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Efficacy of anthranilic insecticide E2Y45 20 SC (Chlorantraniliprole) against *Plutella xylostella* L. in cabbage, *Brassica oleracea* var. *capitata*

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Abstract: Experiments were conducted at farmer's cabbage fields to evaluate the bioefficacy of anthranilic insecticide i.e. E2Y45 20 SC (Chlorantraniliprole) having novel mode of action against the diamondback moth *Plutella xylostella* L. E2Y45 20 SC was applied @ 25.0, 37.5 and 50.0 ml/ha and was compared with Padan 50 SP (cartap hydrochloride) @ 500 g/ha and the untreated control. Lowest mean larval population after two sprays was recorded in higher dose of E2Y 45 20 SC i.e. @ 50.0 ml/ha (0.08 larvae/plant) at 7 days after treatment followed by medium and lower dose of E2Y 45 20 SC i.e. @ 37.5ml/ha (0.10 larvae/plant) and 25.0 ml/ha (0.33 larvae/plant). The larval population in these treatments was significantly lower than standard check, Padan 50 SP (2.56 larvae/plant), and untreated control (9.73 larvae/plant). The highest marketable yield (262.89 q/ha) was recorded in E2Y 45 20 SC @ 50.0 ml/ha which was significantly higher than Padan 50 SP (239.65 q/ha). Lowest yields were recorded in untreated control (106.00 q/ha). Conclusively, medium (37.5 ml/ha) and higher (50.0 ml/ha) dose of E2Y 45 20 SC (chlorantraniliprole) significantly reduced the larval population of *P. xylostella* and increased the cabbage yield.

Keywords: Cabbage, Chlorantraniliprole, Efficacy, *Plutella xylostella*

INTRODUCTION

Diamondback moth, *Plutella xylostella* (Linneaus) is one of the serious pests of crucifer crops throughout the world. In India, it has become an important limiting factor in the successful cultivation of crucifer vegetables and due to its attack yield losses to the tune of 52.0 per cent has been reported in cabbage (Krishnamoorthy, 2004; Rai *et al.*, 2007). High value crops like cabbage and cauliflower are preferred host of *P. xylostella,* therefore necessitate effective pest control. Diamondback moth has history of eventually becoming resistant to insecticide used extensively against it (Syed *et al*., 2004). Subsequently, *P. xylostella* populations have become resistant to all the major classes of insecticides in different areas of its geographical distribution (Li *et al.*, 2006; Pu *et al.*, 2010; Zhou *et al.*, 2011). Therefore insecticides with different modes need to be sought as a means to manage this pest. Also it develops insecticide resistance in few generations of selec-tion, and thus, extension of interval between insecticides' application becomes imperative. The present study with a promising insecticide of anthranilic diamide group, E2Y45 20 SC (Chlorantraniliprole), which exhibits larvicidal activity as an orally ingested toxicant by targeting and disrupting the Ca^{2+} balance, was therefore undertaken to evaluate its bioefficacy against diamondback moth on cabbage (*Brassica oleracea* var. *capitata*) under field conditions. It has very low toxicity for mammals, high intrinsic activity on target pests and gives long lasting crop protection. Moreover, Chlorantraniliprole has been reported to show reasonably high safety to beneficial arthropods (Dinter *et al.*, 2008) and other non-target organisms. Thus, in the current study efficacy of this insecticide has been evaluated for the ecologically sustainable management of one of the most notorious pest of cole crops.

MATERIALS AND METHODS

Experimental layout: Three field trials on cabbage (*Brassica oleracea* var. *capitata*) were conducted at farmer's field at villages *Sada chak*, district Jalandhar (Punjab), *Manderan* and *Jalkelan Kheri* (District Fatehgarh Sahib, Punjab). Anthranilic insecticide, E2Y45 20 SC (Chlorantraniliprole) was applied @ 25.0, 37.5 and 50.0 ml/ha and was compared with standard insecticide Padan 50 SP (cartap hydrochloride) @ 500 g/ha and the untreated control. Two sprays of the insecticides were given at 10 days interval. The experiment was replicated thrice in randomized block design and plot size of 50 m^2 was maintained. The larval population was recorded from ten randomly selected *B. oleracea* plants from each plot and mean population was calculated. The observations on mean larval population from 10 plants per plot per replication were recorded before spray, 3, 7 and 10 days after spray.

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Statistical analysis: The data pertaining to mean larval population were analyzed using ANOVA LSD at p=0.05 level (Gomez and Gomez, 1984). The values were subjected to square root transformation before analysis and the treatment means were compared. The marketable yield was recorded on whole plot basis and expressed as quintals per hectare.

RESULTS AND DISCUSSION

The results of field trial at village *Sada chak* revealed that population of *P. xylostella* were high at the beginning of the observation period. Mean number of larvae was 4.35 per plant in all plots. After first spray, the mean larval population showed a decreasing trend up to 7 days after treatment (DAT) in all the insecticide treatments. There was increase in the larval population recorded at 10 DAT in the insecticide treatments. However, in the untreated control, the larval population was recorded with increasing trend till the end of observation. The mean larval population, after 10 DAT in all doses of E2Y 45 20SC i.e @ 25.0 ml/ha (0.73 larvae/plant), 37.5 ml/ha (0.63 larvae/plant) and 50.0 ml/ha (0.60 larvae/plant), was significantly lower than standard check (1.43 larvae/plant) and untreated control (8.50 larvae/plant). After 2nd spray, all the three doses of E2Y 45 20SC were recorded with 100.00 per

Table 1. Efficacy of E2Y 45 20SC (Chlorantraniliprole) against diamondback moth on cabbage at Village *Sada chak*, Distt. Jalandhar (Punjab).

Treatment	Dose/ha (ml/g)	Mean larval population*							Marketable yield (q/ha)
		Pre-treatment	After 1st Spray			After 2nd Spray			
			3DAT	7DAT	10 DAT	3DAT	7DAT	10 DAT	
E2Y 45 20 SC	25 ml	4.56 (2.35)	0.30 (1.13)	0.00 (1.00)	0.73 (1.31)	0.30 (1.14)	0.00 (1.00)	0.00 (1.00)	295.09
	37.5 ml	4.00 (2.23)	0.00 (1.00)	0.00 (1.00)	0.63 (1.27)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	301.00
	50 ml	4.36 (2.31)	0.00 (1.00)	0.00 (1.00)	0.60 (1.26)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	312.07
Padan 50 SP	500g	3.86 (2.20)	0.86 (1.36)	0.43 (1.19)	1.43 (1.56)	0.76 (1.32)	0.43 (1.19)	0.20 (1.09)	295.36
Control	-	4.96 (2.43)	5.87 (2.62)	7.33 (2.88)	8.50 (3.08)	9.53 (3.24)	10.86 (3.44)	12.90 (3.72)	89.68
LSD (p=0.05)		NS	(0.14)	(0.16)	(0.12)	(0.13)	(0.94)	(0.12)	1.75

Data in parentheses are square root transformed values; DAT: Days after treatment; *Mean of larval population on 10 plants/ plot/replication

Table 2. Efficacy of E2Y 45 20SC (Chlorantraniliprole) against DBM on cabbage at village *Manderan*, Distt. Fatehgarh Sahib (Punjab).

Treatment	Dose/ha (ml/g)	Mean larval population*							Marketable yield (q/ha)
		Pre-treatment	After 1st Spray			After 2nd Spray			
			3DAT	7DAT	10 DAT	3DAT	7DAT	10 DAT	
E2Y 45 20 SC	25 ml	10.00	1.67 (1.62)	1.00 (1.41)	2.33 (1.82)	0.67 (1.27)	1.00 (1.41)	0.67 (1.27)	287.33
	37.5 ml	10.67	2.33 (1.82)	1.00 (1.38)	1.67 (1.62)	0.67 (1.27)	0.00 (1.00)	0.00 (1.00)	297.33
	50 ml	10.33	1.33 (1.49)	0.67 (1.27)	1.33 (1.52)	0.33 (1.13)	0.00 (1.00)	0.00 (1.00)	299.00
Padan 50 SP	500g	9.87	2.33 (1.82)	1.67 (1 .62)	3.33 (2.08)	1.67 (1.62)	1.67 (1.62)	2.33 (1 .80)	278.00
Control	-	9.87	10.67 (3.41)	10.86 (3.44)	11.67 (3.52)	10.67 (3.26)	10.86 (3.44)	10.86 (3.44)	112.33
LSD (p=0.05)		NS	(0.35)	(0.37)	(0.28)	(0.36)	(0.27)	(0.25)	4.11

Data in parentheses are square root transformed values; DAT: Days after treatment ; *Mean of larval population on 10 plants/ plot/replication

Table 3. Efficacy of E2Y 45 20SC (Chlorantraniliprole) against DBM on cabbage at village *Jalkhelan Kheri*, Distt. Fatehgarh Sahib (Punjab).

Treatment	Dose/ha (ml/g)	Mean larval population*							Marketable yield (q/ha)
		Pre-treatment	After 1st Spray			After 2nd Spray			
			3 DAT	7 DAT	10 DAT	3 DAT	7 DAT	10 DAT	
E2Y 45 20 SC	25 9	6.93 (2.81)	3.43 (2.10)	3.13 (2.03)	2.83 (1.95)	0.86 (1.36)	0.70 (1.30)	0.33 (1.15)	156.80
	37.5 9	7.13 (2.85)	2.93 (1.97)	2.23 (1.79)	3.43 (2.10)	0.76 (1.32)	0.37 (1.16)	0.30 (1.13)	164.80
	50.0 9	7.63 (2.94)	2.33 (1.82)	2.03 (1.74)	1.93 (1.71)	0.60 (1 .26)	0.23 (1.10)	0.23 (1.10)	177.60
Padan 50 SP	500g	7.43 (2.90)	4.43 (2.33)	3.83 (2.19)	2.93 (1.98)	2.06 (1.75)	1.00 (1.41)	1.10 (1 .44)	145.60
Control	-	7.00 (2.82)	8.23 (3.03)	8.43 (3.06)	9.03 (3.16)	7.60 (2.93)	6.73 (2.78)	5.43 (2.53)	116.00
LSD (p=0.05)		NS	(0.16)	(0.19)	(0.20)	(0.10)	(0.10)	(0.10)	11.64

Data in parentheses are square root transformed values.; DAT: Days after treatment; *Mean of larval population on 10 plants/ plot/replication

cent larval mortality (Table 1) at 7 DAT. At 10 DAT, the mean larval population in the treatments of E2Y 45 20SC was significantly lower than the untreated control (12.90 larvae/plant). However, these were at par with Padan 50 SP (1.09 larvae/plant). The highest marketable yield of 312.07 q/ha was recorded in E2Y 45 20SC @ 50.0 ml/ha and was significantly higher than other insecticidal treatments (295.09 to 301.00 q/ha). Lowest marketable yield (89.68 q/ha) was recorded in the untreated control.

At village *Manderan*, similar trend was observed wherein, pre-treatment abundance of diamondback moth was quite high with mean number of 10.15 larvae per plant. The mean larval population decreased up to 7 DAT following insecticide applications and then again increased when recorded at 10 DAT. After first spray, significantly lower larval population was recorded in E2Y 45 20SC @ 50.0 ml/ha (1.33 larvae/ plant) and 37.5ml/ha (1.67 larvae/plant). It was followed by lower dose of E2Y 45 20SC @ 25.0 ml/ha (2.33 larvae/plant) which was significantly better than standard check (3.33 larvae/plant) and untreated control (11.67 larvae/plant) in managing the pest population. After 2nd spray of the insecticides, 100.0 per cent larval mortality was recorded in E2Y 45 20SC @ 37.5 and 50.0 ml/ha at 7 DAT. At 10 DAT, the larval population in both these treatments was significantly lower than the lower dose of E2Y 45 20 SC i.e. 25.0 ml/ha (0.67 larvae/plant) and standard insecticide, Padan 50 SP (2.33 larvae/plant) and untreated control (10.86 larvae/plant). The highest marketable yield (299.00q/ ha) was recorded in higher dose of E2Y 45 20 SC i.e. 50.0 ml/ha followed by E2Y 45 20 SC @ 37.5 ml/ha (297.33 q/ha). The yield in these two testaments was significantly higher than lower dose of E2Y 45 20 SC @ 25.0 ml/ha (287.33 q/ha), Padan 50 SP (278.00 q/ ha). The lowest marketable yield (112.33 q/ha) was recorded in untreated check (Table 2).

Field trial at village *Jalkhelan Kheri* revealed similar trend of mean larval population in treated and untreated plots (Table 3). Pre-treated population of mean number of diamondback moth larvae was 7.22 per plant in non-treated plots**.** All the treated plots had recorded significantly lower population than untreated control. The lowest mean larval population (0.23 larvae/plant) after two sprays was recorded in E2Y 45 20 SC @ 50.0 ml/ha. It was at par with E2Y 45 20 SC @ 37.5 ml/ha (0.30 larvae/plant) and E2Y 45 20 SC @ 25.0 ml/ha (0.33 larvae/plant). However, it was significantly lower than Padan 50 SP (1.10 larvae/plant). The highest larval population was recorded in the untreated check (5.43 larvae/plant). The marketable yield in all the treated plots was significantly higher than untreated control (116.00 q/ha). The maximum marketable yield (177.60 q/ha) was recorded in higher dose of E2Y 45 20 SC i.e. @ 50.0 ml/ha, which was significantly higher than E2Y 45 20 SC @ 37.5 ml/ha (164.80 q/ha) and E2Y 4520 SC @ 25.0 ml/ha (156.80 q/ha) and standard check, Padan 50 SP (145.00 q/ ha).Pooled data of experiments conducted at three villages revealed that the lowest mean larval population after first spray was recorded in higher dose of E2Y 45 20 SC @ 50.0 ml/ha (0.90 larvae/plant) at 7 DAT followed by medium dose of E2Y 45 20 SC i.e. 37.5 ml/ ha (1.08 larvae/plant). The larval population in these treatments was significantly lower than standard check, Padan 50 SP (2.56 larvae/plant) and untreated control (9.73 larvae/plant) recorded at 10 DAT. After second spray, lowest larval population was recorded in higher dose of E2Y 45 20 SC @ 50.0 ml/ha (0.08 larvae/plant) at 7 DAT followed by medium dose of E2Y 45 20 SC i.e. 37.5 ml/ha (0.10 larvae/plant) recorded at 10 DAT. The larval population in these treatments was significantly lower than standard check, Padan 50 SP (1.21 larvae/plant) and untreated control (9.73 larvae/ plant) recorded at 10 DAT. Pooled data of marketable

yield of cabbage in the field trials revealed that the highest yield to the extent of 262.89 q/ha was recorded in E2Y 45 20 SC @ 50.0 ml/ha, followed by E2Y 45 20 SC @ 37.5 ml/ha (254.38 q/ha) and E2Y 45 20 SC @ 25.0 ml/ha (246.41q/ha). Among the insecticide treatments, lower marketable yield was recorded in Padan 50 SP (239.65 q/ha) which was, however, significantly better than the untreated control (106.00 q/ ha). The present work is in corroboration with studies on effectiveness of chlorantraniliprole in reducing the diamondback moth density in cole crops, hence proving effective management of the pest (Hiramoto, 2007). Han *et al.* (2012) investigated the effect of sublethal concentrations of chlorantraniliprole on population growth of *P. xylostella* and observed reduced survival and reproduction of the exposed insects. Similar results have also been obtained from baseline studies on toxicity of chlorantraniliprole to field populations of diamondback moth in China (Hu *et al*. 2010; Wang *et al*. 2010; Chen *et al*. 2010) and Brazil (Silva *et al*. 2012). Patra *et al.* (2012) while studying the bioefficacy of diamide insecticides against *P. xylostella* on cabbage reported that Flubendiamide 480SC @ 20, 40 and 60 g a.i. /ha and Chlorantraniliprole 18.5 SC @ 15, 30 and 45 g a.i. /ha were very effective in reducing the pest population resulting in higher yields. They further reported that these insecticides were selective to natural enemies associated with cabbage ecosystem. Similarly, the present studies are also in line with Seal *et al.* (2013) who reported significant reduction of mean number of diamondback moth larvae on 'Gourmet' cabbage seedlings following application of Coragen 20 SC (Chlorantraniliprole) @ 360 g/ha.

Conclusion

Medium and higher dose of E2Y 45 20 SC (chlorantraniliprole) i.e. 37.5 and 50.0 ml/ha, showed their supremacy in significantly reducing the larval population of *P. xylostella* on cabbage and thus increasing the marketable yield of cabbage (*Brassica oleracea* var. *capitata*). These results suggest that this insecticide provide effective management of *P. xylostella* and can be used to delay the development of resistance in diamondback moth against broad spectrum insecticides. The novel mode of action makes chlorantraniliprole a valuable option for vegetable integrated management programs in addition to safety to key beneficial arthropods and environment. However, indiscriminate use of this novel chemistry should be avoided for unwarranted development of resistance in the most notorious pest of cole crops.

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