Research Article

Efficacy of Conventional Insecticides in Comparison with Indigenous Plant Extracts Against Sucking Insect Pests of Sunflower

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Abstract | Sunflower (*Helianthus annuus*) is a key oilseed crop with 15-21% protein and 50% oil content, ranking fourth globally and third in Pakistan. Pakistan currently produces only 18% of its edible oil, with sunflower contributing 11%. Sunflowers are cultivated on 151,000 acres, yielding 87,000 tonnes of seeds and 33,000 tonnes of oil. The Present study evaluated the effectiveness of conventional insecticides and indigenous plant extracts against sucking insect pests (Whitefly and Jassid) on sunflowers. Two different concentrations (50 ml/L and 100 ml/L) of botanical extracts of *Azadirachta indica, Eucalyptus globulus, Nicotiana tabacum, Piper nigrum*, and *Allium sativum* were tested. *A. indica caused* maximum mortality (58.93% and 60.48%, respectively) of whitefly and Jassid @ 50ml/L after one week of treatment. At 100ml/L, *A. indica* caused 80.16% mortality of whitefly and 82.83% of jassid. Among synthetic insecticides, Flonicamid caused 93.33% mortality of whitefly and 92.93% of Jassid after one-week of exposure period. The integration of botanical extracts with synthetic insecticides in Integrated Pest Management (IPM) module can improve pest control and sunflower yield.

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Introduction

Agriculture is a cornerstone of Pakistan's economy, contributing 22.9% to GDP and providing essential food, income, and employment for the rural population (Rasheed *et al.*, 2024). This sector includes crops, livestock, fisheries, and forestry (Islam *et al.*, 2023). Key crops such as cotton, wheat, rice, maize, sugarcane, and oilseeds like rapeseed-mustard, sesame, and sunflower are vital for food security and economic stability. These crops also play a crucial role in generating foreign exchange through exports, underscoring their significance in Pakistan's agricultural landscape (Baig *et al.*, 2023; Ali *et al.*, 2020).

Oilseed crops play a vital role in Pakistan's agricultural sector, with a study highlighting the variability and instability in the cultivation area, yield, and production of nine key oilseed crops, including cotton, rapeseed-mustard, sesame, and sunflower (Khan *et al*., 2024). Local oilseed production in Pakistan accounts for 0.507 million tonnes of the total 3.255 million tonnes, with the remaining 2.748 million tonnes imported. Pakistan primarily focuses on major oilseed crops like sunflower, canola, rapeseed, mustard, and cotton (Manzoor *et al*., 2024).

Sunflower (*Helianthus annuus*), an annual plant in the Asteraceae family, is cultivated globally for its oilseeds and has over 70 species, introduced to Pakistan around 40 years ago, sunflower farming began in the 1980s with support from the Ghee Corporation of Pakistan (GCP). Initially considered non-traditional, it has since become a significant oilseed crop due to its high oil (50%) and protein content (15-21%) (Tabassum *et al*., 2020). It is also a rich source of essential vitamins, minerals, and tocopherols, providing nutrients such as magnesium, iron, copper, calcium, zinc, potassium, phosphorus, manganese, and selenium (Vasudha and Sarla, 2021). Sunflower farming in Pakistan covers 151 thousand acres, producing 87 thousand tonnes of seeds and 33 thousand tonnes of oil (Sher *et al*., 2022).

Sunflower productivity is notably impacted by insect pests, especially jassid (*Amrasca biguttula biguttula*) and whitefly (*Bemisia tabaci*), which are major causes of yield decline (Dake and Bhamare, 2019; Kamakshi *et al*., 2021). Whitefly feed on plant sap, excrete honeydew, and transmit viral diseases like sunflower necrosis, leading to wilting, stunted growth, and yellowing of leaves, all of which reduce yields (Solanki and Jha, 2018; Dake and Bhamare, 2019). Jassid cause leaf stunting, chlorosis, and hopperburn, resulting in wilting, decreased growth, and lower oil production due to sooty mold (Singh *et al*., 2018; Shettar and Jagadish, 2017; Mengal *et al*., 2021).

Chemical treatment is a key component of integrated pest management (IPM) to reduce yield loss in sunflowers caused by sucking pests (Mane *et al*., 2024). Insecticides like imidacloprid, flonicamid, acetamiprid, fipronil, and others are used against most of the sucking pests, among witch imidacloprid and acetamiprid proving most effective and cost-efficient against whitefly and leafhoppers (Halder *et al*., 2023). Insecticides, such as pyrethroids, generate free radicals that cause cellular damage, lipid peroxidation, and oxidative stress, potentially harming non-target organisms, including humans and biological agents. Antioxidants may help mitigate this oxidative stress, reducing pesticide-induced damage (Selamoglu *et al*., 2023). Similarly, nanoparticles used in phytoremediation can induce oxidative stress in plants by producing reactive oxygen species (ROS), which are also linked to hypertension in humans (Hajipour *et al*., 2023). Additionally, pollutants and byproducts from textile dyes and treatment processes generate ROS, leading to oxidative stress that disrupts cellular function and damages tissues, ultimately affecting biodiversity and ecosystem health (Selamoglu, 2020). However, widespread use can lead to environmental contamination, health risks, resistance development and can disrupt ecosystems by harming beneficial organisms and need continuous effectiveness assessment (Mengal *et al*., 2021; Mutkule *et al*., 2023).

Over 2400 plants have been identified for their pest control properties, making botanical insecticides a viable alternative to synthetic options (Rajput *et al*., 2021; Khan *et al*., 2024). Extracts from neem, garlic, tobacco, black pepper, and eucalyptus show significant bio-pesticidal potential. Neem preparations are effective against various pests (Devi and Gogoi, 2023), eucalyptus contains synergistic components enhancing pesticide activity (Maris *et al*., 2022), black pepper's bioactive compounds have broad insecticidal and antimicrobial applications (Sinha and Ray, 2021), and nicotine from tobacco is effective against multiple pests (Xia *et al*., 2021). Biopesticides, despite facing challenges, remain viable alternatives to traditional pesticides due to their low toxicity, biodegradability, and environmental safety. The present study was conducted to assess the efficacy of indigenous plant extracts and insecticides against sucking insect pests (whitefly and jassid) on sunflower.

Materials and Methods

Selection of area

The current study regarding the efficacy of conventional insecticides in comparison with indigenous plant extracts against sucking insects (Whitefly and Jassid) of Sunflower was conducted at the research area of Entomological Research Institute, Ayub Agricultural Research Institute (AARI), Faisalabad, Pakistan.

Preparation of plant extracts

Native plants, including neem, sufaida, tobacco, garlic, and black pepper were collected and washed under running tap water (Table 1). To preserve their effectiveness, the plant materials were transported to the lab and dried in the shade. Once adequately dried, they were finely ground using an electric blender and then sieved through a kitchen strainer to achieve a uniform consistency (Saleem *et al.*, 2024). The ethanolic extracts were prepared by first weighing the plant material, which was then placed in a thimble inside a Soxhlet extractor. Ethanol was added to a round-bottom flask, and the Soxhlet apparatus was assembled. The flask was heated, causing ethanol to evaporate, condense, and repeatedly wash over the plant material, extracting its compounds over several hours. After extraction, the ethanol solution was transferred to a rotary evaporator, where the ethanol was evaporated under reduced pressure, leaving behind a concentrated extract. The concentrated extract was then diluted with a suitable solvent, usually distilled water, according to the desired dilution ratio. The solution was mixed thoroughly using a magnetic stirrer to ensure homogeneity. To ensure the spray solution was free of particles, the mixture was filtered again using a finer filter (Hussein *et al.*, 2023).

Preparation of concentrations

The required concentrations were prepared by using the following formula and the diluted concentrations were used for subsequent experiment (Oblessuc and Melotto, 2020).

$$C1V1 = C2V2$$

Where; C1= given concentration; V1= volume of water which is required; C2= required concentration; V2= volume of a known quantity of water.

Various concentrations of plant extracts were prepared, including Neem leaf extract (50 ml/L, and 100 ml/L), *Eucalyptus* leaf extract (50 ml/L, and 100 ml/L), Tobacco leaf extract (50 ml/L, and 100 ml/L), Black Pepper (50 ml/L, and 100 ml/L), and Garlic extract (50 ml/L, and 100 ml/L). Additionally, Confidor 20SL 500 ml (Imidacloprid) was applied at a rate of 250ml per acre, DUMEI 50% WG (Flonicamid) at 50 g per acre, and a control group was included.

Table 1: *Overview of the plant samples tested against whitefly and jassid.*

S. No	Scientific name	Vernacular name	Diagrams	Family	Parts used
1	*Azadirachta indica*	Neem		Meliaceae	Leaves
2	*Eucalyptus globulus*	Safeda		Myrtaceae	Leaves
3	*Nicotiana tabacum*	Tambaku		Solanaceae	Leaves
4	*Piper nigrum*	Kali Mirch		Piperaceae	Fruit
5	*Allium sativum*	Lehsan		Amaryllidaceae	Fruit

Table 2: *Synthetic insecticides, dose ml/acre, mode of action and manufacturer names evaluated against whitefly and jassid.*

S. No	Insecticides	Dose (ml/acre)	Mode of action	Brand name
1	DUMEI 50%WG (Flonicamid)	48-60 gm/acre	Disrupts the feeding behavior of pests by affecting their nervous system, causing starvation and death (Sakthiselvi *et al*., 2024).	Syngenta
2	Confidor 20SL 500ML (imidacloprid)	250ml/acre	Binds to nicotinic acetylcholine receptors in insects, leading to overstimulation, paralysis, and death (Ali *et al*., 2024).	Bayer

Table 3: *Field efficacy of plant extracts and insecticides against whitefly on sunflower.*

Mean comparison of whitefly between plant extracts and insecticide treated plot					
Treatments	**Conc used**	**Time duration**			
		24 hours	**48 hours**	**72 hours**	**1 week**
Neem (*Azadirachta indica*)	50 ml/l	17.86 ± 6.19^{a}	27.38± 2.06^{a}	36.31 ± 7.22^{a}	58.93 ± 3.09^{ab}
Safeda (*Eucalyptus globulus*)	50 ml/l	10.68 ± 4.07^{a}	13.46 ± 4.49^{ab}	19.02 ± 5.22^{ab}	29.70 ± 4.27^{c}
Tambaku (*Nicotiana tabacum*)	50 ml/l	14.07 ± 5.13^{a}	21.48 ± 1.28^{abc}	28.52 ± 5.7^{abc}	50.37 ± 8.98^{ab}
Kali Mirch (*Piper nigrum*)	50 ml/l	12.04 ± 0.80^{a}	15.74 ± 5.61^{bc}	24.07 ± 1.60^{bc}	40.28 ± 8.67^{bc}
Lehsan (*Allium sativum*)	50 ml/l	8.12 ± 0.37^{a}	10.9 ± 5.01^{bc}	13.68 ± 5.18^{bc}	24.35 ± 1.11^{cd}
Neem (*Azadirachta indica*)	100 ml/l	34.92 ± 7.27^{a}	45.24 ± 4.12^{a}	54.76 ± 4.12^{a}	80.16 ± 7.65^{a}
Safeda (*Eucalyptus globulus*)	100 ml/l	18.52 ± 6.42^{ab}	22.22 ± 3.21^{bc}	25.93 ± 6.42^{bc}	40.74 ± 6.42^{cd}
Tambaku (*Nicotiana tabacum*)	100 ml/l	30.16 ± 2.75^{a}	40.48 ± 10.91^{ab}	45.24 ± 4.12^{a}	70.63 ± 13.11^{ab}
Kali Mirch (*Piper nigrum*)	100 ml/l	23.21 ± 9.28^{ab}	32.14 ± 9.45^{abc}	41.07 ± 3.09^{ab}	58.93 ± 3.09^{bc}
Lehsan (*Allium sativum*)	100 ml/l	15.28 ± 6.05^{ab}	18.98 ± 5.61^{bc}	23.14 ± 1.604^{c}	38.43 ± 5.61^{d}
DUMEI 50%WG (Flonicamid)	48-60 gm/acre	24.81 ± 4.49^{a}	32.22 ± 5.1^{a}	43.33 ± 7.06^{a}	93.33 ± 3.9^{a}
Confidor 20SL 500ML (Imidacloprid)	250ml/acre	20.71 ± 1.28^{a}	27.78±5.9^{a}	37.78 ± 15.4^{a}	90 ± 2.9^{a}
Control	-	4.76 ± 8.25^{b}	8.76 ± 7.38^{b}	16.46 ± 20.76^{a}	20.42 ± 2.24^{a}

Means sharing similar alphabets are not significantly different to each other.

Application of insecticides and plant extracts

When the number of insect pests in the crop reached the Economic Threshold Level (ETL), the prepared plant extracts were thoroughly mixed and sprayed to sunflower using a hand sprayer to ensure the even distribution. Table 2 summarize synthetic insecticides tested against whitefly and jassid.

Monitoring and data collection

The number of sucking pests, such as whitefly and Jassid, were routinely observed after pesticides and plant extract sprays were applied, and data was collected at regular intervals. To record the population of Whitefly and Jassid each replication, leaves from the top, middle, and bottom regions of chosen plants were collected. The percentage of population suppression as opposed to the control treatment was used to express the results. Prior to the introduction of treatments, observations were made on the same day both before and after treatment. Observations were made after 24, 48, 72 hours and 1 week of spraying and compared with control plot. The formula was used to calculate the percentage mortality of Jassid and Whitefly is (Saleem *et al*., 2023).

$$Mortality\ \% = \frac{\text{Pre Treatment} - \text{Post Treatment}}{\text{Pre Treatment}} \times 100$$

Statistical analysis

The recorded data were subjected to statistical analysis for comparing means and analysis of variance (ANOVA) by using SPSS software. Graphs were made to compare the percent mortality by Graphpad prism (Saleem *et al*., 2023).

Results and Discussion

Field efficacy of plant extracts and insecticides against whitefly on sunflower

Table 3 outlines whitefly mortality in sunflower plots treated with plant extracts and insecticides at 50 ml/L and 100 ml/L over time intervals of 24 hours, 48 hours, 72 hours, and 1 week. At 50 ml/L, *Azadirachta indica* (Neem) showed the highest efficacy with 58.93% mortality at 1 week, followed by *Nicotiana tabacum*

(Tobacco) at 50.37%, while *Allium sativum* (Garlic) had the lowest at 24.36%. At 100 ml/L, Neem reached 80.16% and Tobacco 70.63%, with increased efficacy across all treatments. The synthetic insecticides DUMEI (Flonicamid) and Confidor (Imidacloprid) were more effective, with DUMEI achieving 93.33% mortality at 1 week. The control group showed significantly lower mortality, peaking at 20.42% at 1 week. Figure 1 shows that higher concentrations of plant extracts and insecticides increase whitefly mortality, with insecticides being more effective. Neem and Tobacco extracts performed well at higher doses, but insecticides, especially Flonicamid, had the highest efficacy. Plant extracts can be sustainable alternatives; though higher concentrations are required to match insecticide performance.

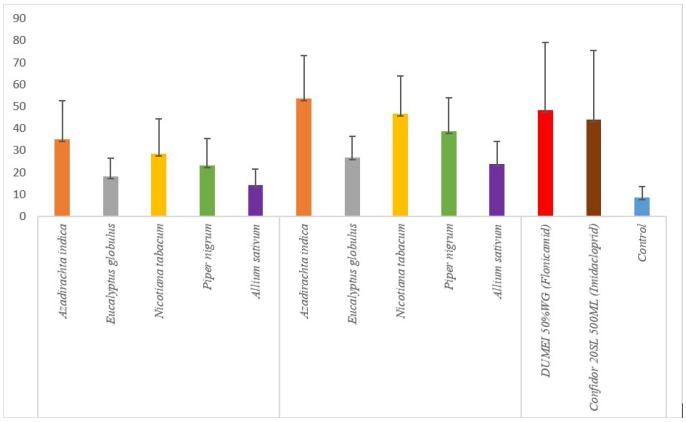

Figure 1: *Comparative percentage mortality of plant extracts at different concentration (25ml/L and 50ml/L) and insecticides against whitefly sucking pest of sunflower.*

Field efficacy of plant extracts and insecticides against jassid on sunflower

Table 3 presents the mean jassid populations observed in plots treated with various plant extracts and insecticides at concentrations of 50 ml/L and 100 ml/L over several time intervals: 24 hours, 48 hours, 72 hours, and 1 week. The plant extracts include Neem, Eucalyptus, Tobacco, Black Pepper, and Garlic. The insecticides evaluated are DUMEI 50% WG (Flonicamid) and Confidor 20 SL (Imidacloprid) and a control group. At a concentration of 50 ml/L, jassid mortality rates were: 22.14% after 24 hours, 34.92% after 48 hours, 46.67% after 72 hours, and 60.48% after 1 week. For 100 ml/L, the rates increased to 31.57% at 24 hours, 40.15% at 48 hours, 57.07% at 72 hours, and 82.83% at 1 week. Insecticides were more effective, with DUMEI 50% WG (Flonicamid) reaching 92.93% mortality after 1 week and Confidor 20 SL (Imidacloprid) achieving 95.63%. The control group showed much lower mortality, peaking at 24.42% after 1 week, as detailed in Table 4. Figure 2 compares the effectiveness of plant extracts at 50 ml/L and 100 ml/L with insecticides in controlling jassid pests on sunflowers. It shows that while higher concentrations of plant extracts enhance jassid mortality, insecticides remain more effective overall. This indicates that although plant extracts are a sustainable option, higher doses are needed to match the effectiveness of chemical insecticides. Both plant extracts and insecticides are effective, with Flonicamid and Imidacloprid showing the highest efficacy.

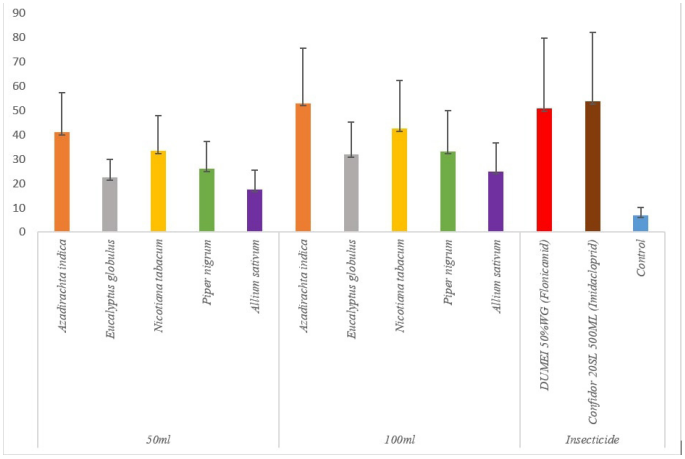

Figure 2: *Comparative percentage mortality of plant extracts at different concentration (50ml/L and 100ml/L) and insecticides against jassid sucking pest of sunflower.*

The efficacy of conventional insecticides and indigenous plant extracts against sunflower pests, specifically whitefly and jassid, was assessed at the Entomological Research Institute, Ayub Agricultural Research Institute (AARI), Faisalabad, Pakistan. The study aimed to compare the effectiveness of botanical extracts with synthetic insecticides for integrated pest management (IPM). Results demonstrated that plant extracts, including neem and tobacco, were as effective as synthetic insecticides in managing both whitefly and jassid populations, supporting their potential as eco-friendly alternatives to chemical controls. Previous research by Mahmood *et al.* (2014) at the University of Karachi highlighted neem and tobacco extracts' significant efficacy against whitefly and jassid, corroborated by the current study's findings. Neem and tobacco extracts exhibited sustained efficacy, aligning with earlier results showing neem's 91.50% reduction in whitefly populations and tobacco's 92.62% reduction (Mahmood *et al.*, 2014). Ali *et al.* (2016) reported Eucalyptus extract's initial effectiveness against whitefly in brinjal but noted reduced efficacy with repeated applications. Similarly, Hussain (2022) found garlic and Eucalyptus

Table 4: *Field efficacy of plant extracts and insecticides against jassid on Sunflower.*

Mean comparison of Jassid between plant extracts and insecticide treated plot					
Treatments	**Conc used**	**Time duration**			
		24 hours	**48 hours**	**72 hours**	**1 week**
Neem (*Azadirachta indica*)	50 ml/l	22.14 ± 2.58^{a}	34.92 ± 7.27^{a}	46.67 ± 5.77^{a}	60.48 ± 3.6^{a}
Safeda (*Eucalyptus globulus*)	50 ml/l	12.82 ± 4.44^{ab}	20.51 ± 4.44^{abc}	28.21 ± 4.44^{bc}	28.21 ± 4.44^{c}
Tambaku (*Nicotiana tabacum*)	50 ml/l	18.52 ± 6.42^{a}	25.93 ± 6.42^{ab}	37.04 ± 6.42^{ab}	51.85 ± 6.42^{ab}
Kali Mirch (*Piper nigrum*)	50 ml/l	14.22 ± 4.66^{ab}	18.88 ± 3.89^{bc}	32.63 ± 3.23^{bc}	38.23 ± 7.35^{bc}
Lehsan (*Allium sativum*)	50 ml/l	9.79 ± 3.09^{ab}	12.22 ± 5.09^{bc}	21.67 ± 2.89^{c}	26.67 ± 6.67^{c}
Neem (*Azadirachta indica*)	100 ml/l	31.57 ± 5.88^{a}	40.15 ± 6.2^{a}	57.07 ± 2.19^{a}	82.82 ± 0.87^{a}
Safeda (*Eucalyptus globulus*)	100 ml/l	16.43 ± 4.7^{bc}	26.5 ± 3.95^{ab}	37.24 ± 8.91^{b}	47.31 ± 9.88^{c}
Tambaku (*Nicotiana tabacum*)	100 ml/l	24.09 ± 3.72^{ab}	33.23 ± 3.18^{ab}	42.68 ± 6.87^{ab}	70.1 ± 8.71^{ab}
Kali Mirch (*Piper nigrum*)	100 ml/l	18.8 ± 3.7^{abc}	24.359 ± 1.11^{b}	32.69 ± 9.31^{bc}	56.84 ± 8.73^{bc}
Lehsan (*Allium sativum*)	100 ml/l	13.28 ± 4.92^{bc}	19.09 ± 7.28^{bc}	27.12 ± 8.39^{bc}	40.15 ± 6.2^{c}
DUMEI 50%WG (Flonicamid)	48-60 gm/acre	24.81± 4.49^{a}	32.22±5.1^{a}	43.33±7.06^{a}	93.33 ± 3.9^{a}
Confidor 20SL 500ML (Imidacloprid)	250ml/acre	20.74 ± 1.28^{a}	27.78 ± 5.9^{a}	37.78 ± 5.45^{a}	90 ± 2.9^{a}
Control	-	4.76 ± 7.38^{b}	8.76 ± 7.38^{b}	12.46 ± 2.76^{a}	24.4 ± 4.9^{a}

Means sharing similar alphabets are not significantly different to each other.

extracts effective against whitefly, with garlic showing higher efficacy compared to Eucalyptus in sunflower. Iqbal *et al.* (2017) noted garlic's superior performance over Eucalyptus against jassid on okra, which was consistent with the current study's findings showing garlic's higher mortality rates in jassid. Baig and Yousaf (2021) demonstrated neem and black pepper's efficacy against whitefly, with black pepper also showing significant effectiveness against jassid. These results support black pepper's potential as a viable biopesticide. Afzal *et al.* (2014) and Kamakshi *et al.* (2021) highlighted the effectiveness of imidacloprid and flonicamid, with imidacloprid showing substantial mortality rates against both pests. The current study reinforced these findings, showing high efficacy of DUMEI 50% WG (Flonicamid) and Confidor 20 SL (Imidacloprid) in managing both whitefly and jassid, thus enhancing sunflower yield compared to controls. Both plant extracts and synthetic insecticides offer effective solutions for managing sunflower pests. However, plant extracts, particularly neem and tobacco, present a sustainable alternative to conventional insecticides, while synthetic options like Flonicamid and Imidacloprid provide high efficacy in pest control.

Conclusions and Recommendations

The study at the Entomological Research Institute, AARI, Faisalabad, demonstrated that both botanical extracts and synthetic insecticides are effective in managing whitefly and jassid in sunflower crop, with Neem and Tobacco extracts emerging as promising alternatives due to their high mortality rates. Integrating these botanical options with synthetic insecticides within an integrated pest management (IPM) strategy can reduce chemical reliance and enhance crop yield. Recommendations include combining plant extracts and synthetic insecticides to bolster control and minimize resistance, rotating different treatments to prevent resistance, using environmentally friendly extracts like neem oil or garlic to protect beneficial insects, applying insecticides selectively during peak infestations to target hotspots, and regularly monitoring fields to adapt treatments based on pest dynamics.

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Novelty Statement

This study compares the efficacy of conventional insecticides with indigenous plant extracts in managing sucking insect pests of sunflower (*Helianthus annuus*). It explores the potential of plant extracts as a sustainable and eco-friendly alternative to traditional chemical methods, offering new insights into effective

and environmentally responsible pest control.

Author's Contribution

Saad Rasheed: Conducted and experiment and data collection.
Dilbar Hussain: Mehodology.
Usama Saleem: Wrote abstract and reviewed.
Muhammad Usman: Formal analysis.
Zeeshan Javed: Conceptualization
Saqlain Irshad: Statistical analysis.
Muhammad Imran: Proof read.
Usama Bilal: Draw the graphs.
Saddam Hussain: Provided technical input.
Rashid Ali: Wrote conclusion.
Muhammad Asrar: Supervised the study.

Conflict of interest

The authors have declared no conflict of interest.

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