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COMPARATIVE EFFICACY OF DIFFERENT INSECTICIDES AGAINST TUR PLUME MOTH (*Exelastis atomosa* WALSINGHAM) INFESTING PIGEONPEA

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ABSTRACT

The different eight chemical insecticides were evaluated against *Exelastis atomosa* (Walshingham) in pigeonpea field during *Kharif*, 2021-22 and 2022-23. The pooled results showed that the plots treated with flubendiamide 39.35 SC @ 0.008 per cent was significantly most effective treatment with recorded lowest (0.17 larva/plant) population and it was followed by chlorantraniliprole 18.50 SC @ 0.006 per cent (0.36 larva/plant), emamectin benzoate 5 SG @ 0.002 percent (0.52 larva/plant), spinosad 45 SC @ 0.015 per cent (0.58 larva/plant) and chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.62 larva/plant). Among the studied insecticides, plots treated with novaluron 10 EC @ 0.005 per cent was found the least effective (0.78 larva/plant).

***Key words*:** Efficacy, *Exelastis atomosa*, Insecticides, Pigeonpea, Population, Larva, Plant

Introduction

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is an important grain legume crop cultivated extensively in tropical and subtropical regions. It is commonly known as tur, arhar or red gram and plays an important role in food and nutritional security, particularly for the vegetarian population. Pigeonpea seeds contain about 22.3 per cent protein and are an important source of dietary protein (Tiwari and Shivhare, 2016). The crop is also a good source of dietary fibre and possesses several medicinal properties owing to the presence of polyphenols and flavonoids (Kandhare, 2014). Besides its use as dal, pigeonpea is utilized as a vegetable, fodder, animal feed and fuel. It also improves soil fertility through biological nitrogen fixation and can be used as a green manure crop. Globally, pigeonpea is cultivated over an area of 6.03 million hectares, with a production of 5.33 million tonnes and an average productivity of 883.40 kg/ha (FAO, 2022). In India, the crop occupies about 5.05 million hectares, producing 4.34 million tonnes with an average productivity of 859 kg/ha.

However, the productivity of pigeonpea is adversely affected by several biotic constraints, among which insect pests are of major importance. The reproductive stages of the crop are particularly vulnerable to insect infestation because multiple key pests target buds, flowers and developing pods, resulting in considerable yield losses. Among the important insect pests associated with pigeonpea, the pod borer, *Helicoverpa armigera* (Hübner); spotted pod borer, *Maruca vitrata* (Geyer); pod fly, *Melanagromyza obtusa* (Malloch); tur plume moth, *Exelastis atomosa* (Walsingham) and blue butterfly, *Lampides boeticus* (Linnaeus) are considered economically important. Among these species, *E. atomosa* is a highly destructive pest of pigeonpea, particularly during the flowering and pod development stages. The larval stages feed aggressively on tender plant parts, flowers and developing pods, causing severe damage to reproductive structures and developing seeds. Infestation during flowering and pod formation can result in extensive flower and pod shedding, damaged pods and poor seed development, ultimately reducing overall grain yield.

The pest assumes greater significance because its destructive window coincides precisely with the reproductive phase of pigeonpea, when the crop is highly susceptible to insect attack. In addition, the hidden feeding habit of the larvae on tender reproductive plant parts severely complicates timely field detection and effective management. Although several insecticides have been broadly recommended for the management of major pigeonpea insect pests, research documenting the comparative performance of specific chemical treatments against this pest under field conditions remains limited. Previous studies have reported substantial damage to pigeonpea pods due to major insect pests, yet comprehensive data regarding target-specific chemical interventions is lacking.

The importance of plume moths within the pigeonpea pest complex has also been documented in field surveys and management studies. Earlier work identified *E. atomosa* among the pests associated with pigeonpea reproductive stages, while subsequent field evaluations have examined newer insecticides including spinosad, emamectin benzoate, indoxacarb, flubendiamide and chlorantraniliprole. These studies provide a useful basis for comparative evaluation of insecticide efficacy under field conditions (Shanower *et al*., 1999; Nithish *et al*., 2017; More *et al*., 2021; Volp *et al*., 2025). Previous studies have established the importance and diversity of insect pests associated with pigeonpea. Balikai and Yelshetty (2008), based on a three-year field survey in northern Karnataka, recorded 30 insect pests on pigeonpea and identified *Exelastis atomosa* among the moderate pests causing appreciable crop damage. Chaudhari and Sachan (1995) also documented a pest complex including pigeonpea plume moth during different crop growth stages and showed that protection during the reproductive phase could reduce pod damage and improve seed yield. These findings emphasize the importance of monitoring pest populations and protecting the crop during the reproductive stage. Muchhadiya *et al.,* (2024) estimated yield losses caused by insect pests in pigeonpea in Gujarat and recorded plume moth associated pod damage of up to 5.60 per cent. Their results demonstrate that *E. atomosa* can contribute appreciably to yield loss under field conditions and emphasize the importance of timely pest management. More recently, Volp *et al.,* (2025) reviewed progress and prospects in integrated pest management of pigeonpea and emphasized that, although synthetic insecticides remain widely used, future management should consider insecticide resistance, conservation of natural enemies and compatibility with sustainable pest-management practices. Therefore, evaluation of the field efficacy of newer insecticides against *E. atomosa* remains relevant for developing effective pest-management options for pigeonpea.

Considering the economic importance of pigeonpea and the high potential for damage caused by *E. atomosa*, a rigorous field evaluation of effective chemical insecticides is essential for developing suitable pest management strategies. Therefore, the present investigation was undertaken to determine the efficacy of chemical insecticides against Tur plume moth, *Exelastis atomosa* (Walsingham) on pigeonpea.

Materials and methods

A field experiment was conducted at the Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, during *Kharif*, 2021-22 and 2022-23 to investigate the comparative efficacy of different chemical insecticides against management of *E. atomosa* in pigeonpea.

Experimental details

Location		: Agronomy Instructional Farm C. P. College of Agriculture S.D. Agricultural University Sardar krushi nagar
Year & Season		: *Kharif*, 2021-22 and 2022-23
Crop and Variety		: Pigeonpea, GT 101
Design		: Randomized Block Design (RBD)
Replications		: 3
No. of treatments		: 9
Plot size	**i) Gross**	: 4.80 m × 4.00 m
	ii) Net	: 3.60 m × 3.00 m
Spacing		: 60 cm × 20 cm
Fertilizer		: 25:50:00 - N:P_2O_5:K_2O (kg/ha)

Treatment details:

The details of insecticides and their doses used in the present investigation were given as below.

Tr. No.	Treatments	Concentration (%)	Dose(g or ml / 10 lit. of water)
T_1	Chlorantraniliprole 18.5 SC	0.006	3
T_2	Spinosad 45 SC	0.015	3
T_3	Flubendiamide 39.35 SC	0.008	2
T_4	Indoxacarb 14.5 SC	0.01	7
T_5	Chlorantraniliprole 9.30 + Lambda cyhalothrin 4.60 ZC	0.006	4
T_6	Novaluron 10 EC	0.005	5
T_7	Profenofos 40 + Cypermethrin 4 EC	0.088	20
T_8	Emamectin benzoate 5 SG	0.002	4
T_9	Untreated control	-	-

Application of insecticides

Two insecticidal applications were imposed during the reproductive phase of the crop. The first application was made at 50% flowering and the second application was made 15 days after the first application. The spray volume required for each treatment was calibrated using water in the control plot before treatment application. The insecticides were applied with a knapsack sprayer during the early morning hours. The untreated control received no insecticide application.

Observations recorded

Before each spray, larval population was assessed to verify the distribution of *E. atomosa* among the experimental plots. Five plants were selected at random from each treatment plot for population assessment. The number of *E. atomosa* larvae present on the selected plants was counted one day before treatment and at 3, 7 and 15 days after each spray. The same observation schedule was followed for both experimental seasons, permitting comparison of treatment response across years and spray periods.

Results and Discussion

A field experiment was conducted at the Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, during *Kharif*, 2021-22 and 2022-23 to investigate the efficacy of different chemical insecticides against management of *E. atomosa* in pigeonpea.

First year (2021-22)

The results showed that the population of *E. atomosa* before spray was homogeneously distributed in all plots between 1.17 and 1.28 larvae per plant which was not statistically significant (Table 1).

First spray:

The findings showed that the lowest population (0.33 larva/plant) was recorded from the plots treated with flubendiamide 39.35 SC @ 0.008 per cent which remained at par with chlorantraniliprole 18.5 SC @ 0.006 per cent (0.57 larva/plant) at three days after first spray. Emamectin benzoate 5 SG @ 0.002 per cent (0.72 larva/plant), spinosad 45 SC @ 0.015 per cent (0.74 larva/plant), chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.80 larvae/plant), indoxacarb 14.50 SC @ 0.010 per cent (0.84 larva/plant), profenofos 40 + cypermethrin 4 EC @ 0.088 per cent (0.89 larva/plant) and novaluron 10 EC @ 0.005 per cent (0.93 larvae/plant) were the next best treatments which were at par with each other.

The perusal of the data on the population of *E. atomosa* taken at the seven days after the first application of insecticides showed flubendiamide 39.35 SC @ 0.008 per cent as the most effective treatment which showed lowest 0.25 larva per plant which remained at par with chlorantraniliprole 18.5 SC @ 0.006 per cent (0.49 larva/plant). The treatments emamectin benzoate 5 SG @ 0.002 per cent, spinosad 45 SC @ 0.015 per cent, chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent, indoxacarb 14.5 SC @ 0.010 per cent and profenofos 40 + cypermethrin 4 EC @ 0.088 per cent were forming second group of effective treatments which were statistically at par with each other as they recorded 0.60, 0.66, 0.70, 0.75 and 0.81 larva per plant, respectively. Novaluron 10 EC @ 0.005 per cent was the least effective among the investigated insecticides (0.88 larva/plant), while being superior to the untreated control (1.55 larvae/plant).

At fifteen days after first spray, more or less similar trend of effectiveness was observed among different treatments. The minimum (0.29 larva/plant) population was recorded from the plots treated with flubendiamide 39.35 SC @ 0.008 per cent which remained at par with chlorantraniliprole 18.5 SC @ 0.006 per cent (0.53 larva/plant). The next most effective set of treatments were emamectin benzoate 5 SG @ 0.002 per cent (0.67 larva/plant), spinosad 45 SC @ 0.015 per cent (0.72 larva/plant), chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.76 larva/plant), indoxacarb 14.5 SC @ 0.010 per cent (0.81 larva/plant), profenofos 40 + cypermethrin 4 EC @ 0.088 per cent (0.86 larva/plant) and novaluron 10 EC @ 0.005 per cent (0.91 larva/plant) which were remained at par with each other.

The pooled data of first spray (Table 1) clearly indicated that flubendiamide 39.35 SC @ 0.008 per cent was significantly most (0.29 larva/plant) effective over other treatments in reducing plume moth population which was followed by chlorantraniliprole 18.50 SC @ 0.006 per cent (0.53 larva/plant). The next best effective treatment was emamectin benzoate 5 SG @ 0.002 per cent with 0.67 larva per plant which was followed by spinosad 45 SC @ 0.015 per cent (0.72 larva/plant), chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.76 larva/plant), indoxacarb 14.50 SC @ 0.010 per cent (0.80 larva/plant) and profenofos 40 + cypermethrin 4 EC @ 0.088 per cent (0.85 larva/plant). Novaluron 10 EC @ 0.005 per cent was found to be the least (0.91 larva/plant) effective among the tested insecticides. The untreated control recorded the maximum population (1.54 larvae/plant).

Table 1: Efficacy of different chemical insecticides against *E. atomosa* on pigeonpea during 2021-22.

Tr. No.	Treatments	Conc. (%)	DBS	No. of larvae/plant								PPS
				1st spray				2nd spray				
				3DAS	7DAS	15DAS	POP	3 DAS	7 DAS	15 DAS	POP	
T_1	Chlorantraniliprole 18.5 SC	0.006	1.30 (1.18)	1.03^{ab} (0.57)	0.99^{ab} (0.49)	1.01^{ab} (0.53)	1.01^{b} (0.53)	0.90^{ab} (0.31)	0.85^{ab} (0.23)	0.88^{ab} (0.28)	0.88^{a} (0.28)	0.95^{b} (0.40)
T_2	Spinosad 45 SC	0.015	1.30 (1.20)	1.11^{b} (0.74)	1.08^{bc} (0.66)	1.10^{b} (0.72)	1.10^{cd} (0.72)	1.03^{bc} (0.56)	0.99^{bc} (0.49)	1.01^{bc} (0.53)	1.01^{bc} (0.53)	1.06^{cd} (0.62)
T_3	Flubendiamide 39.35 SC	0.008	1.29 (1.17)	0.91^{a} (0.33)	0.87^{a} (0.25)	0.89^{a} (0.29)	0.89^{a} (0.29)	0.83^{a} (0.18)	0.78^{a} (0.12)	0.81^{a} (0.16)	0.81^{a} (0.16)	0.85^{a} (0.22)
T_4	Indoxacarb 14.5 SC	0.010	1.31 (1.22)	1.16^{b} (0.84)	1.12^{bc} (0.75)	1.14^{b} (0.81)	1.14^{cd} (0.80)	1.08^{c} (0.67)	1.06^{c} (0.62)	1.07^{c} (0.65)	1.07^{bcd} (0.65)	1.11^{def} (0.73)
T_5	Chlorantraniliprole 9.30 + Lambda cyhalothrin 4.60 ZC	0.006	1.31 (1.21)	1.14^{b} (0.80)	1.10^{bc} (0.70)	1.12^{b} (0.76)	1.12^{cd} (0.76)	1.05^{bc} (0.61)	1.03^{c} (0.57)	1.04^{bc} (0.59)	1.04^{bcd} (0.59)	1.08^{cde} (0.67)
T_6	Novaluron 10 EC	0.005	1.32 (1.24)	1.20^{b} (0.93)	1.17^{c} (0.88)	1.19^{b} (0.91)	1.19^{d} (0.91)	1.14^{c} (0.79)	1.11^{c} (0.73)	1.12^{c} (0.76)	1.12^{d} (0.76)	1.15^{f} (0.82)
T_7	Profenofos 40 + Cypermethrin 4 EC	0.088	1.33 (1.26)	1.18^{b} (0.89)	1.14^{bc} (0.81)	1.17^{b} (0.86)	1.16^{cd} (0.85)	1.11^{c} (0.73)	1.09^{c} (0.69)	1.10^{c} (0.70)	1.10^{cd} (0.70)	1.13^{ef} (0.78)
T_8	Emamectin benzoate 5 SG	0.002	1.30 (1.19)	1.10^{b} (0.72)	1.05^{bc} (0.60)	1.08^{b} (0.67)	1.08^{bc} (0.67)	0.99^{bc} (0.49)	0.96^{bc} (0.43)	0.98^{bc} (0.46)	0.98^{b} (0.46)	1.03^{c} (0.56)
T_9	Untreated control	-	1.33 (1.28)	1.39^{c} (1.43)	1.43^{d} (1.55)	1.47^{c} (1.66)	1.43^{e} (1.54)	1.48^{d} (1.70)	1.51^{d} (1.79)	1.54^{d} (1.87)	1.51^{e} (1.78)	1.47^{g} (1.66)
	S. Em. ±	T	0.06	0.06	0.05	0.06	0.03	0.05	0.05	0.05	0.03	0.02
		P	-	-	-	-	0.02	-	-	-	0.02	0.01
		S	-	-	-	-	-	-	-	-	-	0.01
		T×P	-	-	-	-	0.06	-	-	-	0.07	0.04
		T×S	-	-	-	-	-	-	-	-	-	0.03
		P×S	-	-	-	-	-	-	-	-	-	0.02
		T×P×S	-	-	-	-	-	-	-	-	-	0.05
	C. D. at 5%	T	N.S.	0.17	0.16	0.17	0.08	0.15	0.15	0.16	0.07	0.06
	C. V. (%)		8.01	8.58	8.33	8.86	8.60	8.22	8.23	8.44	8.29	8.06

DBS: Day before spray; POP: Pooled over period; PPS: Pooled over period over spray
Figures in parentheses are retransformed values of $\sqrt{X+0.5}$ transformed values
Treatment means with the letter(s) in common are not significantly different by DNMRT at 5% level of significance

Second spray:

The data recorded on population of *E. atomosa* at 3 days after second spray indicated that all the treatments recorded significantly lower *E. atomosa* population compared to untreated control. Among the different treatments, the lowest (0.18 larva/plant) population was recorded in flubendiamide 39.35 SC @ 0.008 per cent which was at par with chlorantraniliprole 18.50 SC @ 0.006 per cent (0.31 larva/plant). Next effective treatments were emamectin benzoate 5 SG @ 0.002 per cent (0.49 larva/plant), spinosad 45 SC @ 0.015 per cent (0.56 larva/plant) and chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.61 larvae/plant) which were at par with each other. The least effective treatment novaluron 10 EC @ 0.005 per cent, recorded 0.79 larva per plant. The highest population was observed in untreated plots (1.70 larvae /plant).

The data on population of *E. atomosa* recorded at seven days after second spray of insecticides revealed that flubendiamide 39.35 SC @ 0.008 per cent was the significantly most effective treatment which showed lowest 0.12 larva per plant which was remained at par with chlorantraniliprole 18.50 SC @ 0.006 per cent (0.23 larva/plant). The next best treatments were emamectin benzoate 5 SG @ 0.002 per cent and spinosad 45 SC @ 0.015 per cent which were statistically at par with each other as they recorded 0.43 and 0.49 larva per plant, respectively. However, remaining insecticidal treatments were significantly superior over untreated control (1.79 larvae/plant).

Similar trend of effectiveness was observed at fifteen days after second spray. The lowest population (0.16 larva/plant) was recorded from the plots treated with flubendiamide 39.35 SC @ 0.008 per cent which remained

at par with chlorantraniliprole 18.50 SC @ 0.006 per cent (0.28 larva/plant). Emamectin benzoate 5 SG @ 0.002 per cent (0.46 larva/plant), spinosad 45 SC @ 0.015 per cent (0.53 larva/plant) and chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.59 larva/plant) were superior and at par with each other. Among the studied insecticides, novaluron 10 EC @ 0.005 per cent recorded maximum population of 0.76 larva per plant but it was better than the untreated control.

Pooled data of second spray revealed that the plots treated with flubendiamide 39.35 SC @ 0.008 per cent was significantly most effective which showed lowest population of 0.16 larva per plant which remained at par with chlorantraniliprole 18.50 SC @ 0.006 per cent (0.28 larva/plant) followed by emamectin benzoate 5 SG @ 0.002 per cent with 0.46 larva per plant. The treatments, spinosad 45 SC @ 0.015 per cent (0.53 larva/plant), chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.59 larva/plant) and indoxacarb 14.5 SC @ 0.010 per cent (0.65 larva/plant) were superior and remained at par with each other. Novaluron 10 EC @ 0.005 per cent was exhibited significantly higher (0.76 larva/plant) population but was superior over the untreated control. The untreated control recorded the highest population of 1.78 larvae per plant.

Second year (2022-23)

The data on population of tur plume moth one day before and 3, 7 and 15 days after spraying during second year is presented in Table 2. The incidence was non significant indicating unifrom distribution at one day before spraying ranging between 0.99 and 1.10 larvae per plant.

First spray

Third day after first spray, the plots treated with flubendiamide 39.35 SC @ 0.008 per cent recorded lowest population (0.23 larva/plant) which was at par with chlorantraniliprole 18.50 SC @ 0.006 per cent (0.45 larva/plant). The next best treatments were emamectin benzoate 5 SG @ 0.002 per cent (0.62 larva/plant), spinosad 45 SC @ 0.015 per cent (0.65 larva/plant), chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.71 larva/plant) and indoxacarb 14.5 SC @ 0.010 per cent (0.75 larva/plant) which were at par with each other. Among the different studied insecticides novaluron 10 EC @ 0.005 per cent was least effective (0.84 larva/plant) but was superior over the untreated control (1.35 larvae/plant).

The perusal of data recorded at seven days after first spray of insecticides revealed that flubendiamide 39.35 SC @ 0.008 per cent (0.15 larva/plant) maintain superiority over other treatments in reducing tur plume moth population and it was statistically at par with chlorantraniliprole 18.5 SC @ 0.006 per cent (0.36 larva/plant). The treatments emamectin benzoate 5 SG @ 0.002 per cent, spinosad 45 SC @ 0.015 per cent, chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent, indoxacarb 14.50 SC @ 0.010 per cent and profenofos 40 + cypermethrin 4 EC @ 0.088 per cent formed next group of effective treatments and was statistically at par with each other as they recorded 0.51, 0.54, 0.60, 0.64 and 0.69 larva per plant, respectively. Among the studied insecticides, plots treated with novaluron 10 EC @ 0.005 per cent was least effective (0.73 larva/plant) but was superior over the untreated control (1.41/plant).

Fifteen days after first spray, a similar trend of effectiveness was observed in reducing the *E. atomosa* population. The lowest population (0.19 larva/plant) was recorded from the plots treated with flubendiamide 39.35 SC @ 0.008 per cent was remained at par with chlorantraniliprole 18.5 SC @ 0.006 per cent (0.41 larva/plant). The next best treatments were emamectin benzoate 5 SG @ 0.002 per cent (0.56 larva/plant), spinosad 45 SC @ 0.015 per cent (0.60 larva/plant), chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.65 larva/plant), indoxacarb 14.5 SC @ 0.010 per cent (0.69 larva/plant) and profenofos 40 + cypermethrin 4 EC @ 0.088 per cent (0.74 larva/plant) which were at par with each other. Novaluron 10 EC @ 0.005 per cent was least effective (0.78 larva/plant) but was superior over the untreated control (1.49 larvae/plant) in reducing the population of *E. atomosa*.

The pooled results of first spray presented in Table 2 showed that the plots treated with flubendiamide 39.35 SC @ 0.008 per cent was significantly most (0.19 larva/plant) effective in reducing the population of plume moth which was followed by chlorantraniliprole 18.5 SC @ 0.006 per cent (0.41 larva/plant). The next best effective treatment was emamectin benzoate 5 SG @ 0.002 per cent with 0.56 larva per plant followed by spinosad 45 SC @ 0.015 per cent (0.60 larva/plant), chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.65 larva/plant), indoxacarb 14.5 SC @ 0.010 per cent (0.69 larva/plant) and profenofos 40 + cypermethrin 4 EC @ 0.088 per cent (0.74 larva/plant). Among the studied insecticides, plots treated with novaluron 10 EC @ 0.005 per cent was least effective (0.78 larva/plant) but was superior over the untreated control. The untreated control had recorded significantly highest population of 1.43 larvae per plant.

Second spray:

The results showed that lowest population (0.10 larva/

Table 2: Efficacy of different chemical insecticides against *E. atomosa* on pigeonpea during 2022-23.

Tr. No.	Treatments	Conc. (%)	DBS	No. of larvae/plant								PPS
				1st spray				2nd spray				
				3DAS	7DAS	15DAS	POP	3 DAS	7 DAS	15 DAS	POP	
T_1	Chlorantraniliprole 18.5 SC	0.006	1.23 (1.01)	0.97^{ab} (0.45)	0.93^{ab} (0.36)	0.95^{ab} (0.41)	0.95^{b} (1.41)	0.89^{ab} (0.30)	0.82^{ab} (0.18)	0.86^{ab} (0.24)	0.86^{b} (0.24)	0.91^{b} (0.33)
T_2	Spinosad 45 SC	0.015	1.23 (1.02)	1.07^{bc} (0.65)	1.02^{bc} (0.54)	1.05^{bc} (0.60)	1.05^{cd} (0.60)	1.00^{bc} (0.51)	0.96^{bc} (0.43)	0.98^{bc} (0.47)	0.98^{cd} (0.47)	1.02^{cd} (0.54)
T_3	Flubendiamide 39.35 SC	0.008	1.21 (0.97)	0.85^{a} (0.23)	0.80^{a} (0.15)	0.83^{a} (0.19)	0.83^{a} (0.19)	0.78^{a} (0.10)	0.75^{a} (0.06)	0.76^{a} (0.08)	0.76^{a} (0.08)	0.80^{a} (0.14)
T_4	Indoxacarb 14.5 SC	0.010	1.23 (1.02)	1.12^{bc} (0.75)	1.07^{bc} (0.64)	1.09^{bc} (0.69)	1.09^{cd} (0.69)	1.05^{bc} (0.60)	1.01^{c} (0.53)	1.03^{c} (0.57)	1.03^{cde} (0.57)	1.06^{def} (0.62)
T_5	Chlorantraniliprole 9.30 + Lambda cyhalothrin 4.60 ZC	0.006	1.23 (1.00)	1.10^{bc} (0.71)	1.05^{bc} (0.60)	1.07^{bc} (0.65)	1.07^{cd} (0.65)	1.03^{bc} (0.56)	0.99^{c} (0.48)	1.01^{bc} (0.52)	1.01^{cde} (0.52)	1.04^{cde} (0.58)
T_6	Novaluron 10 EC	0.005	1.24 (1.04)	1.16^{c} (0.84)	1.11^{c} (0.73)	1.13^{c} (0.78)	1.13^{d} (0.78)	1.09^{c} (0.69)	1.06^{c} (0.63)	1.08^{c} (0.66)	1.08^{e} (0.66)	1.11^{f} (0.73)
T_7	Profenofos 40 + Cypermethrin 4 EC	0.088	1.25 (1.06)	1.14^{c} (0.79)	1.09^{bc} (0.69)	1.11^{bc} (0.74)	1.11^{cd} (0.74)	1.07^{c} (0.65)	1.04^{c} (0.59)	1.06^{c} (0.62)	1.06^{de} (0.62)	1.09^{ef} (0.69)
T_8	Emamectin benzoate 5 SG	0.002	1.22 (0.99)	1.06^{bc} (0.62)	1.00^{bc} (0.51)	1.03^{bc} (0.56)	1.03^{bc} (0.56)	0.97^{bc} (0.45)	0.93^{bc} (0.37)	0.95^{bc} (0.41)	0.95^{c} (0.41)	0.99^{c} (0.48)
T_9	Untreated control	-	1.26 (1.10)	1.36^{d} (1.35)	1.38^{d} (1.41)	1.41^{d} (1.49)	1.39^{e} (1.43)	1.46^{d} (1.64)	1.48^{d} (1.70)	1.51^{d} (1.79)	1.49^{f} (1.72)	1.44^{g} (1.57)
	S. Em. ±	T	0.06	0.05	0.05	0.05	0.03	0.05	0.05	0.05	0.03	0.02
		P	-	-	-	-	0.02	-	-	-	0.02	0.01
		S	-	-	-	-	-	-	-	-	-	0.01
		T×P	-	-	-	-	0.05	-	-	-	0.05	0.04
		T×S	-	-	-	-	-	-	-	-	-	0.03
		P×S	-	-	-	-	-	-	-	-	-	0.02
		T×P×S	-	-	-	-	-	-	-	-	-	0.05
	C. D. at 5%	T	N.S.	0.16	0.15	0.16	0.07	0.16	0.14	0.15	0.07	0.06
	C. V. (%)		8.10	8.42	8.15	8.41	8.33	8.68	8.07	8.37	8.39	8.06

DBS: Day before spray; POP: Pooled over period; PPS: Pooled over period over spray
Figures in parentheses are retransformed values of $\sqrt{X+0.5}$ transformed values
Treatment means with the letter(s) in common are not significantly different by DNMRT at 5% level of significance

plant) was recorded from the plots treated with flubendiamide 39.35 SC @ 0.008 per cent which remained at par with chlorantraniliprole 18.5 SC @ 0.006 per cent (0.30 larva/plant) at three days after first spray. The next effective group of treatments were emamectin benzoate 5 SG @ 0.002 per cent (0.45 larva/plant), spinosad 45 SC @ 0.015 per cent (0.51 larva/plant), chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.56 larva/plant) and indoxacarb 14.5 SC @ 0.010 per cent (0.60 larva/plant) which were superior over untreated control and at par with each other. Novaluron 10 EC @ 0.005 per cent recorded maximum (0.69 larva/plant) population.

The data on population of *E. atomosa* recorded at seven days after second spray of insecticides revealed that the untreated control had the highest population of 1.70 larvae per plant while flubendiamide 39.35 SC @ 0.008 per cent was the significantly most effective treatment which showed lowest (0.06 larva/plant) population which remained at par with chlorantraniliprole 18.5 SC @ 0.006 per cent (0.18 larva/plant). The treatments, emamectin benzoate 5 SG @ 0.002 per cent and spinosad 45 SC @ 0.015 per cent found statistically at par with each other as they recorded 0.37 and 0.43 larva per plant. However, remaining insecticidal treatments were significantly superior over untreated control.

Fifteen days after second spray, the lowest population (0.08 larva/plant) was recorded from the plots treated with flubendiamide 39.35 SC @ 0.008 per cent which remained at par with chlorantraniliprole 18.5 SC @ 0.006 per cent (0.24 larva/plant). The next best effective group

Table 3: Efficacy of different chemical insecticides against *E. atomosa* on pigeonpea (Pooled).

Tr. No.	Treatments	Conc. (%)	Day before spray	No. of larvae/plant		
				Year		Pooled over year
				2021-22	2022-23	
T_1	Chlorantraniliprole 18.5 SC	0.006	1.26(1.09)	0.95^{b}(0.40)	0.91^{b}(0.33)	0.93^{b}(0.36)
T_2	Spinosad 45 SC	0.015	1.27(1.11)	1.06^{cd}(0.62)	1.02^{cd}(0.54)	1.04^{d}(0.58)
T_3	Flubendiamide 39.35 SC	0.008	1.25(1.06)	0.85^{a}(0.22)	0.80^{a}(0.14)	0.82^{a}(0.17)
T_4	Indoxacarb 14.5 SC	0.010	1.27(1.11)	1.11^{def}(0.73)	1.06^{def}(0.62)	1.08^{e}(0.67)
T_5	Chlorantraniliprole 9.30 + Lambda cyhalothrin 4.60 ZC	0.006	1.27(1.11)	1.08^{cde}(0.67)	1.04^{cde}(0.58)	1.06^{de}(0.62)
T_6	Novaluron 10 EC	0.005	1.28(1.14)	1.15^{f}(0.82)	1.11^{f}(0.73)	1.13^{f}(0.78)
T_7	Profenofos 40 + Cypermethrin 4 EC	0.088	1.29(1.16)	1.13^{ef}(0.78)	1.09^{ef}(0.69)	1.11^{f}(0.73)
T_8	Emamectin benzoate 5 SG	0.002	1.26(1.09)	1.03^{c}(0.56)	0.99^{c}(0.48)	1.01^{c}(0.52)
T_9	Untreated control	-	1.30(1.19)	1.47^{g}(1.66)	1.44^{g}(1.57)	1.45^{g}(1.60)
	S. Em. ±	T	0.04	0.02	0.02	0.01
		P	-	0.01	0.01	0.01
		S	-	0.01	0.01	0.01
		Y	0.02	-	-	0.01
		T×P	-	0.04	0.04	0.03
		T×S	-	0.03	0.03	0.02
		P×S	-	0.02	0.02	0.01
		Y×T	0.06	-	-	0.02
		Y×P	-	-	-	0.01
		Y×S	-	-	-	0.01
		T×P×S	-	0.05	0.05	0.04
		Y×S×T	-	-	-	0.03
		Y×S×P	-	-	-	0.02
		Y×P×T	-	-	-	0.04
		Y×S×P×T	-	-	-	0.05
	C. D. at 5%	T	NS	0.06	0.06	0.04
		Y×T	-	-	-	NS
	C. V. (%)		8.05	8.06	8.06	8.07

Figures in parentheses are retransformed values of $\sqrt{X+0.5}$ transformed values
Treatment means with the letter(s) in common are not significantly different by DNMRT at 5% level of significance

of treatments were emamectin benzoate 5 SG @ 0.002 per cent (0.41 larva/plant), spinosad 45 SC @ 0.015 per cent (0.47 larva/plant) and chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.52 larva/plant) which were at par with each other. Among the studied insecticides, the plots treated with novaluron 10 EC @ 0.005 per cent was least effective (0.66 larva/plant) but was better than untreated control (1.79 larvae/plant).

The mean results of pooled over period data after second spray presented in Table 2 recorded that flubendiamide 39.35 SC @ 0.008 per cent was significantly most effective (0.08 larva/plant) which was followed by chlorantraniliprole 18.5 SC @ 0.006 per cent (0.24 larva/plant) and emamectin benzoate 5 SG @ 0.002 per cent with 0.41 larva per plant. The next best effective treatments were spinosad 45 SC @ 0.015 per cent (0.47 larva/plant), chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.52 larva/plant) and indoxacarb 14.5 SC @ 0.010 per cent (0.57 larva/plant) which were at par with each other. Among the evaluated insecticides, novaluron 10 EC @ 0.005 per cent was least effective (0.66 larva/plant) but was superior over the untreated control. The maximum population (1.72 larvae/plant) was recorded in untreated control.

Pooled over year (2021-22 and 2022-23)

The pooled results (2021-22 and 2022-23) reported in Table 3 showed that the efficacy of various chemical insecticides against *E. atomosa* populations. The data showed that the *E. atomosa* population on the day before spray was homogeneously distributed throughout all the plots, ranging between 1.09 and 1.19 larvae per plant, which was not statistically significant.

During 2021-22, the results are presented in Table 3

and graphically depicted in Fig. 1, showed that the plots treated with flubendiamide 39.35 SC @ 0.008 per cent was significantly most effective which showed lowest population of 0.22 larva per plant which was followed by chlorantraniliprole 18.5 SC @ 0.006 per cent (0.40 larva/ plant) and emamectin benzoate 5 SG @ 0.002 per cent with 0.56 larva per plant. The next effective second group of treatments were spinosad 45 SC @ 0.015 per cent (0.62 larva/plant) and chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.67 larva/plant) which were at par with each other. However, the remaining insecticidal treatments were significantly superior than the untreated control. Among the investigated insecticides, plots treated with novaluron 10 EC @ 0.005 per cent was found least effective with 0.82 larva per plant performed better than untreated control. The untreated control recorded maximum population (1.66 larvae/plant).

Perusal of the results of pooled over spray during 2022-23 are presented in Table 3 and illustrated in Fig. 1 indicated that flubendiamide 39.35 SC @ 0.008 per cent was significantly superior exhibiting lowest (0.14 larva/ plant) population and it was followed by chlorantraniliprole 18.5 SC @ 0.006 per cent (0.33 larva/plant) and emamectin benzoate 5 SG @ 0.002 per cent with 0.48 larva per plant. Spinosad 45 SC @ 0.015 per cent (0.54 larva/plant) and chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.58 larva/plant) were performing next group of effective treatments and were at par with each other. Among the evaluated insecticides, novaluron 10 EC @ 0.005 per cent was least effective (0.73 larva/plant) but was superior over the untreated control. Moreover, significantly highest *E. atomosa* population observed in untreated control (1.57 larvae/plant).

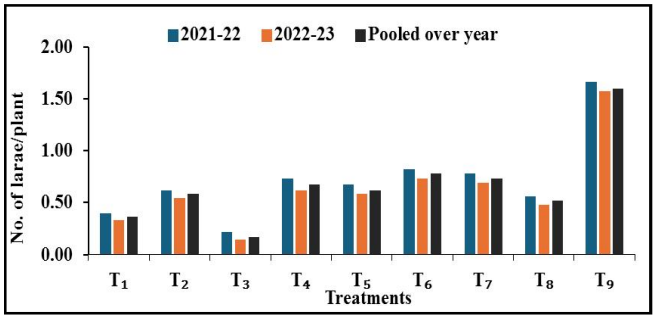


Fig. 1: Efficacy of different chemical insecticides against *E. atomosa* on pigeonpea. [**Note:** T_1=Chlorantraniliprole 18.50% SC, T_2=Spinosad 45% SC, T_3=Flubendiamide 39.35% SC, T_4=Indoxacarb 14.50% SC, T_5=Chlorantraniliprole 9.30% + Lambda cyhalothrin 4.60% ZC, T_6=Novaluron 10% EC, T_7= Profenofos 40% + Cypermethrin 4% EC, T_8=Emamectin benzoate 5% SG, T_9= Untreated control]

The results of pooled over year (2021-22 and 2022-23) data are presented in Table 3 and graphically depicted in Fig. 1, revealed that the plots treated with flubendiamide 39.35 SC @ 0.008 per cent recorded lowest population of 0.17 larva per plant and was significantly most effective treatment in reducing larval population of tur plume moth. It was followed by chlorantraniliprole 18.50 SC @ 0.006 per cent (0.36 larva/plant), emamectin benzoate 5 SG @ 0.002 per cent (0.52 larva/plant), spinosad 45 SC @ 0.015 per cent (0.58 larva/plant) and chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.62 larva/ plant). The next effective treatment was indoxacarb 14.5 SC @ 0.010 per cent showed 0.67 larva per plant. However, remaining insecticidal treatments were significantly superior over untreated control. Among the studied insecticides, plots treated with novaluron 10 EC @ 0.005 per cent was found least effective (0.78 larva/ plant) but was superior over the untreated control. Untreated control plots recorded the highest (1.60 larvae/ plant) population of *E. atomosa*.

Earlier, Priyadarshini *et al.*, (2013) evaluated six insecticides against the major lepidopteran pod-borer complex of pigeonpea, including *E. atomosa*. Flubendiamide 480 SC @ 60 g a.i./ha provided the greatest reduction in pod-borer damage, recording 5.3 per cent pod damage, 3.3 per cent grain damage and 2.9 per cent grain-weight loss. Sonune and Bhamare (2018) at Parbhani, Maharashtra found that emamectin benzoate 0.002 per cent was the most effective treatment in minimizing the larval population of *E. atomosa* (1.60 and 1.93 larvae/ plant) followed by flubendiamide 0.008 per cent (1.67 and 2.07 larvae/ plant) and chlorantraniliprole 0.006 per cent (1.73 and 2.07 larvae/ plant) at 14 days after second and third spray, respectively. Dadas *et al.*, (2019) at Parbhani, Maharashtra revealed that chlorantraniliprole 18.5 SC was the most promising treatment to minimize the larval population of tur plume moth, *E. atomosa* to the extent of mean populations of 0.37 larva/plant followed by flubendiamide 39.37% SC (0.47 larva/plant) and indoxacarb 14.5% SC (0.57 larva/ plant) after first and second spray. More *et al.*, (2021) found that chlorantraniliprole 18.5 SC to be the most promising treatment for reducing *E. atomosa* larval incidence followed by flubendiamide 39.35 SC and indoxacarb 14.5 SC. Thus, the results of present study are in close confromity with that reported by earlier workers.

Conclusion

The present study revealed that the treatment of flubendiamide 39.35 SC @ 0.008 per cent recorded significantly lowest (0.17 larva/plant) population. It was

followed by chlorantraniliprole 18.50 SC @ 0.006 per cent (0.36 larva/plant), emamectin benzoate 5 SG @ 0.002 percent (0.52 larva/plant), spinosad 45 SC @ 0.015 per cent (0.58 larva/plant) and chlorantraniliprole 9.30 + lambda cyhalothrin 4.6 ZC @ 0.006 per cent (0.62 larva/plant). Among the studied insecticides, plots treated with novaluron 10 EC @ 0.005 per cent was found the least effective (0.78 larva/plant).

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