International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(5): 1796-1799

Received: 05-07-2017
Accepted: 06-08-2017

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Bioefficacy of a Diamide Insecticide, Flubendiamide 480 SC against Shoot and Fruit Borer (*Leucinodes orbonalis* Guen.) in Brinjal

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Abstract
Field evaluation was conducted to study the efficacy of Flubendiamide 480 SC against brinjal shoot and fruit borer (*Leucinodes orbonalis* Guen.) during two consecutive seasons of 2014. On the basis of percent shoot and fruit infestations, Flubendiamide 480 SC @ 60-90 g a.i./ha was found most effective treatments (1.28-3.48% shoot and 2.15-3.08% fruit) followed by Quinalphos 20 EC @ 200 g a.i./ha (3.99% shoot and 3.57% fruit). Thiodicarb 75 SP @ 750 g a.i./ha was recorded the least effective treatment (4.29% shoot and 4.07% fruit infestation). The highest marketable fruit yield was obtained with Flubendiamide 480 SC @ 60-90 g a.i. /ha (79.50-87.05 q/ha). The new diamide insecticide, Flubendiamide 480 SC found promising in reducing the infestation of *L. orbonalis* by maximizing the marketable fruit yield. This novel insecticide may be effectively utilized in the IPM programmes of brinjal.

Keywords: Bioefficacy, Insecticide, Flubendiamide, Brinjal, *Leucinodes orbonalis*.

1. Introduction

Brinjal or eggplant (*Solanum melongena* L.) is one of the most popular and principal solanaceous vegetable crops grown in India and other parts of the world. It is a good source of minerals and contains vitamins A, B and C, rich in total water soluble sugars, free reducing sugars, amide proteins among other nutrients and also has ayurvedic medical properties, the fruit being good for diabetic patients [6, 10]. In India, brinjal occupies an area of 663 thousand ha with a production of 12515 thousand MT during 2015-16 [11]. As it is cultivated round the year the crop is proned to attack by a number of insect pests right from its seedling stage to its harvesting in the main field [16]. Among them, brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen. (Lepidoptera: Pyralidae) is the most destructive pest responsible for one of the limiting factor in quantitative as well as qualitative yield loss of brinjal fruits [2, 3, 8, 18]. In India, yield losses due to this pest is accounted to the tune of 70-92% in [2, 5, 12, 15]. To combat this notorious pest farmers tend to apply highly toxic chemicals with higher doses most frequently leading to pest resistance, secondary pest outbreaks and pest resurgence problems along with environmental pollution. A number of new generation insecticide molecules have been found to be more effective with lower doses as well as safer for non-target organism [1, 6, 10, 13, 14, 17, 19, 21]. Keeping above aspects in mind, the present investigation was aimed to test the efficacy of a diamide insecticide, Flubendiamide 480 SC with varying doses against brinjal shoot and fruit borer under field condition.

2. Materials and Methods

2.1 Location of experiments

Two supervised field experiments were carried out at University Experimental Farm, 'C' Unit, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal during two consecutive seasons (March-July and August-November) of 2014.

2.2 Experimental Layout

Field trials were laid out in a Randomized Block Design (RBD) having plot size of 5m x 5m with six treatments including untreated control and four replications. A high yielding variety of brinjal (cv. Muktakeshi) was used for the present investigation.

Seedlings were raised in nursery beds and one month old seedlings were transplanted at a distance of 60 cm between plants and 60 cm between rows on raised beds in the main field. All recommended agronomic package of practices free from pesticide application were adopted for raising the crop. Soon after the shoot and fruit borer infestation reached ETL (5% shoot and fruit damage) spraying with different treatments viz., Flubendiamide 480 SC @ 60, 72 & 90 g a.i./ha, Thiodicarb 75 SP @ 750 g a.i./ha and Quinalphos 20 EC @ 200 g a.i./ha were applied thrice at 21 days interval. Spraying was done with a high volume pneumatic knapsack sprayer using spray fluid @ 500 litres/ha.

2.3 Observations taken

Pre and post treatment observations of shoot and fruit infestations were taken on ten randomly selected tagged plants from each replicated plot at 1 day before and 7, 14 and 21 days after first, second and third sprayings. The healthy and damaged shoots from each replicated plot were counted and percent shoot infestation was calculated. Fruit pickings were done at weekly interval from each plot. Fruit infestation by shoot and fruit borer was recorded after each picking in each replicated plots by counting total number of harvested and damaged fruits. Marketable fruit yield was taken from each plot separately.

2.4 Statistical analysis

Mean percent of shoot and fruit infestation and marketable yield of brinjal fruits were calculated for statistical analysis. The data were subjected to angular transformation and the critical difference (CD) at 5% level of significance was worked out using statistical methods of MS-Excel.

3. Results and Discussion

3.1 Shoot infestation

Perusal data on shoot infestation revealed that (Table 1), there was no significant differences in the pre-treatment count on percent shoot infestation. Post-treatment observations indicates that there exist significant differences between different treatments and all the chemicals gave significant reduction of shoot damage than untreated control during both the seasons. Flubendiamide 480 SC @ 60-90 g a.i./ha registered the lowest percent of shoot infestation at 7, 14 and 21 days after spray during first (1.03-3.25%, 1.66-4.04%, 1.97-6.41%) and second (0.72-2.09%, 1.05-2.34%, 1.23-2.75%) seasons, 2014 followed by Quinalphos 20 EC @ 200 g a.i./ha (3.46 & 2.75%, 4.42 & 3.12%, 6.70 & 3.51% - first and second season, respectively). From the mean shoot infestation (Table 1) it is revealed that, Flubendiamide 480 SC @ 60-90 g a.i./ha (1.28-3.48%) recorded as the best treatment with maximum reduction over control (70.18-89.03%) followed by Quinalphos 20 EC @ 200 g a.i./ha (3.99%) with 65.81% reduction over control. Among the treatments, the highest mean shoot infestation was recorded in Thiodicarb 75 SP @ 750 g a.i./ha (4.29%) with lowest percent reduction over control (63.24%) and was found least effective.

3.2 Fruit infestation

The mean fruit infestation in the pretreatment count was found to be non-significant (Table 2).

Table 1: Effect of Flubendiamide 480 SC on shoot infestation by brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen.

Treatment	Dose (g a.i./ha)	Pre-treatment count (%)	Percent shoot infestation (days after each spray)							Reduction over control (%)
			First Season, 2014 (Mean of three sprayings)			Second Season, 2014 (Mean of three sprayings)			Mean (%)	
			7 DAS	14 DAS	21 DAS	7 DAS	14 DAS	21 DAS		
Flubendiamide 480 SC	60	4.72 (12.55)	3.25 (10.38)	4.04 (11.59)	6.41 (14.67)	2.09 (8.30)	2.34 (8.80)	2.75 (9.54)	3.48 (10.68)	70.18
Flubendiamide 480 SC	72	4.95 (12.85)	2.04 (8.22)	2.83 (9.69)	3.25 (10.39)	1.32 (6.60)	1.44 (6.89)	1.83 (7.77)	2.12 (8.34)	81.83
Flubendiamide 480 SC	90	4.86 (12.74)	1.03 (5.82)	1.66 (7.41)	1.97 (8.07)	0.72 (4.85)	1.05 (5.97)	1.23 (6.35)	1.28 (6.44)	89.03
Thiodicarb 75 SP	750	4.88 (12.76)	3.62 (10.97)	4.86 (12.74)	6.96 (15.29)	3.15 (10.22)	3.37 (10.57)	3.77 (11.19)	4.29 (11.90)	63.24
Quinalphos 20 EC	200	4.91 (12.80)	3.46 (10.72)	4.42 (12.13)	6.70 (15.00)	2.75 (9.54)	3.12 (10.18)	3.51 (10.79)	3.99 (11.47)	65.81
Untreated Control	-	4.89 (12.78)	6.93 (15.26)	7.83 (16.25)	9.20 (17.65)	13.01 (21.14)	15.19 (22.93)	17.89 (25.02)	11.67 (19.94)	-
S. Em (±) C.D. at 0.05%		0.07 NS	0.03 0.10*	0.09 0.26*	0.08 0.23*	0.10 0.30*	0.09 0.26*	0.06 0.18	0.21 0.66*	-

NS – Not significant; Figures in parentheses are angular transformed values; *Significant at 0.05 level; DAS- Days after spray

Table 2: Effect of Flubendiamide 480 SC on fruit infestation by brinjal shoot and fruit borer, *Leucinodes orbonalis* Guen.

Treatment	Dose (g a.i./ha)	Pre-treatment count (%)	Percent fruit infestation (days after each spray)							Reduction over control (%)
			First Season, 2014 (Mean of three sprayings)			Second Season, 2014 (Mean of three sprayings)			Mean (%)	
			7 DAS	14 DAS	21 DAS	7 DAS	14 DAS	21 DAS		
Flubendiamide 480 SC	60	5.17 (13.14)	2.36 (8.83)	2.94 (9.87)	3.63 (10.98)	2.42 (8.95)	3.42 (10.65)	3.73 (11.14)	3.08 (10.07)	74.67
Flubendiamide 480 SC	72	5.12 (13.07)	1.94 (8.01)	2.56 (9.21)	3.16 (10.24)	1.86 (7.83)	2.76 (9.56)	3.24 (10.37)	2.59 (9.20)	78.70
Flubendiamide 480 SC	90	5.14 (13.10)	1.52 (7.08)	2.17 (8.47)	2.88 (9.77)	1.45 (6.91)	2.27 (8.67)	2.60 (9.28)	2.15 (8.37)	82.32
Thiodicarb 75 SP	750	5.16 (13.12)	3.45 (10.71)	3.97 (11.50)	4.65 (12.45)	3.45 (10.70)	4.23 (11.87)	4.68 (12.50)	4.07 (11.62)	66.53
Quinalphos 20 EC	200	5.19 (13.17)	2.93 (9.86)	3.51 (10.79)	4.14 (11.74)	2.83 (9.68)	3.81 (11.26)	4.21 (11.84)	3.57 (10.86)	70.64

Untreated Control	-	5.18 (13.15)	9.38 (17.83)	11.32 (19.66)	14.50 (22.38)	10.36 (18.77)	12.52 (20.72)	14.88 (22.69)	12.16 (20.35)	-
S. Em (±) C.D. at 0.05%		0.09 NS	0.03 0.08*	0.03 0.09*	0.06 0.17*	0.04 0.11*	0.04 0.12*	0.07 0.21*	0.26 0.83*	-

NS – Not significant; Figures in parentheses are angular transformed values; *Significant at 0.05 level; DAS- Days after spray

Table 3: Effect of Flubendiamide 480 SC on marketable fruit yield of brinjal.

Treatment	Dose (g a.i./ha)	Yield (q/ha)		Mean Yield (q/ha)
		First Season, 2014	Second Season, 2014	
Flubendiamide 480 SC	60	77.17	81.83	79.50
Flubendiamide 480 SC	72	81.51	85.27	83.39
Flubendiamide 480 SC	90	85.14	88.96	87.05
Thiodicarb 75 SP	750	72.14	72.44	72.29
Quinalphos 20 EC	200	74.76	76.53	75.65
Untreated Control	-	43.15	40.79	41.97
S. Em (±) C.D. at 0.05%		1.60 4.82*	0.90 2.72*	1.08 3.27*

*Significant at 0.05 level

From the data presented in Table 2, it is evident that there exists significant differences between different treatments in all the post observation dates and all chemicals significantly reduce fruit infestation than untreated control during both the seasons. Among the treatments, Flubendiamide 480 SC @ 60-90 g a.i./ha recorded the lowest fruit infestation at 7, 14 and 21 days after spray during first (1.52-2.36%, 2.17-2.94%, 2.88-3.63%) and second (1.45-2.42%, 2.27-3.42%, 2.60-3.73%) seasons, 2014. Next best treatment with lowest fruit infestation was observed in Quinalphos 20 EC @ 200 g a.i./ha (2.93 & 2.83%, 3.51 & 3.81%, 4.14 & 4.21% - first and second season, respectively). Highest fruit infestation among the treatments was observed in Thiodicarb 75 SP @ 750 g a.i./ha during first (3.45, 3.97 & 4.65%) and second (3.45, 4.23 & 4.68%) seasons, 2014 at 7, 14 and 21 days after spray but found effective over untreated control (9.38 & 10.36%, 11.32 & 12.52%, 14.50 & 14.88% - first and second season, repectively). In terms of mean percent fruit infestation (Table 2), Flubendiamide 480 SC @ 60-90 g a.i./ha (2.15-3.08%%) was recorded the best treatments with highest percent reduction over control (74.67-82.32%) followed by Quinalphos 20 EC @ 200 g a.i./ha (3.57%) with 70.64% reduction over untreated control. The least effective treatment in this case was recorded in Thiodicarb 75 SP @ 750 g a.i./ha (4.07%) with 66.53% reduction over control.

3.3 Marketable fruit yield

The yield of marketable fruit of brinjal for the first and second season, 2014 are presented in Table 3. All the insecticidal treatments exhibited significantly higher marketable fruit yield during both the seasons than untreated control. Among the treatments, Flubendiamide 480 SC @ 60-90 g a.i./ha provided the highest marketable fruit yield during first (77.17-85.14 q/ha) and second (81.83-88.96 q/ha) season followed by Quinalphos 20 EC @ 200 g a.i./ha (74.76 q/ha in first season and 76.53q/ha in second season). Thiodicarb 75 SP @ 750 g a.i./ha was recorded lowest marketable fruit yield during first (72.14 q/ha) and second (72.44 q/ha) season, 2014 but found superior over untreated control (43.15 & 40.79 q/ha during first and second season, 2014). The mean yield of marketable fruit revealed that, Flubendiamide 480 SC @ 60-90 g a.i./ha recorded the highest yield (79.50-87.05 q/ha) followed by Quinalphos 20 EC @ 200 g a.i./ha (75.65 q/ha) and Thiodicarb 75 SP @ 750 g a.i./ha (72.29 q/ha) and lowest in untreated control (41.97 q/ha).

In the present findings, Flubendiamide 480 SC @ 60-90 g a.i./ha found promising in reducing the infestation of shoot and fruit borer with higher marketable fruit yield during both the seasons. The reason for its effectiveness may be attributed due to its novel and unique mode of action by targeting the specific reaction sites in the cells of the pest species. These findings are supported by Yousafi *et al*. [21], Mahata *et al*. [10], Latif *et al*. [9], Jagginavar *et al*. [5], Chakraborty and Sarkar [2] who reported that Flubendiamide was the best treatments in reducing shoot and fruit borer infestation with highest marketable fruit yields. The efficacy of Flubendiamide against Lepidopteran pests are reported by many researchers [7, 4, 20] which are similar to the results of present findings.

4. Conclusion

It may be concluded that the diamide insecticide, Flubendiamide 480 SC provided satisfactory control of brinjal shoot and fruit borer by maximizing the marketable fruit yield during the course of study. This novel insecticide can be effectively utilized in the IPM programme for brinjal shoot and fruit borer.

5. Acknowledgments

The authors are thankful to Professor and Head, Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia for providing necessary facilities to carry out the present investigations. We also acknowledge M/S Bayer Crop Science Ltd., Mumbai for providing the facilities and sample of Flubendiamide 480 SC for the experiments.

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