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INHIBITORY EFFECT OF BUPROFEZIN ON THE LARVAL GROWTH AND DEVELOPMENT OF *SPODOPTERA LITURA* (F.)

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ABSTRACT

Effectiveness of buprofezin (Award 40 SC) was evaluated against 2nd instar larvae of *Spodoptera litura* (F.) under laboratory conditions to analyse the growth and development at three concentrations viz., 200, 400, and 600 ppm with three application methods (direct or topical, indirect or leaf-dip and combined). Observations made at 3 and 7 days after treatment and compared with untreated control. The results revealed that buprofezin significantly inhibited the larval weight, length and width, and the effect was dose, time and method dependent. Maximum (29.41%) weight reduction was observed with 600 ppm in combined application method, and it was followed by leaf-dip (16.10%) and topical application methods (13.80%). Similarly, 20.89% length and 19.58% width were inhibited when larvae were treated with 600 ppm through combined application method. The 2nd best result was found from 400 ppm and leaf-dip application method. The dose at 200 ppm and topical application method were found to be the least effective.

Key words: *Spodoptera litura*, larva, buprofezin, growth and development, dose, time, application method, direct, topical, indirect, leaf- dip

Spodoptera litura (F) is a primary polyphagous insect pest of various crops, and it attacks more than 120 host plants including many agricultural and horticultural crops[2; 19; 21]. It causes economic losses of crops from 25.8-100%[6]. On soybean in India, soybean protected from *S. litura* and other pests yielded 42% more[22]; on tobacco, two, four and eight larvae/ plant reduced yield by 23-24, 44.2 and 50.4%, respectively[17]; on *Colocasia esculenta,* an average of 4.8, 4th-instar larvae/ plant reduced yield by 10%, and it was 2.3 and 1.5 larvae reduced yield of aubergines (eggplant) and capsicum in glasshouses by 10%[15]. Mainly insecticides have been used to control *S. litura*, but it has developed resistance [11], necessitating the search for alternative methods. Target based/ selective biodegradable insecticides based on bacteria, fungi, insect growth regulators and botanical pesticides is one such alternative[15,21,23].

Insect growth regulators (IGRs), in general, IGRs, which act as chitin synthesis inhibitors have been regarded as best alternatives[3, 7, 9, 24]. (3.; 7. Among IGRs, buprofezin is a potential chitin synthesis inhibitor (CSIs) showing promise[8, 13,12]. Buprofezin also affects *S. litura* by reducing fecundity, egg hatchability, egg sterility, production of abnormal larvae and pupae [18]. Buprofezin was found to be effective against hemipteran pests, some lepidopteran larvae, spiders etc.[4, 10, 16]. Such IGRs had been successfully used against *S. litura*[23] and *S. littoralis*[8]. Buprofezin, chitin synthesis inhibitor (CSI) introduced in Bangladesh as an alternative and for integration with other components of IPM againt *S. litura* requires to be explored well. The present study investigates the efficacy of buprofezin on certain morphological aspects of *S. litura*.

MATERIALS AND METHODS

Experiments were conducted in the laboratory of the Department of Entomology, Bangladesh Agricultural University, Bangladesh from July 2015 to June 2016. The egg masses of *S. litura* were collected from soybean field, and reared in petri dishes for hatching. After hatching, fresh soybean leaves were fed to the neonate larvae until they grow to final instar. These were transferred to the plastic container filled with soil for pupation. Male and female moths emerging were kept in a rearing chamber with previously grown aroid plants for mating. After mating, female moths laid eggs in masses on the lower and upper surface of the aroid leaves. These leaves with egg masses were removed to petri dishes having wet cotton to prevent the drying of leaves. After 3-4 days, the hatching neonate larvae were fed with for further rearing. When the larvae reached to 2nd instar with uniform size were used for treatment applications, with the rearing continued. Buprofezin (Award 40 SC) doses viz. 200, 400 and 600 ppm along

with untreated control were evaluated as treatments replicated thrice, under three application methods as given below. Ten 2nd instar larvae formed a replication.

For the topical application (direct) method, the larvae were directly treated (using micropipette) with the doses selected. The treated larvae were immediately transferred to petri dish having moist filter paper using a sterilized fine brush, and provided with fresh soybean leaves as food. The petri dish was covered with sterilized lid allowing proper air circulation and preventing larvae from escape. The larvae when full grown were transferred to a plastic box with lid that was perforated and covered with net. For the leaf-dip (indirect) method, soybean leaves were treated with the doses selected, and dried suitably, before placed on moist filter paper in a petri dish, with untreated larvae reared in a similar manner. The larvae when full grown handled as given above. In case of combination (direct + indirect) method, both larvae and soybean leaves were treated with selected doses, with all other details remaining the same. The larval mortality was observed at 1, 3, 5 and 7 DAT (days after treatment). Died larvae were separated and alive larvae were further provided with fresh or treated soybean leaves based on treatment application method.

The following parameters were computed with the formulae given below:

% Weight reduction = (Po – Pr)/ Po x 100, where, Po = Mean weight of a single larva in control condition; Pr = Mean weight of a single larva in a treated condition; and 2. % Length/ Width inhibition = (Po – Pr)/ Po x 100, where, Po = Mean length/width of a single larva in control treatment; Pr = Mean length/width of a single larva in a specific treatment. The data were subjected to ANOVA in MSTAT package, and the mean differences among the treatments were adjudged with Duncan`s Multiple Range Test (DMRT) and Least Significant Difference (LSD).

RESULTS AND DISCUSSION

WEIGHT CHANGE

In the topical application method, buprofezin had significant ($p< 0.01$) dose-dependent effects on larval weight changes (**Table** 1). In the 2nd instar larvae, the maximum weight reduction was observed at 7 DAT from 600 ppm that was 13.80% which was followed by 400 and 200 ppm 8.36% and 5.10%, respectively; at 3 DAT it was similar but maximum weight reduction was observed at 7 DAT. With the leaf-dip method, as given in Table 2, maximum weight reduction was observed from 600 ppm at 7 DAT (16.10%) which was followed by 400 ppm (11.11%) and 200 ppm (7.75%), respectively. This indicate that stomach action was found more potential and effective than contact action. In the combined application method, maximum reduction was observed compared to the two methods separately. The reduction was clearly dose and time dependent. The maximum 29.41% reduction was with 600 ppm at 7 DAT which was followed by 400 ppm (23.36%) and 200 ppm (17.32%), respectively. Maximum reduction observed on 7 DAT than 3 DAT confirms that chitin synthesis inhibitors (CSIs) need longer time to do action against moulting process. It was also observed that combined action i.e. cuticle + stomach action does stronger activity of CSI rather than individual action (cuticle or stomach).

Reduction in length

In the topical application method, significant effect with reduction of larval length ($p<0.01$, Table 4) was observed. The reduction in length at 3 and 7 DAT was observed to be clearly dose, method and time dependent. The maximum inhibition was recorded from 600 ppm at 7 DAT (9.08%) which was followed by 400 (6.88%) and 200 ppm (4.95%), respectively. In the leaf-dip method too, buprofezin significantly inhibited the larval length, but reduction was comparatively higher ($p<0.01$, Table 4); 600 ppm was found to the most effective (13.12%) followed by 400 (9.40%) and 200 ppm (6.57%), respectively. At 3 DAT, all the treatments also significantly reduced larval length but maximum reduction was observed at 7 DAT. In the combined application method, maximum reduction was observed compared to the other two, maximum effect being with 600 ppm at 7 DAT (20.89%), followed by 400 (16.98%) and 200 (12.90%) ppm, respectively. At 3 DAT, all the treatments significantly reduced the larval length.

Reduction in width

In the topical application method, the width gradually decreased with concentration (Table 5); maximum reduction was observed with 600 ppm at 7 DAT (12.61%), followed by 400 (7.38%) and 200 ppm (4.76%), respectively; at 7 DAT width reduction was maximum and for both 3 and 7 DAT 200 and 400 ppm was insignificantly different. In the leaf-dip method, width reduction was more with 600 at 7 DAT (13.98%), followed by 400 ppm (8.85%) and 200 ppm (4.76%), respectively; it was 12.61% at 7 DAT with 600 ppm but in leaf-dip method maximum reduction was 13.98%

Table 1. Effect of buprofezin on larvae of *S. litura* in various methods

Treatments	Pre-treated weight (mg/larva)	Larval weight (mg/larva) at 3 DAT	% reduction over control	Larval weight (mg/ larva) at 7 DAT	% reduction over control	Pre-treated weight (mg/ larva)	Larval weight (mg/ larva) at 3 DAT	% reduction over control	Larval weight (mg/ larva) at 7 DAT	% reduction over control	Pre-treated weight (mg/ larva)	Larval weight (mg/ larva) at 3 DAT	% reduction over control	Larval weight (mg/larva) at 7 DAT	% reduction over control
	Topical application method					Leaf dip method					Combination method				
						Larval weight									
200 ppm	10.44	65.94b	3.27	334.80b	5.10	10.30	61.97b	5.80	331.55b	7.75	10.18	63.90b	9.27	301.85b	17.32
400 ppm	10.09	64.08b	5.99	323.30c	8.36	10.08	59.16b	9.77	319.47c	11.11	10.27	59.36c	15.71	279.81c	23.36
600 ppm	10.17	61.98c	9.08	304.10d	13.80	10.06	55.95c	14.63	301.55d	16.10	10.32	53.90d	23.47	257.70d	29.41
Control	10.42	68.17a	---	352.80a	---	10.03	65.57a	---	359.43a	---	10.36	70.43a	---	365.10a	---
SD	0.18	2.64		20.43		0.12	4.09		24.31		0.08	7.01		46.31	
P-level	NS	**		**		NS	**		**		NS	**		**	
CV (%)	0.44	0.05		0.13		0.60	0.23		0.17		0.53	0.20		0.05	
							Larval length								

Table 2

Treatments	Topical application method					Leaf-dip method					Combination method				
	Pre-treated length (mm)	Length at 3 DAT (mm)	% inhibition over control	Length at 7 DAT (mm)	% inhibition over control	Pre-treated length (mm)	Length at 3 DAT (mm)	% inhibition over control	Length at 7 DAT (mm)	% inhibition over control	Pre-treated length (mm)	Length at 3 DAT (mm)	% inhibition over control	Length at 7 DAT (mm)	% inhibition over control
200 ppm	8.1	16.68b	3.80	32.42b	4.95	8.0	16.19b	5.70	32.39b	6.57	8.0	15.97b	8.63	30.09b	12.90
400 ppm	8.2	16.33b	5.82	31.76b	6.88	7.9	15.88b	7.51	31.41c	9.40	8.0	15.23b	12.87	28.68c	16.98
600 ppm	8.1	16.10c	7.15	31.01c	9.08	8.1	15.42c	10.19	30.12d	13.12	8.2	14.83c	15.33	27.33c	20.89
Control	8.0	17.34a	----	34.11a	----	8.0	17.17a	----	34.67a	----	8.1	17.48a	----	34.55a	----
SD	0.07	0.54		1.32		0.08	0.74		1.92		0.09	1.17		3.13	
P-level	NS	**		**		NS	**		**		NS	**		**	
CV (%)	1.47	0.33		1.10		1.30	0.35		0.67		1.07	0.28		0.20	

Larval width

Treatments	Topical application method					Leaf-dip method					Combination method				
	Pre-treated width (mm)	Width at 3 DAT (mm)	% inhibition over control	Width at 7 DAT (mm)	% inhibition over control	Pre-treated width (mm)	Width at 3 DAT (mm)	% inhibition over control	Width at 7 DAT (mm)	% inhibition over control	Pre-treated width (mm)	Width at 3 DAT (mm)	% inhibition over control	Width at 7 DAT (mm)	% inhibition over control
200 ppm	1.1	3.28b	2.67	4.00b	4.76	1.0	3.07b	3.76	4.10b	4.42	1.1	2.72b	6.52	4.03b	7.14
400 ppm	1.2	3.19b	5.34	3.89b	7.38	0.99	2.94b	7.83	3.91b	8.85	1.3	2.61b	10.30	3.74c	13.82
600 ppm	1.1	2.99c	11.27	3.67c	12.61	1.0	2.78c	12.85	3.69c	13.98	1.1	2.49c	14.43	3.49d	19.58
Control	1.1	3.37a	----	4.20a	----	1.0	3.19a	-----	4.29a	----	1.2	2.99a	----	4.34a	----
SD	0.05	0.16		0.22		0.01	0.18		0.26		0.10	0.18		0.37	
P-level	NS	**		**		NS	**		**		*	**		**	
CV (%)	8.75	0.81		0.49		5.09	1.02		0.82		6.00	1.12		0.64	

In a column, means of similar letter (s) do not differ significantly; DAT- Days After Treatment; **Significant at p = 0.01; NS- Not significant; CV- Coefficient of Variation; SD- Standard Deviation.

which was more than direct application method. In the combined method, as given in Table 5, maximum effect was observed with 600 ppm at 7 DAT (19.58%), followed by 400 ppm (13.82%) and 200 ppm (7.14%), respectively. At 3 DAT all treatments significantly reduced larval width but less so.

Thus it was observed that buprofezin inhibits the larval weight, length and width. IGRs have been reported to possess a specific activity spectrum, disrupt the physiology and development [5]. The present findings are in close agreement with those of earlier study[12] on *Spodoptera littoralis*. Effects on *S. litura* observed now are method, dose and time dependent. These findings could be corroborated with those of[12] who observed that lufeneuron inhibits the growth and development of *S. littoralis* by multiple targets like prevents moulting, feeding inhibition increase larval duration and abnormalities.

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