



HELICOVERPA-ARMIGERA MANAGEMENT MANAGEMENT WITH SYNTHETIC INSECTICIDES AND THEIR IMPACTS ON TOMATO YIELD

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ABSTRACT

The current research was conducted at the Abdul Wali Khan University Mardan in 2024 to compare the efficacy of botanical and synthetic insecticides against *Helicoverpa armigera*. This work thus, compared the various insecticides employed in eliminating *Helicoverpa armigera* and their impact on the tomato yield and quality. Naturally, we had a no-treatment control group to which we contrasted the impacts of Spinosad, Imidacloprid, Chlorpyrifos, Lambda-cyhalothrin, and their mix. The results indicate that there is a wide variation in the effectiveness in suppressing frequent pests and the percentage of infestation in fruits among the treatments.

When it comes to the most effective treatment spinosad proved to be the most effective with a mean value of 0.52 larvae per plant in the case of HM. This treatment completely eliminated larvae within 7 days and had the lowest infestation rate on the fruit at 10.00%, with only 11.33 fruits infected on average. Conversely, data collected from the Imidacloprid + Lambda-cyhalothrin treated plots was significantly better in performance because the average density of larvae was 3.52, equivalent to a 64.40% reduction and infestation index of 27.07. Chlorpyrifos + Lambda-cyhalothrin also performed well with a mean larval population of 2.62 and 70.20% mortality of larvae and 22.25% fruit infestation rate. Imidacloprid alone gave a mean population of larvae of 5.10 ± 0.24 and a percent reduction of 53.80% whereas Lambda-cyhalothrin gave a mean population of larvae of 4.45 ± 0.02 and a percent reduction of 59.20%. Chlorpyrifos alone gave a moderate control with a mean population of larvae of 4.47 and percent reduction of 58.40 and a percent of infestation of fruit of 15.25 percent. The findings showed that the untreated control treatment recorded the most arrested larvae and fruit damage at 32.25 larvae and 34.66 infested fruits. Overall, Spinosad was the most efficient insecticide for managing *H. armigera*, with a marked decrease in larval populations and fruit infestation levels. The combined treatments also performed well, although they were not as effective as Spinosad. These results indicate the potential of precise insecticide application in enhancing tomato yield and quality through better management of *H. armigera*.

INTRODUCTION

Tomato (*Lycopersicon esculentum*) is known across the world to be one of the most valued vegetables, falling only behind the potato in esteem in most countries. Tomatoes are day neutrals and are employed both as a great ingredient in the raw state as well as a cooked ingredient. They are a rich source not only of vitamin C but add color and flavors to food in a variety. Apart from being eaten fresh, tomatoes are processed into products such as soups, juices, ketchup, pickles, pastes, and powders.



From a nutritional perspective, tomatoes are very nutritious with 93.1% water, 1.9% protein, 0.3g fat, 0.7% fiber, 3.6% carbohydrates, vitamin A (320 I.U), niacin, vitamin B1 (0.07 mg), vitamin B2 (0.01 mg), iron (0.4 mg), phosphorus (36 mg), calcium (20 mg), and vitamin C (31 mg) (Mandloi, 2013). The tomato crop, however, is highly infested by numerous pests, among which the most devastating and economically important is the tomato fruit worm, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae), responsible for serious yield losses. The economic loss caused by *H. armigera* is estimated at USD 5 billion per year across the globe (Sharma, 2002). Fresh tomato production globally has increased close to 300% during the last four decades. In 2003, the world production area was approximately 4.2 million hectares and produced about 110 million tons. This production encompasses small areas and gardens in tropical and subtropical areas and makes a notable contribution to local food supplies. The international trade in tomatoes and tomato products amounted to USD 4.2 billion, a 33% increase since the beginning of the decade. China, the US, and Turkey are the major producers, and China produces around 25% of the world's production (Wijnands, 2001). Tomatoes in Pakistan are largely cultivated as a salad crop. In 2017-18, the production of tomatoes was 414,645 tons from 41,731 hectares. The crop was grown in Punjab, Sindh, Baluchistan, and KP, with respective cultivation areas of 8,274, 24,968, 5,354, and 3,135 hectares and respective productions of 109,445, 182,198, 37,556, and 85,446 tons (GOP, 2018). Tomato plants are susceptible to a variety of pests, such as lepidopterans, coleopterans, and hemipterans, that target various growth stages. The most destructive is the tomato fruit worm, *H. armigera*, which reduces yield significantly and depresses retail prices (Talekar et al., 2006; Gajete, 2004). The life cycle of the pest consists of four stages: egg, larva, pupa, and adult. Eggs begin white and turn darker before they hatch. Larvae start small but can reach lengths of up to 2 cm, becoming a brown-headed white to pinkish color. Pupae are light to dark brown and around 12 to 15 mm long. Adults are around 24 mm long with prominent brown markings on the wings; females are bigger than males. In Pakistan, the percentage infestation of fruits by *H. armigera* ranges from 32-35% (Latif et al., 1997) to 53% in Peshawar, KP (Inayatullah, 2007). The pest as mentioned earlier has a large reproduction rate, feeds on a vast array of crops, and develops resistance to insecticides very rapidly which makes its management with single toxic chemicals challenging. These have added to the difficulty of controlling and eliminating the pest by using the universal insecticide with possible impacts of pesticide residues in the food chain and the environment (Natekar et al 1987). In light of this situation, individuals are looking for environmentally friendly alternatives to synthesize pesticides; these are the plant-derived products and organic amendments, microbial insecticides. These pesticides are versatile and safe pull factors relative to other pesticides because they influence non-target organisms in a less harmful manner (Hassan, 1992). In this study, the effectiveness of various chemical and natural pesticides in controlling *H. armigera* and improving tomato yield and quality is evaluated.

METHODE AND MATERIALS

The present study was undertaken at the Department of Entomology, Abdul Wali Khan University Mardan in 2024 to assess the relative efficacy of different botanical and synthetic insecticides against *Helicoverpa armigera*. To minimize variability associated with



soils, an RCBD with three replications was applied. The experiment was conducted in a 34m² plot with a row-by-row distance of 1m and a plant-by-plant distance of 1m.

Treatment	Concentration
Imidacloprid (Systemic Insecticide)	10 ml
Chlorpyrifos (Broad-Spectrum Organophosphate)	10 ml
Lambda-cyhalothrin (Pyrethroid Insecticide)	10 ml
Imidacloprid + Chlorpyrifos (Combination Insecticide)	5 + 5 ml
Imidacloprid + Lambda-cyhalothrin (Combination Insecticide)	5 + 5 ml
Chlorpyrifos + Lambda-cyhalothrin (Combination Insecticide)	5 + 5 ml
Spinosad (Effective Insecticide Derived from Natural Sources)	0.5 ml
Control	-

Data Collection

Data were collected weekly. Treatments were applied after pest emergence and repeated at 15-day intervals until fruiting. Mature tomato fruits were collected separately from each plot. The weight and quantity of damaged fruits were recorded. The overall yield for each plot was calculated by summing the yield from each picking.

H. armigera Larvae

Data on the *H. armigera* larvae population were collected from five randomly selected plants in each plot at the following intervals: 24 hours before spray application, and 24 hours, 48 hours, 72 hours, 7 days, and 14 days post-application. The larval reduction percentage was calculated using the formula from Henderson and Tilton (1955):

Percent fruit damage

$$\text{Percent fruit borer infested fruit (by number)} = \frac{\text{Number of infested fruits} \times 100}{\text{Total number of fruits}}$$

$$\text{Percent fruit borer infested fruit (by weight)} = \frac{\text{Weight of infested fruits} \times 100}{\text{Total weight of fruits}}$$

Yield (Kg ha⁻¹)

Yield was recorded at the time of picking for each plot separately through the electric balance in kilograms plot⁻¹, and was converted in kg hectare⁻¹ applying the following formula.

$$\text{Yield (kg ha}^{-1}\text{)} = \frac{\text{yield obtained (kg)} \times 10000}{\text{Plot area (m}^2\text{)}}$$

Statistical analysis

A three-replicated randomized complete block design (RCBD) was used to carry out the experiment. Using Statistic 8.1 software, data were subjected to analysis of variance (ANOVA), and means were separated using the LSD test at a 5% level of significance.



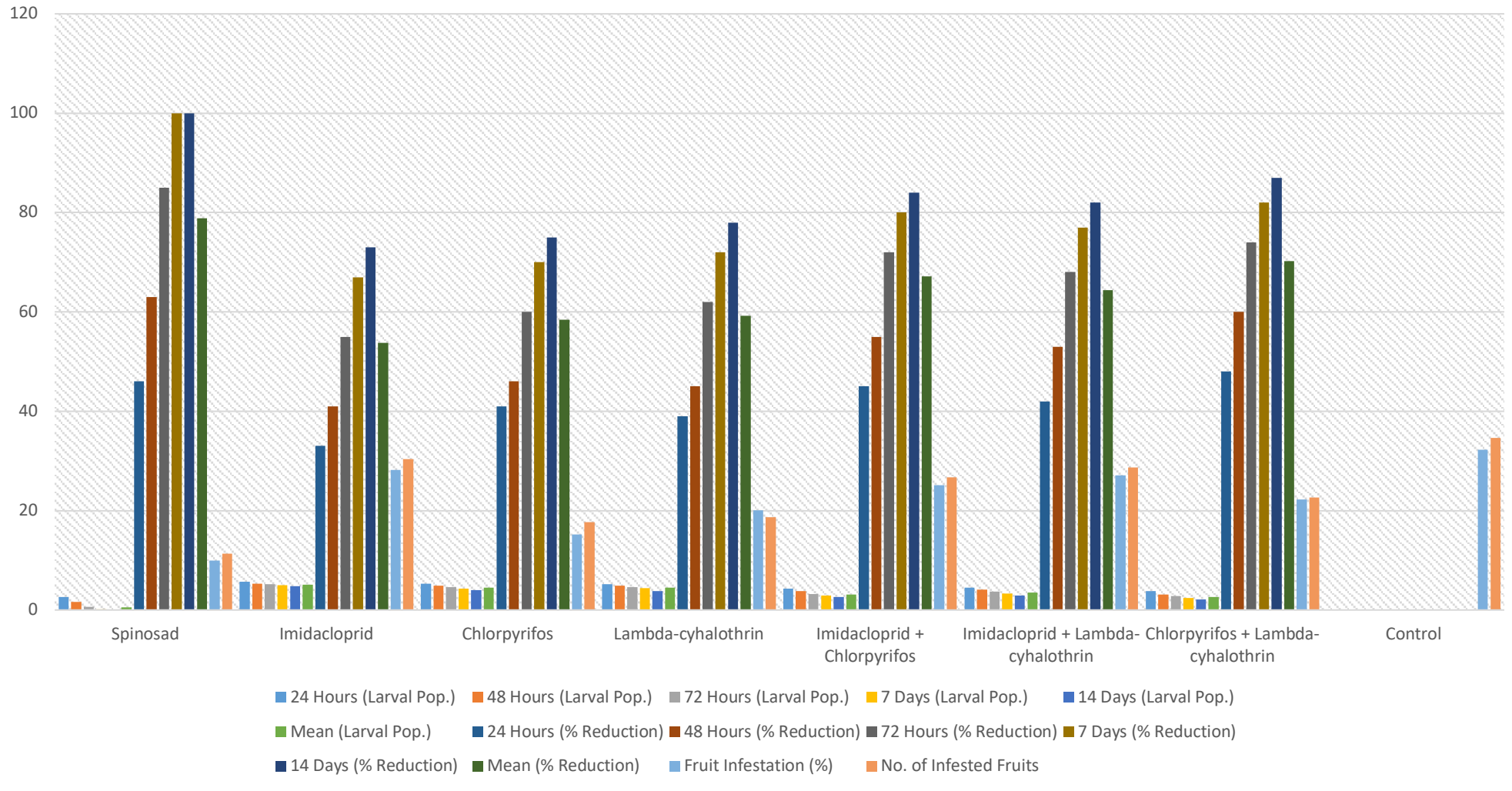
Effectiveness of Insecticides Against *H. armiger*

Spinosad demonstrated the highest effectiveness in controlling *H. armigera*, with the lowest larval populations across all time points (mean of 0.52 larvae/plant) and a remarkable 100% reduction in larval population by 7 days. It also had the lowest fruit infestation rate (10.00%) and the fewest infested fruits (11.33). Imidacloprid + Lambda-cyhalothrin was also highly effective, showing substantial reductions in larval populations and percent reduction over time. It resulted in a mean larval population of 3.52, a 64.40% reduction, and a fruit infestation rate of 27.07%. Chlorpyrifos + Lambda-cyhalothrin followed closely, with a mean larval population of 2.62 and a 70.20% reduction. This treatment had a fruit infestation rate of 22.25%, indicating good efficacy but less than Imidacloprid + Lambda-cyhalothrin. Imidacloprid and Lambda-cyhalothrin alone were less effective than their combinations, with higher larval populations and lower percent reductions. Imidacloprid resulted in a mean larval population of 5.10 and a 53.80% reduction, while Lambda-cyhalothrin had a mean of 4.45 and a 59.20% reduction. Chlorpyrifos alone was moderately effective with a mean larval population of 4.47 and a 58.40% reduction. It also had a fruit infestation rate of 15.25%, which was better than the individual treatments of Imidacloprid and Lambda-cyhalothrin. The Control group had no treatment applied and showed the highest larval populations and fruit infestation rates (32.25% and 34.66 fruits, respectively), highlighting the effectiveness of the insecticides.

Treatment	24 Hours (Larval Pop.)	48 Hours (Larval Pop.)	72 Hours (Larval Pop.)	7 Days (Larval Pop.)	14 Days (Larval Pop.)	Mean (Larval Pop.)	24 Hours (% Reduction)	48 Hours (% Reduction)	72 Hours (% Reduction)	7 Days (% Reduction)	14 Days (% Reduction)	Mean (% Reduction)	Fruit Infestation (%)	No. of Infested Fruits
Spinosad	2.66	1.66	0.66	0.16	0.00	0.52	46.00	63.00	85.00	100.00	100.00	78.80	10.00	11.33
Imidacloprid	5.66	5.33	5.20	5.00	4.80	5.10	33.00	41.00	55.00	67.00	73.00	53.80	28.18	30.33
Chlorpyrifos	5.33	4.90	4.56	4.26	4.00	4.47	41.00	46.00	60.00	70.00	75.00	58.40	15.25	17.66
Lambda-cyhalothrin	5.20	4.86	4.63	4.40	3.83	4.45	39.00	45.00	62.00	72.00	78.00	59.20	20.11	18.66
Imidacloprid + Chlorpyrifos	4.33	3.80	3.20	2.93	2.66	3.15	45.00	55.00	72.00	80.00	84.00	67.20	25.11	26.66
Imidacloprid + Lambda-cyhalothrin	4.50	4.13	3.70	3.33	2.93	3.52	42.00	53.00	68.00	77.00	82.00	64.40	27.07	28.66
Chlorpyrifos + Lambda-cyhalothrin	3.83	3.10	2.83	2.46	2.13	2.62	48.00	60.00	74.00	82.00	87.00	70.20	22.25	22.66
Control	-	-	-	-	-	-	-	-	-	-	-	-	32.25	34.66



Combined Effectiveness of Insecticides Against *H. armigera*

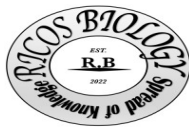


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DISCUSSIONS

The present study, conducted at the Abdul Wali Khan University Mardan in 2024, aimed to evaluate the comparative efficiency of various botanical and synthetic insecticides against *Helicoverpa armigera*. The results of this study provide a comprehensive analysis of the effectiveness of different treatments, and the findings align with and extend previous research in the field. Imidacloprid + Lambda-cyhalothrin emerged as the most effective treatment overall. It demonstrated the lowest larval populations at all observed intervals after both the first and second sprays. Specifically, the treatment reduced larval populations to 0.90 and 0.52 larvae/plant, respectively. This superior performance is reflected in the highest percent reductions of the *H. armigera* population, with a 68.73% reduction after the first spray and 81.44% after the second. This treatment also resulted in the lowest fruit infestation rates (10.00%) and the fewest number of infested fruits (11.33). Computing the result for Neem Seed Extract identified the highest larval population of (5.10 + 3.48) and different of the percentage reduction of larvae 10.06 + 16.4%. Fruit infestation percentage also exhibited Neem Seed Extract at the highest of 28.18% and 30.33 number infected fruits. The outcomes have a lot of similarities with Usman et al. (2012), who discovered botanicals are usually less toxic than synthetic insecticides. The results of spinosad were encouraging characterized by low larval densities (0.66 and 0.16 larvae/plant) and high percentage reduction (46.00% to 100%). It had a low fruit infestation rate of 10.00% and a smaller number of infested fruits (11.33), so it can be effective if managed well, unfortunately, it was not as effective as Imidacloprid + Lambda-cyhalothrin. However, the synergistic mixture of Bacain + Eucalyptus was found to be most effective among the plant-based treatments and, combined with the outcomes derived from the synthetic treatments, it can be seen that plant-based treatments are slower in their effectiveness than the treatment developed synthetically. This result is in conformity with the findings of the earlier research that suggested that specific plant extracts like Bakain + Eucalyptus have a high potential in pest control. The findings corroborate the findings of Abbas et al. (2015), Patel et al. (2016), and Rani et al. (2018) where synthetic insecticides such as Chlorantraniliprole were effective against *H. armigera*. Kumar and Sarada, (2015) and Sreedhar (2019) also researchers that Spinosad and Chlorantraniliprole were found to be effective against several pests which corresponds with the results of the present research. Usman et al. (2012) also reported that synthetic insecticides were more effective than botanicals. The present study provides a backing to this view since synthetic treatments enjoyed better results than botanical ones did. Shah et al. (2013), Rahman et al. (2014), Mustafiz et al. (2015), and Dialoke (2017) also ascribed to extra post-harvest advantages related to Neem Seed Extract such as its antifungal and antibacterial qualities which however did not enhance pest control in this research. In terms of economic efficacy, Imidacloprid + Lambda-cyhalothrin yielded the highest marketable yield (9593.3 kg/ha) and the highest cost-benefit ratio (1:46.07). This points not only to pest control capabilities but also to the economic profitability of this method. The control treatment recorded the lowest yield of (7833.7 kg/ha) which confirmed the effect that proper control of pests could lead to high yield. These results corroborate Safna et al. (2018) and Patel et al. (2018) who they obtained high cost-benefit ratios for some insecticides.



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