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Bio efficacy of new molecules of insecticides against pod borer complex of pigeonpea, *Cajanus cajan*

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Abstract

The present investigation entitled “Bioefficacy of new molecules of insecticides against pod borer complex of pigeonpea, *Cajanus cajan*” were undertaken at the experimental farm of Department of Entomology, College of Agriculture, Vasant Rao Naik Marathwada Krishi Vidyapeeth, Parbhani. Three applications of new molecules of insecticides spray were applied against pod borer of pigeonpea. First spray given at 50 per-cent flowering, second spray at pod development and third at pod maturity stage. In field evaluation of new molecules of insecticides viz., spinetoram 11.7% SC, thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC, novaluron 5.25% + emamectin benzoate 0.9% SC, lambda cyhalothrin 4.6% + choranthraniliprole 9.3% ZC, emamectin benzoate 1.5% + fipronil 3.5% SC and flubendiamide 19.92% + thiacloprid 19.92% SC were evaluated for their bioefficacy against larval population, pod damage and grain damage due to pod borer complex of pigeonpea. After three spray of new molecules of insecticides lambda cyhalothrin 4.6% + choranthraniliprole 9.3% ZC was effectively reduce population of *H.armigera* (0.68 larvae/plant), *M.vitrata* (0.97 larvae/plant), *E.atomosa* (0.82 larvae/plant) and *M.obtusa* (21.84 maggot and pupa/plant). In case of pod damage and grain damage lambda cyhalothrin 4.6% + choranthraniliprole 9.3% ZC showcased the lowest pod damage (7.50 per cent) and grain damage (10.53 per cent) and grain yield lambda cyhalothrin 4.6% + choranthraniliprole 9.3% ZC produced the highest grain yield (1790 kg/ha) significantly surpassing other treatments.

Keywords: Pigeonpea, pod borer complex, new molecules, bioefficacy, *H.armigera*

Introduction

Pigeonpea (*Cajanus cajan* (L.) Millsp.), commonly referred to as tur, arhar, or red gram, is a crucial leguminous crop in India, widely recognized for its rich protein content (ranging from 16.2% to 35%) and well-balanced amino acid profile. It serves as a dietary staple, predominantly consumed in the form of split pulses (dal) and immature green pods, while its by-products are utilized as livestock fodder and domestic fuel. Beyond its nutritional significance, pigeonpea contributes to sustainable agriculture by enhancing soil fertility through biological nitrogen fixation and promoting nutrient recycling.

Its inherent tolerance to drought and low soil fertility makes pigeonpea particularly well-suited for dryland farming and intercropping systems, enhancing its viability in resource-limited regions. India stands as the largest global producer, accounting for approximately 85% of the total pigeonpea production. According to the fourth advance estimates (2022) by the Directorate of Economics and Statistics (DES), Ministry of Agriculture & Farmers Welfare (MoAF&W), pigeonpea was cultivated across 5.05 million hectares in India, producing 4.34 million tonnes with an average productivity of 859 kg/ha. In the 2023-24 season, as per the third advance estimates, Maharashtra alone contributed 11.11 lakh hectares of the cultivated area, producing 9.82 lakh tonnes with a productivity of 884 kg/ha.

Despite the expansion in cultivation, pigeonpea yields have remained relatively stagnant, primarily due to severe infestations by insect pests, especially during the reproductive phase. Major insect pests affecting the crop include *Helicoverpa armigera* (pod borer), *Melanagromyza obtusa* (pod fly), *Maruca vitrata*, *Exelastis atomosa*, and *Lampides boeticus*, along with pod-sucking bugs such as *Riptortus pedestris*, *Nezara viridula*, and *Clavigralla gibbosa*. In total, over 300 insect species across eight orders and 61 families have been documented as pests of pigeonpea (Keval *et al.*, 2010) [8].

Under favorable conditions for pest development, yield losses may range between 60% and 90% (Lal *et al.*, 1992) [10], with pod fly damage alone accounting for losses between 14.3% and 46.6% (Wadasker *et al.*, 2013). The combined effect of *H. armigera* and *M. obtusa* has been reported to cause up to 60% of the total yield losses. Pod damage across early, mid, and late-maturing varieties can range from 20.95% to 57% (Shrivastava *et al.*, 1993) [20], while *M. vitrata* infestations can result in 50%-68% yield reductions. Consequently, despite the crop's genetic potential to yield 1800-2000 kg/ha, actual field productivity often drops to 500-800 kg/ha due to pest-related constraints, with the borer complex remaining a major production bottleneck.

Prior to 1975, insecticide use among pigeonpea growers was limited to about 20%, but adoption increased significantly after 1993. However, indiscriminate pesticide use contributed to the development of resistance in key pests such as *H. armigera* (Armes *et al.*, 1992) [21]. Although chemical control remains the most widely used pest management strategy due to its rapid efficacy, newer insecticides such as thiodicarb and spinosad are gaining preference due to their effectiveness against larval stages and comparatively lower environmental toxicity (Rao *et al.*, 2007) [15]. Nevertheless, excessive reliance on chemical inputs has led to resistance build-up, resurgence of secondary pests, and adverse environmental impacts. Consequently, the use of insecticide combinations with varied modes of action is being explored to broaden pest control efficacy and delay resistance onset.

Despite these advances, comprehensive data evaluating the effectiveness of these chemical strategies across the entire pest complex in pigeonpea remains insufficient. This highlights the urgent need for continued research and development of integrated pest management (IPM) frameworks. These should ideally combine chemical, biological, and environmentally sustainable approaches to mitigate yield losses, enhance productivity, and promote long-term agroecosystem resilience. Farmers commonly depend on conventional insecticides for the management of the pod borer complex in pigeonpea, primarily due to their widespread availability and quick knockdown effect. Nevertheless, the prolonged and indiscriminate use of these chemical agents has raised significant concerns regarding the development of insecticide resistance among target pests and potential ecological hazards. In response to these issues, the current investigation was initiated to assess newer insecticidal formulations with the objective of identifying more effective and environmentally sustainable alternatives for controlling pod borers in pigeonpea.

Materials and Methods

The field experiment was conducted at experimental farm, Department of Entomology, College of Agriculture, V.N.M.K.V. Parbhani (M.S) during *kharif* 2024-25. The site was located 19°16' North latitude and 76°47' East longitude and at an elevation of 408.50 meters above mean sea level and has a semi- arid climate. The short-duration pigeonpea variety BDN 2013-41 (Godavari) was used for the study. The randomized block designs with consist of seven treatments and replicated thrice to get unbiased data. Net plot size and gross plot size of plot was 7.20 m x 4.00 m and 25.60 m x 34.00 m respectively. Pigeonpea crop variety BDN 2013-41 was sown with dibbled method at 90 cm row

to row and 30 cm plant to plant distance during *kharif* 2024-25. After sowing, intercultural operations as well as fertilizer applications were done as per recommendations. Due care was taken to maintain proper growth of the crop. Three applications of insecticides spray were applied against pod borer complex of pigeon pea. First spray given at 50 per cent flowering, second spray at pod development and third at pod maturity stage of the crop with the help of knapsack sprayer. Treatment consist T₁ Spinetoram 11.7% SC @ 1ml/L, T₂ Thiamethoxam 12.6% + Lambda cyhalothrin 9.5% ZC @ 0.40ml/L, T₃ Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 1.70ml/L, T₄ Lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC 0.40ml/L, T₅ Emamectin benzoate 1.5% + Fipronil 3.5% SC @ 1ml/L, T₆ Flubendiamide 19.92% + Thiacloprid 19.92% SC @ 0.40ml/L and T₇ untreated control.

Method of recording observations

The effectiveness of different insecticide applications was evaluated based on several key parameters. Larval populations of gram pod borer, tur plum moth, and webbing caused by spotted pod borer were counted and recorded from five randomly tagged plants in each treatment. Pre-treatment observations of larval populations were taken 24 hours before applying the insecticides. Following the treatments, subsequent observations were made on the 3rd, 7th, and 14th days after spraying from each tagged plant to assess the impact of the insecticide applications over time. One hundred green pods were randomly collected from each treatment and examined in the laboratory to assess the damage caused by pigeonpea pod fly maggots on the 3rd, 7th, and 14th days after the second and third insecticide applications. At harvest, 200 pods were randomly selected from each treatment. The healthy and damaged pods were counted to calculate the percentage of pod damage and grain damage caused by the gram pod borer and pod fly. The percentage of pod damage was calculated using the following formula:

$$\text{Pod Damage (\%)} = \frac{\text{Number of damaged pods}}{\text{Total number of pods}} \times 100$$

Results

Effect of different new molecule of insecticides against *H.armigera* on pigeonpea based on pooled mean of three sprays

The mean of pooled analysis of larval populations recorded at 3, 7, and 14 days after each of the three insecticidal sprays revealed consistent and marked differences among the treatments, highlighting the effectiveness of the evaluated insecticidal combinations in reducing *Helicoverpa armigera* infestation in pigeonpea (Table 1). Among the treatments, lambda-cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC was the most effective, recording the lowest overall mean larval population of 0.68 larvae per plant and which was found at par with thiamethoxam 12.6% + lambda-cyhalothrin 9.5% ZC and spinetoram 11.7% SC, with pooled mean larval populations of 0.93 and 1.10 larvae per plant, respectively. Other treatments, including flubendiamide 19.92% + thiacloprid 19.92% SC, novaluron 5.25% + emamectin benzoate 0.9% SC, and emamectin benzoate 1.5% + fipronil 3.5% SC, showed moderate efficacy, with pooled mean larval populations ranging from 1.51 to 1.72 larvae per plant. In contrast, the untreated control consistently

exhibited the highest larval incidence, with an average of 3.73 larvae per plant.

A time-wise assessment further confirmed the superior efficacy of lambda-cyhalothrin + chlorantraniliprole, which recorded 1.27 larvae per plant at 3 days after spraying, decreasing to 0.57 at 7 days and further to 0.22 larvae per plant at 14 days. A similar downward trend was observed in other effective treatments, while the untreated plots showed a progressive increase, peaking at 3.24, 3.71 and 4.34 larvae per plant at 3, 7, 14 days. These results clearly demonstrate the potential of new-generation insecticidal combinations in effectively suppressing *H. armigera* populations under field conditions.

The results obtained in the present investigation are in accordance with earlier works viz., Patel *et al.* (2015) [12] reported chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC @ 37.5 g a.i./ha and chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC @ 30 g a.i./ha and proved effective group of treatments against *H. armigera*. Ameta and Swami (2017) [1] reported chlorantraniliprole 9.6% + lambda cyhalothrin 4.6% at 300ml/ha caused highest reduction in pod borer larvae during both the years with a mean reduction of 91.86 and 89.14 per cent during kharif 2011 and 2012, respectively. Whereas, Roy *et al.* (2017) [19] reported, emamectin benzoate + fipronil (60.66%) and flubendiamide + thiacloprid (60.35%) considering superior in the mean percent reduction of pod damage caused by pod borer and Kumar and Muthukrishnan (2018) [7] investigated pigeonpea pod borer complex comprising of *Helicoverpa armigera* (Hubner), *Maruca vitrata* (Geyer), *Lampides boeticus* (Linnaeus), *Exelastis atomosa* (Walshingham) and *Melanagromyza obtusa* (Malloch) in Tamil Nadu cause considerable yield loss. The results revealed that spinetoram 12 SC 45 g alone was significantly superior, when sprayed thrice at 15 days interval with increase in grain yield, and without any phytotoxic symptoms.

Effect of different new molecule of insecticides against *M. vitrata* on pigeonpea based on pooled mean of three sprays:

The consolidated data on *Maruca vitrata* larval populations, recorded at 3, 7, and 14 days following each of the three insecticide applications, demonstrated clear and consistent differences in treatment efficacy, thereby highlighting the potential of the evaluated insecticidal formulations to effectively manage larval infestations under field conditions (Table 2). Initial observations prior to the first spray showed a uniform distribution of larvae across all plots, indicating no significant pre-treatment variability.

Among the various treatments lambda-cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC was found significantly superior over the other treatments, achieving the lowest pooled mean larval population of 0.97 larvae per plant. In moderate group of the treatments thiamethoxam 12.6% + lambda-cyhalothrin 9.5% ZC followed by flubendiamide 19.92% + thiacloprid 19.92% SC and spinetoram 11.7% SC, which recorded mean larval counts of 1.28, 1.32, and 1.68 larvae per plant, respectively, and showed comparable levels of efficacy. Meanwhile, novaluron 5.25% + emamectin benzoate 0.9% SC and emamectin benzoate 1.5% + fipronil 3.5% SC were moderately effective, reducing larval populations to 1.85 and 1.94 larvae per plant, respectively. The untreated control consistently had the highest larval density, averaging 3.71 larvae per plant.

Further temporal analysis revealed a consistent decline in larval populations over time in treated plots. Lambda-cyhalothrin + chlorantraniliprole showed the most significant reduction, with larval populations decreasing from 1.79 at 3 days, to 0.86 at 7 days, and reaching 0.23 at 14 days after spraying. Comparable downward trends were observed in plots treated with thiamethoxam + lambda-cyhalothrin and flubendiamide + thiacloprid, which recorded final larval counts of 0.59 and 0.60, respectively, by the 14th day. Although spinetoram, novaluron + emamectin benzoate, and emamectin + fipronil were slightly less effective, they still resulted in substantial reductions compared to the untreated control, which peaked at 3.95 larvae per plant at 14 days. These results affirm the efficacy of newer insecticidal combinations in effectively controlling *M. vitrata* infestations in pigeonpea.

The present findings were similar with the results of Reddy and Paul (2019) [16] lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC @ 30 g a.i ha-1, thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 27.5 g a.i ha-1 and chlorantraniliprole 8.8% + thiamethoxam 17.5% SC @ 150 g a.i ha-1 were found superior in the management of *M. vitrata* and *S. litura* over other treatments in cowpea.

Effect of different new molecule of insecticides against *E. atomosa* on pigeonpea based on pooled mean of three sprays:

The combined analysis of *E. atomosa* larval counts recorded at 3, 7, and 14 days following each of the three insecticidal applications showed significant variation between treatments, highlighting the efficacy of the insecticidal mixtures tested in suppressing larval populations (Table 3). Among the tested options, lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC proved to be the most effective, exhibiting the lowest average larval count of 0.82 larvae per plant. This was followed closely by flubendiamide 19.92% + thiacloprid 19.92% SC and thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC, with pooled means of 1.20 and 1.21 larvae per plant, respectively.

Other insecticidal treatments, including novaluron 5.25% + emamectin benzoate 0.9% SC, spinetoram 11.7% SC, and emamectin benzoate 1.5% + fipronil 3.5% SC, demonstrated moderate control, with larval populations ranging from 1.49 to 1.62 larvae per plant. Conversely, the untreated control plots consistently recorded the highest larval densities, averaging 3.23 larvae per plant.

When assessing the larval populations over time, lambda cyhalothrin + chlorantraniliprole showed the greatest reduction, with larval counts decreasing from 1.38 at 3 days post-spray to 0.86 at 7 days, and reaching 0.15 larvae per plant by day 14. Other effective treatments followed a similar downward pattern, while larval numbers in untreated plots increased, peaking at 3.62 larvae per plant on day 14. These results demonstrate the promising potential of these insecticide combinations for managing *E. atomosa* larvae in field conditions.

Present findings is closely accordance with Subbireddy *et al.* (2018) [21] conducted field experiment to evaluate the effectiveness of seven ready-mix insecticides against fruit borer i.e *Earias vittella* and *Helicoverpa armigera* in okra. Among seven different ready-mix insecticides, chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC (0.007%) found most effective against fruit borers by recording less larval population and fruit damage both

number and weight basis. Rohokale *et al.* (2018) [18] in field experiment on efficacy of newer insecticides combinations against shoot and fruit borer of brinjal in *kharif* season 2017- 18. Reported that the lowest shoot infestation by *L. orbonalis*, were observed in chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC (1.38%), was statistically at par with flubendiamide 19.92% + thiacloprid 19.92% (1.42%), and chlorantraniliprole 8.8% + thiamethoxam 17.5% SC (10.47%) was the most superior treatment shows lowest fruit damage was statistically at par with flubendiamide 19.92% + thiacloprid 19.92% (10.78%).

Effect of different new molecule of insecticides against *M. obtusa* on pigeonpea based on pooled mean of three sprays:

The combined analysis of *Melanagromyza obtusa* maggot and pupal populations recorded at 3, 7, and 14 days of two insecticide applications revealed significant differences among the treatments, highlighting the effectiveness of the tested insecticidal combinations in managing pod fly infestations (Table 4). Lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC emerged as the most efficient treatment, significantly showing the lowest overall average infestation of 21.84 maggots and pupae per 100 pods which was found at par with flubendiamide 19.92% + thiacloprid 19.92% SC and thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC, with pooled mean infestations of 26.76 and 31.20 per 100 pods, respectively.

Other insecticidal treatments such as spinetoram 11.7% SC, novaluron 5.25% + emamectin benzoate 0.9% SC, and emamectin benzoate 1.5% + fipronil 3.5% SC provided moderate control, with infestation levels ranging between 34.79 and 45.11 maggots and pupae per 100 pods. Conversely, the untreated control plots recorded the highest infestation, averaging 97.37 maggots and pupae per 100 pods.

A temporal evaluation demonstrated the superior performance of lambda cyhalothrin + chlorantraniliprole, with infestation levels reducing from 33.71 maggots and pupae per 100 pods at 3 days after spraying to 19.24 at 7 days, and further dropping to 12.58 at 14 days. Other effective treatments followed a similar declining pattern over the observation period, while the untreated control showed a rising trend, peaking at 117.23 maggots and pupae per 100 pods at 14 days. These findings emphasize the strong and consistent potential of these insecticide combinations in controlling *M. obtusa* populations in field conditions.

The results obtained in the present investigation are in accordance with earlier works *viz.*, Bantewad *et al.* (2018) [3] reported that spray of chlorantraniliprole 18.5 SC @ 0.2 ml/l of water at 50% flowering stage provided better control of *Melanagromyza obtusa* on pigeonpea in terms of lower pod and grain damage and getting higher grain yield. Similarly, Kamoriya *et al.* (2017) reported that, chlorantraniliprole @ 30 g a.i./ha was the most effective insecticide against *Melanagromyza obtusa* on pigeonpea in terms of lower pod and grain damage and getting higher grain yield.

Efficacy new molecules of insecticides against percent pod and grain damage cause by *H. armigera* and *M. obtusa* after third spray: Statistically significant differences were observed in pod and grain damage among the various insecticidal treatments (Table 5). The

combination of lambda-cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC emerged as the most effective, resulting in the lowest pod damage caused by *Helicoverpa armigera* (7.50%) and *Melanagromyza obtusa* (5.46%) as well as minimal grain damage (11.52% and 10.53%, respectively). Comparable efficacy was noted with thiamethoxam 12.6% + lambda-cyhalothrin 9.5% ZC as pod damage 8.42% and 7.28% grain damage 15.20% and 13.98% and flubendiamide 19.92% + thiacloprid 19.92% SC as pod damage 8.55% and 7.25% grain damage 17.66% and 11.74%. All insecticidal treatments significantly outperformed the untreated control, which recorded the highest levels of pod and grain damage. These findings highlight the efficacy of novel insecticidal combinations in effectively managing pod borer infestations in pigeonpea under field conditions.

These findings align well with earlier research. Bantewad *et al.* (2018) [3] observed that spraying chlorantraniliprole 18.5 SC at 0.2 ml/l of water during the 50% flowering stage in pigeonpea effectively controlled *Melanagromyza obtusa*, resulting in reduced pod and grain damage and enhanced grain yield. Similarly, Kamoriya *et al.* (2017) reported chlorantraniliprole at 30 g a.i./ha as the most effective insecticide against *M. obtusa* on pigeonpea, also emphasizing its superior performance in minimizing damage and improving yield. The combination of lambda-cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC, which recorded the lowest pod and grain damage in the current study, has been consistently reported as the most effective by researchers such as Patil *et al.* (2018) [13] and Kumar *et al.* (2020) [9]. Similarly, thiamethoxam + lambda-cyhalothrin and flubendiamide + thiacloprid also showed promising results, supported by studies like Reddy *et al.* (2017) [17] and Rani *et al.* (2019) [14], confirming their efficacy against lepidopteran pod borers.

Effect of new molecules of insecticides on grain yield of pigeonpea:

The impact of insecticidal treatments on pigeonpea grain yield is summarized in Table 5. All treatments elicited a significant increase in yield relative to the untreated control, which recorded the lowest output of 1019 kg/ha. The combination of lambda-cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC achieved the 1790 kg/ha which was found significantly more yield and at par with flubendiamide 19.92% + thiacloprid 19.92% SC (1670 kg/ha) and thiamethoxam 12.6% + lambda-cyhalothrin 9.5% ZC (1635 kg/ha), both exhibiting statistically comparable performance. Moderate yield improvements were also observed with novaluron + emamectin benzoate, spinetoram, and emamectin benzoate + fipronil treatments. These results underscore the pivotal role of effective insecticidal management in optimizing pigeonpea productivity under field conditions.

The present investigation aligns well with several earlier studies that emphasized the effectiveness of newer insecticidal combinations in enhancing pigeonpea yield through efficient pest management. Patil *et al.* (2018) [13] reported that the combination of lambda cyhalothrin + chlorantraniliprole significantly reduced pod borer infestation and resulted in the highest grain yield among all treatments tested, which closely supports the current finding of maximum yield (1790 kg/ha) under this treatment.

Conclusion

In the present investigation, it may be concluded that among the different combination of insecticides, lambda-cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC were found most effective followed by thiamethoxam 12.6% + lambda-cyhalothrin 9.5% ZC, flubendiamide 19.92% + thiacloprid 19.92% SC and spinetoram 11.7% SC recorded the lowest

larval population, pod and grain damage due to pod borer and higher grain yield of pigeonpea.

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Table 1: Effect of different new molecule of insecticides against *H.armigera* on pigeonpea based on pooled mean of three sprays

Mean no. of <i>H.armigera</i> larvae						
Treatments	Dose ml/lit	1DBS	3DAS	7DAS	14DAS	MEAN
Spinetoram 11.7% SC	1.0	2.97 (1.86)	1.96 (1.54)	0.93 (1.19)	0.67 (1.08)	1.10 (1.26)
Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC	0.4	2.97 (1.86)	1.33 (1.35)	0.96 (1.20)	0.49 (0.99)	0.93 (1.19)
Novaluron 5.25% + Emamectin benzoate 0.9% SC	1.7	3.03 (1.88)	2.12 (1.61)	1.35 (1.36)	1.07 (1.25)	1.51 (1.42)
Lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC	0.4	3.09 (1.89)	1.27 (1.32)	0.57 (1.03)	0.22 (0.85)	0.68 (1.08)
Emamectin benzoate 1.5% + Fipronil 3.5% SC	1.0	3.13 (1.90)	2.08 (1.61)	1.62 (1.45)	1.46 (1.40)	1.72 (1.49)
Flubendiamide 19.92% + thiacloprid 19.92% SC	0.4	2.98 (1.87)	2.22 (1.65)	1.39 (1.37)	0.92 (1.19)	1.51 (1.41)
Control	-	2.99 (1.87)	3.24 (1.93)	3.71 (2.05)	4.34 (2.20)	3.73 (2.06)
SE±		0.026	0.069	0.039	0.029	0.025
C.D.at 5%		0.082	0.213	0.122	0.089	0.077
C.V. (%)		7.12	7.65	7.28	7.03	7.38

*Figures in parentheses are square root transformed values ($\sqrt{x + 0.5}$); N/S: Non-significant

Table 2: Effect of different new molecule of insecticides against *M.vitrata* on pigeonpea based on pooled mean of three sprays

Mean no. of <i>M.vitrata</i> larvae						
Treatments	Dose ml/lit	1DBS	3DAS	7DAS	14DAS	MEAN
Spinetoram 11.7% SC	1	3.24 (1.93)	2.44 (1.71)	1.60 (1.44)	1.03 (1.24)	1.68 (1.47)
Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC	0.4	3.21 (1.92)	2.04 (1.59)	1.20 (1.30)	0.59 (1.04)	1.28 (1.33)
Novaluron 5.25% + Emamectin benzoate 0.9% SC	1.7	3.08 (1.89)	2.56 (1.75)	1.66 (1.47)	1.35 (1.35)	1.85 (1.53)
Lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC	0.4	3.17 (1.91)	1.79 (1.51)	0.86 (1.16)	0.23 (0.86)	0.97 (1.21)
Emamectin benzoate 1.5% + Fipronil 3.5% SC	1	3.17 (1.91)	2.61 (1.76)	1.78 (1.51)	1.43 (1.39)	1.94 (1.56)
Flubendiamide 19.92% + thiacloprid 19.92% SC	0.4	3.18 (1.91)	2.11 (1.61)	1.26 (1.33)	0.60 (1.05)	1.32 (1.35)
Control	-	3.41 (1.97)	3.05 (1.88)	4.19 (2.17)	3.95 (2.11)	3.71 (2.05)
SE±		0.031	0.027	0.036	0.051	0.021
C.D.at 5%		N/S	0.082	0.111	0.156	0.065
C.V. (%)		7.22	7.45	7.11	7.40	7.36

*Figures in parentheses are square root transformed values ($\sqrt{x + 0.5}$); N/S: Non-significant

Table 3: Effect of different new molecule of insecticides against *E.atomosa* on pigeonpea based on pooled mean of three sprays

Mean no. of <i>E.atomosa</i> larvae						
Treatments	Dose ml/lit	1DBS	3DAS	7DAS	14DAS	MEAN
Spinetoram 11.7% SC	1	2.49 (1.72)	2.15 (1.62)	1.52 (1.42)	1.07 (1.25)	1.58 (1.44)
Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC	0.4	2.61 (1.75)	1.63 (1.46)	1.28 (1.33)	0.64 (1.07)	1.21 (1.31)
Novaluron 5.25% + Emamectin benzoate 0.9% SC	1.7	3.01 (1.86)	2.09 (1.61)	1.34 (1.36)	1.04 (1.24)	1.49 (1.41)
Lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC	0.4	2.84 (1.81)	1.38 (1.37)	0.86 (1.17)	0.15 (0.80)	0.82 (1.15)
Emamectin benzoate 1.5% + Fipronil 3.5% SC	1	2.72	1.98	1.65	1.28	1.62

		(1.78)	(1.57)	(1.47)	(1.33)	(1.46)
Flubendiamide 19.92% + thiacloprid 19.92% SC	0.4	2.70 (1.78)	1.78 (1.51)	1.21 (1.31)	0.52 (1.00)	1.20 (1.30)
Control	-	2.73 (1.79)	2.93 (1.84)	3.26 (1.93)	3.62 (2.03)	3.23 (1.93)
SE±		0.026	0.041	0.043	0.043	0.031
C.D.at 5%		N/S	0.127	0.134	0.131	0.095
C.V. (%)		7.32	7.56	7.88	7.23	7.50

*Figures in parentheses are square root transformed values ($\sqrt{x + 0.5}$); N/S: Non-significant

Table 4: Effect of different new molecule of insecticides against *M.obtusa* on pigeonpea based on pooled mean spray

Mean no. of maggot and pupa of <i>M.obtusa</i>						
Treatments	Dose ml/lit	1DBS	3DAS	7DAS	14DAS	MEAN
Spinetoram 11.7% SC	1	54.47 (7.41)	40.59 (6.41)	35.53 (6.00)	29.09 (5.43)	34.79 (5.94)
Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC	0.4	54.79 (7.43)	42.53 (6.56)	27.98 (5.33)	23.08 (4.85)	31.20 (5.63)
Novaluron 5.25% + Emamectin benzoate 0.9% SC	1.7	57.70 (7.63)	46.41 (6.85)	36.43 (6.07)	31.54 (5.65)	39.63 (6.33)
Lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC	0.4	57.58 (7.62)	33.71 (5.85)	19.24 (4.44)	12.58 (3.61)	21.84 (4.72)
Emamectin benzoate 1.5% + Fipronil 3.5% SC	1	61.93 (7.90)	47.70 (6.94)	38.49 (6.24)	32.35 (5.72)	45.11 (6.70)
Flubendiamide 19.92% + thiacloprid 19.92% SC	0.4	53.54 (7.35)	39.34 (6.31)	23.93 (4.92)	17.04 (4.18)	26.76 (5.22)
Control	-	60.64 (7.82)	78.41 (8.88)	96.48 (9.85)	117.23 (10.84)	97.37 (9.89)
SE±		0.109	0.075	0.117	0.187	1.462
C.D.at 5%		N/S	0.232	0.359	0.576	3.505
C.V. (%)		7.21	7.65	7.77	7.28	7.54

*Figures in parentheses are square root transformed values ($\sqrt{x + 0.5}$); N/S: Non-significant

Table 5: Per-cent pod and grain damage due to pod borer after third spray and effect of different new molecules of insecticides on yield of pigeonpea

Treatments	Dose ml/lit	% pod damage		% grain damage		Grain yield (kg/ha)
		<i>H.armigera</i>	<i>M.obtusa</i>	<i>H.armigera</i>	<i>M.obtusa</i>	
Spinetoram 11.7% SC	1	10.68 (19.07)	9.40 (17.85)	15.99 (23.57)	14.04 (22.01)	1430
Thiamethoxam 12.6%+lambda cyhalothrin 9.5% ZC	0.4	8.42 (16.87)	7.28 (15.65)	15.20 (22.95)	13.98 (21.96)	1635
Novaluron 5.25% + Emamectinbenzoate 0.9% SC	1.7	10.99 (19.36)	10.34 (18.76)	21.24 (27.44)	14.66 (22.44)	1445
Lambda cyhalothrin 4.6% + chlorantraniliprole 9.3% ZC	0.4	7.50 (15.89)	5.46 (13.51)	11.52 (19.39)	10.53 (18.58)	1790
Emamectin benzoate 1.5% + Fipronil 3.5% SC	1	11.18 (19.34)	10.99 (19.03)	19.20 (25.91)	14.68 (22.53)	1340
Flubendiamide 19.92% + thiacloprid 19.92% SC	0.4	8.55 (17.00)	7.25 (15.62)	17.66 (24.85)	11.74 (20.04)	1670
Control	-	19.18 (25.97)	16.20 (23.73)	20.21 (26.72)	18.81 (25.70)	1019
SE±		0.807	1.028	1.427	1.102	92.12
C.D.at 5%		N/S	3.167	4.397	3.395	288.36
C.V. (%)		7.32	10.03	10.128	8.717	10.89

*Figures in parentheses are angular transformed values

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