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Proceeding Paper

Biopotency of Salicylic Acid against Oviposition and Feeding Behavior of *Pectinophora gossypiella* in Cotton †

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Abstract: *Pectinophora gossypiella* (Saunders) is a potential threat for the successful cultivation of cotton all over the world. Despite the use of modern management strategies, the damage caused by this pest is increasing. The repeated exposure of this pest to *Bacillus thuringenisis* (Bt) crops resulted in resistance development, which has threatened the continued success of Bt cotton cultivation. Salicylic acid has been reported to enhance the efficiency of crops. The present study was carried out to determine the effect of salicylic acid on the oviposition (pre-oviposition and post-oviposition time) and feeding behavior (pre-feeding time and post-feeding time) of pink bollworm larvae in two cotton varieties, i.e., CIM-70 and NIAB-78. In the first experiment, leaves and bolls treated with different concentrations of salicylic acid were kept in an oviposition chamber and adults were released in a chamber with a ratio of 5:5 males to females, respectively. The experiment was performed following a Completely Randomized Design (CRD) with three replications and six concentrations of salicylic acid (0, 10, 20, 40, 80, and 160 ppm). In a second complementary experiment, salicylic acid was evaluated against feeding behavior, i.e., larval duration, pre-feeding time, feeding time, post-feeding time, and percentage mortality of pink bollworm. In both experiments, the results revealed that the application of salicylic acid at a maximum concentration was effective against the oviposition and feeding of pink bollworm only in the NIAB-78 cultivar. It is concluded that salicylic acid has the potential to reduce pink bollworm risks, and the present investigation will help researchers as well as farmers plan for the timely sustainable management of pink bollworm.

Keywords: feeding behavior; oviposition; Pectinophora gossypiella; salicylic acid

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1. Introduction

The pink bollworm is a significant pest of cotton crops, with a global impact that results in losses ranging from 20 to 90 percent of the annual output. It has a diverse range of hosts and can survive in a variety of climatic conditions, which has led to its spread across multiple regions, including Mexico, the United States, Asia, Africa, Egypt, and parts of tropical America [1]. The pink bollworm is the most damaging pest of cotton, leading to a significant reduction in cotton oil content (2.1–47.10%) and seed cotton yield (2.8–61.9%) due to its feeding pattern. In severe attacks, up to 59.20 percent of bolls may remain unopened, resulting in substantial damage [2]. This pest has caused damage to approximately one million bales in Pakistan, highlighting the need for effective pest management strategies to mitigate its impact on cotton production [3]. The larvae of the pink bollworm can damage cotton crops by feeding on blossoms, sensitive squares, and green cotton bolls. This feeding can result in the petals of cotton flowers becoming close in a rosette structure, and can also harm the quality of lint and fiber when bolls are affected [4].

Plants respond to salicylic acid (SA), a natural growth regulator and elicitor, in various ways that impact their development and growth. SA affects processes like ion uptake, transport, and membrane permeability [5]. Insects that feed on plants can be deterred by the presence of SA, which triggers the synthesis and accumulation of secondary metabolites. For instance, cotton bollworm pupae mortality rates were found to be higher when exposed to high concentrations of SA in laboratory settings. Moreover, applying jasmonic acid or SA analogs can induce systemic defenses that reduce potato aphid population growth on tomato plants [6].

Studies have shown that application of salicylic acid via spraying can significantly increase the resistance of plants to various sucking pests, including *Nezara viridula, Myzus persicae, Empoasca lubica*, and *Tetranychus urtica* [7]. This discovery has important implications for the agricultural industry, as it provides a potential means of reducing crop losses due to pest infestations.

In order to control the proper and sustainable growth of pink bollworms, it is imperative to find different potential obstacles that may impede their development. These barriers can be attributed to various biological factors, such as feeding habits, fertility, and egg-laying behavior. The objective of this study was to investigate the egg-laying behavior and feeding response of PBW in relation to two cotton cultivars that were treated with salicylic acid.

2. Material and Methods

2.1. Experimental Layout

The germplasm of two cotton varieties (NIAB-78 (early maturity, gives higher yield, and shows wider adaptability and greater pest avoidance) and CIM-70 (heat tolerant, short stature, and very early maturing and best fiber characteristics) was collected from the Ayub Agriculture Research Institute (AARI), Faisalabad, Punjab, Pakistan. These cotton varieties were cultivated at the entomological research area of the University of Agriculture, Faisalabad, following all agronomic practices. Recommended cultural and agronomic practices were adopted from sowing to harvesting. The experimental area was further divided into six treatment areas, including the control, and each treatment included four replicates following a randomized complete block design (RCBD).

2.2. Salicylic Acid Treatments

The cotton plots of both varieties were sprayed with salicylic acid (SA) at the rates of 0, 10, 20, 40, 80, and 160 ppm. Plants were sprayed after 60 days of sowing in one-week interval for four times with the help of a hydraulic sprayer, whereas the control plots were sprayed with only distilled water.

2.3. Insect Collection and Rearing Technique

Initially, pink bollworms were collected by visiting different cotton fields. The proper conditions and diet for maintaining a mass culture of *Pectinophora gossypiella* (PBW) were followed as described by [8]. Pink bollworm larvae were incubated at constant conditions of 26 ± 1 °C and 70 ± 5% RH (relative humidity) in an electric incubation at the Cotton Bollworms Entomological Department laboratory, University of Agriculture, Faisalabad, Punjab, Pakistan.

2.4. Toxicity Tests

2.4.1. Assessment of Salicylic Acid against the Oviposition of *Pectinophora gossypiella*

To study the latent effect of salicylic acid at concentrations of 10, 20, 40, 80, and 160 ppm on the oviposition of PBWs, four male and four female adults were transferred to cages containing an artificial diet consisting of salicylic acid-treated cotton leaves. Different adults were kept on different feeding diets in cages containing cotton leaves treated with different salicylic acid concentrations. Each concentration was used in three replicates, and each cage contained two pairs (female + male). Each cage was inspected daily to record

pre-oviposition, oviposition, and post-oviposition times and number of females sitting on cotton leaves [9].

2.4.2. Assessment of Salicylic Acid against the Feeding Behavior of *Pectinophora gossypiella*

Larvae of the 3rd and 4th instars were tested for their damage level on cotton crop against salicylic acid. Cotton leaves and bolls treated with different concentrations (0, 10, 20, 40, 80, and 160 ppm) of salicylic acid were put in different cages. Pink bollworm larvae were transferred to the cages. Each treatment as well as the control was replicated three times. Data regarding % mortality, pre-feeding time, feeding time, and post-feeding time were collected regularly to assess the efficacy of salicylic acid against the larvae of pink bollworm during the 3rd and 4th instars.

2.5. Statistical Analysis

The data collected on various parameters of oviposition and feeding behavior of pink bollworm were subjected to ANOVA techniques, and the means of the treatments were compared using Tukey's HSD test at a probability level of 5%.

3. Results and Discussion

3.1. Impact of Salicylic Acid on the Oviposition Behavior of Pink Bollworm

The results revealed that the application of salicylic acid significantly influenced the oviposition behavior of pink bollworm. Among all the concentrations of salicylic acid tested, the maximum concentration (160 ppm) increased the pre-oviposition time (25.27 min) and oviposition time (27.32 min) and decreased the post-oviposition time (10.11 min) along with the number of setting females (18.24 min) in both cotton varieties NIAB-78 and CIM-70, followed by the 80 ppm concentration, which increased the pre-oviposition time (19.22 min) and oviposition time (22.26 min) and decreased the post-oviposition time (12.13 min) along with the number of setting females (21.28 min) in both cotton varieties NIAB-78 and CIM-70 (Figure 1).

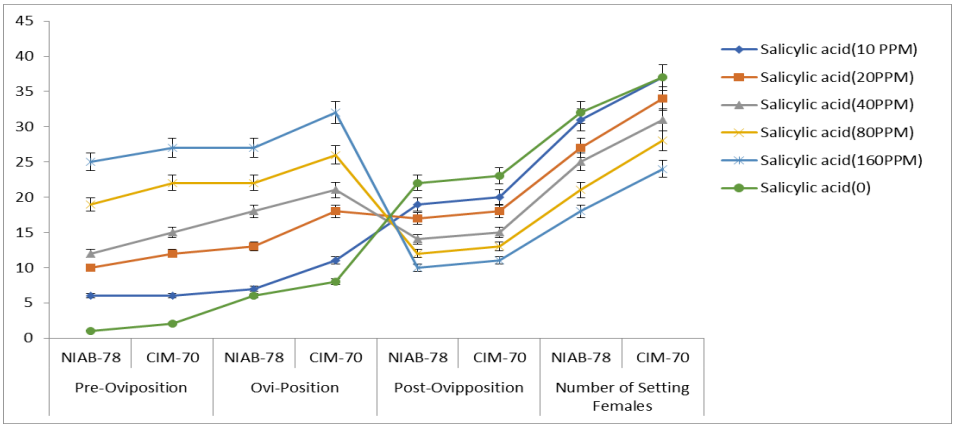

Figure 1. Impact of salicylic acid on the oviposition behavior of pink bollworm in two cotton cultivars.

Among all the concentrations tested, the minimum increase in pre-oviposition (6) and oviposition (7,11) times was recorded for the lowest concentration (10 ppm). Moreover, the lowest rate of salicylic acid application also caused a smaller decrease in post-oviposition time and number of setting females in both cotton varieties NIAB-78 and CIM-70.

However, when examining the impact of salicylic acid between cotton varieties, it was recorded that in NIAB-78, the pre-oviposition and oviposition times increased less in comparison to CIM-70. Additionally, in the case of post-oviposition time and number of setting females, salicylic acid in NIAB-78 also proved to be the most effective and caused a maximum decrease in post-oviposition time and number of setting females. It was

found that one of the two cotton varieties, CIM-70, had the longest pre-oviposition and oviposition times.

3.2. Impact of Salicylic Acid on the Feeding Behavior of Pink Bollworm

The results revealed that among all salicylic acid concentrations, the maximum % mortality (78%) was recorded in NIAB-78 with the application of the maximum concentration of 160 ppm, followed by CIM-70 (62%). It was recorded that the pre-feeding time was maximum (8 min) with the application of salicylic acid at the rate of 160 ppm in NIAB-78, followed by CIM-70 (7 min). However, a minimum feeding time was noticed at the maximum concentration in NIAB-78, followed by CIM-70. Moreover, salicylic acid in NIAB-78 also proved to be most effective against pink bollworm and caused the minimum post-feeding time in comparison to CIM-70. Among all the concentrations of salicylic acid, the lowest concentration (10 ppm) caused minimum % mortality, pre-feeding time, feeding time, and post-feeding time in comparison to the control (Figure 2).

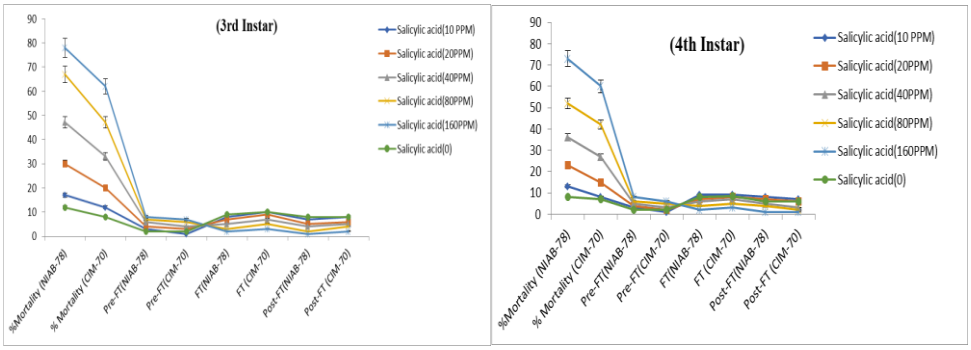

Figure 2. Impact of salicylic acid on the feeding behavior during the 3rd and 4th instars of pink bollworm larvae.

In a study conducted by Shrinivas et al. [10], the larval period of *Pectinophora gossypiella* (Saunders) was examined in relation to their feeding on different host plants. The researchers discovered that a diet consisting of okra fruits resulted in a shorter larval time of 23 days. However, when the larvae were fed Bt cotton, the researchers observed a longer larval period of 26 days. These findings suggest that the choice of host plant can have a significant impact on the development of *Pectinophora gossypiella* larvae, and that might be the reason why, in our present study, the pre-feeding time and feeding time of pink bollworms feeding on cotton leaves treated with salicylic acid were recorded to be minimum in comparison to when feeding on untreated leaves.

Overall, among both cotton varieties, the application of salicylic acid in NIAB-78 exhibited significant results and caused the maximum percent mortality of pink bollworms, and pink bollworms also spent the maximum time to start feeding. The feeding time and post-feeding time were also recorded to be minimum in NIAB-78 in comparison to the control. Almost the same trend was followed during the fourth instar of pink bollworms.

4. Conclusions

It was concluded that salicylic acid had an inhibitory effect on the pink bollworm, and its application significantly disturbed the pre-oviposition, post-oviposition, pre-feeding, feeding, and post-feeding times. Among the two cotton varieties, the application of salicylic acid in NIAB-78 showed maximum mortality percentage in comparison to CIM-70. These results are helpful for researchers and farmers to protect their cotton field from the harms of *Pectinophora Gossypiella.*

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