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Chlorantraniliprole resistance in diamondback moth on different locations of Maharashtra

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Abstract
Diamondback moth (*Plutella xylostella* L.) is one of the few insect species that has developed field resistance to all major classes of insecticides and is ranked second in the Arthropod Pesticide Resistance Database (APRD) for the highest number of insecticides which reported resistance in at least one population. In this view, the present investigation was framed to study the levels of insecticidal resistance in the larvae of diamondback moth collected from major cabbage growing districts of Maharashtra at Post Graduate Laboratory, Department of Agricultural Entomology, College of Agriculture, Latur (V.N.M.K.V., Parbhani) during *Kharif* 2015. Based on variations in LC_{50} values and comparison with recommended dosages, the insecticidal resistance in cabbage diamondback moth from different locations of Maharashtra region was quite alarming to chlorantraniliprole, The resistance ratio to chlorantraniliprole 18.5 per cent SG was found to be highest in the diamondback moth population of Nashik (12.8-fold) followed by Ahmednagar (6.25-fold), Osmanabad (4.76-fold), Solapur (3.62-fold), Pune (2.80 -fold) and Latur (2.07-fold). Compared with the susceptible strain only Nashik population of diamondback moth (12.8-fold) indicated low resistance while, other field populations (83.33 per cent) i.e. Osmanabad, Solapur, Pune, Latur and Ahmednagar showed decreased susceptibility to chlorantraniliprole 18.5 per cent SG.

Keywords: Chlorantraniliprole, resistance, diamondback, different locations, (*Plutella xylostella* l.)

Introduction
In vegetable production, India is now second largest producer in the world after China with estimated production of about 90.39 lakh tonnes during 2015 from an area of more than 4.3 million hectares (Anonymous, 2015) [2].

India ranks second in respect of area under cabbage cultivation (400.138 ha) at world level but in respect of productivity it ranks tenth (22.6 MT/ha). One of the serious constraint to the successful production of these crops is ravages of insect pests, especially diamondback moth, *Plutella xylostella* (Lim *et al.* 1997) [8]. Due to its high reproductive potential and extensive application of insecticides, development of resistance has been observed in different parts of the world by Garg *et al.* (1987) [6] and Sweeden and McLeod (1997) [11]. This resulted in the need to look for more effective insecticides for its better control (Halimie *et al*., 1992; Narkiewicz, 1995; Freuler *et al.*, 2001; Aslam and Ahmad, 2002) [3, 7, 5, 9]. Little work has been reported to monitor the insecticides resistance against this pest. Thus, it was planned to study the resistance against some commonly used insecticides for its control.

Material and method
Insecticide
The insecticide solution required for log dose assays was prepared using formulated insecticide by serial dilution technique.

Bioassay
F_1 larval culture (II instar – Six day old larvae) was subjected to bioassay for resistance profile assessment to insecticide. The bioassay was conducted by standard leaf dip method (IRAC-7) using 5 cm diameter leaf disk. Three sets were subjected to bioassays for insecticidal concentration of chlorantraniliprole with at least 10 larvae in each replication. In general three concentrations of chlorantraniliprole insecticide were used to generate dose mortality response for *Plutella xylostella*.

The mortality caused by insecticide treatments was recorded at 48 hrs. after treatment. The mortality obtained after 48hrs. was treated as a final mortality. The leaf disk without any treatments would serve as a control. The mortality in control was also recorded. If the mortality in control exceeded 10 per cent, the set of experiments was discarded. The final

mortality was corrected using Abbots formula and same was used for final analysis. The dose mortality response data was used for Probit analysis.

Maintenance of susceptible and resistant strain

Plutella xylostella culture with higher susceptibility to insecticides was reared separately without further exposure to insecticide. Similarly, *Plutella xylostella* culture with high level of tolerance to certain insecticide (The survivors of *Plutella xylostella* from bioassay) was reared separately with continuous selection pressure for elimination of susceptible individuals.

Result and Discussion

Chlorantraniliprole 18.5 per cent SG resistance

The data on the degrees of resistance acquired by *Plutella xylostella* from different locations of Maharashtra region to chlorantraniliprole 18.5 per cent SG are presented in Table. The results of the comparison of LC_{50} values in different populations of *Plutella xylostella* showed that different populations had various levels of resistance. LC_{50} values for larvae of *Plutella xylostella* exposed to chlorantraniliprole 18.5 per cent SG ranged from 0.0390 to 0.0063 ml/l. The Nashik population recorded a maximum LC_{50} value to chlorantraniliprole 18.5 per cent SG (0.039ml/l) followed by populations from Ahmednagar (0.019 ml/l), Osmanabad (0.0145 ml/l), Solapur (0.011 ml/l), Pune (0.0085 ml/l) and Latur (0.0063 ml/l). However, LC_{50} value of susceptible strain of *Plutella xylostella* to chlorantraniliprole 18.5 per cent SG was 0.039 ml/l.

The resistance ratio was found to be highest in the population of Nashik (12.8-fold) followed by Ahmednagar (6.25-fold), Osmanabad (4.76-fold), Solapur (3.62-fold), Pune (2.80-fold) and Latur (2.07-fold).There was 10.73-fold difference in LC_{50} values of Nashik and Latur strain among the field populations. Compared with the susceptible strain only Nashik population (16.66 per cent) indicated moderate resistance while, other 2 of 6 field populations (33.33per cent) i.e., Solapur and Osmanabad showed decreased susceptible to chlorantraniliprole 18.5 per cent SG.

Chlorantraniliprole was the first commercialized ryanodine receptor insecticide from a novel class of chemistry, the anthranilic diamides (Cordova *et al.* 2006; Nauen 2006) [4], [10]. Although most the tested populations of DBM exhibited susceptibility to low resistance levels to chlorantraniliprole (RR = 0.7-5.3), resistance to chlorantraniliprole of DBM increased noticeably in individual locations. Similarly, a very high level of resistance was reported in 2011 for a population from Zeng cheng (RR > 2000-fold) in the Guangdong province of South China (Wang *et al*. 2013; Wang *et al*. 2010; Wang & Wu 2012) [12]. In our study, obvious variations of susceptibility (up to 242-fold between WA13 and WX13B populations) existed among the populations, which was similar to previous studies (Wang & Wu 2012) [12]. However, the resistance ratios of the Zeng cheng population declined to 25-fold after 6 generations without selection (Wang *et al*. 2013) [12]. It indicated that a very high-level resistance to chlorantraniliprole in a field population was unstable. Hence, chlorantraniliprole should be rotated with other insecticides with different modes of action in the locations where very high level of resistance was found.

Table: Insecticide resistance of Chlorantraniliprole 18.5 per cent SG against cabbage DBM of different locations

S. No.	Strain	LC_{50} ml/g/l	Fiducial limits at 50%		LC_{90} ml/g/l	Slope ± S.E.	x^2	RR
			LL	UL				
1	Ahmednagar	0.019	0.0075	0.0054	0.964	0.752 ±0.244	0.7769	6.25
2	Latur	0.0063	0.0006	0.0145	0.534	0.665 ±0.248	0.0310	2.07
3	Nashik	0.0389	0.0162	0.1610	4.479	0.622±0.241	0.4232	12.8
4	Osmanabad	0.0145	0.0031	0.0340	1.667	0.622±0.240	0.3180	4.77
5	Pune	0.0085	0.0005	0.0211	1.515	0.570±0.241	0.1541	2.80
6	Solapur	0.0110	0.0013	0.0308	0.752	0.703 ±0.245	0.0031	3.62
7	Susceptible	0.0030	0.0001	0.0084	0.286	0.650±0.256	0.4266	-

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