biology and life sciences forum

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Proceedings

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 of the modern management strategies, the damage by the pest is increasing. The repeated exposure of the pest to *Bacillus thuringenisis* (Bt) crops resulted in resistance development which has threatened the continued success of Bt cotton. Salicylic acid has been reported to enhance efficiency of the crops. Present study was carried out to determine the effect of salicylic acid on the oviposition (pre-oviposition, post-oviposition time) and feeding behavior (pre-feeding time, post-feeding time) of Pink Bollworm larvae in cotton varieties i.e., CIM-70 and NIAB-78. In 1st experiment, leaves and bolls treated with different concentrations of salicylic acid were kept in oviposition chamber and adults were released in chamber with the ratio of 5:5 male and female respectively. Experiment was performed following Complete Randomized Design (CRD) with three replications and six concentrations of salicylic acid (0, 10, 20, 40, 80, 160 ppm). In 2nd compliment of the experiment, salicylic acid was evaluated against feeding behavior i.e., larval duration, pre-feeding time, feeding time, post-feeding time and percentage mortality of the Pink Bollworm. In both experiments, the results revealed that the application of salicylic acid in maximum concentration was effective against oviposition and feeding of the pink bollworm only in the NIAB-78 cultivar. It is concluded that salicylic acid has the potential to reduce pink bollworms risks and present investigations will help researchers as well as farmers for the timely sustainable management of Pink Bollworm.

Keywords: Feeding behavior; Oviposition; *Pectinophora gossypiella;* Salicylic acid

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 the blossoms, sensitive squares, and green cotton bolls. This feeding can result in the petals of cotton flowers becoming close together in a rosette structure, and can also harm the quality of the lint and fiber when the 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 bollworm, 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

Germplasm of the two cotton varieties {NIAB-78 (early maturity, gives higher yield, shows wider adaptability and greater pest avoidance), CIM-70 (Heat tolerant, short stature, very early maturing and best fiber Characteristics)} was collected from the Ayub Agriculture Research Institute (AARI) Faisalabad, Punjab, Pakistan. Cotton varieties were cultivated at the entomological research area, University of Agriculture, Faisalabad following all agronomic practices. Recommended cultural and agronomic practices were adopted from sowing to harvest. 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

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

2.3. Insect Collection and Rearing technique:

Initially Pink bollworm was collected by visiting different cotton fields. However, 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 PBW a, the four male and four female adults were transferred to the cages containing artificial diet of salicylic acid treated cotton leaves. Different adults were kept on feeding in to the cages containing cotton leaves treated with different salicylic acid concentrations. Each concentration was used in three replicates and each cage contain two pairs (female + male). Each cage was inspected daily to record pre-oviposition, oviposition, post-oviposition time 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 3rd and 4th instar were tested as per their damage level on cotton crop against salicylic acid. Cotton leaves and bolls treated with different concentrations (0,10,20,40,80,160 ppm) of salicylic acid were putted in to different cages. Pink bollworm larvae were transferred to the cages. Each treatment as well as control was replicated three times. Data regarding their % mortality, pre-feeding time, feeding time and post feeding time was collected regularly to asses' efficacy of salicylic acid against the larvae of 3rd and 4th Pink bollworm instars.

2.5. Statistical Analysis: -

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

3. Results and Discussion

3.1. Impact of the Salicylic acid on the oviposition behavior of pink bollworm:

Results revealed that the application of Salicylic acid significantly influenced oviposition behavior of pink bollworm. Among all the concentrations of the Salicylic acid maximum concentration (160ppm) increased the Pre-oviposition time (25.27 min), oviposition (27.32 min) and decreased post oviposition time (10.11min) along with the number of setting females (18.24 min) on both cotton varieties NIAB-78 and CIM-70 respectively followed by the 80ppm who increased Pre-oviposition time (19.22 min), oviposition (22.26 min) and decreased post oviposition time (12.13 min) along with the number of setting females (21.28 min) on both cotton varieties NIAB-78 and CIM-70 respectively.

Among all concentration minimum pre-oviposition (6,6) and oviposition (7,11) was increased by the lowest concentration (10 ppm), moreover, the lowest rate of application also caused the less decrease in post oviposition and number of setting females on both cotton varieties NIAB-78 and CIM-70 respectively.

However, during the impact of interaction between cotton varieties, it was recorded that NIAB-78 increased less pre-oviposition and Ovi-position time on comparison to CIM-70. Additionally, in case of post-oviposition and number of setting females NIAB-78 also proved most effective and caused maximum decrease in post-oviposition and number of setting females' time. It was found that of the two cotton varieties, CIM-70 had the longest pre-oviposition and oviposition times.

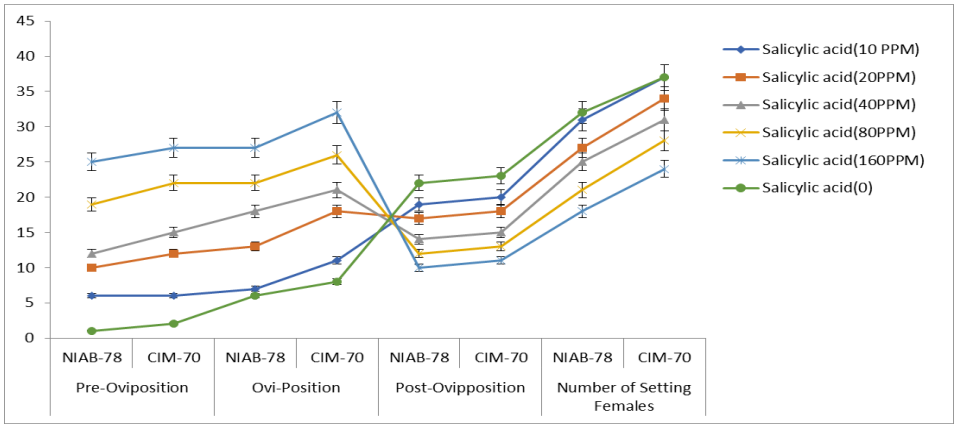

Figure 3. Impact of the Salicylic acid on the oviposition behavior of pink bollworm on cotton cultivars.

3.2. Impact of the Salicylic acid on the feeding behavior of pink bollworm:

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

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 in our contemporary study where pre-feeding time and feeding time of pink bollworm feeding on cotton leaves treated with salicylic acid was recorded minimum on comparison to their feed on untreated leaves.

Overall, among both cotton varieties against the application of salicylic acid NIAB-78 expressed significant results and caused maximum percent mortality of the pink bollworm and pink bollworm also spent maximum time to start the feeding. Feeding time and post feeding time were also recorded minimum on NIAB-78 on comparison to the control. Almost same trend was followed during the 4th instar of pink bollworm.

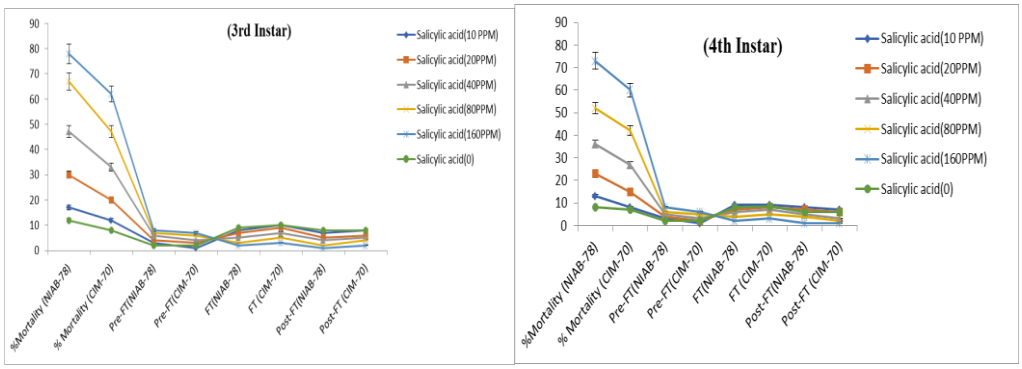

Figure 4. Impact of the Salicylic acid on the feeding behavior of 3rd and 4th instar of the Pink bollworm larvae.

Conclusion

It was concluded that salicylic acid had inhibitory effect on the Pink bollworm and their application significantly disturbed the time of pre-oviposition, post-oviposition, pre-feeding, feeding and post-feeding time. Among cotton varieties NIAB-78 showed maximum mortality percentage on comparison to CIM-70. Results are helpful for the researcher and farmers to save their cotton field from the harms of *Pectinophora Gossypiella.*

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