

Botanical Insecticide Against Insect Pests of Tobacco Crop at District Swabi

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Abstract

Tobacco (*Nicotiana tabacum* L.) is an economically important cash crop in Pakistan; however, its productivity is severely constrained by insect pests, particularly aphids and budworms. Excessive reliance on synthetic insecticides has raised concerns regarding environmental safety, resistance development, and residue contamination, necessitating the evaluation of alternative pest management strategies. The present study was conducted during 2025 at Sikandari Dagi, District Swabi, Khyber Pakhtunkhwa, Pakistan, to assess the comparative efficacy of a synthetic insecticide (lambda-cyhalothrin) and selected botanical extracts against major insect pests of tobacco. The experiment was laid out in a randomized complete block design with seven treatments and an untreated control, replicated three times. Treatments included lambda-cyhalothrin, neem oil, chongan, chinaberry seed, bakain leaf, and moringa leaf extracts, all applied at 5% concentration. Pest populations were recorded before treatment and at 24, 48, and 7 days after application, while plant height and cured leaf yield were also evaluated. Results revealed that lambda-cyhalothrin provided the most effective and consistent suppression of budworm populations, followed by moringa and neem extracts. Although botanical treatments exhibited comparatively lower efficacy than the synthetic insecticide, all treatments significantly reduced pest populations relative to the untreated control. Lambda-cyhalothrin also resulted in the maximum plant height (105.74 cm) and highest cured leaf yield (2097.7 kg ha⁻¹), whereas botanical extracts produced moderate but statistically significant improvements in growth and yield over the control. The findings suggest that while synthetic insecticides remain highly effective for rapid pest suppression, certain botanical extracts, particularly moringa and neem, hold potential as environmentally safer components of integrated pest management programs for tobacco cultivation.

Keywords: Tobacco, *Nicotiana Tabacum*, Lambda-Cyhalothrin, Insecticides, Aphids, Budworm

Introduction

Nicotiana tabacum L. is an important cash crop cultivated worldwide for its nicotine-rich leaves, which are used extensively in commercial products (Ren & Timko, 2001; Wexler et al., 2005). Nearly 90% of global tobacco production occurs in developing countries, with Pakistan ranking

among the top producers (Zafeiridou et al., 2018). In Pakistan, tobacco occupies about 0.23% of irrigated agricultural land and is primarily grown in Khyber Pakhtunkhwa (KP), where favorable climatic and soil conditions support high productivity (PTC, 2017; KPBOS, 2022). During 2022–2023, tobacco was cultivated on approximately 43,700 ha nationwide, producing about 133,700 tonnes, while KP alone contributed a major share of this production (Pakistan Economic Survey, 2022–2023; PTB, 2021). Despite its economic importance, tobacco productivity is severely constrained by insect pests. Although nicotine possesses insecticidal properties, tobacco crops are attacked throughout their growth stages by several pests, notably aphids, budworms, and cutworms (Edde, 2018). Tobacco aphid (Hemiptera: Aphididae) causes direct damage through sap sucking and honeydew deposition, leading to sooty mold development and reduced leaf quality, while also acting as a vector of viral diseases (Syed et al., 2005; Sreedhar, 2020). Among lepidopteran pests, *Helicoverpa armigera* is particularly destructive, as its larvae feed on leaves and floral structures, resulting in significant yield losses (Edde, 2018). Chemical control remains the primary management strategy against these pests, with synthetic insecticides such as pyrethroids widely adopted due to their high efficacy and comparatively low mammalian toxicity (Zim et al., 2000; Allen et al., 2000). However, increasing concerns over pesticide residues, resistance development, and environmental safety have encouraged the exploration of alternative approaches. Botanical extracts, particularly from *Azadirachta indica* (neem) and *Caralluma tuberculata*, have demonstrated promising insecticidal properties owing to their bioactive compounds, including flavonoids and other secondary metabolites (Isman, 2006; Dua et al., 2009; Alqurashi et al., 2010). In the tobacco-growing region of Sikandari Dagi, Swabi (KP), limited information is available regarding pest prevalence and the comparative efficacy of synthetic insecticides and botanical extracts against aphids and budworms. Therefore, the present study was conducted to evaluate the effectiveness of lambda-cyhalothrin and selected botanical extracts for the management of major tobacco pests, aiming to identify environmentally safer and economically viable control options.

Materials and Methods

Field experiments entitled “botanical insecticide against insect pests of tobacco crop at district swabi” were conducted during 2025 at a farmer’s field in Sikandari Dagi, District Swabi, Khyber Pakhtunkhwa, Pakistan.

Experimental Design and Crop Establishment

The experiment was laid out in a randomized complete block design (RCBD) comprising seven treatments and one untreated control, each replicated three times. Cigarette tobacco variety K399 was sown in February 2024 on a well-prepared nursery bed. Seedlings were transplanted during the last week of March into prepared plots measuring 158.76 m². Plant-to-plant and row-to-row spacing were maintained at 60 cm and 90 cm, respectively, with 15 plants per treatment plot. All experimental plots received uniform agronomic practices throughout the study period.

Treatments

Seven treatments along with a control were evaluated. Lambda-cyhalothrin and neem oil were procured from the local market in Swabi, while botanical extracts (Chongan, Chinaberry seed, Bakain leaves, and Moringa leaves) were prepared in the laboratory following the method described by Badshah et al. (2015). All treatments were applied at a concentration of 5%.

Treatment Application

Applications were made using a knapsack sprayer when aphid and budworm populations reached the economic threshold level (ETL). Treatments were applied according to the concentrations.

Data Collection

Budworm Population

The mean number of budworms per leaf was recorded by counting larvae on the top, middle, and bottom leaves of five randomly selected plants from each plot.

Plant Height

At crop maturity, plant height was measured from soil surface to the tip of the highest leaf on five randomly selected plants from the two central rows of each plot, and the average was calculated.

Yield

Cured leaf yield was recorded after each picking for every treatment. Total yield per plot was converted to kg ha⁻¹ using the formula:

$$\text{Yield (kg ha}^{-1}\text{)} = \frac{\text{Obtained yield (kg)}}{\text{plot Area}} \times 10000\text{m}^2$$

Observations were recorded 24 hours before treatment application and subsequently at 24 hours, 48 hours, and 7 days after each application.

Statistical Analysis

Collected data were subjected to analysis of variance (ANOVA) using Statistix software (version 8.1). Treatment means were compared at a 5% level of significance.

Results and Discussion

Effect of Different Treatments on Budworm Population

Table 1 illustrates the comparative efficacy of botanical extracts and a synthetic insecticide against budworm infestation following foliar application during 2025. Prior to treatment, all plots exhibited comparable levels of budworm infestation. Relative to the untreated control (4.16 larvae plant⁻¹), lambda-cyhalothrin and Chongan resulted in the greatest initial reduction (2.16 larvae plant⁻¹), followed by neem extract (2.66 larvae plant⁻¹), chinaberry (2.76 larvae plant⁻¹), and Bakain leaf extract (2.86 larvae plant⁻¹), whereas moringa leaf extract exhibited the lowest reduction (3.16 larvae plant⁻¹). At 48 hours post-application, lambda-cyhalothrin achieved the maximum suppression (1.20 larvae plant⁻¹), followed by moringa leaf extract (1.66 larvae plant⁻¹), neem extract (2.16 larvae plant⁻¹), chinaberry (2.33 larvae plant⁻¹), and Bakain leaf extract (2.36 larvae plant⁻¹), while Chongan showed comparatively lower efficacy (2.50 larvae plant⁻¹) compared with the control (4.83 larvae plant⁻¹).

A gradual resurgence in pest population was observed seven days after application, indicating a decline in treatment efficacy over time. Nevertheless, lambda-cyhalothrin and moringa leaf extract maintained the lowest populations (2.16 larvae plant⁻¹), followed by neem extract (2.66 larvae plant⁻¹), chinaberry and Bakain leaf extracts (3.16 larvae plant⁻¹), whereas Chongan recorded the highest infestation among treated plots (3.20 larvae plant⁻¹), relative to the control (5.36 larvae plant⁻¹). Overall mean pest density was lowest in lambda-cyhalothrin-treated plots (1.84 larvae plant⁻¹), followed by moringa leaf extract (2.33 larvae plant⁻¹), neem extract (2.50 larvae plant⁻¹), chinaberry (2.75 larvae plant⁻¹), and Bakain leaf extract (2.80 larvae plant⁻¹), while Chongan exhibited comparatively higher mean infestation (2.91 larvae plant⁻¹). All treatments significantly reduced budworm populations compared with the untreated control (4.78 larvae plant⁻¹). The present findings corroborate earlier reports highlighting the superior efficacy of synthetic insecticides in controlling lepidopteran pests, including budworm. Pyrethroid compounds, particularly lambda-cyhalothrin, have been widely recognized for their rapid knockdown effect and high insecticidal activity. Dutta et al. (2017) similarly reported a significant reduction in budworm populations following lambda-cyhalothrin application, supporting its reliability as a pest management option. Moreover, Kumar and Sharma (2019) documented that synthetic insecticides

generally provide faster and more consistent control compared to botanical products. In contrast, the variable performance observed with plant-based treatments in the present study aligns with previous research indicating that botanical extracts often exhibit moderate and inconsistent efficacy. Isman (2006) reported that although plant-derived insecticides can contribute to pest suppression, they rarely match the immediate effectiveness of synthetic chemicals. Likewise, Singh et al. (2021) demonstrated that while certain botanical extracts possess insecticidal potential, synthetic insecticides consistently achieved significantly greater reductions in budworm populations.

Table 1: Impact of botanicals and lambda-cyhalothrin on budworm population in tobacco in (2025)

Treatments	Before Spraying	Days After spray			Mean
		1	2	7	
Lambda cyhalothrin 5%	4.00 a	2.16 c	1.20 d	2.16 b	1.84 c
Neem extract 5%	3.16 c	2.66 bc	2.16 bc	2.66 b	2.50 bc
Chongan 5%	3.26 bc	2.16 b	2.50 b	3.20 b	2.91 b
Chinaberry leaves extract 5%	3.50 b	2.76 b	2.33 bc	3.16 b	2.75 b
Bakain leaves extract 5%	3.23bc	2.86 b	2.36 bc	3.16 b	2.80 b
Moringa leaves extract 5%	4.16 a	3.16 b	1.66 cd	2.16 b	2.33 bc
Control	4.16 a	4.16a	4.83 a	5.36 a	4.78 a
LSD (0.05)	0.32	0.56	0.82	1.04	0.79

Means within columns followed by the same letter are not significantly different at the 5% probability

Plant height and Yield kg ha⁻¹

Table 2 illustrates the effect of different botanical extracts and synthetic insecticide on plant height and grain yield. Among all treatments, lambda-cyhalothrin resulted in the maximum plant height (105.74 cm), followed by neem extract (101.74 cm), moringa leaf extract (98.50 cm), bakain leaf extract (97.78 cm), and chinaberry extract (96.74 cm), whereas the minimum plant height was observed in Chongan-treated plots (94.04 cm), compared with the control (93.04 cm). Similarly, the highest yield was recorded in lambda-cyhalothrin-treated plots (2097.7 kg ha⁻¹), followed by neem extract (1757.7 kg ha⁻¹), moringa leaf extract (1699.7 kg ha⁻¹), bakain leaf extract (1643.7 kg ha⁻¹), and chinaberry extract (1595.3 kg ha⁻¹). The lowest yield among treatments was obtained with Chongan (1545.0 kg ha⁻¹), while the control plot produced the minimum yield (1123.0 kg ha⁻¹). These findings are consistent with previous studies highlighting the positive impact of effective pest management on crop growth and productivity. Ahmed et al. (2018) reported that the application of synthetic insecticides such as lambda-cyhalothrin significantly enhanced plant growth parameters and yield by minimizing pest-induced damage. This agrees with the present results, where improved plant height and yield were associated with successful suppression of aphids and budworm. In contrast, the comparatively lower plant height and yield observed under *Caralluma tuberculata* treatment suggest that, although botanical pesticides may provide partial pest control, their overall influence on crop performance remains inferior to that of synthetic insecticides. Similarly, Isman (2006) emphasized that plant-based extracts often face limitations in delivering rapid pest suppression and subsequent crop growth benefits when compared with conventional chemical insecticides.

Table 2: Impact of botanicals and lambda-cyhalothrin on plant height and yield kg ha⁻¹.

Treatments	Plant height (cm)	Yield kg ha ⁻¹
Lambda cyhalothrin 5%	105.74 a	2097.7 a
Neem extract 5%	101.74 b	1757.7 b
Chongan 5%	94.04 f	1545.0 f
Chinaberry leaves extract 5%	96.74 d	1595.3 e
Bakain leaves extract 5%	97.78 cd	1643.7 d
Moringa leaves extract 5%	98.50 c	1699.7 c
Control	93.04 f	1123.0 g
LSD (0.05)	1.56	15.45

Means within columns followed by the same letter are not significantly different at the 5% probability

Conclusions and recommendations

It was concluded that lambda-cyhalothrin resulted in a significantly greater reduction in budworm population compared to all other treatments. Among the tested bio-insecticides, neem extract exhibited the highest level of pest suppression, whereas chongan provided the least control. Furthermore, the maximum plant height and grain yield (kg ha⁻¹) were recorded in plots treated with lambda-cyhalothrin, while the lowest values were observed under *Caralluma tuberculata* treatment. Based on the present findings, lambda-cyhalothrin is recommended for effective management of budworm in tobacco due to its superior pest suppression and positive impact on plant growth and yield. Among the botanical treatments, neem extract showed comparatively better performance and may be considered as an alternative in integrated pest management (IPM) programs to reduce reliance on synthetic insecticides. However, to minimize environmental risks and delay resistance development, judicious use of chemical insecticides at recommended doses and proper timing is advised. Future studies should focus on combining effective botanicals with reduced chemical inputs to develop sustainable and eco-friendly pest management strategies.

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