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Research Article

Assessing the Efficacy of Bio-Derived and Synthetic Insecticides onControlling *Helicoverpa armigera* Infestation inCotton under Varied Irrigation Regimes at Ghurki Farm House, District Kasur

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Abstract

Cotton is an important fiber and cash crop throughout the world. Various factors influence the yield of cotton, with insect pests being of prime importance. Cotton bollworm cause serve damage to at boll formation stage. Management of the insect pests is mainly done through insecticides. The present research work was executed Ghurki Agricultural Farm House, District Kasur. The experiment was conducted using a Randomized Complete Block Design (RCBD). The experiment comprised of irrigation was done through drip irrigation and surface/flood irrigation arrangements. The spacing between plants was 30 cm, and between rows, it was 120 cm. Treatments and control were replicated in thrice. Synthetic insecticides; Emamectin-Benzoate, Profenophos+Cypermethrin, Lambda-cyhalothrin and Profenophos (Curacon) procured from Syngenta company sale point located in Okara and were applied by Knapsack sprayer at recommended dose rates. Mean effects were statistically significant regarding mean infested bolls per plant. In case of interaction effects, maximum mean infestation (2.73 infested bolls/plant) were recorded in control plot followed by Emamectin-Benzoate. (0.93 2.73 infested bolls/plant) while the lowest (0.53 infested bolls/plant) was recorded in Profenophos+Cypermethrin treated plots. Crop water productivity was higher (0.61 kg/m^3) in experimental plots under drip irrigation compared to those under surface irrigation (0.53 kg/m^3).

Keywords: Bollworms, Irrigation system, Maximum, Infestation, Crop water productivity, Randomized Complete Block Design (RCBD)

INTRODUCTION

Cotton (*Gossypium hirsutum*) holds significant value globally as a fiber crop, primarily utilized in the textile industry (Chen G et al., 2020). Pakistan, ranking fifth in global cotton production, heavily relies on cotton exports, contributing around 0.6% to the country's GDP and 2.4% to the agricultural value added (Zhang Z et al., 2023). Despite its economic importance, the cotton industry faces challenges, including a reported decline in cotton fiber quality attributed to chemically synthesized fibers and the impacts of climatic changes and pest outbreaks (Shahzadi I et al., 2023). Cotton crops are vulnerable to various sucking insect pests and bollworms, with the American bollworm, *Helicoverpa armigera* (Hubner), emerging as a significant pest for numerous agricultural crops, particularly fiber crops (Rauf S et al., 2019). *H. armigera*, being polyphagous, poses a threat to a wide range of crops in diverse climatic conditions, including cotton, fodders, tobacco, and oilseed crops (Tokel D et al., 2022). Its characteristics, such as high fecundity, extensive movement, and resistance to synthetic entomocidal chemicals, contribute to its status as a serious pest (Riaz S et al., 2021). The larvae stage of *H. armigera* is particularly destructive, causing significant yield losses in cotton crops (Noor-ul-Ane M et al., 2018). Given that these larvae often hide in fruits, bolls, or pods, traditional chemical sprays may not effectively control the pest (Tossou E et al., 2019). Hence, regular monitoring for timely detection of insect populations and the application of appropriate insecticides are crucial for effective pest control (Zheng S et al., 2022). Bio-derived insecticides being natural and eco-friendly are getting importance these days to be applied for the control filed as stored commodities insect pests (Ramya S, 2008). The insecticides have the capability of insect control without harming the quality of the product (Malinga LN et al., 2022). Several studies described plant derived materials having insecticidal properties and hence having sufficient potential to be practiced against numerous kinds of insect pests (Bini KK et al., 2023). Neem extract is the most usually practiced natural entomologic material (Kumar R et al., 2022). *Azadirachtin* is the active compound extracted from different parts of the neem plant, like seeds and leaves (de Souza TD et al., 2020). *Azadirachtin* is one of the plant products for efficient management of the lepidopteron and many other insect pests. Oil of *Jatropha curcas* was found to be toxic against *H. armigera*. In a toxicity bioassay, castor oil and garlic oil resulted in mortality of against *H. armigera*. Among the synthetic insecticides, Pyrethroids like Lamda-cyhalothrin, has been used to control *H. armigera* and *P. gossypiella*. Organophosphorus insecticides have shown remarkable toxicity against a variety of chewing insects of crops (Valdez-Ramirez A et al., 2023). Amides group found effective against *Earias insulana*.

Use of all the insect pest management tactics in an integrated way has attained huge importance in past few years (Haile F et al., 2021). The philosophy of Integrated Pest Management (IPM) programme is intellectual use of all the possible insect control techniques in a compatible manner to minimize the cost of crop protection (Alemu Z et al., 2022). The purpose of this programme is to keep the insect pest number below economic threshold level (Naik VC et al., 2023). Though bio-derived chemicals are slow-release insecticides compared to synthetic pesticides yet have been found effective against many lepidopteran insect pests (Radwan EM et al., 2018). However, in Pakistan, there are very a smaller number of listed bio-derived insecticides for control of bollworms (Mangrio WM et al., 2023). Therefore, the proposed research trial will focus on assessing the relative effectiveness of some bio-derived insecticides together with the synthetic insecticides against *H. armigera*.

MATERIALS AND METHODS

Location of study area

The research trials were executed at Ghurki Agricultural Farm House, District Kasur, 56000.

Experimental layout

Cotton variety BS-15 was sown during the Kharif season. The experiment followed a Randomized Complete Block Design (RCBD). Irrigation was implemented through both drip irrigation and surface/flood irrigation arrangements. Plant-to-Plant (P × P) and Row-to-Row (R × R) distances were set at 30 and 120 cm, respectively. The entire experimental area was divided into three blocks, each with an equal area. Treatments and controls were replicated thrice. Standard cultural practices were adopted to ensure optimum crop growth (Table 1).

Table 1. Treatments description.

Treatment	Trade name	Active ingredient
T_1	Curacron	Profenophos
T_2	Karate	Lamda-cyhalothrin
T_3	Proclaim	Emamectin-Benzoate
T_4	Polytrin c	Profenophos+Cypermethrin

Insect infestation data

Synthetic insecticides; Emamectin-Benzoate, Profenophos+Cypermethrin, Lamda-cyhalothrin and Profenophos (Curacon) procured from Syngenta company sale point located in Okara and were applied by Knapsack sprayer at recommended dose rates. A 2 m meter long wood stick was thrown in each plot and five cotton plants along the stick length were selected arbitrarily from each treatment plot and infestation data was computed after regular intervals of 24 h. till 96 h. of post-treatment by a formula as described by Hajatmand et al.

$$\text{Insect infestation (\%)} = \frac{\text{Damaged bolls/plant}}{\text{Total healthy bolls/plant}} \times 100$$

Crop water productivity

Estimation of crop water productivity of the cotton was done according to formula given by Awan et al.

$$\text{Crop Water Productivity (Kg/m}^3) = \frac{\text{Lint Yield (Kg/ha)}}{\text{Amount of water applied (m}^3\text{/ha)}}$$

Statistical analysis

The recorded data were analyzed through Statistic Software 8.1 and means of treatments were compared by LSD.

RESULTS

All the insecticides were applied on recommended dose rates and number of infested bolls per plant were counted every plot and infestation was compared with control plot (Table 2).

Table 2. Comparison of mean number of infested bolls per plant in the cotton variety under application of the insecticides.

Treatments	Mean infestation ± S.E.
Profenophos	0.95 ± 0.06
Lamda-cyhalothrin	0.68 ± 0.06
Emamectin-Benzoate	0.92 ± 0.06
Profenophos+Cypermethrin	0.55 ± 0.06
Control	2.48 ± 0.06

Results (Table 2) showed maximum mean infestation (2.48 infested bolls/plant) were recorded in case of control plot followed by Profenophos (0.95 infested bolls/plant), Emamectin-Benzoate (0.92 infested bolls/plant) while the lowest (0.55 infested bolls/plant) were recorded in case of Profenophos+Cypermethrin mixture (Figure 1).

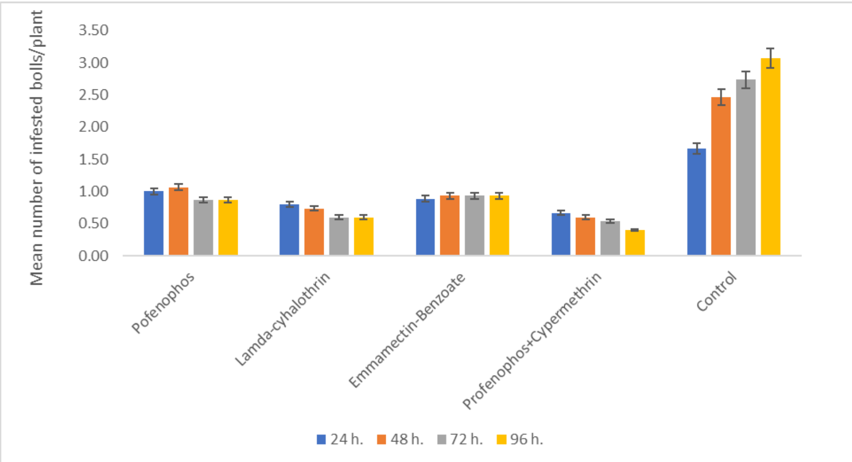

Figure 1. Comparison of mean number of infested bolls per plant in cotton after different exposure period under application of different insecticides.

Estimation of Crop Water Productivity (CWP)

Irrigation was applied through surface and drip irrigation systems and water was calculated throughout the crop period (Table 3).

Table 3. Comparison of crop water productivity of cotton under two irrigation regimes.

Experimental plot	Water applied (mm)	Yield (kg)	CWP (Kg/m^3)
Control plot (under surface irrigation)	345	184	0.53
Experimental plot (under drip irrigation system)	290	180	0.61

Results (Table 3) showed that CWP was greater (0.61 kg/m^3) in case of experimental plots under drip irrigation system compared with the experimental plot under surface irrigation (0.53 0.61 kg/m^3).

DISCUSSION

Cotton is cultivated extensively worldwide, driven by its substantial socio-economic benefits. As a primary source of fiber, it holds utmost importance in agriculture. However, the yield of cotton is compromised by various biotic and abiotic factors, with insect pest attacks standing out as a significant challenge. Plant protection plays a vital role in sustaining cotton production, shielding it from pest infestations. Numerous studies have investigated insecticidal applications to assess and manage infestations. Explored various insecticide formulations against *H. armigera* in cotton, identifying Lamda-cyhalothrin as the second most effective treatment a result consistent with our findings. Similarly, examined the toxic effects of synthetic insecticides on *H. armigera*, highlighting the efficacy of Emamectin benzoate against larval populations a result also mirrored in our research. In the study by Mahalakshmi, synthetic pyrethroids such as bifenthrin 10 EC @800 ml/ha and cypermethrin 25 EC @500 ml/ha outperformed traditionally used insecticides like Profenophos 40 EC. Our research supported this trend, with Lamda-cyhalothrin, Emamectin-Benzoate, and Profenophos+Cypermethrin demonstrating superiority over Profenophos 40 EC. However, our results deviated from those of Chaudhari et al., who evaluated the toxicity of entomocidal chemicals against *H. armigera* on chickpea, noting Emamectin benzoate's superiority over Lamda-cyhalothrin 5 in chickpeas but not in cotton crops.

REFERENCES

1. Chen G, Liu H, Mo BC, Hu J, Liu SQ, et al. (2020). Growth and development of *Helicoverpa armigera* (*Lepidoptera*: *Noctuidae*) larvae infected by *Heliothis virescens* ascovirus 3i (HvAV-3i). Front Physiol. 11: 93.
2. Zhang Z, Huang J, Yao Y, Peters G, Macdonald B, et al. (2023). Environmental impacts of cotton and opportunities for improvement. Nat Rev Earth Environ. 4(10): 703-715.
3. Shahzadi I, Mazhar N, Abbas S (2023). An assessment of changes and variability of climate impact on cotton production yield over Southern Punjab, Pakistan. Environ Dev Sustain. 1-7.
4. Rauf S, Shehzad M, Al-Khayri JM, Imran HM, Noorka IR (2019). Cotton (*Gossypium hirsutum* L.) breeding strategies. Adv Plant Breed Strateg Ind Food Crops. 6: 29-59.
5. Tokel D, Dogan I, Hocaoglu-Ozyigit A, Ozyigit II (2022). Cotton agriculture in Turkey and worldwide economic impacts of Turkish cotton. J Nat Fibers. 19: 10648-10667.
6. Riaz S, Johnson JB, Ahmad M, Fitt GP, Naiker M (2021). A review on biological interactions and management of the cotton bollworm, *Helicoverpa armigera* (*Lepidoptera*: *Noctuidae*). J Appl Entomol. 145: 467-498.
7. Noor-ul-Ane M, Kim DS, Zalucki MP (2018). Fecundity and egg laying in *Helicoverpa armigera* (*Lepidoptera*: *Noctuidae*): Model development and field validation. J Econ Entomol. 111: 2208-2216.
8. Tossou E, Tepa-Yotto G, Kpindou OK, Sandeu R, Datinon B, et al. (2019). Susceptibility profiles of *Helicoverpa armigera* (Hubner) (*Lepidoptera*: *Noctuidae*) to deltamethrin reveal a contrast between the Northern and the Southern Benin. Int J Environ Res Public Health. 16: 1882.
9. Zheng S, Chen R, Wang L, Pan S, Liu W, et al. (2022). Effect of metabolic changes in *Aphis gossypii*-damaged cotton plants on oviposition preference and larval development of subsequent *Helicoverpa armigera*. J Agric Food Chem. 70: 9584-9595.
10. Ramya S (2008). Antifeedant activity of leaf aqueous extracts of selected medicinal plants on VI instar larva of *Helicoverpa armigera* (Hubner). Ethnobot Leafl. 2008: 127.
11. Malinga LN, Laing MD (2022). Efficacy of biopesticides in the management of the cotton bollworm, *Helicoverpa armigera* (*Noctuidae*), under field conditions. Insects. 13: 673.
12. Bini KK, Kobenan KC, Kouakou M, Kouadio IS, Zengin G, et al. (2023). Phytochemical profiling, antioxidant activities, enzymatic activities and insecticidal potential of aqueous extracts of four plants on the larvae of *Helicoverpa armigera* (*Lepidoptera*: *Noctuidae*), the main pest of cotton plant in Ivory Coast. Arch Insect Biochem Physiol. 113: e22017.
13. Kumar R, Das J, Mahto JK, Sharma M, Vivek S, et al. (2022). Crystal structure and molecular characterization of NADP+-farnesol dehydrogenase from cotton bollworm, *Helicoverpa armigera*. Insect Biochem Mol Biol. 147: 103812.
14. de Souza TD, Fernandes FO, Sanches AC, Polanczyk RA (2020). Sublethal effects of different fungal isolates on *Helicoverpa armigera* (*Lepidoptera*: *Noctuidae*). Egypt J Biol Pest Control. 30: 1-12.
15. Valdez-Ramirez A, Flores-Macias A, Figueroa-Brito R, Torre-Hernandez ME, Ramos-Lopez MA, et al. (2023). A Systematic Review of the Bioactivity of *Jatropha curcas* L. (*Euphorbiaceae*) Extracts in the Control of Insect Pests. Sustainability. 15: 11637.
16. Haile F, Nowatzki T, Storer N (2021). Overview of pest status, potential risk, and management considerations of *Helicoverpa armigera* (*Lepidoptera*: *Noctuidae*) for US soybean production. J Integr Pest Manag. 12: 3.
17. Alemu Z, Azerefegne F, Terefe G (2022). Susceptibility of African Bollworm, *Helicoverpa armigera* (Hubner) (*Lepidoptera*: *Noctuidae*) to Different Commercial Pyrethroid Insecticides on Cotton. Ethiop J Agric Sci. 32: 56-72.
18. Naik VC, Subbireddy KB, Nagrare VS, Venugopalan MV (2023). Insecticide Spray Regimes to Manage *Helicoverpa armigera* (Hubner) and their Impact on Natural Enemies in Cotton under High Density Planting System. Indian J Entomol. 85: 932-939.
19. Radwan EM, El-Malla MA, Fouda MA, Mesbah RA (2018). Appraisal of Positive Pesticides Influence on pink bollworm larvae, *Pectinophora gossypiella* (Saunders).

 ISSN: 2251-0044

Egypt Acad J Biol Sci F Toxicol Pest Control. 10: 37-47.

20. Mangrio WM, Chachar ZA, Sahito HA, Sahito FI, Mastoi AH, et al. (2023). Management of *Earias vittella* and *Pectinophora gossypiella* through different insecticides under cotton field conditions. Pak J Biotechnol. 20: 100-109.