Research Article

Assessment of Botanical and Synthetic Insecticides Against Aphids (*Lipaphis Erysimi* (Kalt.)) and their Effect on the Natural Predators Associated with Canola Crop

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Abstract | Aphids are devastating insect pest of canola and can cause 10–90% damage depending upon the severity of the infestation and crop stage. The study aimed to evaluate the efficacy of various synthetic insecticides and botanical extract against mustard aphids while considering its impact on ladybird beetles and green lacewings, which are important bioagents. A Randomized Complete Block Design (RCBD) with eight treatments and three replications experiment was setup with six synthetic insecticides, a botanical extract (neem leaves extract) and a control, to find out the best performing treatment against aphids with minimal impact on the natural predator in canola crop. The results indicated a clear exposure-interval dependent variation in the reduction of mustard aphid populations. Following the first and second spray applications, the percent reduction in aphid populations after 24 hours ranged from 24.51% to 43.62% and 52.88% to 59.26%, respectively. Notably, after an exposure interval of one week (7 days post spray), the reduction in aphid populations increased significantly, reaching between 66.87% and 87.07% for the first application and 76.16% to 94.94% for the second application. The efficacy of all insecticides tend to decrease with time however Mospilan 20SP and Novastar 56EC were particularly effective, achieving over 80% reduction in aphid populations after 14 days post-treatment. Insecticides residues remained toxic for up to 72 hours, causing a significant reduction in populations of beneficial insects like Coccinellids and *Chrysoperla carnea*. However, increase in the population of both predators was noted after 7 days post spray. Mospilan 20SP exhibited the highest acute knockdown toxicity to coccinellid and lacewings, with rates of 87.10% to 90.06% and 67.65% to 79.52% respectively after 1st spray and 78.75% to 88.72% and 71.18-79.15% after 2nd spray for coccinellid and lacewings respectively. Actara 25WP, Imicid 20SL, Movento 480SC and Neem leaves extract demonstrated chronic residual toxicity against coccinellid and green lacewings predators, suggesting their suitability for integrated pest management (IPM) strategies. These treatments offer a more balanced approach by effectively managing aphid populations while minimizing harm to beneficial insects. These findings highlight the importance of selecting pest control options that align with sustainable agricultural practices. Botanical plants extracts like neem show promise as eco-friendly alternatives and warrant further investigation for cost effective, environmental safe aphid management of in canola agroecosystems.

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Introduction

Pakistan is currently grappling with a significant shortage of edible oil, leading to the import of over 80% of its needs at a high cost, while only 20% is produced locally. In the year 2020-21, the country produced 127 thousand tons of oil from canola, mustard, and rapeseed, cultivated over an area of 277 thousand hectares (Din *et al.*, 2022). Among these, the canola (*Brassica napus* L.) is a key oilseed crop belonging to the Brassicaceae family (Miri, 2007), valued for its high-quality oil and versatility in use, including fodder, feed, and vegetables. The byproduct, oilseed cake, is also utilized as animal feed (Chand *et al.*, 2017).

Currently, Pakistan produces approximately 70% of its canola oil, with the remaining 30% being imported (Din *et al.*, 2022). Canola is recognized for its high yield potential, characterized by its elongate flower raceme, which contains a moderate number of large siliqua filled with bold seeds. Canola seeds typically contain 40% or more oil and yield meals with 35-40% protein (Raymer, 2002).

Despite its importance, canola and other oilseed brassicas, such as *Brassica juncea* (Raya) and *Brassica compestris* (Sarsoon), are still considered minor crops in Pakistan. The seeds of canola are low in erucic acid and glucosinolates, and the oil contains 5-8% saturated fats, which is lower than that of other vegetable oils (Sharma *et al.*, 2020). However, the canola crop faces threats from various insect pests, including the mustard aphid (*Lipaphis erysimi*), green peach aphid (*Myzus persicae* Sulzer), cabbage aphid (*Brevicoryne brassicae* L.), cabbage caterpillar (*Pieris brassicae*), and leaf miner (Saljoqi *et al.*, 2006).

Among these, *L. erysimi* is particularly destructive, causing significant damage to flower buds, shoots, and pods (Kumar *et al.*, 2021). The indiscriminate use of pesticides has led to resistance development and resurgence of pests, alongside environmental and health concerns. High-intensity insecticide applications can also harm beneficial arthropods that play a role in pest control. Biological control methods utilizing predators and parasitoids are essential components of integrated pest management (IPM) (Ali *et al.*, 2022). To effectively select and apply insecticides, it is crucial to understand their residual effects on both target pests and beneficial biocontrol agents (Mansour *et al.*, 2011). Therefore, the present study aims to investigate the toxic effects of selected insecticides and botanical extract on *L. erysimi* mustard aphids and their associated natural predators under field conditions.

Materials and Methods

Experimental site

The study was performed at the Entomology Research field, Agricultural Research Institute (ARI) Tarnab Peshawar during the Rabi season 2024.

Experimental design

The experiment was laid out in a Randomized Complete Block Design (RCBD) comprises of eight treatments including control (Table 1) where each treatment was replicated three times. Prior to experiment, the field was prepared by tractor's ploughing and then divided into three main blocks. Each block was then split into eight equal plots ($4x4m^2$). There were total 21 plots in the experiment and each plot had four rows.

Table 1: *Different synthetic insecticides and botanical extract tested against mustard aphids in canola crop*

Treatments	Trade name	Active ingredients	Dose $acre^{-1}$
T1	Imicid 20 SL	Imidacloprid	250 ml
T2	Mospilan 20 SP	Acetamiprid	100 gm
T3	Movento 480 SC	Spirotetramate	150 ml+250 ml adjuvent
T4	Novastar 56 EC	Abamectin+ Bifenthrin	50 ml
T5	All Star 10 SC	Bifenthrin	250 ml
T6	Actara 25 WP	Thiamethoxam	24 gm
T7	Neem leaves extract	Azadirachtin	1000 ml
T8	Control	-----	-----

Sowing and management of Canola crop

The canola (*Brassica napus*) seeds (Raya) were purchased from local pesticides dealers and sown in the first week of October, 2023. Plant-to-plant and row-to-row distance was kept as 35 and 50cm respectively. Fifteen canola plants were maintained in a row. Field management activities such as cultivation, weeding, irrigation and maintenance were completed as required. A manually controlled 20-liters knapsack sprayer with a flat jet nozzle was used for spraying purpose.

Table 2: *Percent reduction in population of mustard aphids following treatment with synthetic insecticides and botanical extract after first and second spray applications*

1st Spray	Treatments	Percent reduction in aphid population				
		24h	48h	72h	7 days	14 days
	Imicid 20 SL	30.72±6.33cd	75.17±4.02a	82.81±5.14b	80.27±3.97b	62.71±4.31d
	Mospilan 20 SP	43.62±3.51a	74.5±5.84a	83.99±6.63ab	87.07±4.01a	85.92±5.12a
	Movento 480 SC	36.93±3.98a-c	71.55±5.93c	78.66±4.34bc	81.05±5.05b	67.18±4.28e
	Novastar 56 EC	33.76±4.10bc	72.02±4.72a	79.38±6.27c	87.19±3.59a	83.47±6.38a
	All Star 10 SC	40.65±7.34ab	64.73±6.01b	77.87±4.98bc	75.21±5.40c	72.71±3.23bc
	Actara 25 WP	40.31±3.08ab	61.31±3.91bc	83.23±4.13a	81.17±3.46b	74.68±5.35b
	Neem leaves extract	24.51±5.15d	56.43±5.29a	76.65±5.36bc	65.83±6.15d	55.07±4.13cd
	LSD (0.05)	7.9213	4.8412	8.8120	4.8545	7.0607
2nd Spray	Imicid 20 SL	54.17±1.05ab	69.66±4.71ab	83.28±3.89ab	87.55±4.08b	80.08±2.54b
	Mospilan 20 SP	59.26±2.08a	70.51±2.32a	89.36±2.93a	94.37±3.81a	86.89±2.02a
	Movento 480 SC	53.27±5.93ab	67.84±1.89c	88.92±5.45ab	84.19±3.07c	75.53±1.89e
	Novastar 56 EC	54.72±2.74ab	68.61±3.32ab	89.61±2.89a	94.94±4.58a	80.71±3.11bc
	All Star 10 SC	58.99±3.94a	63.39±3.57bc	75.57±4.71b	92.35±5.00a	73.12±1.96d
	Actara 25 WP	57.46±3.87c	62.97±1.90c	82.81±4.09a	86.78±3.89b	78.29±2.11bc
	Neem leaves extract	52.88±2.04b	62.35±2.02ab	82.92±2.55a	76.16±4.05b	69.74±3.26cd
	LSD (0.05)	6.6061	4.6938	7.8077	4.6185	5.7063

Details of synthetic insecticides tested in experiment

All the tested synthetic insecticides were purchased from the local pesticides dealers and were sprayed onto the crop when the aphids population plant^{-1} reached at the economic threshold level (10-15 plant^{-1}). The details of all treatments are mentioned in Table 1.

Neem extract preparation

Fresh neem leaves were collected from the neem trees located at ARI Tarnab, Peshawar. The leaves were gently rinsed with water to remove any dirt, dust or other contaminants and were sun dried for 10 days to remove excess of moisture and preserved. The dried leaves were then ground into fine powder with the help of grinder and 70 gm of this fine powder was mixed with 2-3 grams of detergent (Bonus Tristar). The whole solute was then wrapped in a muslin cloth and soaked in one liter pre boiled water for 24 hours. The extract was properly squeezed by hand and stored as stock solution (10%) for further experimentation. The stock solution was then diluted to 2% concentraion according to the protocol followed by Badshah *et al.* (2015).

Parameters studied

Percent reduction in aphids population

Percent reduction in natural enemies population

Effect of insecticides on average yield of canola

Percent increase in yield over control

Field observation and data collection

For every observation, 15 plants per replicated plot were randomly selected and tagged. The plants were thoroughly observed by inspecting the top, middle and bottom portion of plants and mean population of aphids was calculated. Two sprays were applied at 14-days interval beginning at the onset of infestation to evaluate the efficacy of selected insecticides. The top, middle, and bottom leaves of 15 randomly chosen plants were sprayed, and the population densities were measured 24 h, 48 h, 72 h, 7 days and 14 days after each application. Only the two central rows were used to obtain all the data.

Statistical analysis

The recorded data regarding reduction of mustard aphids and their natural predators were subjected to ANOVA technique to determine the level of significance of evaluated treatments. The means of significant treatments were compared by LSD test.

Results

Efficacy of different synthetic insecticides and botanical extract against mustard aphids

Results regarding the efficacy of synthetic insecticides

on the mean population of mustard aphids and their associated natural predators are presented below.

Percent reduction in mustard aphid population 24 hours after first and second spray applications

Table 2 showed the 24h post spray effects of synthetic insecticides on the population of mustard aphids. After the 1st spray, maximum percent reduction in population of mustard aphids was obtained by Mospilan 20SP followed by All Star 10SC and Actara 25WP which caused 43.62±3.51%, 40.65±7.34% and 40.313.08% reduction in aphid population respectively. Movento 480SC (36.93±3.98%), Novastar 56EC (33.76±4.10%) and Imicid 20SL (30.72±6.33%) exhibit moderate mortality against aphids and were non-significant in their performance. Minimum percent reduction (24.51±5.15%) was recorded in plots sprayed with Neem leaves extract and hence found comparatively less effective.

Similar trend in population of mustard aphids was observed after the 2nd application. Mospilan 20SP proved superior in efficacy against the aphids with (59.26±2.08%) reduction in aphid population which was statistically similar with All Star 10SC (58.993.94%) and Actara 25WP (57.46±3.87%) compared to all other treatments. The lowest reduction in mustard aphid population was obtained in Neem leaves extract (52.88±2.04%) and Movento 480SC (53.27±5.93%) post spray of 24h, both the treatments were statistically at par with each other.

Percent reduction in mustard aphid population 48 hours after first and second spray applications

The effect of insecticides on the population of mustard aphids after 48 hours of the first spray is detailed in Table 2. The results indicated that Imicid 20SL achieved the highest percent reduction in aphid population (75.17%), followed by, Neem leaves extract (74.50±5.84%), Novastar 56EC (72.02±4.72%) and Mospilan 20SP (71.55±5.93%), with all differences being statistically non-significant in efficacy. All Star 10SC (64.73±6.01%) and Actara 25WP (61.31±3.91%) were intermediate in their efficacy against the aphid's infestation. Movento 480SC resulted in the lowest reduction (56.43±5.29%), making it less effective compared to the other insecticides.

After the second spray, Mospilan 20SP again demonstrated the highest efficacy, achieving a maximum reduction of (70.51±2.32%), followed by Imicid 20SL (69.66±4.71%), insignificant with each other. Other treatments, Novastar 56EC and Movento 480SC lowered the aphid's population upto 68.61±3.32% and 67.84±1.89% respectively. Actara 25WP and Neem leaves extract were comparatively less effective, leading to only 62.97±1.90% and 62.35±2.02% reductions in aphid populations, respectively.

Percent reduction in mustard aphid population 72 hours after first and second spray applications

The results observed 72 hours after the first spray application of various synthetic insecticides against mustard aphids are presented in Table 2. Analysis of variance revealed that Actara 25WP achieved the highest reduction (83.23±4.13%) in aphid population, followed closely by Mospilan 20SP (83.99±6.63%) which was statistically similar with Imicid 20SL (82.81±5.14%), however significantly different from rest of the treatments. Percent reduction of 79.38±6.27%, 78.66±4.34%, 77.87±4.98% was observed in plots treated with Novastar 56 EC, Movento 480SC and All Star 10SC respectively, all showing non-significant differences. Neem leaves extract was the least effective, resulting in minimal reductions of 77.67±5.36% which was statistically similar to All Star 10SC. Overall, the insecticides significantly outperformed the control in reducing aphid populations.

A similar trend was observed following the second spray application. All insecticides caused over 80% reduction in aphid populations, except All Star 10SC which caused lowest resulted in the lowest reduction (75.57±4.71%) in aphid's infestation on canola. The treatments, Novastar 56EC, Mospilan 20SP and Movento 480SC had led to significant reductions of 89.61±2.89%, 89.36±2.93% and 88.92±5.45% in aphids infestation respectively.

Percent reduction in mustard aphid population 7 days after first and second spray applications

One week after spray application (Table 2), all insecticides except Movento 480SC, significantly affected the mean population of mustard aphids, achieving over 80% reduction in their numbers. Novastar 56EC (87.19±3.59%) and Mospilan 20SP (87.07±4.01%) demonstrated high effectiveness, each reducing aphid populations by more than 85%. Other insecticides, Actara 25WP and Imicid 20SL e.

Table 3: *Percent reduction in the population of Ladybird beetle (Coccinellid sp.) following treatment with synthetic insecticides and botanical extract after first and second spray applications*

1st-Spray	Treatments	Percent reduction inCoccinellid sp.population				
		24h	48h	72h	7 days	14 days
	Imicid 20 SL	69.37±2.09d	73.17±3.83d	81.24±1.67bc	73.91±2.74b	57.64±4.22c
	Mospilan 20 SP	87.35±3.16a	90.06±2.41a	87.11±3.3a	81.07±4.13a	73.28±2.15a
	Movento 480 SC	65.29±2.44e	76.61±3.17c	70.42±4.12d	63.37±2.88cd	51.61±3.41d
	Novastar 56 EC	77.41±1.58b	83.40±3.31b	85.11±2.59ab	75.39±2.13b	60.25±3.29bc
	All Star 10 SC	65.66±2.75e	57.19±1.97g	72.63±2.36d	61.18±3.87d	62.47±4.18b
	Actara 25 WP	73.29±3.27c	69.67±2.13e	63.28±3.18e	54.71±2.69e	46.19±2.55e
	Neem leaves extract	59.82±2.56f	64.35±3.07f	79.72±2.54c	68.23±1.98c	51.36±2.23d
	LSD (0.05)	2.57	2.42	4.45	4.94	3.79
2nd Spray	Imicid 20 SL	60.61±4.12d	76.01±1.95c	80.61±3.44d	53.96±2.27e	41.12±2.46f
	Mospilan 20 SP	78.75±2.81a	83.05±2.67ab	88.72±4.29a	76.67±1.84a	65.34±2.09a
	Movento 480 SC	66.73±3.86c	73.93±2.79c	85.34±3.87c	61.34±2.52c	59.49±4.12c
	Novastar 56 EC	61.22±2.52d	83.92±4.08a	85.02±3.11c	73.95±1.63a	62.19±3.21b
	All Star 10 SC	77.98±3.11ab	73.08±2.64c	87.23±4.09b	70.55±2.44b	63.31±1.59ab
	Actara 25 WP	69.15±3.34c	74.91±3.19c	76.49±2.88f	57.67±3.17d	47.33±3.11e
	Neem leaves extract	75.29±2.62b	79.72±4.51b	78.24±2.71e	61.76±2.47c	57.28±3.10d
	LSD (0.05)	2.94	3.63	1.37	3.21	2.09

showed significant reduction of 81.17±3.46% and 80.27±3.97% respectively compared to Movento 480SC which was less effective, with reductions of 66.87±6.15%, making it the least effective options in this study. During the second spray, all the insecticides exhibits highest efficacy against the aphids after one week of application. The highest percent reduction (94.94±4.58%) in aphid's population was displayed by Novastar 56EC which was statistically insignificant with percent mortality achieved by Mospilan 20SP (94.37±3.81%). Neem leaves extract with 76.16±4.05% reduction in aphid population proved comparatively least effective

Percent reduction in mustard aphid population 14 days after first and second spray applications

The results of insecticide efficacy against mustard aphids, assessed two weeks after each of the two spray applications, are summarized in Table 2. The data revealed that Mospilan 20SP and Novastar 56EC were the most effective insecticides, achieving aphid population reductions of 85.92±5.12% and 83.47±6.38% after the first spray, and 86.89±2.02% and 80.10±3.11% after the second spray, respectively. Actara 25WP, All Star 10SC and Imicid 20SL also showed considerable efficacy, with reduction of 74.68±5.35% and 78.29±2.11%, 72.71±3.23% and 72.71±3.23% and 73.12±1.96% and 80.08±2.54% after the first and second sprays respectively. In contrast, neem leaf extract was the least effective treatment resulting in a 55.07±4.13% reduction after the first spray and 69.74±3.26% reduction two weeks after the second spray application.

Effects of synthetic insecticides and botanical extract on mean population of ladybird beetle (Coccinellid sp.) after first and second spray applications

The application of synthetic insecticides has had a detrimental impact on ladybird beetle (Coccinellids) populations across all treated plots compared to control groups (Table 3). Analysis of variance revealed a significant reduction ($p<0.05$) in mean populations, with Mospilan 20SP causing the highest reduction at 73.28±2.15% ($p<0.05$). This was followed by All Star 10SC at 62.47±4.18%, which was statistically similar to Novastar 56EC at 60.25±3.29% reduction. The least reduction in coccinellids population was caused with Actara 25WP, which showed a 46.19±2.55% (1st spray) and 47.33±3.11% (2nd spray) decrease after 14 days post-application. Additionally, Neem leaves extract (51.36±2.23% and 57.28±3.10%), Movento 480SC (51.61±3.41% and 59.49±4.12%) and Imicid 20SL (57.64±4.22% and 41.12±2.46%) demonstrated moderate toxicity against coccinellids on canola crops

Table 4: *Percent reduction in the population of green lacewings (Chrysoperla carnea) following treatment with synthetic insecticides and botanical extract after first and second spray applications*

1ST Spray	Treatments	Percent reduction in C. carnea population				
		24h	48h	72h	7 days	14 days
	Imicid 20 SL	72.55±5.13a	77.29±3.39a	69.40±3.06b	61.43±3.96c	57.87±1.98c
	Mospilan 20 SP	67.65±2.99a	73.14±2.02a	79.52±2.98a	73.83±2.03a	61.05±2.69bc
	Movento 480 SC	42.53±1.22d	55.83±2.90c	64.54±1.94c	58.15±3.05d	52.34±2.11d
	Novastar 56 EC	53.63±2.06bc	61.24±2.26bc	76.56±4.31a	68.73±2.88b	65.29±4.04ab
	All Star 10 SC	48.69±3.17cd	66.91±2.13b	62.35±2.08cd	55.34±3.09e	68.61±2.06a
	Actara 25 WP	67.47±5.04a	66.33±2.71b	59.88±2.97d	57.99±4.13d	51.34±1.95d
	Neem leaves extract	55.88±2.03b	59.26±3.29c	61.08±1.86cd	56.95±1.43de	50.17±3.95d
	LSD (0.05)	6.9831	5.9316	4.0626	1.6644	4.5900
2nd Spray	Imicid 20 SL	65.72±2.91a-c	70.15±1.97b	60.67±1.89c	54.19±4.07b	49.71±2.04b-d
	Mospilan 20 SP	71.18±4.45a	75.48±2.97a	79.15±0.99a	68.10±2.50a	58.77±2.96a
	Movento 480 SC	61.16±3.99b-d	68.36±1.55bc	77.57±2.12a	65.08±2.97a	51.92±1.68bc
	Novastar 56 EC	54.65±3.13d	75.35±2.26a	77.45±3.26a	66.38±1.67a	54.62±3.96ab
	All Star 10 SC	70.41±1.78a	65.51±2.53c	79.66±2.87a	70.98±3.23a	59.74±2.1a
	Actara 25 WP	60.58±2.78cd	67.33±3.16bc	68.92±1.37b	54.10±2.13b	48.62±1.74cd
	Neem leaves extract	67.86±2.17ab	65.52±1.05c	63.18±1.67c	50.84±2.94b	44.5±1.87d
	LSD (0.05)	6.9851	4.2624	5.6778	6.5034	5.2884

after 14 days of 1st and 2nd spray respectively.

Table 5: *Effect of different synthetic insecticides and botanical extract on average canola yield (kg ha^{-1})*

Treatments	Yield		
	Kg plot^{-1}	Kg ha^{-1}	% increase
Imicid 20 SL	1.73	1081.25±9.02b	53.10
Mospilan 20 SP	1.83	1143.75±13.43a	61.95
Movento 480 SC	1.52	950.00±16.98d	34.51
Novastar 56 EC	1.67	1043.75±12.94bc	47.79
All Star 10 SC	1.55	968.75±16.49d	37.17
Actara 25 WP	1.61	1006.25±13.03c	42.48
Neem leaves extract	1.46	912.50±11.17e	29.20
Control	1.13	706.25±9.48f	----
LSD (0.05)		38.582	----

Effects of synthetic insecticides and botanical extract on mean population of green lace wings (GLW) (Chrysoperla carnea) after first and second spray applications

The mean population of green lacewing (*C. carnea*) was significantly affected by all the synthetic insecticides as shown in Table 4. Maximum mean population of GLW was recorded in control. However, among the insecticidal treatments, All Star 10SC was noted as most toxic insecticides against GLW which resulted in highest percent reduction (68.61±2.06% and 59.74±2.10%) in GLW population after both 1st and 2nd spray respectively. Neem leaves extract, Actara 25WP and Movento 480SC were found comparatively less toxic against lacewings with mean reduction of (50.17% and 44.5%), (51.34% and 48.62%) and (52.34% and 51.92%) in population of green lace wings respectively. Neem leaves extract and Actara 25WP were non-significant compared to rest of the treatments. Mospilan 20SP (61.05±2.69% and 58.77±2.96%) and Novastar 56EC (65.29±4.04% and 54.62±3.96%) exhibit moderate toxicity against the mean population of green lacewings after both the sprays applications.

Effect of synthetic insecticides and botanical extract on average canola yield (kg ha^{-1})

Results in Table 5 indicated the effect of insecticides on the final yield of canola. The yield was significantly improved in treated plots than control. The yield was significantly higher in plots treated with insecticides compared to untreated (control). The highest yield was recorded in plots sprayed with Mospilan 20SP (1143.75 kg ha^{-1}), followed by Imicid 20SL (1061.25 kg ha^{-1}), Novastar 56EC (1043.75 kg ha^{-1}) which were statistically similar to the yield obtained in plots where the Actara 25WP (1006.25 kg ha^{-1}) was applied. Yields from All Star 10SC (968.75 kg ha^{-}

[1]), and Movento 480SC (950.00 kg ha^{-1}) were all significantly higher than the control, but there were no significant differences among these treatments. The lowest yield was observed in the untreated control plots (487.50 kg ha^{-1}). Similarly, Mospilan 20SP and Imicid 20SL resulted highest percent increase (61.95%) and (53.10%) respectively in canola yield over control compared to 29.20% increase recorded in the plots treated with Neem leaves extract.

Discussion

Canola crop (*Brassica napus*) is heavy attacked by mustard aphids, *Lipaphis erysimi* (Kalt.) from seedling to flowering stage causing yellowing of the leaves, cessation and wilting of flowers. It is responsible for causing about 30-35% yield losses on brassica plants but if left uncontrolled, the yield losses may exceed up to 70%. Therefore, insecticides application becomes necessary to reduce the damage caused by aphids. However, indiscriminate use of insecticides can result in the development of resistance and resurgence in the pest besides environmental and health hazards. Extensive application of insecticide sprays causes mortality of beneficial insects associated with canola. To avoid these problems, identification and development of safe chemicals with improved insecticidal properties, low mammalian toxicity and safety to natural enemies is needed. Therefore, the study was planned to evaluate the efficacy of some commonly used insecticides against mustard aphids and their associated natural predators under natural field condition during the year 2023.

Results showed that all the tested insecticides significantly reduced the infestation of mustard aphids (>70%) compared to the control during the studied period. Among all treatments, Mospilan 20SP and Novastar 56EC proved highly effective and caused maximum reduction during both the sprays while Movento 480SC and Neem extract were comparatively less effective against the mustard aphids at all intervals. The results are in agreement with findings proposed by Arif *et al.* (2012), who tested the efficacy of various synthetic insecticides against the mustard aphids and their natural predator and recorded advantage and Mospilan 20SP as best performing insecticide among all the treatments. The results align with current findings as Mospilan 20SP gave maximum reduction in aphid population. These results also are more or less comparable with those of Schroeder *et al.* (2001). The insecticides, Mospilan 20SP and Novastar 56EC showed maximum reduction in mean population of aphids during all the intervals in both the sprays while Bifenthrin (All Star 10SC) remained effective after 72h and 7 days of insecticides application. Imicid 20SL and Fixin were moderately toxic against the aphids and remained effective upto 72h after the spray afterward a slight in increase in population was recorded while Neem extract proved to be comparatively least effective against the aphids on canola in all the intervals. The results are in agreements with those of Schroeder *et al.* (2001) and Kumar and Dikshit (2001). The results are partially at par with findings reported by Sarwar *et al.* (2003), the variation in results might be due to the difference in experimental treatments. In studies conducted by Gaber *et al.* (2015) and Amer *et al.* (2010) synthetic insecticides were found effective against the mustard aphids compared to the control. They recorded thiamethoxam and bifenthrin respectively as most effective insecticides against the target insect pest population. In present study, Imicid 20SL and Actara 25WP were moderately toxic against the aphids and remained effective upto 72h after the spray while later on a slight in increase in population was recorded however Neem extract proved to be comparatively least effective against the as reported by Kumar and Dikshit (2001). Iqbal *et al.* (2015) who studied the effect of different botanicals for the management pf insect pest and found neem leaves extract as efficient candidate compared to other treatments. The results are also in agreement with the findings reported by Liyanage *et al.* (2019).

Toxicity of all the insecticides against the natural enemies including the ladybird beetle and green lacewings were also evaluated. The population of ladybird beetle and green lacewings was significantly affected by all the insecticides, hence all of the tested insecticide harm the natural enemies upto some extant. As the insecticides have quick knock down effect they were highly toxic against the aphids as well as natural predators. Among the treatments, highest toxicity against the predator was recorded in plots sprayed with Mospilan 20SP followed by All Star 10 SC and Neem extract after 48h of spray application compared to Imicid 20SL where the population of predators were slightly high. The results are in confirmation with that of Echegaray (1999), who concluded that ladybird beetles are vulnerable to the synthetic insecticides. Similar finding were made

by Ahmad and Shah (2022) who studied the effect of insecticides against the natural enemies on okra crop and found bifenthrin as toxic insecticide which is in agreement with current findings. Kar (2017) also reported bifenthrin as toxic chemicals compared to Imida 20SL and Actara 25WP which is consistent with the present results. Rahmani *et al*., (2013) stated that thiamethoxam (Actara 25WP 25WP) is safe against the ladybird beetles but should be used cautiously in IPM programs. According to He *et al*. (2012), Imidacloprid and Actara 25WP when sprayed at recommended dose, is less toxic to the ladybird beetle. Overall it was observed that insecticides drastically reduced the population of natural enemies at 72h of spray and then exhibit slight decline in population after 7 days of application which means that these insecticides have residual toxicity for 72h against the natural predators after which the toxicity decreases. Hence it can be concluded these insecticides should be applied 72h before the introduction of ladybird beetles and green lacewings.

Conclusions and Recommendations

Based on the results of this experiment, synthetic insecticides have shown to be the most effective strategy for managing mustard aphid infestations. Mospilan 20SP and Novastar 56EC significantly reduced aphid populations and increased crop yields. Despite of better aphid's control, Mospilan 20SP also negatively affected the population of natural predators such as ladybird beetle and green lacewings indicating the need for careful application. In contrast, Actara 25WP and Neem extract exhibited lower toxicity to beneficial insects, making them more environmentally friendly alternatives.

Although the synthetic insecticides (Mospilan 20SP, All Star 10SC and Novastar 56 EC) did affected the natural enemies, the impact was relatively minor compared to significant increase in crop yield. However, it is advisable to explore the use of locally available bio-pesticides or botanical extracts such as neem extract or others which are often more affordable and offer a sustainable alternative for effective pest management.

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Novelty Statement

This study is novel in highlighting the potential of integrated pest management approaches using selective synthetic insecticides and botanical extracts against canola aphids, providing valuable insights into sustainable management options that minimize harm to natural predators and promote eco-friendly pest control strategies.

Author's Contribution

Dr. Fazli Amin: Conceived and designed the experiment, conducted data collection and analysis, and prepared the initial manuscript draft.
Dr. Saboor Naeem: Supervised the overall research work and ensured the scientific accuracy of the study.
Mr. Abdul Qadar: Assisted in experimental setup and data analysis.
Mrs. Qurratul Ain Tahira: Provided technical inputs and critical manuscript review.
Muhammad Junaid: Contributed in data collection and overall field maintenance.
All authors read and approved the final version of the manuscript.

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No AI tool was used in the completion of this article/research work.

Conflict of interest
The authors have no conflict of interest.

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