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## Bio-efficacy of spinetoram insecticide against diamondback moth (*Plutella xylostella* Linn.) in cabbage

**Ashithosh Mohanan, Gajendra Chandrakar, Krishna Gupta and Priyanka Nagdev**

### Abstract

Investigation was undertaken during 2020 and 2021 on experimental field research cum instructional farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) to study the bio-efficacy of newer insecticide against *Plutella xylostella* L. infesting cabbage. The cabbage crop was raised by following recommended package of practices except for plant protection measures. Highest Percent reduction of *Plutella xylostella* population over untreated control was observed in treatment no. (T4) i.e Spinetoram 12% SC w/v (11.7% w/w) SC @ 67.5 g.a.i./ha. (75.89%) followed by (T3) Spinetoram 12% SC w/v (11.7% w/w) SC @ 54 g.a.i./ha, (74.86%). There was minimum percent reduction of *Plutella xylostella* population (62.18%) over untreated control in treatment no. (T1) i.e. Spinetoram 12% SC w/v (11.7% w/w) SC @ 36 g.a.i./ha. The highest increase in yield over control was observed in treatment no. (T4) i.e Spinetoram 12% SC w/v (11.7% w/w) SC @ 67.5 g.a.i./ha (73.63%) followed by treatment no. (T3) Spinetoram 12% SC w/v (11.7% w/w) SC @ 54 g.a.i./ha, (65.04%).

**Keywords:** Spinetoram insecticide, diamondback moth, *Plutella xylostella* Linn., cabbage

### Introduction

For India's primarily vegetarian population, vegetables are a major source of carbohydrates, proteins, minerals, and roughages. After China, India is the world's second-largest producer of vegetables. Low vegetable consumption may be connected to a lack of availability coupled with a high price that is out of reach for most people. Vegetarianism is becoming more popular around the world, resulting in an increase in the vegetable market. As a result, there is a lot of room for increasing vegetable production to meet domestic demand at reasonable prices while also gaining foreign cash on the international market. Cole crops are superior to other winter vegetables and are grown all around the country. Cabbage, cauliflower, Knol-khol, Brussels sprouts, sprouting broccoli, and Chinese cabbage are examples of cole crops. They are members of the Cruciferae family and the genus Brassica. Cabbage (*Brassica oleracea* var. *capitata* Linn.) is a popular cole vegetable that is grown on around 0.39 million hectares and produces 8.80 million tonnes. It is grown for the edible expanded terminal buds known as head, which are high in vitamins A, B1, and C, as well as minerals like as phosphorus, potassium, salt, calcium, and iron. This crop is native to West Europe and the Mediterranean's northern coastlines.

Pests such as the tobacco caterpillar, diamondback moth, painted bug, cabbage semilooper, aphids, flea beetle, and others damage the crop. In India, 37 insect pests have been identified as feeding on cabbage, with the diamondback moth, *Plutella xylostella* Linnaeus, cabbage butterfly, *Pieris brassicae* Linnaeus, and mustard aphid, *Lipaphis erysimi* Kaltentbach, being the most serious threats to the crop's profitability. Diamondback moth is a widespread crucifer pest, and *M. persicae* is a highly polyphagous aphid that has been recorded to feed on over 500 kinds of host plants from at least forty different families, including some major agricultural crops. Because of their versatility, effectiveness, and fast control, insecticides have been frequently employed to control pests on vegetables. The indiscriminate and illogical application of insecticides at high levels has resulted in insect pest recurrence and resistance, as well as residues in food. The indiscriminate use has increased the expense of cultivation and has resulted in certain irreversible biosphere alterations. As a result, novel pesticide molecules with high toxicity to insect pests even at low dosages are needed, which should also be safer for natural enemies in the agro-ecosystem as well as the customer.

## Method and Materials

### Field Studies

The studies were undertaken on the Indira Gandhi Krishi Vishwavidyalaya's research and instructional farm in Raipur in the years 2020 and 2021. (C.G.). The study used a randomised block design (RBD) with seven treatments, including an untreated control, and was replicated three times. The crop was grown on a plot of 25 sqm (5x5m) with 60 x 60cm spacing and with recommended agronomic techniques. The insecticides evaluated were Spinetoram 12% SC 36 g a.i./ha, Spinetoram 12% SC 45 g a.i./ha, Spinetoram 12% SC 54 g a.i./ha, Spinetoram 12% SC 67.5 g a.i./ha, Emamectin benzoate 5.00% SG 7.60 g a.i./ha, Spinosad 2.5% SC 7.90 g a.i./ha. When the attack of *P. xylostella* larvae reached ETL (2 larvae/plant), insecticides were sprayed as foliar sprays. Insecticidal treatments were diluted in water (500 L ha<sup>-1</sup>) and applied with a hollow cone nozzle using a knapsack sprayer (16 L). There were two rounds of applications in all. The larvae on the head and outside the head were counted One day before the spray (pre-count) and one, three, seven, ten, and fourteen days after the spray were recorded. The "Direct Visual Counting Method" was used to estimate the diamondback moth population. Five plants were chosen at random from each repeated plot, and the larvae population on these plants was counted on a weekly basis.

### Statistical Analysis

Observation on live larvae per plant will be recorded on the following parameters: one day before application (pre-treatment and then at 1<sup>st</sup>, 3<sup>rd</sup>, 7<sup>th</sup>, 10<sup>th</sup> and 14<sup>th</sup> day after each application or till until treatment effect continues. Efficacy of different treatment in controlling the insect pests was determined by calculating percent reduction with the formula given by Henderson and Tilton (1955) [8] which is as under:

$$\text{The percent reduction in population} = 100 \times \left[ 1 - \frac{T_a - C_b}{T_b - C_a} \right]$$

Where,

T<sub>a</sub> = Number of insects after treatment

T<sub>b</sub> = Number of insects before treatment

C<sub>a</sub> = Number of insects in untreated check after treatment

C<sub>b</sub> = Number of insects in untreated check before treatment

The values of percent reduction will be transformed to angular values, from which analysis of variance will be calculated for determining critical difference (C.D) at 5 percent level of significance.

## Result and Discussion

### I year

The data (Table 01) revealed that all the insecticides under investigation were observed to be significantly superior over untreated control in reducing the larval population of *P. xylostella* at all the days (1, 3, 7, 10 and 14 DAS) of observations. The overall results of first and second spray indicated that, Spinetoram 12% SC @ 67.5 g a.i. ha<sup>-1</sup> recorded lowest number of larval population of *P. xylostella* and proved to be superior over all the remaining treatments (5.90 over all mean larvae). Whereas, Spinetoram 12% SC @ 54 g

a.i. ha<sup>-1</sup> with 6.26 over all mean no. of larvae after 1<sup>st</sup> and 2<sup>nd</sup> spray was the next promising treatment. Emamectin benzoate 5.00% SG @ 10 g a.i. ha<sup>-1</sup> was next in the order of effectiveness showing over all mean larval population of 7.58 larvae. It was followed by Spinosad 2.5% SC @ 17.50 g a.i. ha<sup>-1</sup> and Spinetoram 12% SC @ 19.75 g a.i. ha<sup>-1</sup> which were recorded with 7.76 larvae and 8.25 over all mean larvae after 1<sup>st</sup> and 2<sup>nd</sup> spray respectively. Untreated plots showed maximum over all mean number of larval population i.e. 20.24 after 1<sup>st</sup> and 2<sup>nd</sup> spray.

### II year

The data (Table 02) revealed that, all the insecticides under investigation were observed to be significantly superior over untreated control in reducing the larval population of *P. xylostella* at all the days i.e. 1, 3, 7, 10 and 14 DAS of observations. The over all mean number of larval population ranged between 3.80 and 20.43. The overall results of first and second spray indicated that, Spinetoram 12% SC @ 67.5 g a.i. ha<sup>-1</sup> recorded lowest number of larval population of *P. xylostella* and proved to be superior over all the remaining treatments (3.80 over all mean no. of larvae). Whereas, Spinetoram 12% SC @ 54 g a.i. ha<sup>-1</sup> with 3.96 over all mean no. of larvae after 1<sup>st</sup> and 2<sup>nd</sup> spray was the next promising treatment. Emamectin benzoate 5.00% SG @ 10 g a.i. ha<sup>-1</sup> was next in the order of effectiveness showing over all mean larval population of 4.45 larvae. It was followed by Spinosad 2.5% SC @ 17.50 g a.i. ha<sup>-1</sup> and Spinetoram 12% SC @ 45 g a.i. ha<sup>-1</sup> which were recorded with 4.67 larvae and 5.15 over all mean no. larvae after 1<sup>st</sup> and 2<sup>nd</sup> spray respectively. Untreated plots showed maximum over all mean number of larval population i.e. 20.43 after 1<sup>st</sup> and 2<sup>nd</sup> spray.

### Cumulative bio-efficacy of newer insecticides against *P. xylostella* during I and II year (Pooled)

The pooled analysis data of both the years 2020 and 2021 on bio-efficacy of newer insecticides against the larval population of *P. xylostella* on cabbage are presented in Table 3. It could be seen that, all the insecticidal treatments were significantly superior in reducing the infestation of *P. xylostella* over untreated control. The overall mean number of larval population ranged between 4.85 and 20.33. Spinetoram 12% SC @ 67.5 g a.i. ha<sup>-1</sup> consistently proved its superiority by recording least larval population 4.90 with highest percent reduction in larval population of *P. xylostella* over control (75.89%). Next in order of effectiveness were, Spinetoram 12% SC @ 54 g a.i. ha<sup>-1</sup> (5.11 over all mean no. of larvae in both year) with 74.86 percent larval reduction and Emamectin benzoate 5.00% SG @ 10 g a.i. ha<sup>-1</sup> (6.00 over all mean no. of larvae in both year) with 70.48 percent larval reduction, The next effective treatment was Spinosad 2.5% SC @ 17.50 g a.i. ha<sup>-1</sup> (69.45% larval reduction) followed by Spinetoram 12% SC @ 45 g a.i. ha<sup>-1</sup> (with 67.01 percent larval reduction). Maximum larval population was recorded in the untreated control (20.33 larvae).

### Yield

The two years mean data of total head yield of cabbage showed that all the treatments were significantly superior over untreated control. The yield of cabbage head presented in table no. 03, ranged between 153.06 to 265.76. Minimum cabbage head yield was recorded under treatment (T7) untreated control, (153.06 q/ha.). The maximum head yield of cabbage was recorded under treatment no. (T4) i.e.

Spinetoram 12% SC w/v (11.7% w/w) SC @ 67.5 g.a.i/ha 12% SC w/v (11.7% w/w) SC@ 54 g.a.i/ha (253.21q/ha). (265.76 q/ha) followed by treatment no. (T3) i.e Spinetoram

**Table 1:** Bio-efficacy of Spinetoram 12% SC w/v (11.7% w/w) SC against DBM (*Plutella xylostella*) on cabbage during rabi 2020

S. No.	Treatments	Dose g a.i./ha	Pre-treatment population/ 5 plants	Average no. of caterpillar/5 plants										Over all mean
				I Spray					II Spray					
				1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
T1	Spinetoram 12% SC w/v (11.7% w/w) SC	36	19.65	9.06 (7.55)	9.27 (8.45)	9.26 (8.32)	9.79 (8.59)	9.71 (8.6)	8.79 (7.95)	8.64 (8.2)	8.35 (8.1)	9.35 (8.28)	10.15 (8.6)	9.23
T2	Spinetoram 12% SC w/v (11.7% w/w) SC	45	19.75	7.72 (6.69)	8.17 (7.1)	8.69 (8.1)	7.9 (6.9)	8.2 (7.9)	7.89 (6.67)	7.98 (6.71)	8.34 (7.65)	8.85 (7.76)	8.82 (7.72)	8.25
T3	Spinetoram 12% SC w/v (11.7% w/w) SC	54	20.76	6.35 (5.24)	4.00 (6.03)	6.86 (5.90)	4.65 (7.08)	7.85 (7.11)	5.36 (4.84)	6.42 (5.78)	5.94 (4.58)	7.46 (7.00)	7.76 (7.10)	6.26
T4	Spinetoram 12% SC w/v (11.7% w/w) SC	67.5	20.76	3.30 (2.20)	6.70 (5.70)	6.77 (5.90)	6.63 (5.17)	6.62 (5.18)	3.07 (6.00)	6.37 (5.95)	6.90 (5.86)	6.98 (6.01)	6.73 (5.22)	5.90
T5	Emamectin benzoate 5.00% SG	10	18.78	7.60 (6.20)	7.65 (7.19)	7.69 (7.04)	7.60 (7.17)	7.62 (6.18)	7.03 (6.02)	7.10 (5.95)	7.20 (5.86)	7.99 (6.19)	8.10 (6.22)	7.58
T6	Spinosad 2.5% SC	17.50	19.56	7.7 (6.21)	7.81 (6.08)	6.57 (5.86)	7.77 (5.63)	8.20 (6.09)	6.64 (5.90)	8.15 (6.75)	7.82 (6.63)	8.21 (6.01)	8.8 (8.08)	7.76
T7	Untreated control		20.45	19.45 (9.41)	20.56 (9.66)	19.65 (9.69)	20.65 (9.76)	20.76 (11.27)	20.67 (10.92)	19.74 (9.80)	20.76 (9.77)	19.67 (10.91)	20.56 (10.79)	20.24
SEm±			NS	0.078	0.085	0.249	0.154	0.099	0.090	0.065	0.084	0.091	0.093	
CD at 5%			NS	0.235	0.257	0.747	0.462	0.297	0.271	0.197	0.254	0.274	0.281	

, DAS= Days after spray ( ) Figures in parentheses are square root transformed, NS= Non significant

**Table 2:** Bio-efficacy of Spinetoram 12% SC w/v (11.7% w/w) SC against DBM (*Plutella xylostella*) on cabbage mean data during summer 2021

S. No.	Treatments	Dose g a.i./ha	Pre-treatment population/ 5 plants	Average no. of caterpillar/5 plants										Over all mean
				I Spray					II Spray					
				1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
T1	Spinetoram 12% SC w/v (11.7% w/w) SC	36	17.80	5.96 (4.45)	6.17 (5.35)	6.16 (5.22)	6.69 (5.49)	6.61 (5.5)	5.69 (4.85)	5.54 (5.1)	5.25 (5)	6.25 (5.18)	7.05 (5.5)	6.13
T2	Spinetoram 12% SC w/v (11.7% w/w) SC	45	18.20	4.62 (3.59)	5.07 (4)	5.59 (5)	4.8 (3.8)	5.1 (4.8)	4.79 (3.57)	4.88 (3.61)	5.24 (4.55)	5.75 (4.66)	5.72 (4.62)	5.15
T3	Spinetoram 12% SC w/v (11.7% w/w) SC	54	20.75	3.25 (2.14)	3.90 (2.93)	3.76 (2.8)	4.55 (3.98)	4.75 (4.01)	3.26 (2.74)	3.32 (2.68)	3.84 (2.48)	4.36 (3.90)	4.66 (4.00)	3.96
T4	Spinetoram 12% SC w/v (11.7% w/w) SC	67.5	20.79	3.2 (2.1)	3.6 (2.6)	3.67 (2.8)	4.53 (3.07)	4.52 (3.08)	3.2 (2.90)	3.27 (2.85)	3.8 (2.76)	3.88 (2.91)	4.63 (3.12)	3.80
T5	Emamectin benzoate 5.00% SG	10	19.54	4.5 (3.10)	4.55 (4.09)	4.59 (3.94)	4.50 (4.07)	4.52 (3.08)	3.93 (2.92)	4.00 (2.85)	4.10 (3.76)	4.89 (3.09)	5.00 (4.12)	4.45
T6	Spinosad 2.5% SC	17.50	19.76	4.60 (3.11)	4.71 (2.98)	3.47 (2.76)	4.67 (2.53)	5.10 (2.99)	3.54 (2.80)	5.05 (4.65)	4.72 (3.53)	5.11 (2.91)	5.70 (4.98)	4.67
T7	Untreated control		20.43	20.65 (6.31)	20.67 (6.56)	19.65 (6.59)	20.89 (6.66)	20.76 (8.17)	19.76 (7.82)	20.76 (6.7)	20.76 (6.67)	19.65 (7.81)	20.76 (7.69)	20.43
SEm±			NS	0.068	0.075	0.238	0.143	0.088	0.08	0.055	0.074	0.081	0.083	
CD at 5%			NS	0.204	0.226	0.716	0.431	0.266	0.24	0.166	0.223	0.243	0.250	

DAS= Days after spray ( ) Figures in parentheses are square root transformed, NS= Non significant,

**Table 3:** Bio-efficacy of spinetoram 12% SC w/v (11.7% w/w) SC against Diamond back moth (*Plutella xylostella*) in cabbage two year mean data during rabi 2020 and summer 2021

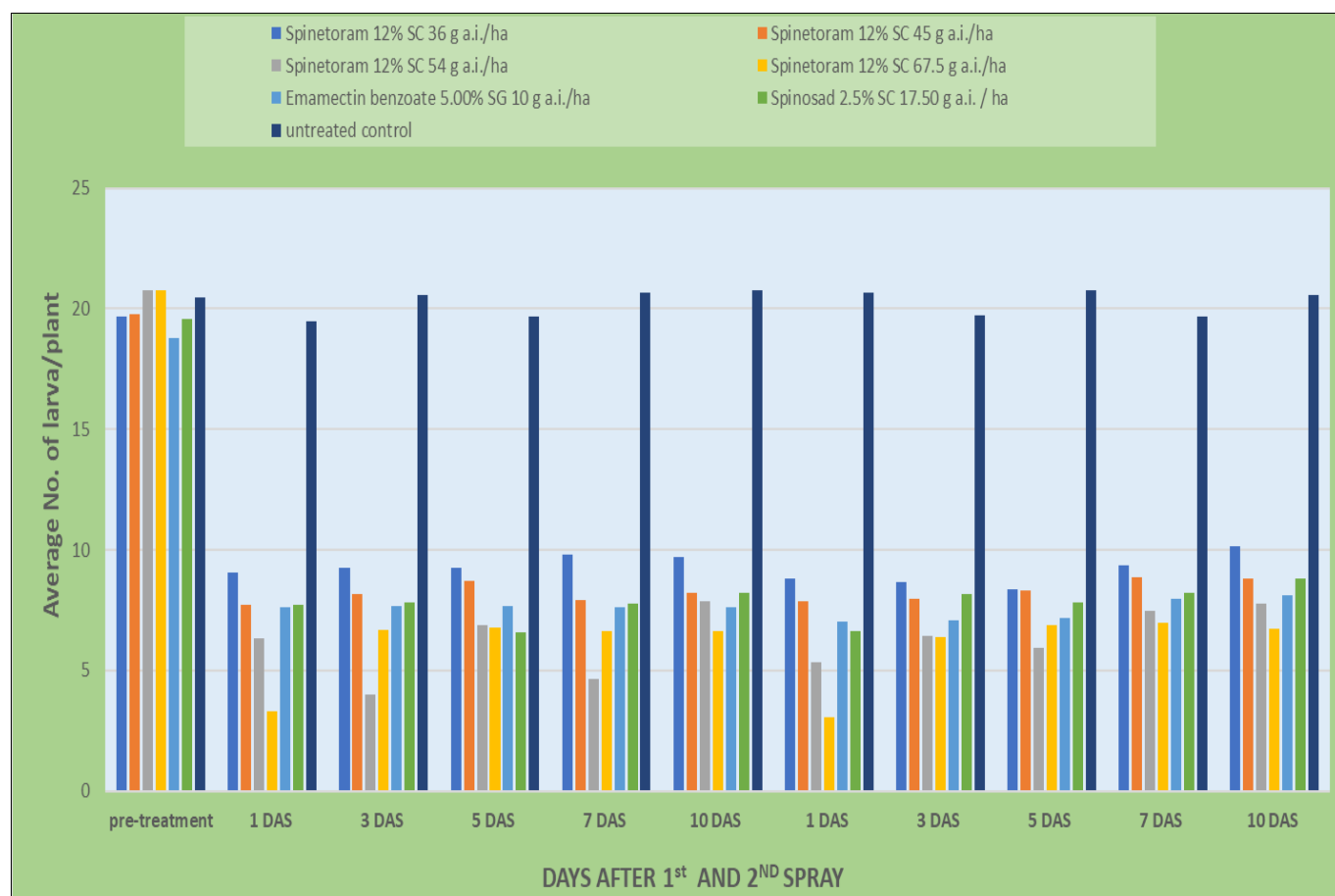
S.N.	Treatments	Dose g a.i./ha	Pre-treatment population	Average no. of caterpillar/ plant										Over all mean
				I Spray					II Spray					
				1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	1 DAS	3 DAS	5 DAS	7 DAS	10 DAS	
T1	Spinetoram 12% SC w/v (11.7% w/w) SC	36	18.72	7.51	7.72	7.71	8.24	8.16	7.24	7.09	6.8	7.8	8.6	7.68
T2	Spinetoram 12% SC w/v (11.7% w/w) SC	45	18.97	6.17	6.62	7.14	6.35	6.65	6.34	6.43	6.79	7.3	7.27	6.7
T3	Spinetoram 12% SC w/v (11.7% w/w) SC	54	20.75	4.8	3.95	5.31	4.6	6.3	4.31	4.87	4.89	5.91	6.21	5.11
T4	Spinetoram 12% SC w/v (11.7% w/w) SC	67.5	20.77	3.25	5.15	5.22	5.58	5.57	3.135	4.82	5.35	5.43	5.68	4.85
T5	Emamectin benzoate 5.00% SG	10	19.16	6.05	6.1	6.14	6.05	6.07	5.48	5.55	5.65	6.44	6.55	6.015
T6	Spinosad 2.5% SC	17.50	19.66	6.15	6.26	5.02	6.22	6.65	5.09	6.6	6.27	6.66	7.25	6.215
T7	Untreated control		20.44	20.05	20.61	19.65	20.77	20.76	20.21	20.25	20.76	19.66	20.66	20.33
SEm±			NS	0.073	0.08	0.243	0.148	0.093	0.085	0.06	0.079	0.086	0.088	
CD at 5%			NS	0.219	0.241	0.731	0.446	0.281	0.255	0.181	0.238	0.258	0.265	

DAS= Days after spray, NS= Non significant,

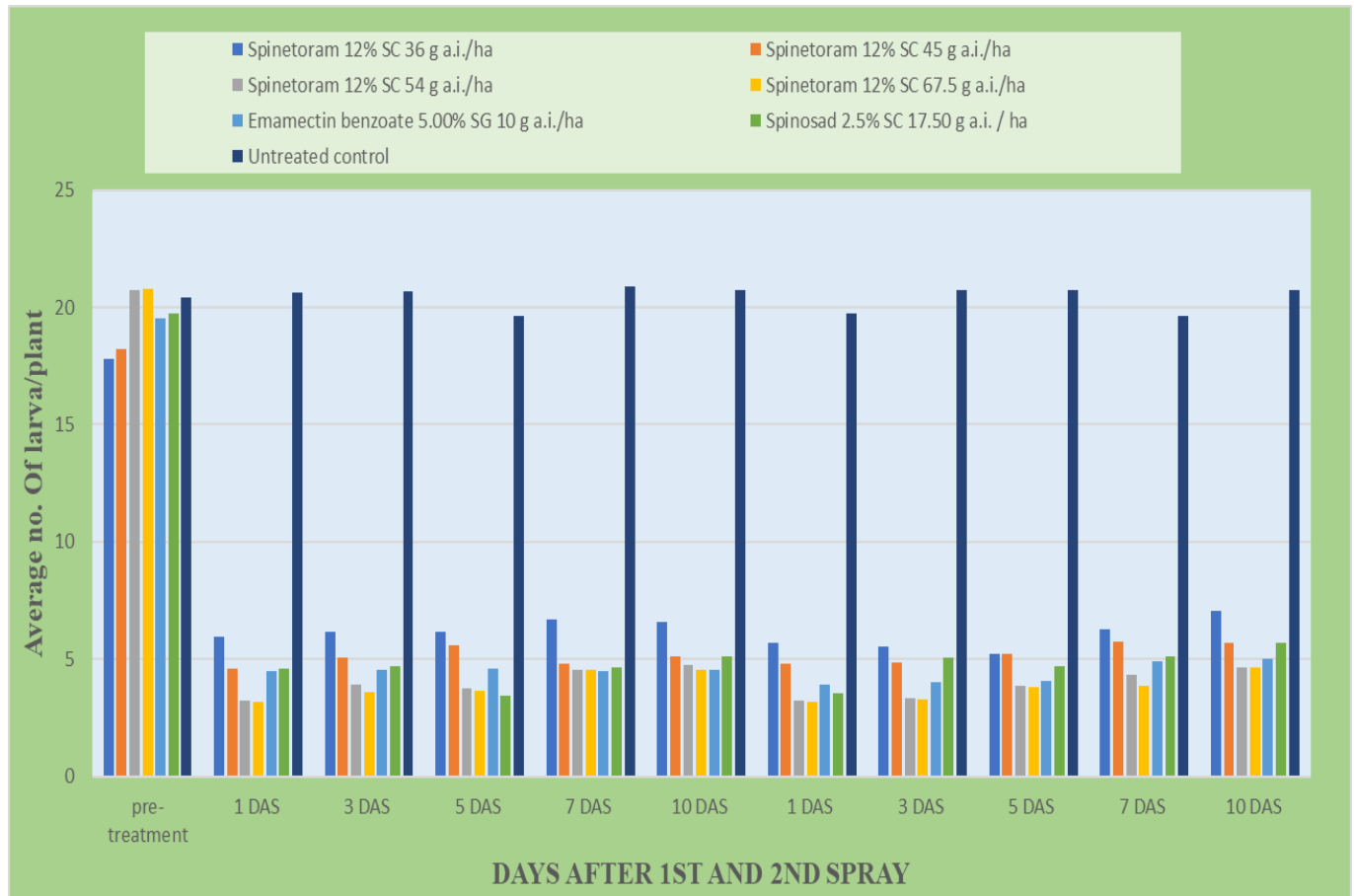
**Table 4:** Bio-efficacy of spinetoram 12% SC w/v (11.7% w/w) SC against Diamond back moth (*Plutella xylostella*) in cabbage crop, % reduction over control, yield of cabbage, mean data during rabi 2020 and summer 2021.

S.N.	Treatments	Dose		Rabi 2020			Summer 2021			Over all mean	Percent reduction of caterpillar over untreated control	Cabbage head yield (q/ha)	Increase in yield over control (q/ha)	% Increase in yield over control
		g a.i./ha.	Formulation (ml)/ha.	Mean population 5 plants after 1 <sup>st</sup> spray	Mean population 5 plants after (2 <sup>nd</sup> spray)	Mean of 1 <sup>st</sup> and 2 <sup>nd</sup> sprays	Mean population 5 plants after 1 <sup>st</sup> spray	Mean population 5 plants after 2 <sup>nd</sup> spray)	Mean of 1 <sup>st</sup> and 2 <sup>nd</sup> sprays					
T1	Spinetoram 12% SC w/v (11.7% w/w) SC	36	300	9.418	9.056	9.237	6.318	5.956	6.137	7.687	62.18	164.15	11.09	7.2
T2	Spinetoram 12% SC w/v (11.7% w/w) SC	45	375	8.136	8.376	8.256	5.036	5.276	5.156	6.706	67.01	183.94	30.88	20.17
T3	Spinetoram 12% SC w/v (11.7% w/w) SC	54	450	7.140	6.988	7.064	4.042	3.888	3.965	5.11	74.86	253.21	99.56	65.04
T4	Spinetoram 12% SC w/v (11.7% w/w) SC	67.5	562.5	7.004	6.856	6.93	3.904	3.756	3.830	4.90	75.89	265.76	112.70	73.63
T5	Emamectin benzoate 5.00% SG	10	375	7.632	7.484	7.558	4.532	4.384	4.458	6.00	70.48	181.995	28.93	18.90
T6	Spinosad 2.5% SC	17.50	700	7.610	7.924	7.767	4.51	4.824	4.667	6.21	69.45	172.475	19.41	12.68
T7	Untreated control			20.21	20.28	20.24	20.52	20.33	20.42	20.33		153.065		

This table show mean data and percent reduction values so no need of transformed value



**Fig 1:** Bio-efficacy Evaluation of Spinetoram insecticide against larval population of *P. xylostella* Rabi 2020



**Fig 2:** Bio-efficacy Evaluation of Spinetoram insecticide against larval population of *P. xylostella* summer 2021

### Conclusion

Different doses of test insecticide Spinetoram 12% SC w/v (11.7% w/w) SC along with reference insecticides and untreated control were evaluated for bio-efficacy, at the research farm of IGKV, Raipur during rabi 2020 and summer 2021.

The treatment number (T4) Spinetoram 12% SC w/v (11.7% w/w) SC @ 67.5 g.a.i/ha was found superior in reducing population as compared to rest of the insecticidal treatments during both the season of study. The highest fruit yield of 255.75 q/ha and 250.67 q/ha. were observed during rabi 2020 and Summer 2021 season respectively were recorded under (T4) i.e Spinetoram 12% SC w/v (11.7% w/w) SC @ 67.5g.a.i/ha.

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