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Acute toxicity of different doses of spinetoram 12% SC against 3rd instar larvae of diamondback moth (*Plutella xylostella*) on cauliflower under laboratory condition

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Abstract
The acute toxicity of spinetoram against the 3rd instar larvae of diamondback moth (DBM) *Plutella xylostella* on cauliflower were initiated in the laboratory, Department of Entomology, College of Agriculture, IGKV, Raipur in 2020-21. Using six different doses of spinetoram: 0.2, 0.4, 0.6, 0.8, 1.0 and 1.2 ml/L, experiment were conducted against DBM 3rd instar larvae. Each treatment was replicated three times; probit analysis was used to determine LC_{50} values for the treatments against 3rd instar larvae. When the treatments were assessed at 24, 48 and 72 hours, LC_{50} values against larvae were 0.788%, .0478% and 0.331%. The slopes of the probit lines for larvae assessed at 24, 48 and 72 hours after application of spinetoram were 2.09, 2.32 and 2.95.This indicates that there was a more rapid changes in larval mortality with increase in pesticide dosage. The study shows that spinetoram can achieve effective control of DBM 3rd instar larvae under laboratory conditions.

Keywords: Spinetoram, diamondback moth, cauliflower

Introduction
Brassica oleracea var. botrytis L., (Cauliflower) is one of the most important winter vegetable cole crops in our countries. After China, India is the world's second-largest producer of cauliflower. It is mainly grown throughout the world's tropical and subtropical climates. It shares near about 4.6 percent of total vegetable area and 5.3 percent of overall production. (Ramzan *et al*., 2019) [7].

It has been cultivated more intensively throughout the year, resulting in a severe insect infestation. Direct pest attack is believed to be responsible for more than 40% of yield loss in some vegetables (Srinivasan, 1993) [9]. The major constraints in the profitable cultivation of cole crops are the diamondback moth (DBM), *Plutella xylostella* L. (Lepidoptera: Plutellidae), head caterpillar (*Crocidolomia binotalis*), web worm (*Hellula undalis*), cabbage butterflies (*Pieris brassicae*), aphid (*Liphapis erysimi*), and flea beetle (*Phyllotreta brassicae*).

Cauliflower's most harmful pest, the diamondback moth (DBM), is too responsible for the crop's low production. Cauliflower and cabbage are the preferred host plants. The amount of yield lost due to this insect ranges from 31 to 100 percent (Lingappa *et al*., 2006) [5]. The current loss in marketable yield is estimated to be between 53 and 80 percent as a result of the DBM attack alone, and the loss could be more if the attack is severe. (Chelliah and Srinivasan, 1986) [3].

In recent times, new insecticide molecules offer advantages over earlier chemistry in terms of greater levels of safety, better performance and reduced environmental impact. One such new insecticide molecule is spinetoram, has shown outstanding efficacy against diamond back moth *Plutella xylostella.*

Methods and Materials
The laboratory culture pests were initiated in the Ph. D. Entomology laboratory, college of agriculture, IGKV, Raipur by collecting egg mass and larvae from experimental field. For acute toxicity experiments leaf-dip method was preferred by many researchers, because of its stomach poison. Fresh cauliflower leaves of uniform size were thoroughly washed with water. Then leaves were dipped into the serial concentration of insecticide solutions for 60 seconds and air dried at room temperature for removing surface water. The treated leaves were transferred to clean plastic containers lined with moistened filter paper at the bottom.

In each container, 10 laboratory reared larvae of third instar was released and kept under the normal rearing conditions for observation. For the control, leaves treated with water alone were used. The larvae were considered dead when they became desiccated with shortened body and dark cuticle, and unable to move in a coordinated manner when disturbed with a needle. In this acute toxicity experiment, observations on larval mortality was fixed till 72 hours of exposure as spinetoram 12 SC tested is lepidoptericide characterized by stomach action showing slower mortality. The cumulative mortality data was observed till 72 h at 24 h intervals.

Preparation of spray solution

The appropriate amount of insecticide was calculated, measured properly with a micropipette for liquid formulation, and blended in distilled water while making the spray solution. The solution was then poured into a beaker (250ml) to get the necessary volume by adding water. It was well mixed with a wooden stick and used for further application.

Statistical analysis

The larval mortality has been recorded during the 24h of treatment and the mortality percentage was calculated using Abbott formula (1925). The corrected percent mortality were transformed to arcsine percentage and subjected to statistical analysis adopting completely randomized design (CRD). The lethal concentrations (LC_{50}) of insecticide were calculated through probit analysis using SPSS software (IBM SPSS Statistics for Window, version 26, IBM crop, Armonk, New York, USA).

$$\text{Corrected mortality} = \frac{\text{Mortality in treatment (\%)} - \text{Mortality in control (\%)}}{100 - \text{Mortality in control (\%)}} \times 100$$

The appropriate amount of insecticide was calculated, measured properly with a micropipette for liquid formulation, and blended in distilled water while making the spray solution. The solution was then poured into a beaker (250ml) to get the necessary volume by adding water. It was well mixed with a wooden stick and used for further application.

Results and Discussion

Acute toxicity experiment to estimate LC_{50} values of spinetoram 12% SC to the third instar larvae of DBM was carried out by leaf dip method at different doses at 24, 48 and 72 h after treatment. The response of larvae to different doses was represented by straight regression lines, indicating homogeneity of the population to the tested concentrations. LC_{50} 's of spinetoram in third instar larvae after 24, 48 and 72 h were 0.788, 0.478 and 0.331% respectively. The probit regression line for spinetoram 12 SC were Y = 2.09+1.89*x, Y = 2.32+1.75*x and Y = 2.95+1.99*x at 24, 48 and 72 h after treatment respectively. Spinetoram 12 SC had the least slope of 2.09 with 24 h after exposure, while slope values were 2.32 and 2.95 with 48 and 72 h after exposure respectively (Table 1).

Results from this study is similar with Ismail *et al*. (2012) [4] who showed that the spinosad was most effective and toxic to control *Plutella xylostella* L. because it gave lower LC_{50} value (1010.080 µl/5000 ml). Results of the present study revealed that the lower LC_{50} values of spinosad for *P. xylostella* was reported earlier by Arora *et al*. (2003) [2] and Maiti *et al*. (2007) [6]. Results of present investigations are also supported by Ranjbari *et al*. (2012) [8] who reported higher toxicity of Spinosad to different instars of *Plutella xylostella* and suggested that spinosad could be an important insecticide in control of different larval instars of *P. xylostella*.

Table 1: Acute toxicity of different dose of spinetoram 12% SC on 3rd instar larvae of *Plutella xylostella*

Dose of spinetoram (ml/l)	24 hrs		48 hrs		72 hrs	
	Mortality (%)	Corrected mortality (%)	Mortality (%)	Corrected mortality (%)	Mortality (%)	Corrected mortality (%)
0.2	16.66 (23.84)	-	33.33 (35.20)	28.57	40.00 (39.13)	30.77
0.4	23.33 (28.76)	-	40.00 (39.13)	35.71	53.33 (46.90)	46.15
0.6	36.66 (37.21)	-	50.00 (44.98)	46.43	60.00 (50.83)	53.84
0.8	50.00 (44.98)	-	56.66 (48.82)	53.56	73.33 (59.18)	69.22
1.0	56.66 (48.82)	-	70.00 (56.97)	67.85	80.00 (63.90)	76.92
1.2	70.00 (56.97)	-	86.66 (68.82)	85.70	93.33 (77.69)	92.30
0.0	00.00 (00.00)	-	06.66 (12.28)	-	13.33 (21.13)	-
SEm	3.42	-	3.56	-	3.93	-
C.D. 5%	10.49	-	10.90	-	12.03	-
LC_{50} and Fiducial limit 0.788 (0.627 – 1.074)			0.478 (0.332- 0.622)		0.331 (0.205- 0.433)	
LC_{95} and Fiducial limit 5.524 (2.873- 25.311)			4.592 (2.356-24.421)		2.586 (1.574- 7.978)	
Slope		2.09		2.32		2.95
Regression equation		Y = 2.09+1.89*x		Y = 2.32+1.75*x		Y = 2.95+1.99*x

( ) Figures in parentheses are arcsine transformed values

Conclusion

In present investigation it was found that with increase in dose there was increase in mortality of third instar larvae of diamondback moth. LC_{50} value of spinetoram also decreased with time of exposure of spinetoram with third instar larvae of diamondback moth. When the treatments were assessed at 24, 48 and 72 hours, LC_{50} values against larvae were 0.788, .0478 and 0.331. The slopes of the probit lines for larvae assessed at 24, 48 and 72 hours after application of spinetoram were 2.09, 2.32 and 2.95.

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