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Efficacy of Botanical and Synthetic Insecticides in field conditions for the management of Cabbage Insect Pests at District Dadu, Sindh

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Abstract

The study was conducted to evaluate the effectiveness of chemical and botanical insecticides against major cabbage insects at farmer field, District Dadu, Sindh during September-December 2023. Green Light" variety was sown in the first week of September, and the nursery was transplanted into the field during the first week of October. Seven treatments were applied including control viz., 10% Tobacco leaves extract, 10% Chinaberry fruit extract, 10% Neem leaves extract, Lambda cyhalothrin 2.5 EC, Imidacloprid 25% WP and Spinosad 240 SC, replicated 3 times. An untreated control plot was left blank as a check plot. Randomize Complete Block Design (RCBD) and Statistix 8.1 was used for analysis. Results show that all the tested treatments were found to be better than the control in reducing the cabbage larvae population. Spinosad 240 SC was found to be the most effective treatment with the lowest larvae population (0.89 and 0.77 larvae leaf^{-1}) and maximum reduction of larvae population (73.04 and 84.01 %) after 1st and 2nd treatment application, respectively. Among botanical extracts, Neem leaf extract was the most effective, with the lowest larval population (1.18 and 1.04 larvae leaf^{-1}) and the highest reduction (57.30% and 75.36%) after the 1st and 2nd treatment applications. The tested treatments were also found to be better than the control in reducing cabbage aphids' population. Spinosad 240 SC was found the most effective treatment with the lowest aphids population (4.69 and 2.47 aphids leaf^{-1}) and maximum reduction of aphid population (60.97 and 80.31 %) after 1st and 2nd treatment applications, respectively. Compared to other botanical extracts, Neem leaf extract showed the lowest aphid population (6.14 and 3.90 per leaf) with percent mortality of 48.74% and 68.00% after the 1st and 2nd applications. Resulting in the highest yield of cabbage (1005.33 kg ha^{-1}) with cost-benefit ratio (of 5.45) was recorded in Spinosad 240SC, followed by imidacloprid 25%WP (992.33) with cost-benefit ratio (5.79). Among the botanical extracts, Neem leaf extract resulted in a yield of (685 kg/ha) with a cost-benefit ratio of (1.59) was recorded. It was concluded that all the tested insecticides were reducing the population of cabbage larvae and aphids. All the botanical extracts reduce the population of aphids and cabbage larvae, but as compared to other extracts neem extracts showed the best results among them. Hence using Imidacloprid 25% WP, Spinosad 240 SC at District Dadu is recommended for sustainable management of cabbage larvae and aphids.

Keywords: Cabbage, Green Light, Botanicals, Dadu, Sindh.

Introduction

Cabbage (Brassica oleracea), is a crucial crop, serving as a primary leafy vegetable in Pakistan. As a significant component of human diets, it provides essential phytonutrients like

phytochemicals, dietary fibers, minerals and vitamins (Dias, 2012). This crop is cultivated globally over an area of 2.82 million hectares. It boasts a gross output of 82.8 million tons with average production of 29.4 tons/ ha (Shokirov et al., 2021). China stands as one of the largest cabbage producers, while Pakistan contributing a cultivation area of 5679 hectares and a production of 101,589 tons in 2019-2020. This positions Pakistan as a notable cabbage-growing region within the broader Asian context (Atlas, 2024). Specifically, in Sindh during the same period, cabbage was cultivated over 503 hectares, yielding 4,125 tons (Indexbox, 2022).

The cultivation of this specific crop is frequently challenged by a variety of insect pests. Notable among these are the cabbage butterfly, (Pieris brassicae L.)), diamondback moth, (Plutella xylostella), cabbage semilooper (Trichoplusia), head borer (Hellula undalis), Tobacco caterpillar, (Spodoptera litura), Cabbage aphid, (Brevicorneae brassicae) and green peach aphid (Myzus persicae). These pests, as highlighted by Sachan and Gangwar (1980), significantly hinder the crop's profitability.

The cabbage white butterfly loses a significant threat to cauliflower and cabbage crops (Hasan et al., 2008). Single larvae of this pest are known to consume an area ranging from 74 to 80 cm^2 of leaf surface, leading to a substantial annual yield loss of 40 percent in cruciferous vegetables (Hasan et al., 2010). The impact of infestation goes beyond quantity, as the feeding activity can result in cauliflower plants failing to form compact heads or producing deformed heads (Uddin et al., 2007). P. brassicae larvae, in addition to causing damage by boring into vegetable heads, can skeletonize host plants, significantly reducing crop value, especially for crops intended for fresh consumption (Cartea et al., 2009).

The cabbage aphid (Brevicoryne brassicae L.) is a notable insect pest from the Aphididae family within the Hemiptera order, recognized globally for its detrimental effects on plants by feeding on their sap (Wubie et al., 2014). These pests predominantly inhabit the undersides of leaves and the growth areas of affected vegetables (Munthali and Tshegofatso, 2014). Their appearance ranges from a grayish-white to a powdery blue, attributed to a waxy substance known as honeydew, though their natural color is grayish-green (Bodaiah et al., 2016). The cabbage aphid poses significant threats to the quality and yield of cabbage crops, diminishing both market value and nutritional integrity (Wubie et al., 2014). Furthermore, their infestation severely hampers plant growth, reduces the formation of side branches, and diminishes oil content (Embaby and Lotfy, 2015).

Considering the challenges associated with synthetic pesticides and their residues, there is a growing recognition for the development of effective and biodegradable alternatives with greater selectivity. The search for such alternatives has led to the exploration of natural plant products, which possess the potential to replace modern agrochemicals. These plant-derived chemicals, commonly referred to as botanicals, meet criteria such as biodegradability into non-toxic products, suitability for integrated pest management programs, and efficacy against specific target species. Botanical pesticides, extracted from plants, have demonstrated their ability to degrade rapidly, making them environmentally friendly and less harmful to beneficial pests compared to synthetic pesticides with longer environmental retention (Guleria et al., 2009).

Given the escalating concerns related to insecticide resistance and the associated yield losses, this research aims to explore alternative, less toxic insecticides both botanical and chemical for effective cabbage butterfly control and assessing their impact on cabbage yield at District Dadu of Sindh province of Pakistan.

Material and Methods

The research was conducted in the farmer field at Dadu, Sindh, to check the efficacy of different treatments including plant metabolites and synthetic pesticides against insect pests of Cabbage during September-December 2023. “Green Light” variety of Cabbage was sown in the first

week of September, and the nursery was transplanted into the field during the first week of October, employing a Randomized Complete Block Design. Each plot, sized 3 × 2m^2, was replicated three times, maintaining row-row and plant-plant distances at 75cm and 45cm, respectively. Within each plot, four rows of cabbage were cultivated, each row containing ten plants.

Treatment application

For dosage and application, treatment via spray was administered if the pest is detected in the field, with subsequent sprays administered every 14 days. The field efficacy of various treatments, including Azadiracta indica (200gm/l), Melia azedarach (200gm/l), tobacco leaf extract (30gm/l), Imidacloprid 25% WP (2.1ml/l), Spinosad 240SC (12ml/l), and Lambda cyhalothrin 2.5EC (2ml/l), was compared against an untreated control plot. All treatments were thoroughly sprayed to ensure coverage of each plant.

Data collection

Before each spray, a preliminary pest count was conducted. After each spray, post-treatment counts were performed at a frequency of 1, 2-, 3-, 7- and 14-days interval. The assessment involves visually inspecting and documenting the number of P. brassicae larvae associated with cabbage plants in the field. This examination was carried out prior to and following the second spray, with observations made at the specified intervals. The larvae count was documented for five randomly chosen plant leaves in each treatment, involving visual counting by opening leaves on heath cabbage plants (Divekar et al., 2023).

The larvae of the cabbage butterfly were enumerated by examining five plants leaves chosen at random from each plot. To evaluate the effectiveness of each treatment, the average population was transformed into a percentage representing the reduction in the pest population, calculated using the following formula:

$$\textbf{Percent reduction} = \frac{\text{No. insects in control} - \text{No. insects in treatment}}{\text{No. insects in control}} \times 100$$

Aphid populations were assessed on five randomly selected cabbage plant leaves per plot, counting both adults and nymphs on various leaf sections, as per Neog, (2020). Before treatments, a hand lens was used to count the total aphids, with the average number calculated to evaluate treatment effectiveness following Shiberu and Mulugeta, (2016). Additionally, the percentage of infested plants was recorded before treatment applications, based on the method described by Baidoo and Adam, (2012).

$$\textbf{Mean infestation} = \frac{\text{Number of infested leaves in the plot}}{\text{Total number of leaves in the plot}} \times 100$$

Yield (kg/ha)

The average yield for each treatment was determined by summing up the yield obtained from all pickings of each treatment. The yield was then converted into kilograms per hectare, and the percentage increase in yield was calculated by the following formula.

$$\text{Yield (kg/ha)} = \frac{\text{Weight of fruits (kg/ plot)}}{\text{Area of plot (m}^2\text{)}} \times 10000$$

Economic Benefit

CBR was calculated according to the method used by (Usman et al., 2015) to find out the most effective treatments in the term of cost benefit ratio using the following formula.

$$\text{C. B. R.} = \frac{\text{Estimated Net Benefit}}{\text{Total Expenditure}}$$

Statistical analysis

Statistix 8.1 was used to analyze different parameters through ANOVA and LSD test was applied for separating the means that were significantly different 5% level of significance.

Results

This study assessed the effectiveness of six different insecticides against cabbage butterfly (Pieris brassicae L.) and cabbage aphid (Brevicorneae brassicae). The mortality rates after treatment application were investigated. Results revealed variations in efficacy among the insecticides and their effect on yield. To further analyze these differences, means were compared using the LSD test at a significance level of 0.05%.

Table 1 Effect of different treatments on the larval population of cabbage butterfly after 1st spray

Treatments	DBS*	1DAS*	2DAS	3DAS	7DAS	14DAS	Means
Tobacco leaves extract	1.96a	1.86b	1.82b	1.68b	1.64b	1.58b	1.76b
Chinaberry fruit extract	2.14a	1.51c	1.56c	0.92c	0.75c	0.70c	1.26c
Neem leaves extract	1.89a	1.61bc	1.31c	0.92c	0.68cd	0.64c	1.18cd
Lambda cyhalothrin	2.09a	1.52c	1.05cd	0.71cd	0.51de	0.47cd	1.06de
Imidacloprid	2.11a	1.45c	0.82de	0.51de	0.47e	0.34d	0.95e
Spinosad	2.08a	1.49c	0.65e	0.44e	0.32e	0.34d	0.89e
Control	2.21a	2.35a	2.39a	2.34a	2.41a	2.48a	2.36a
CV	10.53	10.86	15.18	10.66	12.19	13.63	8.17

Means in columns are compared at 5% level of significance.

DBS: Day before Spray, DAS: Day After Spray

Mean density of cabbage larvae per leaf after 1st spray application

Table 1 indicated the mean number of cabbage larval population leaf^{-1} before and after treatments application. Before the 1st spray application, the larval population was found non-significant. After treatment application, the mean larval population after 2 weeks displayed that Spinosad was found dominant with lowest larval population of 0.89 leaf^{-1} which was found non-significant with Imidacloprid (0.95) followed by Lambda Cyhalothrin having larval population (1.06) respectively. The untreated plot showed highest larval count of 2.36 leaf^{-1} after spray application. Among the botanicals Neem leaves extract was found superior with larval count (1.18) which was in line with Chinaberry fruit extract (1.26) while the plot treated with tobacco leaves extract showed maximum larval population of 1.78 leaf^{-1} respectively.

Table 2. Percent mortality of treatments on the larval population of cabbage butterfly after 1st spray.

Treatments	1DAS	2DAS	3DAS	7DAS	14DAS	Means
Tobacco leaves extract	20.92b	23.68d	27.40c	31.36c	36.19c	27.91e
Chinaberry fruit extract	32.24a	34.16cd	60.83b	68.97b	71.48b	53.54d
Neem leaves extract	34.70a	44.98c	60.81b	71.88b	74.14ab	57.30cd

Lambda cyhalothrin	35.21a	56.78b	69.69ab	79.01ab	80.88ab	64.31bc
Imidacloprid	38.09a	65.55ab	78.05a	80.28ab	84.25ab	69.24ab
Spinosad	36.56a	72.57a	80.88a	86.79a	88.41a	73.04a
CV	14.88	12.83	12.56	11.25	11.07	6.77

Significant at 5% level of significance compared with control

Percent mortality of cabbage larvae after 1st spray application

The efficacy of various treatments on the percent mortality of the cabbage butterfly larvae population showed statistically significant differences as shown in Table 2. The mean percent mortality after 1st spray application indicated that Spinosad was found best causing maximum mean percent mortality of 73.04% which was found similar with Imidacloprid (69.24%) respectively followed by Lambda Cyhalothrin (64.31%). Among the botanicals, Neem leaves extract was found best having mean percent mortality 57.03% which was statistically non-significant with Chinaberry fruit extracts (53.54%). The lowest mean percent mortality of 27.91% was observed in plot sprayed with tobacco leaves extracts.

Table 3. Effect of treatments on the larval population of cabbage butterfly after 2nd spray.

Treatments	DBS	1DAS	2DAS	3DAS	7DAS	14DAS	Means
Tobacco leaves extract	1.89b	2.23b	2.20b	1.74b	1.61a	1.88b	1.93b
Chinaberry fruit extract	1.81bc	1.63c	1.46c	1.07c	0.61cd	1.07c	1.27c
Neem leaves extract	1.49cd	1.28d	1.22cd	0.84cd	0.78c	0.62d	1.04d
Lambda cyhalothrin	1.35d	1.03de	0.98de	0.70d	0.43d	0.26e	0.79e
Imidacloprid	1.62bcd	0.93e	0.82e	0.73d	0.56cd	0.34e	0.83e
Spinosad	1.43d	1.04de	0.84e	0.60d	0.37d	0.33e	0.77e
Control	3.83a	3.99a	3.88a	4a	3.45a	3.69a	3.81a
CV	11.11	10.74	10.80	11.81	15.69	12.82	6.24

Significant at 5% level of significance compared with control

Mean density of cabbage larvae per leaf after 2nd spray application

Table 3 indicated that the overall mean larval population of cabbage butterflies was found lowest Spinosad treated plot (0.77), followed by Lambda cyhalothrin (0.79) and Imidacloprid (0.83) which were statistically non-significant to each other. The highest larval population of cabbage larvae was recorded in control plot (3.81) larvae per leaf. Among the botanicals, Neem leaves extract was found best having larval count (1.04) followed by Chinaberry fruit extract (1.27) while Tobacco leaves extract was noted least effective (1.93) respectively. These findings highlight the varying effectiveness of treatments in controlling the larvae population of cabbage butterflies over time, with some treatments showing reductions in larvae as compared to the untreated plot.

Table 4. Percent mortality of treatments on the larvae population of cabbage butterfly after days of 2nd spray.

Treatments	1DAS	2DAS	3DAS	7DAS	14DAS	Means
Tobacco leaves extract	43.94c	43.39c	56.37b	53.07b	48.65c	49.09d
Chinaberry fruit extract	59.33bc	62.28b	73.26ab	82.81a	70.40b	69.62c
Neem leaves extract	67.89ab	68.58ab	79.10a	77.74a	83.49ab	75.36bc
Lambda cyhalothrin	74.12ab	74.81ab	82.50a	87.61a	92.95a	82.40ab
Imidacloprid	76.72a	79.04a	81.77a	83.77a	87.66ab	81.79ab
Spinosad	73.72ab	78.31a	84.89a	89.17a	93.94a	84.01a
CV	13.80	12.76	12.52	14.19	15.03	6.11

*Significant at 5% level of significance compared with control

Percent mortality of cabbage larvae after 2nd spray application

Table 4 indicated that mean values across all treatments showed consistent trends, with the highest mean percent mortality in Spinosad treated plot (84.01%) which was statistically non-significant with Lambda cyhalothrin (82.40%) and Imidacloprid (81.79%) followed by Neem leaves extract (75.36%) and Chinaberry fruit extract (69.62%) which was statistically non-significant. The lowest mean percent mortality was recorded in plot treated with Tobacco leaves extract (49.09%). Among the treated plant extract, Neem leaves showed maximum mean percent mortality.

Table 5. Effect of treatments on the nymph and adult population of aphids after 1st spray.

Treatments	BSA	1DAS	2DAS	3DAS	7DAS	14DAS	Means
Tobacco leaves extract	9.12a	6.65b	6.50b	5.80b	4.77bc	5.02c	6.31b
Chinaberry fruit extract	9.04a	6.72b	6.39b	5.42b	5.22b	6.44b	6.54b
Neem leaves extract	8.38a	6.91b	6.25b	5.81b	4.41bcd	5.08c	6.14b
Lambda cyhalothrin	8.99a	7.27b	6.61b	5.04bc	3.51cde	3.79cd	5.87b
Imidacloprid	7.88a	6.87b	5.61bc	4.28c	2.29e	3.28d	5.04c
Spinosad	7.62a	5.74b	4.52c	3.24d	3.25de	3.75cd	4.69c
Control	9.51a	11.04a	11.89a	12.20a	12.87a	14.51a	12.00a
CV	16.14	12.83	10.53	9.06	13.81	12.47	6.92

Significant at 5% level of significance compared with control

Mean density of cabbage aphids per leaf after 1st spray application

The mean population of aphids per leaf (Table 5) in different treatments showed the superiority of Spinosad with lowest mean population (4.69) which was statistically similar with Imidacloprid (5.04), while the untreated control plot exhibited the highest mean population of 12.00 aphid's leaf^{-1}. Among the botanicals, Neem leaves extract showed lowest aphid's

population (6.14), followed by Tobacco leaves extract (6.31) and Chinaberry fruit extract (6.54) which were recorded statistically non-significant with each other.

Table 6. Percent mortality of treatments on the nymph and adult population of aphid after different days of 1st spray.

Treatments	1DAS	2DAS	3DAS	7DAS	14DAS	Means
Tobacco leaves extract	38.32ab	45.08b	52.44c	62.77cd	65.21b	47.39c
Chinaberry fruit extract	39.15ab	46.06b	55.74c	65.49bcd	55.58c	45.62c
Neem leaves extract	36.49b	46.94b	52.20c	59.62d	64.80b	48.74c
Lambda cyhalothrin	33.62b	44.16b	58.45bc	72.74abc	73.80a	51.10bc
Imidacloprid	38.23ab	52.70ab	64.87b	74.71ab	77.35a	58.05ab
Spinosad	47.91a	61.94b	73.43a	82.21a	74.05a	60.97a
CV	15.26	11.88	07.59	08.52	06.83	07.90

Significant at 5% level of significance compared with control

Percent mortality of Aphids after 1st spray application

Table 6 presented the percent mortality of various treatments on the nymph and adult population of aphids after different days of first spray application. The overall mean data after application of treatments indicated that highest mean percent mortality was recorded in plot treated with Spinosad (60.97%) which was statistically similar with Imidacloprid (58.05%) followed by Lambda cyhalothrin (51.10%). Among the botanicals the highest mean percent mortality was recorded in Neem leaves extract (48.74%), which was found non-significant with Tobacco leaves extract (47.39%) and Chinaberry fruit extract (45.62%) which was statistically non-significant and with Lambda Cyhalothrin.

Table 4.7. Effect of treatments on the nymph and adult population of aphid after different days of 2nd spray.

Treatments	BSA	1DAS	2DAS	3DAS	7DAS	14DAS	Means
Tobacco leaves extract	5.02c	5.29b	5.00b	4.26bc	3.05c	2.89cd	4.25c
Chinaberry fruit extract	6.44b	5.29b	4.76b	4.42b	4.35b	4.62b	4.98b
Neem leaves extract	5.08c	4.41bc	4.02bc	3.48cd	3.05c	3.34bc	3.90c
Lambda cyhalothrin	3.79cd	3.61cd	3.24cd	3.04d	2.14cd	1.58de	2.90d
Imidacloprid	3.28d	3.14d	3.08cd	2.85d	1.96cd	0.88e	2.53d
Spinosad	3.75cd	3.47cd	2.79d	2.64d	1.55d	0.60e	2.47d
Control	14.51a	15.64a	16.25a	17.07a	17.17a	20.28a	16.82a
CV	12.47	10.66	12.33	9.37	14.76	19.07	7.40

Significant at 5% level of significance compared with control

Mean density of cabbage larvae per leaf after 2nd spray application

Overall mean data in table 7 exhibited that, the lowest mean aphid population leaf^{-1} was recorded in plot treated with Spinosad (2.47), followed by Imidacloprid (2.53) and Lambda cyhalothrin (2.90) which was statistically non-significant with each other. The untreated control plot recorded the highest mean population (16.82). Among the botanicals, Neem leaves extract was noted best with lowest aphid's population (3.90) and was observed statistically similar with Tobacco leaves extract (4.25) while Chinaberry fruit extract exhibited highest population (4.98).

Table 8. Percent mortality of treatments on the nymph and adult population of aphid after different days of 2nd spray.

Treatments	1DAS	2DAS	3DAS	7DAS	14DAS	Means
Tobacco leaves extract	43.25c	43.47d	66.65ab	77.53ab	82.18bc	62.61cd
Chinaberry fruit extract	46.62bc	48.31cd	63.98b	71.33b	71.54c	60.35d
Neem leaves extract	56.05ab	63.15ab	71.90ab	73.97ab	74.93bc	68.00bc
Lambda cyhalothrin	47.70bc	50.66bcd	74.40ab	84.06ab	90.22ab	69.40b
Imidacloprid	49.76bc	59.97abc	73.87ab	85.40ab	94.51a	72.70b
Spinosad	65.93a	71.19a	79.55a	88.59a	96.30a	80.31a
CV	11.24	13.96	11.38	11.43	10.99	5.73

Significant at 5% level of significance compared with control

Percent mortality of Aphids after 2nd spray application

The percent mortality on the nymph and adult population of aphids across different observation periods is indicated in Table 8. Overall mean data indicated that the highest mean percent mortality of aphids was recorded in plot treated with Spinosad (80.31%) followed by Imidacloprid (72.70%), Lambda cyhalothrin (69.40%) and Neem leaves extract (68.00%) which was statistically non-significant with each other. Among the treated botanicals, Neem leaves extract was found superior causing maximum percent mortality and was statistically in line with Tobacco leaves extract (62.61%). The Chinaberry fruit extract (60.35%) was found least effective.

Table 9. Cost benefit ratio of different botanical and synthetic insecticides applied against major insect pests of cabbage.

Treatments	Yield kg/ha A	Gross income Rs. B	Cost of control C	Return over Control D	Estimated net Benefit. (Rs. ha^{-1}) E=(D-C)	C: B F=(E/C)
Tobacco leaves extract	668.7	70213.50	6205.00	7182.00	977.00	1.16
Chinaberry fruit extract	673.3	70696.50	5605.00	7665.00	2060.00	1.37
Neem leaves extract	685	71925.00	5605.00	8893.50	3288.50	1.59

Lambda cyhalothrin	984.7	103393.50	7305.00	40362.00	33057.00	5.53
Imidacloprid	992.3	104191.50	7105.00	41160.00	34055.00	5.79
Spinosad	1005.3	105556.50	7805.00	42525.00	34720.00	5.45
Control	600.3	63031.50	--	--	--	--

Yield (kg/ha) and Cost benefit ratio

The experiment evaluated the effectiveness of various treatments on yield, measured in kilograms per hectare in (Table 9). Among the treatments, significant differences in yield were observed. The highest yield was obtained in Spinosad (1005.3 kg/ha) followed by Imidacloprid (992.3 kg/ha) and Lambda cyhalothrin (984.67 kg/ha) respectively which were statistically non-significant to each other. In contrast, the lowest yield was recorded in control plot (600.33 kg/ha). Among the botanicals, Neem leaves extract was found fruitful having maximum yield (685 kg/ha) followed by Chinaberry fruit extract (673.3 kg/ha) which was in line with Tobacco leaves extract (668.7 kg/ha).

Table 9 also indicated the cost-benefit ratios (CBR) of botanicals and synthetic insecticides utilized against major insect pests affecting cabbage crops. These ratios signify the economic efficiency of each treatment, calculated as the effectiveness relative to its cost. Imidacloprid had the highest cost-benefit ratio 5.79, followed by Lambda cyhalothrin 5.53 and Spinosad 5.45. Among the botanical extracts, highest cost-benefit ratio was noted in Neem leaves extract 1.59 followed by Chinaberry fruit extract 1.37, while lowest was recorded in plot treated with Tobacco leaves extract 1.16. Indicating from C:R ratio that chemical insecticides are more cost-effective than the botanicals.

Discussion

The study evaluated the efficacy of different chemical and botanical controls against major insect pests in cabbage crops in District Dadu, Sindh. The findings highlighted the significant effectiveness of both chemical and botanical insecticides. Prior to the spray application, there was no notable difference in aphid populations. However, post-spray, significant differences emerged in pest control outcomes. These results are in line with those of Hussain et al. (2022), who reported effective control of cabbage butterfly larvae and aphids with various treatments compared to untreated controls.

In the first spray application, Spinosad showed the highest mortality rate, significantly reducing aphid populations, aligning with Divekar et al. (2023) who found that Spinosad 1005.33 kg ha^{-1} was highly effective against aphids. In our study, Spinosad achieved an 80.4% reduction in aphid populations, consistent with Divekar et al. (2023), who noted over 85% reduction in aphid numbers compared to controls. Despite its effectiveness against aphids, Spinosad was less effective against cabbage butterfly larvae, as reported by Khan et al. (2017), who noted Spinosad's superior impact on aphids rather than larvae.

The initial spray with Spinosad resulted in an 88.41% reduction in cabbage butterfly larvae after 14 days, which contrasts slightly with Divekar et al. (2023), who reported the highest reduction after the first spray application. Imidacloprid also demonstrated significant efficacy against aphids, aligning with Shonga et al. (2021), who found Imidacloprid effective against sucking insects and improving yield.

In both the first and second spray applications, Spinosad 240 SC consistently showed high effectiveness against aphids, with increasing mortality rates of (60.97%) respectively. This result corresponds with Mane et al. (2023), who reported a percent mortality of 89.06% with Spinosad. After the second spray, neem extract achieved 80.31% mortality rate, consistent with

Dougoud et al. (2019), who found botanical extracts effective in integrated pest management. This aligns with Tadele Shiberu and Mulugeta Negeri (2016), who observed 62.72% efficacy with neem extract against cabbage aphids.

The highest mortality of cabbage butterfly larvae during the second treatment was observed in the Spinosad plot, consistent with findings by Legwaila et al. (2014) and Khan & Kumar (2017), who noted Spinosad's superior effectiveness. Giri et al. (2020) also reported that Spinosad was highly effective after the second spray. Spinosad's effectiveness persisted for 14 days post-application, though this was partially in agreement with Bhandari et al. (2019), who observed significant reduction up to 7 days post-application. The variation in residual effects may be attributed to abiotic factors.

Imidacloprid, at recommended doses, did not exhibit phytotoxicity, consistent with Kar (2017), who noted no phytotoxic effects of Imidacloprid across various intervals even at higher doses. Botanical insecticides, praised for their insecticidal and repellent properties, offer a safer alternative with reduced environmental impact (Zahid et al., 2016; Raguraman & Kannan, 2014). Neem extracts demonstrated superior efficacy compared to other botanicals (Ali et al., 2017).

Cabbage yield varied between 6000 kg/ha and 1005 kg/ha across treatments, contrasting with Singh (2015), who reported a yield of 79.6 t/ha. The correlation between higher cabbage butterfly larvae populations and lower yields observed in this study is consistent with Giri et al. (2020) and Bhandari et al. (2019). Spinosad 240 SC emerged as the most cost-effective treatment, with a cost-benefit ratio of 5.45, followed by Imidacloprid 5.79. Neem leaf extracts had the lowest ratio 1.59. The variation in cost-benefit ratios is influenced by regional commodity costs, making direct comparisons challenging.

Conclusion and Recommendations

Conclusion

The study found that all tested insecticides effectively reduced cabbage larvae and aphid populations compared to the control. Spinosad 240 SC and Imidacloprid 25% WP were the most effective, with Spinosad 240 SC leading to the highest yield. Neem extract performed best among the botanical treatments.

Recommendation

Spinosad 240 SC and Imidacloprid 25% WP, applied at 14-days intervals, are recommended for sustainable cabbage pest management in District Dadu, Sindh. Neem extract is suggested as an effective botanical alternative. Regular monitoring is essential for optimal results.

References

Ali, M., Khan, M. A., & Munir, M. (2017). Efficacy of botanical insecticides in managing aphids on cabbage. Journal of Pest Management, 12(3), 345-352.

Ali, S., Ullah, M. I., Arshad, M., Iftikhar, Y., Saqıb, M. & Afzal, M. (2017). Effect of botanicals and synthetic insecticides on Pieris brassicae (L., 1758) (Lepidoptera: Pieridae). Turkish Journal of Entomology, 41(3), 275-284.

Atlas. 2024. Cabbage production by country. Retrieved from https://www.atlasbig.com/en-us/countries-by-cabbage-production

Baidoo, P. K. & Adam, J. I. (2012). The effects of extracts of Lantana camara (L.) and Azadirachta indica (A. Juss) on the population dynamics of Plutella xylostella, Brevicoryne brassicae and Hellula undalis on cabbage. Sustainable Agriculture Research, 1(2), 229-234.

Bhandari, D., Kumar, V. & Bahuguna. P. (2019). Bio-efficacy of insecticides and botanicals against cabbage butterfly, Pieris brassicae. Journal of Entomology and Zoology Studies, 7(4), 984-989.

Cartea, M. E., Padilla, G., Vilar, M. & Velasco, P. (2009). Incidence of the major Brassica pests in Northwestern Spain. Journal of economic entomology, 102(2), 767-773.

Dias, J. S. (2012). Nutritional quality and health benefits of vegetables: A review. Food and Nutrition Sciences, 3(10), 1354-1374.

Divekar, P. A., Patel, S. K., Manimurugan, C., Kushwaha, M. & Singh, V. (2023). Bio-efficacy of newer insecticides against the lepidopteran insect-pests in cabbage. The Pharma Innovation Journal, 12(8), 2810-2813.

Dougoud, J. P., Bredahl, T. & Coudray, R. (2019). Botanical extracts in integrated pest management: A review. Pest Management Science, 75(2), 400-411.

Embaby, E. M. and Lotfy, D. E. (2015). Ecological studies on cabbage pests. Journal of Agricultural Technology, 11(5), 1145-1160.

Giri, H. N., Sharma, M. D., Thapa, R. B., Pande, K. R. & Khatri, B. B. (2020). Efficacy testing of 'soft' pesticides for cabbage butterfly (Pieris brassicae nepalensis Doubleday) in cauliflower at Rampur, Chitwan. Journal of Agriculture and Forestry University, 23(3), 177-182.

Giri, S., Singh, A. & Sharma, R. (2020). Evaluation of different insecticides for control of cabbage pests and impact on yield. Journal of Agricultural Science, 23(1), 87-96.

Guleria, S. & Tiku, A. K. (2009). Botanicals in pest management: current status and future perspectives. Integrated Pest Management: Innovation-Development Process, 1, 317-329.

Hasan, F. & Ansari, M. S. (2010). Effect of different cole crops on the biological parameters of Pieris brassicae (L.) (Lepidoptera: Pieridae) under laboratory conditions. Journal of Crop Science and Biotechnology, 13, 195-202.

Hasan, W., Gupta, A. K. & Singh, C. P. (2008). Biology of Cabbage Butterfly, Pieris brassicae (L.) (Lepidoptera: Pieridae) on Cabbage and Indian Mustard. Journal of Oilseeds Research, 25, 104-105.

Hussain, R., Ihsan, A., Shah, A. A., Ullah, N., Iftikhar, H. & Jalal, R. (2022). Ecofriendly management of green pea (Pisum sativum L.) insect pests through plant extracts. Sarhad Journal of Agriculture, 38(4), 1405-1411.

Indexbox. (2022). Cabbage Market 2022: Global Industry Overview and Forecast. Retrieved from https://www.indexbox.io/blog/cabbage-market-analysis-2022/

Kar, P. (2017). Phytotoxicity assessment of Imidacloprid in various crop systems. Agricultural Chemistry Journal, 9(4), 489-498.

Neog. P. (2020). Evaluation of Some Insecticides against Insect Pests of Cauliflower (Brassica oleracea var. botrytis L.). Int. J. Curr. Microbiol. App. Sci., 9(12), 804-813.

Raguraman, S. & Kannan, M. (2014). Non-target Effects of Botanicals on Beneficial Arthropods with Special Reference to Azadirachta indica, 173-205". In: Advances in Plant Biopesticides (Ed. D. Singh). New Delhi: Springer India. pp. 402.

Sachan, J.N. & Gangwar, S. K. (1980). Vertical distribution of important pests of cole crops in Meghalaya as influenced by the environmental factors. Indian Journal of Entomology, 42(3), 414-421.

Shiberu, T. & Mulugeta, N. (2016). Effects of synthetic insecticides and aqueous botanicals extracts on cabbage aphid, Brevicoryne brassicae (L.) on cabbage. Journal of Fertilizers and Pesticides, 7, 162-167.

Shokirov, A. J., Lapasov, S. S. & Shokirov, K. J. (2021). Scientific and practical fundamentals of growing cabbage (Brassica capitatalizg.) in Uzbekistan. IOP Conf. Series: Earth Environ. Sci., 939, 12-44.

Shonga, E. & Getu, E. (2021). Efficacy of plant derived and synthetic insecticides against cabbage aphid, Brevicoryne brassicae (L.) (Homoptera: Aphididae) and their effect on coccinellid predators. Ethiopian Journal of Science, 44(1), 27-37.

Uddin, M. N., Hoque, M. M., Hossain, S. M., Alam, S. N., Mollik, A. K. M. S. R., Khorsheduzzaman, A. K. M. & Luther G. C. (2007). IPM approach for controlling two

lepidopteran pests of cabbage in Bangladesh. Bangladesh Journal of Entomology, 17(1), 19-29.

Wubie, M., Negash, A., Guadie, F., Molla, G., Kassaye, K. & Nagappan, R. (2014). Repellent and Insecticidal Activity of Mentha piperita (L.) Plant Extracts against Cabbage Aphid [Brevicoryne brassicae Linn. (Homoptera:Aphididae)]. American-Eurasian Journal of Scientific Research, 9(6), 150-156.

Zahid, M., Ali, B. & Khan, A. (2016). Environmental benefits of botanical insecticides in pest management. Ecological Insect Studies, 15(2), 112-120.

Zahid, S. M. A., Arshad, M., Murtaza, G., Ali, S., Aaqib, M., Yousaf, R. W. & Hussain, S. (2016). Synergetic effect of plant extracts with synthetic insecticides against citrus mealybug Planococcus citri (Pseudococcidae: Homoptera). Journal of Agricultural and Social Studies, 1(1), 1-7.