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Research Article

Evaluation of the cost economics viability and field effectiveness of synthetic insecticides against Mirid bug (Creontiades dilutus) (Hemiptera; Miridae) in sesame

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ABSTRACT

Sesame is a traditionally important crop and is well-known as the "queen of oilseeds". Sesame seeds contained 18-25% protein, 44-57% oil and 13-14% carbohydrates. Mirid bug (*Creontiades dilutus*) is considered as major pest of the sesame. In current study, seven treatments, viz. Nitenpyrum 25%SP, Acephate 97DF, Dimethoate 40% EC, Flunicamid 50% DF, Chlorfenapyr 360SC, Fipronil 80WG, Chlorantraniliprole 20SC were applied on mirid bug present on sesame at Research Farm Area of Entomological Research Institute Faisalabad during Kharif 2023-24 at recommended doses. The application of above said treatments on sesame crop was done at ETL population of mirid bug. Pretreatment data and percent reduction was recorded after 3 and 7 days after application of treatments. The results revealed that maximum percentage reduction in mirid bug population was recorded in plots treated with nitenpyram 25%SP 84% and 85% during 2023-24 respectively. However, chlorfenapyr 360SC and dimethoate 40%EC observed 81.84 and 81.05 percentage population reduction alternatively, while chlorantraniliprole 20SC showed the lowest population reduction during both years. These findings emphasize the importance of integrating multiple control options within IPM frameworks to sustain effective pest control and reduce the risk of resistance development. Continuous monitoring and further research are essential to assess environmental impact and the potential of combining chemical and non-chemical methods for sustainable sesame production.

Keywords: Sesame; bio efficacy; new chemistry Insecticides; *Creontiades dilutes*; cost benefit ratio.

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INTRODUCTION

Sesame, also known as "queen of oilseeds" is a traditional crop (Fuller, 2003; Gupta et al., 2022), predominantly cultivated for the oil production in South Asian countries (Umar & Okoye, 2010; Bedigian, 2010; Tunde-Akintunde & Akintunde, 2004). Beyond oil production, sesame has multiple uses: it is cultivated as a cover crop, its seeds are consumed as food and its leaves and young branches are used as animal feed (Bedigian, 2010). Additionally, various plant components, including the flowers, have demonstrated medicinal properties (Pusadkar et al., 2016; Langyan et al., 2022). Sesame seeds comprise off about 18-25% protein, 44-57% oil and 13-14% carbohydrates (Teklu et al., 2021; Wei et al., 2022). According to FAO estimates, Egypt and Honduras achieve the highest recorded production of sesame at 1063 kg/ha and 1267 kg/ha respectively; however, the genetic potential of improved sesame varieties can reach up to 2000 kg/ha (FAOSTAT, 2024). Sesame production

is hindered by multiple factors i.e. lack of cost-effective cultivation practices and insect pest infestations (Ali et al., 2024), later are the critical constraint, often resulting in 25% to 90% decline in production (Ahuja & Kalyan, 2002).
Potential insects invading sesame are *Antigastra catalaunalis, Orosius albicinctus, Bemisia tabaci* and *Nesidiocoris tenuis* (Ahirwar et al., 2009). *N. tenuis* also known as mirid bug or plant bug, is a highly diverse group within the order Hemiptera. It damages crops by extracting sap, which weakens plant vigor and transmission of viral plant pathogens which causes direct damage to tissue (Lu et al., 2010; Lu et al., 2011). Owing to their potential damaging nature implementing targeted IPM management strategies during pivotal periods could significantly suppress the initial population buildup of these bugs (Lu et al., 2010).
Currently, chemical control remains one of the primary management strategies for mirid bugs to keep their infestation below ETL (Liu et al., 2008; Zhang et al., 2009). Several insecticides are commonly applied to control this pest under field condition while few provides efficient results. Hence, present study was designed to evaluate the effectiveness of selective insecticides against mirid bug under field conditions.

MATERIALS AND METHODS

Study Area

The study was conducted in Kharif 2023–2024 at the Entomological Research Institute's Research at Ayub Agricultural Research Institute, Faisalabad. Sesame variety (TH-6) was sown for two simoultansous years i.e on 09.05.2023 and 03.05.2024 respectively. The seven treatments viz. Nitenpyrum 25%SP, 97DF Acephate 97DF, Dimethoate 40EC, Flunicamid 50%DF, chlorfenapyr 360SC, fipronil 80WG, chlorantraniliprole 20SC and one control were applied to sesame crop at recommended doses of each commercially available product when the mirid bug population was observed in the field.

Research Design

The sesame variety TH-6 was sown during the 2023 and 2024 growing seasons on May 9, 2023 and May 3, 2024 respectively. The experiment followed a randomized complete block design (RCBD) with three replications, consisting of seven treatments and one untreated control. The net plot dimensions were maintained at 10.0 × 20.0 m^2 in 2023 and adjusted to 12.0 × 19.0 m^2 in 2024. All plots received uniformly agronomic practices throughout the study period to minimize variability due to external factors and to ensure optimal crop performance under each treatment condition.

Data Collection

Insecticidal treatments were administered to the designated experimental plots using a hand-operated knapsack sprayer fitted with a hollow cone nozzle, calibrated to deliver spray at a consistent operating pressure of 3 bars. To assess the population of mirid bug (family: Miridae), twenty plants were randomly selected from each plot for data collection. A standardized leaf sampling protocol was employed in which insect counts were taken sequentially from the upper, middle and lower leaves of the same selected plants. Pre-treatment data were recorded before the insecticide application to facilitate comparative analysis. Subsequently, post-treatment observations were conducted at 3 and 7 days after application of the treatments to evaluate the population reduction and residual impact of each insecticidal treatment on mirid bug populations.

Data Analysis

The collected data were subjected to statistical analysis using Statistix 8.1 software. An analysis of variance (ANOVA) was performed to determine the significance of treatment effects, and mean comparisons were conducted using the Tukey test at a 5% level of significance ($P \leq 0.05$). To account for natural variation in pest populations and to correct treatment efficacy, percentage reduction in mirid bug population was calculated using a modified Abbott’s formula as proposed by Flemings and Ratnakaran (1985)
The formula used for calculating the percentage reduction in insect population was:

$$\text{Percentage population reduction} = \frac{\text{Control Treatment pop.} - \text{Post treatment pop.}}{\text{Control Treatment pop.}}$$

The harvested healthy sesame yield from each treatment was collected separately and weighed. The cost associated with agronomic management practices and plant protection measure such as treatment cost, sprayer rental and labour charges etc was calculated.
The BCR (cost benefit ratio) was calculated using the following formula:

$$\text{Cost benefit ratio (BCR)} = \frac{\text{Gross return}}{\text{Total cost}}$$

Where:
*BCR = Benefit–Cost Ratio
*Gross Returns = Marketable yield × Market price
*Net Return = Gross Returns − Cost of Cultivation (Zorempuii and Kumar, 2019)

RESULTS AND DISCUSSION

A significant reduction in the mirid bug population was observed in plots treated with Nitenpyrum 25%SP, 97DF Acephate 97DF, Dimethoate 40EC, Flunicamid50%DF, chlorfenapyr360SC, fipronil80WG, chlorantraniliprole20SC. Among these treatments, plots treated with Nitenpyram 25%SP consistently recorded the highest population reduction across both years of the study.

The percentage reduction in mirid bug (Miridae) populations in sesame before and after insecticidal applications during the 2023 study period. Pre-treatment data indicated a mirid bug density ranging from 8.07 to 10.27 bugs per plant (including both adults and nymphs) which exceeded the Economic Threshold Level (ETL) of 06 Mirid bugs per plant, thereby necessitating treatment's application. In the first year of the study, the results after 3 days of treatments revealed that the highest percentage reduction in mirid bug population was recorded with Nitenpyrum 25%SP (85.02%), followed by chlorfenapyr 360SC (81.84%), and Dimethoate 40EC (81.05%). The minimum percentage reduction was observed in plots treated with chlorantraniliprole20SC (74.26%). A similar trend was observed at 7 days' post-application. The results after 07 days after treatment revealed that Nitenpyrum 25%SP gave 80.84% reduction, followed by Dimethoate 40EC (78.58%) and Acephate 97DF (77.20%), these results were statistically non-significant from each other whereas Chlorantraniliprole 20SC again recorded the lowest population reduction (72.19%) (Table 1).

Table 01. Percentage population reduction of Sesame mirid bug after 03 days and 07 Days after treatments during Kharif-2023.

Treatments	Recommended Dose/acre	Pre-treatment data (avg. pop. per plant)	Population Reduction (%)	
			03 DAT	07DAT
Nitenpyrum 25%SP	100gm	8.07	85.02 a	80.84 a
Acephate 97DF	200gm	7.40	78.95 cd	77.20 bc
Dimethoate 40EC	400ml	9.00	81.05 bc	78.58 abc
Flunicamid 50%DF	80gms	7.80	78.53 d	76.53 c
Chlorfenapyr 360SC	100ml	9.53	81.84 b	80.56 a
Fipronil 80WG	30gm	10.27	80.41 bcd	79.47 ab
Chlorantraniliprole 20SC	50ml	8.87	74.26 e	72.19 d
Tukey value			2.27	2.46

*DAT=days after treatment

During second year of study (2024), The results after three (03) days of application of treatment depicted that maximum decrease in percentage population reduction was recorded in plots treated with Nitenpyram 25%SP (84.77%) followed by Fipronil 80WG (80.44%) and chlorfenapyr 360SC (78.95%) which are also non-significant to each other whereas minimum percentage population reduction was observed in the case of Chlorantraniliprole 20SC (72.20%) similarly maximum percentage population reduction after seven days after application of treatment was recorded in the plot treated with Nitenpyrum 25%SP (80.28%) followed by chlorfenapyr 360SC (79.01%) and Fipronil ((78.51%) while minimum population reduction of sesame mirid bug was observed in the case of Chlorantraniliprole 20SC (69.91%). The results showed that all insecticides gave better insect pest population control butNitenpyram25%SP established an excellent control of mirid bug (Table 2). Similar findings were reported by Chaitra (2016), who observed highest efficacy of neonicotinoid insecticides against Antigastra catalaunalis in sesame crop rather than mirid bugs. The findings align with previous research by Kishor (2020) who reported that insecticidal mixtures such as Profenophos 40% + Cypermethrin 4% effectively reduced larval density and minimized pod damage in sesame. Additionally, the results corroborate Fakeer and Gameel (2022) who highlighted the potency of Lambda-cyhalothrin in achieving high larval suppression rates. These consistencies reinforce the validity of the current study and emphasize the continued effectiveness of these chemical controls across various insect pests in sesame. Devaiah et al. (2020) further demonstrated that seed treatment combined with foliar sprays of imidacloprid 60 FS and thiamethoxam 25 WG was most effective against mirid bugs reinforcing the significance of neonicotinoid based insecticides. Their findings also highlighted the efficacy of flonicamid and clothianidin offering additional options for rotation and resistance management. Our results are in line with Udikeri et al. (2009) and Prasada et al. (2011) consistently reported the effectiveness of acephate, acetamiprid, and imidacloprid across different crops and seasons, further validating the reliability of these insecticides. Additionally, Saleem et al. (2017) ranked acephate as the most effective insecticide, followed by profenophos, chlorpyrifos, and others, including fipronil and imidacloprid, which corresponds with the present study's findings.

Table 02. Percentage population reduction of sesame mirid bug after 03 Days and 07 Day after treatments kharif-2024.

Treatments	Recommended Dose/acre	Pre-treatment data (avg. pop. per plant)	Population Reduction (%)	
			03 DAT	07DAT
Nitenpyrum 25%SP	100gm	7.02	84.77a	80. 28a
Acephate 97DF	200gm	7.47	77.17c	76.82 bc
Dimethoate 40EC	400ml	8.67	81.29b	77.53b
Flunicamid 50%DF	80gms	7.60	76.30c	74.86 c
Chlorfenapyr 360SC	100ml	7.84	78.95bc	79.01ab
Fipronil 80WG	30gm	9.76	80.44b	78.51ab
Chlorantraniliprole 20SC	50ml	8.29	72.20d	69.91d
Tukey value			2.65	2.53

*DAT=days after treatment

The sesame yield from each treatment was harvested separately and their cost benefit ratio was evaluated. The cost associated with agronomic management practices and plant protection measure such as treatment cost, sprayer rental and labour charges etc was calculated. The treatment with Nitenpyram 25%SP gave the highest healthy yield of 1086.8 kg/ha and afforded maximum net profit of PKR PKR278,616/ha and a benefit-cost ratio (B.C. R) of 3.74, indicating superior economic viability being followed by Acephate 97%DF and Fipronil 80WG with yields of 864.5 kg/ha and 889.2 kg/ha, net returns of PKR195,624/ha and PKR 203,602/ha, and B.C.R ratios of 2.83 and 2.89, respectively while in the case of Flunicamid 50%DF and Chlorantraniliprole 20SC recorded lower yields of 790.4 kg/ha and 666.9 kg/ha, with net returns of PKR158,055/ha and PKR 124,982/ha, and B.C ratios of 2.33 and 2.15 respectively. The untreated control plot exhibited the lowest yield (395.2 kg/ha), net return (PKR39,520/ha), and B.C ratio (1.40) (Table 3). The results clearly indicate that the application of Nitenpyram 25%SP is the most effective both in enhancing sesame yield and in maximizing economic returns, followed by Fipronil 80WG and Acephate 97%DF. All insecticidal treatments demonstrated a positive impact on yield and profitability compared to the untreated control, although significant variability was observed among treatments in both agronomic and economic performance. These results resonate with Akbari et al. (2024) who similarly reported the highest cost benefit ratio (1:11.00) from thiamethoxam 12.60% + lambda-cyhalothrin 09.50% ZC followed by acephate 50% + imidacloprid 01.80% SP and beta-cyfluthrin + imidacloprid. Panday et al. (2018) also highlighted that seed treatment with imidacloprid 70 WS combined with foliar sprays of imidacloprid 17.8 SL significantly increased yields (770 kg/ha), underscoring the effectiveness of integrated insecticide applications. Moreover, neem-based insecticides have shown promise as effective alternatives. Sarnaik et al., 1986 demonstrated that treatments using neem seed kernel extract (NSKE) and neem oil outperformed seed treatment alone. He also reported that 70.48% yield increase with NSKE 5% application reflecting the potential of botanical options in integrated pest management (IPM). Additional studies (Misra 2003) documented yield improvements of 725–870 kg/ha in treated plots versus 326 kg/ha in untreated plots, reinforcing the conclusion that effective pest management translates into significant agronomic gains. Devaiah et al. (2020) also observed that seed treatment with imidacloprid 60 FS, combined with foliar applications, provided the highest net profit (Rs. 60,680/ha) and a maximum BCR of 1:4.38, further demonstrating the economic value of integrated insecticide strategies. Collectively, these findings highlight the dual benefit of effective pest control and economic gain through judicious insecticide use, with Nitenpyram emerging as a particularly promising treatment. The consistency of these results with earlier research strengthens the recommendation to incorporate Nitenpyram and other neonicotinoid-based insecticides into IPM programs for sesame. Nevertheless, the inclusion of botanical insecticides and the rotation of active ingredients remain critical to delaying resistance development and ensuring sustainable pest management.

Table 3. Economic performance of different insecticides in managing mirid bug: A two-year cumulative analysis.

Treatments	Sesame yield in kg/ha	Total income /ha	Expenses w.o insecticides/ha	Expenses with insecticides/ha (PKR.)	Net return/ha (PKR)	B.C.R
Nitenpyrum 25%SP	1086.8	380380	98800	101764	278616	3.738
Acephate 97DF	864.5	302575	98800	106951	195624	2.829
Dimethoate 40EC	938.6	328510	98800	118807	209703	2.765
Flunicamid50%DF	790.4	276640	98800	118584.7	158055.3	2.333
chlorfenapyr360SC	988	345800	98800	134368	211432	2.574
Fipronil80WG	889.2	311220	98800	107617.9	203602.1	2.892
Chlorantraniliprole20SC	666.9	233415	98800	108433	124982	2.153
Control	395.2	138320	98800	98800	39520	1.400

*Market price of the sesame per kg= Rs.350/-
*Expenses for one treatment = Cost of insecticide/ha + cost of labour (2labour/day & 1000/person/day)
*Expenses other than treatments=cost of all agronomic practices+ cost of labour (1labour/day & 1000/person/day).

CONCLUSION

Overall, the results confirm that Nitenpyram is highly effective in managing sesame mirid bug populations, while Fipronil and Chlorfenapyr provide strong alternatives. Although Chlorantraniliprole showed lower efficacy. These findings emphasize the importance of integrating multiple control options within IPM frameworks to sustain effective pest control and reduce the risk of resistance development. Continuous monitoring and further research are essential to assess long-term efficacy, environmental impact, and the potential of combining chemical and non-chemical for sustainable sesame production.

AUTHOR'S CONTRIBUTION

Q. Ali and H. Malik Design and supervised the Trial, A. Aslam and M.K. malik Conducted the research Trial, A.M. sabir and I. Nadeem Provided the research material to conduct the research trial, M. Arshad supervised the agronomic practice of trial, T. Nazir and N.A. anjum analyzed the data, K. Hanif and A. Aslam wrote the research Paper, M F. Akhtar, and M.B.B. Iqbal review the research paper, A. Aslam arranged and submitted the research paper to the journal. All authors read and approved to submit the research paper to the journal.

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AVAILABILITY OF DATA AND MATERIAL

All data generated or analyzed in this study are presented within this article in the form of tables and figures.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONSENT FOR PUBLICATION
All authors are agreed for its publication.

CONFLICT OF INTERESTS
Authors have no conflict of Interest regarding this publication.

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