Plant Archives Vol. 25, Supplement 1, 2025 pp. 485-489 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-1.065

BIO-EFFICACY OF INSECTICIDES AGAINST MUSTARD SAWFLY (*A. PROXIMA* (KLUG)) IN RADISH

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(Date of Receiving : 05-08-2024; Date of Acceptance : 30-09-2024)

ABSTRACT

In order to study the bio-efficacy of insecticide against mustard sawfly, *A. proxima* in radish, an experiment was conducted at Agronomy farm, Anand Agricultural University, Anand during *Rabi,* 2022-23. Nine different insecticides, along with control, were evaluated for their bio-efficacy against *A. proxima* in radish. The treatment of emamectin benzoate 0.0025 per cent, quinalphos 0.0600 per cent and flubendiamide 0.0100 per cent were found to be the most effective. The higher root yield of radish was recorded in the plots treated with emamectin benzoate 0.0025 per cent and it was at par with quinalphos 0.0600 per cent, flubendiamide 0.0100 per cent, spinetoram 0.0108 per cent, indoxacarb 0.0120 per cent, novaluron 0.0150 per cent, chlorantraniliprole 0.0060 per cent and cyantraniliprole 0.0120 per cent. The highest ICBR of 1:17.26 was calculated for the treatment of quinalphos 0.0600.

***Keywords*: *Athalia proxima,* Radish, Mustard, Mustard sawfly, Yield

Introduction

The mustard sawfly, *Athalia proxima* (Klug) [=*Athalia lugens proxima* (Klug)] (Hymenoptera: Tenthredinidae) is a polyphagous insect and is considered a devastating pest of vegetables in India. It mainly remains active during the cold weather from October to March. The larva alone is the most destructive stage and feeds on the margin of the leaves towards the center. The later instars make holes, preferably on the younger leaves, and skeletonize them. Sometimes they also feed on the epidermis of the tender shoots, flowers and fruits (Chauhan & Shukla, 2014). The incidence of mustard sawfly on radish crop can be as high as 85 per cent (Srivastava *et al*., 1972). Management strategies for the sawfly include summer ploughing to destroy the pupae, maintenance of clean cultivation and early sowing (Sahu *et al*., 2018). In spite of having certain limitations, the use of chemical insecticides still remains to be the most economically viable method to combat this pest. Despite the fact that this pest causes significant damage and yield losses in radish, not much attention has been given to the management of *A. proxima* in radish. In light of this, the current study aims to assess the efficacy of different insecticides for the management of *A. proxima* in radish.

Material and Methods

A field experiment to evaluate the bio-efficacy of insecticides against *A. proxima* in radish (var. Pusa Himani) was conducted at Agronomy farm, Anand Agricultural University, Anand during *Rabi,* 2022-23. All recommended agronomical practices were followed to raise the radish crop. The crop was grown at a spacing of 15 x 10 cm with three replications and total ten treatments along with control in Randomized Block Design. The first spray was applied on the initiation of pest infestation in the experimental plot and the second spray was applied after 15 days. All the treatments were applied as foliar spray by using manually operated high volume knapsack sprayer, fitted with a hollow cone nozzle. To record observations on larval population of sawfly, 10 plants were randomly selected from each net plot area. Entire plant was critically observed and the number of larvae were counted. The observations were recorded before the first spray as well as 3, 7, 10 and 14 days after each spray. Root yield was recorded from each net plot area.

Results and Discussion

The results of the study are presented in Table 1, 2, 3 (pooled data), 4 and depicted in Fig. 1.

Impact of Insecticides on Larval Population of Mustard Sawfly

The effectiveness of the insecticide sprays was judged on the basis of the larval population of *A. proxima*. There were non-significant differences among the treatments for the larval population before the first spray, indicating that there was a uniform infestation of *A. proxima* in all the experimental plots.

According to the pooled data, there were significant differences among the treatments. Furthermore, emamectin benzoate 0.0025 per cent (0.16 larva/plant) was the most effective treatment in controlling the population of *A. proxima.* However, it was at par with quinalphos 0.0600 per cent (0.19 larva/plant) and flubendiamide 0.0100 per cent (0.22 larva/plant). The next treatment in the order of effectiveness against *A. proxima* was spinetoram 0.0108 per cent (0.56 larva/plant) which was at par with indoxacarb 0.0120 per cent (0.60 larva/plant) and novaluron 0.0150 per cent (0.64 larva/plant). Among the evaluated insecticides, the treatment of chlorfluazuron 0.0162 per cent (1.11 larvae/plant) was the least effective treatment and it was at par with cyantraniliprole 0.0120 per cent (1.09 larva/plant) and chlorantraniliprole 0.0060 per cent (1.04 larva/plant). The control plots recorded significantly the highest larval population (1.69 larvae/plant) as compared to the other treatments.

The above results are in agreement with Patel (1995) who reported that quinalphos 0.05 per cent was the most effective insecticide which recorded more than 80 per cent larval morality. Dhaka *et al.* (2011) reported that the treatment of emamectin benzoate 5 SG proved to be the best with maximum reduction in sawfly larval populations. Further, Yadav (2012) reported that treatment of quinalphos 0.05 per cent was the most effective treatment in reducing the population of mustard sawfly in mustard. Hence, the present findings are in agreement with earlier findings.

Table 1: Bio-efficacy of insecticides against mustard sawfly in radish after first spray

Tr. No.	Treatments	Concentration (%)	No. of larvae/plant before spray	No. of larva(e) per plant at indicated days after spray				
				3	7	10	14	Pooled
T_1	Chlorantraniliprole 18.50 SC	0.0060	1.40 (1.46)	1.22^{d} (0.98)	1.30^{d} (1.20)	1.36^{de} (1.35)	1.43^{de} (1.53)	1.33^{c} (1.27)
T_2	Chlorfluazuron 5.40 EC	0.0162	1.32 (1.23)	1.25^{d} (1.07)	1.33^{d} (1.26)	1.38^{de} (1.39)	1.45^{e} (1.59)	1.35^{c} (1.32)
T_3	Cyantraniliprole 10.26 OD	0.0120	1.30 (1.19)	1.24^{d} (1.03)	1.32^{d} (1.23)	1.37^{de} (1.36)	1.44^{de} (1.56)	1.34^{c} (1.30)
T_4	Emamectin benzoate 5 SG	0.0025	1.38 (1.41)	0.79^{a} (0.13)	0.82^{a} (0.17)	0.87^{a} (0.26)	1.00^{a} (0.50)	0.87^{a} (0.26)
T_5	Flubendiamide 20 WG	0.0100	1.37 (1.38)	0.84^{abc} (0.20)	0.86^{ab} (0.23)	0.91^{ab} (0.32)	1.02^{ab} (0.55)	0.91^{a} (0.33)
T_6	Indoxacarb 14.50 SC	0.0120	1.45 (1.59)	1.05^{cd} (0.60)	1.06^{c} (0.63)	1.14^{cd} (0.80)	1.22^{c} (0.99)	1.12^{b} (0.75)
T_7	Novaluron 10 EC	0.0150	1.34 (1.29)	1.06^{cd} (0.63)	1.08^{c} (0.66)	1.16^{cd} (0.85)	1.24^{cd} (1.03)	1.14^{b} (0.80)
T_8	Spinetoram 11.7 SC	0.0108	1.35 (1.32)	1.03^{bcd} (0.56)	1.05^{bc} (0.60)	1.12^{bc} (0.75)	1.21^{bc} (0.95)	1.10^{b} (0.71)
T_9	Quinalphos 25 EC	0.0600	1.40 (1.46)	0.82^{ab} (0.17)	0.84^{a} (0.20)	0.89^{ab} (0.30)	1.01^{a} (0.53)	0.89^{a} (0.29)
T_{10}	Control	-	1.42 (1.52)	1.50^{e} (1.75)	1.54^{e} (1.87)	1.60^{e} (2.06)	1.65^{f} (2.23)	1.57^{d} (1.96)
S. Em. ± T (Treatments)		-	0.07	0.07	0.06	0.07	0.06	0.03
P (Periods)		-	-	-	-	-	-	0.02
T × P		-	-	-	-	-	-	0.06
F Test (T)		-	NS	Sig.	Sig.	Sig.	Sig.	Sig.
C. V. (%)		-	9.17	10.57	9.28	10.17	8.38	9.63

Notes: Figures outside the parentheses are $\sqrt{X + 0.5}$ transformed values and those inside the parentheses are retransformed values

Significant parameters and interaction: Nil

Treatment means followed by the same letter within a column are not significantly different by Duncan's New Multiple Range Test (DNMRT) at 5% level of significance

NS: Non significant; Sig: Significant

Table 2: Bio-efficacy of insecticides against mustard sawfly in radish after second spray

Tr. No.	Treatments	Concentration (%)	No. of larva(e) per plant at indicated days after spray				
			3	7	10	14	Pooled
T_1	Chlorantraniliprole 18.50 SC	0.0060	1.24^{c} (1.03)	1.19^{def} (0.92)	1.12^{cde} (0.76)	1.09^{bc} (0.69)	1.16^{c} (0.85)
T_2	Chlorfluazuron 5.40 EC	0.0162	1.27^{c} (1.12)	1.22^{fg} (1.00)	1.15^{e} (0.83)	1.11^{c} (0.73)	1.19^{c} (0.92)
T_3	Cyantraniliprole 10.26 OD	0.0120	1.26^{c} (1.09)	1.21^{ef} (0.96)	1.14^{de} (0.80)	1.10^{c} (0.72)	1.18^{c} (0.89)
T_4	Emamectin benzoate 5 SG	0.0025	0.80^{a} (0.13)	0.75^{a} (0.07)	0.73^{a} (0.03)	0.73^{a} (0.03)	0.75^{a} (0.06)
T_5	Flubendiamide 20 WG	0.0100	0.84^{a} (0.20)	0.80^{ab} (0.13)	0.77^{a} (0.10)	0.75^{a} (0.07)	0.79^{a} (0.12)
T_6	Indoxacarb 14.50 SC	0.0120	1.03^{b} (0.56)	0.99^{cd} (0.48)	0.96^{bc} (0.43)	0.93^{b} (0.37)	0.98^{b} (0.46)
T_7	Novaluron 10 EC	0.0150	1.05^{b} (0.61)	1.01^{cde} (0.53)	0.98^{bcd} (0.46)	0.95^{bc} (0.39)	1.00^{b} (0.50)
T_8	Spinetoram 11.7 SC	0.0108	1.01^{b} (0.53)	0.98^{bc} (0.45)	0.94^{b} (0.39)	0.92^{b} (0.36)	0.96^{b} (0.42)
T_9	Quinalphos 25 EC	0.0600	0.82^{a} (0.17)	0.77^{a} (0.10)	0.75^{a} (0.07)	0.73^{a} (0.03)	0.77^{a} (0.09)
T_{10}	Control	-	1.45^{d} (1.60)	1.42^{g} (1.52)	1.34^{f} (1.29)	1.30^{d} (1.20)	1.38^{d} (1.40)
S. Em. ± T (Treatments)		-	0.05	0.06	0.05	0.05	0.03
P (Periods)		-	-	-	-	-	0.02
T ×P		-	-	-	-	-	0.05
F Test (T)		-	Sig.	Sig.	Sig.	Sig.	Sig.
C. V. (%)		-	8.29	10.28	8.82	9.48	9.03

Notes: Figures outside the parentheses are $\sqrt{X + 0.5}$ transformed values and those inside the parentheses are retransformed values

Significant parameters and interaction: Nil

Treatment means followed by the same letter within a column are not significantly different by DNMRT at 5% level of significance

Sig: Significant

Table 3: Bio-efficacy of insecticides against *A. proxima* in radish (pooled over periods)

Tr. No.	Treatments	Concen-tration (%)	No. of larva(e) per plant after indicated spray		
			First	Second	Pooled over periods and sprays
T_1	Chlorantraniliprole 18.50 SC	0.0060	1.33^{c} (1.27)	1.16^{c} (0.85)	1.24^{c} (1.04)
T_2	Chlorfluazuron 5.40 EC	0.0162	1.35^{c} (1.32)	1.19^{c} (0.92)	1.27^{c} (1.11)
T_3	Cyantraniliprole 10.26 OD	0.0120	1.34^{c} (1.30)	1.18^{c} (0.89)	1.26^{c} (1.09)
T_4	Emamectin benzoate 5 SG	0.0025	0.87^{a} (0.26)	0.75^{a} (0.06)	0.81^{a} (0.16)
T_5	Flubendiamide 20 WG	0.0100	0.91^{a} (0.33)	0.79^{a} (0.12)	0.85^{a} (0.22)
T_6	Indoxacarb 14.50 SC	0.0120	1.12^{b} (0.75)	0.98^{b} (0.46)	1.05^{b} (0.60)
T_7	Novaluron 10 EC	0.0150	1.14^{b} (0.80)	1.00^{b} (0.50)	1.07^{b} (0.64)
T_8	Spinetoram 11.7 SC	0.0108	1.10^{b} (0.71)	0.96^{b} (0.42)	1.03^{b} (0.56)
T_9	Quinalphos 25 EC	0.0600	0.89^{a} (0.29)	0.77^{a} (0.09)	0.83^{a} (0.19)
T_{10}	Control	-	1.57^{d} (1.96)	1.38^{d} (1.40)	1.48^{d} (1.69)
S. Em. ± T (Treatments)		-	0.03	0.03	0.02

P (Periods)	-	0.02	0.02	0.01
S (Sprays)	-	-	-	0.01
T × P	-	0.06	0.05	0.04
T × S	-	-	-	0.03
P × S	-	-	-	0.02
T × P × S	-	-	-	0.06
F Test (T)	-	Sig.	Sig.	Sig.
C.V. (%)	-	9.63	9.03	9.35

Notes:
1. Figures outside the parentheses are $\sqrt{X + 0.5}$ transformed values and those inside the parentheses are retransformed values
2. Significant parameters and interaction: S, P × S and T
3. Treatment means followed by the same letter within a column are not significantly different by DNMRT at 5% level of significance
4. Sig: Significant

Yield

Data on the root yield of radish are presented in Table 4 and graphically depicted in Fig. 1. Differences among the treatments for the root yield were significant. All insecticidal treatments recorded significantly higher yields than control plots. The highest root yield (237.12 q/ha) was recorded in plots treated with emamectin benzoate 0.0025 per cent which was at par with quinalphos 0.0600 per cent (233.13 q/ha), flubendiamide 0.0100 per cent (230.25 q/ha), spinetoram 0.0108 per cent (220.19 q/ha), indoxacarb 0.0120 per cent (217.70 q/ha), novaluron 0.0150 per cent (214.74 q/ha), chlorantraniliprole 0.0060 per cent (204.64 q/ha) and cyantraniliprole 0.0120 per cent (201.58 q/ha). Significantly lower root yield was recorded for chlorfluazuron 0.0162 per cent (198.75 q/ha) which was at par with all insecticidal treatments except emamectin benzoate 0.0025 per cent. Control plots recorded the root yield of 160.56 q/ha which was significantly lowest as compared to the rest of the treatments.

Very few workers have studied the effect of insecticide application on the root yield of radish. The reports of the present finding are confirmed by the reports of Ramoliya *et al*. (2011) who revealed that significantly higher yield of radish was observed in the plots treated with quinalphos 0.0500 per cent (194.25 q/ha).

Economics (ICBR)

The data on economics of various insecticides evaluated against *A. proxima* in radish are presented in Table 4.

The highest ICBR (1:17.26) was calculated for the treatment of quinalphos 0.0600 per cent followed by emamectin benzoate 0.0025 per cent (1:14.24) and flubendiamide 0.0100 per cent (1:11.29). The ICBR value for the treatments of indoxacarb 0.0120 per cent, novaluron 0.0150 per cent, chlorantraniliprole 0.0060 per cent, chlorfluazuron 0.0162 per cent and spinetoram 0.0108 per cent was 1:8.25, 1:7.40, 1:6.77, 1:5.68 and 1:4.33, respectively. The treatment of cyantraniliprole 0.0120 per cent showed the lowest ICBR (1:2.07).

Table 4: Impact of various insecticides on root yield of radish

Tr. No.	Treatments	Concentration (%)	Yield (q/ha)	Increase in yield over control (%)	Avoidable loss (%)	ICBR
T_1	Chlorantraniliprole 18.50 SC	0.0060	204.64^{ab}	27.45	13.69	1:6.77
T_2	Chlorfluazuron 5.40 EC	0.0162	198.75^{b}	23.78	16.18	1:5.68
T_3	Cyantraniliprole 10.26 OD	0.0120	201.58^{ab}	25.55	14.98	1:2.07
T_4	Emamectin benzoate 5 SG	0.0025	237.12^{a}	47.68	-	1:14.24
T_5	Flubendiamide 20 WG	0.0100	230.25^{ab}	43.40	2.89	1:11.29
T_6	Indoxacarb 14.50 SC	0.0120	217.70^{ab}	35.58	8.19	1:8.25
T_7	Novaluron 10 EC	0.0150	214.74^{ab}	33.74	9.43	1:7.40
T_8	Spinetoram 11.7 SC	0.0108	220.19^{ab}	37.13	7.14	1:4.33
T_9	Quinalphos 25 EC	0.0600	233.13^{ab}	45.19	1.68	1:17.26
T_{10}	Control	-	160.56^{c}	-	32.28	-
S. Em. ±		-	11.03	-	-	
F Test (T)		-	Sig.	-	-	
C. V. (%)		-	9.01	-	-	

Note: Treatment means followed by same letter(s) within a column are not significantly different by DNMRT at 5% level of significance

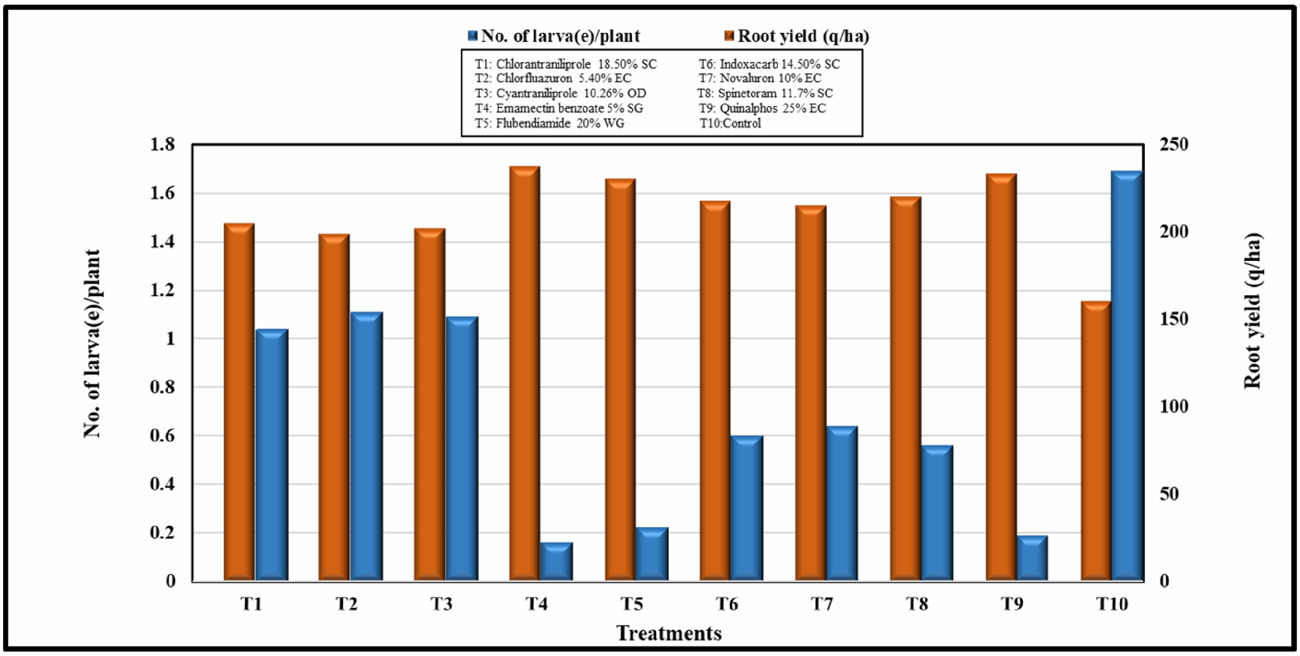

Fig. 1: Bio-efficacy of insecticides against *A. proxima* and their impact on yield of radish

Conclusions

From the present study, it can be concluded that emamectin benzoate 0.0025 per cent was the most effective in managing *A. proxima* in radish by reducing larval population and facilitating higher yields of radish.

Conflict of interest: The authors declare that they have no conflict of interest.

Acknowledgement

The authors are thankful to the Director of Research and Dean, Post Graduate Studies, Anand Agricultural University, Anand for providing all the necessary facilities and encouragement during the present investigation.

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