
		3 DAT	5 DAT	7 DAT		
Award 40 SC @ 0.50 ml/L	0.55	3.47b	4.837b	6.213b	4.84b	27.22%
Award 40 SC @ 0.75 ml/L	0.51	1.787c	2.693c	3.643c	2.708c	59.28%
Award 40 SC @ 1.00 ml/L	0.47	0.57d	1.107d	1.643d	1.107d	83.35%
Water treated control	0.48	5.15a	6.667a	8.133a	6.65a
Significance level	NS	P<0.01	P<0.01	P<0.01	P<0.01	

In a column, means of similar letter (s) do not differ significantly as per DMRT.

DAT = Days after Treatment, NS= Not Significant

Among the different concentrations of Award 40 SC, the lowest mean nymphal weight was obtained from 1.00 ml/L (1.107 mg/nymph) which was followed by 0.75 ml/L (2.708 mg/nymph) and 0.50 ml/L (4.84 mg/nymph), respectively. Here, mean nymphal weight in case of all the concentrations of Award 40 SC was significantly different as compared to the nymphs of water treated control. The maximum mean weight of nymphs (6.65 mg/nymph) was found in water treated control. The pattern of nymphal weight reduction was similar with that of leaf-dip method although the reduction level was higher than leaf-dip method (Table 8). It was observed that nymphal weight reduced gradually with increasing time and the effect was clearly concentration dependent. The maximum weight reduction of nymphs (83.35%) was observed from 1.00 ml/L of Award 40 SC which was followed by 0.75 ml/L (59.28%) and 0.50 ml/L (27.22%), respectively as compared to the nymphs of water treated control.

3.3 Efficacy of different concentrations of Award 40 SC (Buprofezin) on the wing deformation of *Idioscopus clypealis* in combination (topical+leaf-dip) application method

The highest level of wing deformation was found when both the mango leaves and mango hopper nymphs were treated with different concentrations of Award 40 SC compared to the individual application method ($P < 0.01$, Table 9). No wing deformation was found at 3 days after treatment application (DAT) but wings were significantly deformed at 5 DAT which further increased at 7 DAT. At 7 DAT, the highest, 80.97% wing deformation was recorded from 1.00 ml/L which was followed by 0.75 ml/L (72.33%) and 0.50 ml/L (55.33%) of Award 40 SC, respectively (Table 9). The lowest percentage of wing

deformation (16.67%) was recorded from the water treated control where the untreated nymphs were placed on the untreated mango leaves. Nasr *et al.* (2010) observed that Buprofezin at 1500 mg a.i./kg diet caused 93.33% pupation and 53.33% emergence of adults compared to 100% pupation and 96.30% emergence of adults in the control on larvae of cotton leafworm.

Table 9. Efficacy of different concentrations of Award 40 SC (Buprofezin) on the wing deformation of *Idioscopus clypealis* at different time intervals through combination (topical + leaf-dip) application method.

Treatments	Mean percent of wing deformation		
	3 DAT	5 DAT	7 DAT
Award 40 SC @ 0.50 ml/L	0.00	32.67c	55.33c
Award 40 SC @ 0.75 ml/L	0.00	40.67b	72.33b
Award 40 SC @ 1.00 ml/L	0.00	50.33a	80.97a
Water treated control	0.00	13.67d	16.67d
Significance level	NS	P<0.01	P<0.01

In a column, means of similar letter (s) do not differ significantly as per DMRT.

DAT = Days after Treatment, NS= Not Significant

The results clearly indicate that the combination method was the most effective which was followed by the leaf-dip and topical methods. It raises the possibility that Award 40 SC (Buprofezin) works more effectively when it reaches to the stomach through food consumption than cuticular contact. This finding suggests that moulting or chitin bio-synthesis is an inter-physiological process.

CONCLUSION

The effect of buprofezin has been evaluated against mango hopper, *Idioscopus clypealis* (Leth.), a sucking pest of mango and has been found effective. Therefore, it can be concluded that the IGR, Award 40 SC (Buprofezin) might be effective and

potent alternative of chemical insecticides for the successful management of mango hopper in the field conditions.

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