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Management strategies of pink bollworm (*Pectinophora gossypiella*) in Bt Cotton in Suryapet district of Telangana state

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Abstract

Pink bollworm is a dangerous pest that severely impacts cotton production worldwide, reducing crop quality and yield and causing significant financial losses. The purpose of this research is to analyze different methods for controlling pink bollworm infestations and emphasize the importance of integrated pest management (IPM) techniques. The article discusses that the chemical control with pesticides which despite their efficacy, cause environmental problems and the rise of resistance. It also draws attention to sustainable biological management approaches like parasitoids, entomopathogenic fungi and natural predators. Additionally, pheromone disruption strategies such as mating disruption and pheromone trap monitoring, are being studied as effective means of reducing insect populations without jeopardizing the environment. The key findings indicate that while each strategy has benefits, a comprehensive, integrated approach combining cultural, physical, biological and chemical methods is the best long-term solution for controlling pink bollworm in cotton. The average gross returns from demonstration practice were Rs. 83,366/acre, and in Farmer practice is Rs. 61,200/acre. Demonstrative practice produced net returns of Rs. 47,950/acre, while farmers' practice produced net returns of Rs. 32,016/acre. The average cost of cultivation during the study period was Rs. 35,416/acre in the demonstration plot and Rs. 29,333/acre in farmer's practice. The cumulative effect of technological interventions over a three-year period showed that the average benefit-cost ratio in demonstration plots was 2.34, whereas in farmers' practice it was 2.06.

Keywords: Pink bollworm, *pectinophora gossypiella*, Integrated Pest Management (IPM), biological control, chemical control, Bt cotton, pheromone disruption, pest resistance and sustainable agriculture

Introduction

Cotton (*Gossypium hirsutum* L.) one of India's most significant commercial fibre crops. The Cotton Association of India's (CAI) most recent estimate places the cotton supply for 2024–2025 at 354.49 lakh bales, each weighing 170 kg. An estimated 315 lakh bales weighing 170 kg each will be used domestically, leaving 39.49 lakh bales available. In India, the area planted to cotton in 2024–2025 was 112.94 lakh ha, compared to 123.70 lakh ha in 2023–2024. Maharashtra is the state with the most cotton acreage, with 40.86 lakh hectares, followed by Madhya Pradesh (6.14 lakh hectares), Telangana (17.70 lakh hectares), Gujarat (23.66 lakh hectares), and Karnataka (6.84 lakh hectares). In Telangana state, 43,76,043 acres was cultivated with cotton in 2024–2025 compared to 44,52,411 acres in 2023–2024. The largest district was Nalgonda (5,40,022 acres), followed by Adilabad (4,34,993 acres), Sangareddy (3,56,619 acres), Asifabad (3,26,318 acres), and Vikarabad (2,41,592 acres). According to the second advance projections, Telangana was expected to produce 48.12 lakh bales of cotton in 2023–2024 as opposed to 57.45 lakh bales in 2022–2023. India is the only nation in the world that grows all four varieties of cotton. India's nine major cotton-growing states are divided into three distinct agro-ecological zones: 1) The Northern zone, which includes Punjab, Haryana and Rajasthan; 2) The Central zone, which includes Gujarat, Maharashtra, and Madhya Pradesh; 3) The Southern zone, which includes Telangana, Andhra Pradesh and Karnataka. There are 1326 insect pest species that impact cotton crops worldwide, however only 166 arthropod pest species have been identified in India. Insect infestations caused yield losses of between 50 and 60 percent.

Table 1: Major pests of boll worm complex in cotton

S. No.	Common name	Scientific name
1.	American bollworm	<i>Helicoverpa armigera</i>
2.	Tobacco caterpillar	<i>Spodoptera litura</i>
3.	Spotted bollworm	<i>Earias vittella</i>
4.	Pink bollworm	<i>Pectinophora gossypiella</i>

The incidence of bollworm complexes on the crop has significantly decreased since the introduction of Bt Cotton, or Bollgard-I technology, which consists of Cry1Ac protein in 2002 and Boll guard technology-II, which consists of Cry1Ac and Cry2Ab protein in 2006. Over the past few decades, India's cotton production and productivity have both greatly increased. Due to the development of tolerance against Cry1Ac and Cry2Ab toxins in India, Bt-cotton technology has recently been unable to protect cotton crops from pink bollworm. In states like Karnataka and Andhra Pradesh, the pink bollworm survived on all Bt-cotton hybrids after developing resistance to Cry1Ac in 2009 and 2010. Due to the significant yield losses, it developed into a significant and devastating pest of cotton with national significance. In recent years, Pink Bollworm (PBW) infestation has become more common. When compared to other nations like the United States of America and China, India's productivity levels are quite low. The pink bollworm larvae eat on anthers, pollens, flowers, green bolls, locules, lint and seed, causing harm from the blossoming to harvesting stage. "Rosette flowers" are damaged flowers that are twisted into the shape of a rose. The larvae first make tiny holes inside the green bolls, dig into the lint and then pierce the seeds. The impacted bolls decay and shed too soon. Immature fibers degrade the quality of lint during opening. The development of long-duration hybrids, year-round hosts and the long-term storage of raw cotton at ginning mills all contributed to the high occurrence of pink bollworms. Using traditional insecticides to control pink bollworm it is very challenging and not a long-term solution. Repeated sprayings led to the development of insect resistance and community pest management practices would be totally effective in controlling this pest. Pests below the Economic Threshold Level (ETL) are controlled by integrating several pest management techniques, such as cultural, mechanical, physical, biological and chemical. Therefore, the current study was conducted to evaluate the effectiveness of the IPM module in the field against pink bollworm in cotton in Suryapet district in Telangana state. According to Greenberg *et al.* (2012) ^[4], integrated pest management (IPM) is a sustainable method of controlling pests by combining cultural, physical, biological and chemical instruments in a way that reduces threats to the environment, economy and public health. IPM uses a variety of crop-specific and location-specific pest management techniques. According to Greenberg *et al.* (2012) ^[4], it can alternatively be described as a knowledge-based decision-making process that foresees boundaries and removes or prevents pest problems, ideally before they have established themselves. The goal of integrated pest management (IPM) in cotton is to minimize pesticide use while preserving profitability, output and fiber quality by utilizing all available methods for controlling pest populations.

Materials and Methods

The (Krishi Vigyan Kendra) KVK-Gaddipally carried out the demonstrations in seasons Kharif 2023, 2024 and 2025 to evaluate several approaches for controlling pink bollworms in cotton in farmer's fields. Through pre-Kharif awareness programs, targeted group talks, method demonstrations, training programs, sensitization workshops and Field Days, the farmers

were made aware of the importance of these technologies during the sessions. A total of 10 demos were held in the Suryapet region with 12 locations in each season in three years. All IPM practices were applied to 10 acres of the total experimental area, which was 10 acres in different locations in the district. One acre was chosen as a demonstration plot and remaining as a check in each location in the district. Soil samples were systematically collected from the field following standard sampling procedures and were analyzed in the laboratory to assess key soil parameters such as pH, organic carbon and available macro and micro nutrients, which helped in understanding the soil fertility status and in recommending appropriate crop and nutrient management practices.

Farmers in both the demo and the check plots were personally interacted in order to gather data. The purpose of the demonstrations was to examine the yield discrepancy between the farmer's practice and the demonstration plot. The yield statistics from the farmer's practice and demonstration trials were recorded and a random crop cutting experiment was also carried out. The cost of cultivation, net returns, gross returns and benefit-cost ratio were among the other data characteristics that were noted.

Results and Discussion

Integrated Pest Management (IPM) is an approach that combines multiple strategies to manage pest populations in an environmentally sustainable and economically viable way Integrated Pest Management (IPM) is an approach that combines multiple strategies to manage pest populations in an environmentally sustainable and economically viable way integrated Pest Management (IPM) is an approach that combines multiple strategies to manage pest populations in an environmentally sustainable and economically viable way integrated Pest Management (IPM) is an approach that combines multiple strategies to manage pest populations in an environmentally sustainable and economically viable way

Integrated Pest Management (IPM)

The goal of Integrated Pest Management (IPM) is to control pest populations in a way that is both economically and environmentally sustainable. One of the key components of IPM is monitoring, which comprises regular observation of pest populations to determine the presence and quantity of pests, such as the pink bollworm, in the field. Instead of using pesticides at random, this enables farmers to make well-informed decisions based on real-time data (Kranthi, 2015) ^[8]. Another crucial element is threshold levels, or the density of pests at which control measures are necessary. By establishing these thresholds, farmers can avoid using unnecessary pesticides when pest populations are below ETL levels. The final step in integrated pest management (IPM) is the selection of appropriate control methods, which can include cultural practices like crop rotation, mechanical methods like destroying agricultural leftovers and biological controls like parasitoids or predators (Sundararaj and Ramasubramanian, 2023) ^[17].

Cultural control measures

Cultural control methods, which are often considered the first line of defense against pink bollworm infestations, include crop rotation, post-harvest, crop residue removal, and timing of planting and harvesting.

Crop rotation has been one of the most effective cultural strategies. Crop rotation has been one of the most effective cultural strategies. Crop rotation has been one of the most

effective cultural strategies. Crop rotation is one of the most successful cultural practice. By switching cotton with non-host crops, you can disrupt the pink bollworm's life cycle and reduce its ability to establish a stable population. However, the efficacy of this strategy is often limited by local agricultural practices; in many places, cotton is grown continuously, making rotation less feasible (Gunderson and Simmel, 2021) ^[5]. Destroying crop remnants after harvest is another frequently recommended practice. Cotton stalks must be ploughed or shredded to eliminate the larvae that overwinter in the plant debris and prevent the pest from surviving between cropping seasons. When combined with early planting and harvesting, which shortens the window of exposure to pink bollworm infestation, these techniques can significantly limit the impact of the pest (Jayaraj and Muthukrishnan, 2021) ^[6].

Mechanical and Physical Control Measures

Managing and controlling pests with methods like collection of adult insects with nets, removal of rosette flowers and infested bolls, installation of pheromone traps @ 10/ac are known as mechanical control. In order to control pests, weeding and temperature changes are also included. Farmers are looking for sustainable methods to control pests without harming the environment.

Biological Control Measures

Chemical treatments are becoming less effective due to

environmental concerns and resistance, biological management strategies are now essential for controlling pink bollworm in cotton fields. Beneficial insects such as parasitoid, particularly *Trichogramma* species, are among the most significant biological control agents. These small wasps parasitize and finally kill the host insect eggs by laying their eggs within the eggs of the pink bollworm. These natural enemies have actually been effectively employed in integrated pest management (IPM) programs in some cotton-growing areas to decrease the need for chemical treatments, particularly when paired with other control techniques (Gunderson and Simmel, 2021) ^[5]. By using these biological control agents, it leads to more sustainable pest management (Sundararaj and Ramasubramanian, 2023) ^[17].

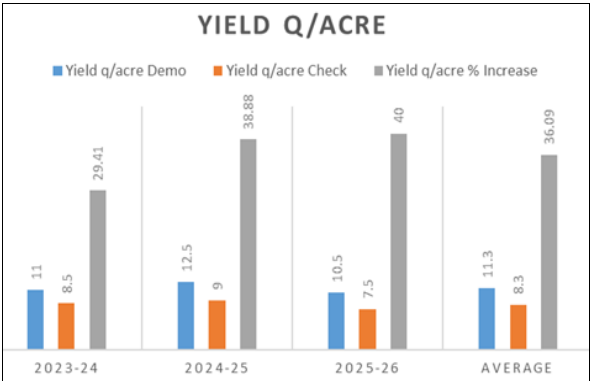
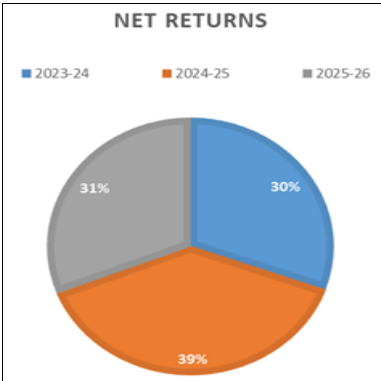
Chemical Control Measures

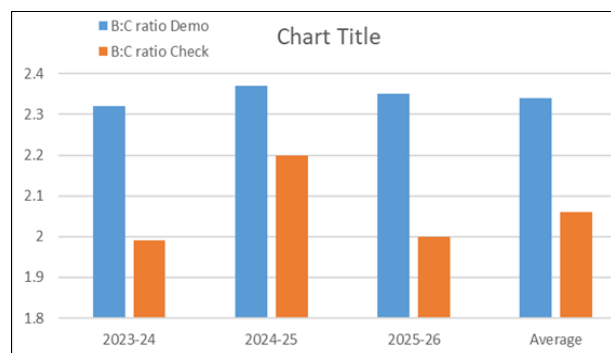
If trap catches exceed 8-10 adults / day for 3 consecutive days / if 10% rosette flowers or 10% damaged green bolls are observed then the schedule of sprays as below followed rotating the chemicals on need basis- a) azadirachtin 1500 ppm @ 5ml/ lit with surf (1g), quinalphos @ 2.5ml/ lit or emamectin benzoate 0.5 g/ lit; thiodicarb @1.5 g/ lit; spinosad @ 0.35 ml/ lit; and spray 1 or 2 times in later stages of the crop cypermethrin @1ml/ lit or lambda cyhalothrin @ 1 ml/ lit. Farmer’s practice includes spraying of insecticides like acephate 1.5 g/ lit, chlorantraniliprole 0.3 ml/ lit, and lambda cyhalothrin 0.5 ml/ lit.



Table 2: Economics

Year	Area(ac)	Demos	Yield q/acre			Cost of Cultivation		Gross Returns		Net Returns		B:C ratio	
		Demo	Demo	Check	% Increase	Demo	Check	Demo	Check	Demo	Check	Demo	Check
2023-24	10 acres	10	11.0	8.5	29.41	32,650	29,350	75,900	58,650	43,250	29,300	2.32	1.99
2024-25	10 acres	10	12.5	9	38.88	38,400	28,700	91,250	65,700	52,850	37,000	2.37	2.2
2025-26	10 acres	10	10.5	7.5	40.0	35200	29,500	82,950	59,250	47,750	29,750	2.35	2.00
Average	10 acres	10	11.3	8.3	36.09	35,416	29,333	83,366	61,200	47,950	32,016	2.34	2.06





Conclusion

The economic metrics, including net returns, gross returns and the B:C ratio, were displayed in Table 2. The figures show that the gross returns, net returns and BC ratio of the demonstration plots were much higher than farmers' practices throughout the course of the three research years. In farmer practice, the average gross returns were Rs. 61,200/acre, whereas in demonstration practice, it was Rs. 83,366/acre. In Demonstrative practice net returns generated is Rs. 47,950/acre, while in farmers' practice it is Rs. 32,016/acre. The average cost of cultivation during the study period was Rs. 35,416/acre in the demonstration plot and Rs. 29,333/acre in farmer's practice. The cumulative effect of technological interventions over a three-year period showed that the average benefit-cost ratio in demonstration plots was 2.34, whereas in farmers' practice it was 2.06. The results are consistent with those of Narendar *et al.*, who discovered that Demo farmers had greater B:C ratios and net returns. The incidence and damage of pink bollworm was low in demonstration plots because of the use of Integrated Pest Management technologies, such as the identification of pests and damage symptoms at the field level, regular pest monitoring through field visits and recommendations periodically provided by KVK, Gaddipally scientists. Farmers were able to understand the purpose and importance of pest monitoring, the concept of ETL and need-based pesticide application. The incidence was high in farmers' practices because they were unaware of new technology and did not adopt IPM methods. Similar results were reported by Kolhe *et al.*, who noted that the incidence of pink bollworms was low in demonstration plot.

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