

Phenology and monitoring of lepidopteran pests in cotton agroecosystems of Beshariq district,
Fergana Valley

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Abstract: The cotton (*Gossypium spp.*) agroecosystems in Besharik district of the Fergana Valley are vulnerable to infestation by several Lepidoptera species, including *Helicoverpa armigera*, *Spodoptera litura*, and *Agrotis segetum*. This study, carried out during the 2023–2024 growing season, aimed to assess the diversity, population dynamics, and seasonal activity of major lepidopteran pests under regional agro-climatic conditions. Field surveys, pheromone traps, and mercury vapor light traps were used to monitor pest populations, supported by soil sampling and meteorological data analysis. Results demonstrated distinct temporal population peaks for each species, with *H. armigera* showing the highest activity during flowering and boll development stages, *S. litura* in late summer, and *A. segetum* during early seedling stages. Pest abundance was strongly influenced by environmental variables, particularly temperature and humidity. The integration of pheromone and light trap data provided robust insights into species phenology and highlighted the importance of implementing region-specific, ecologically-based integrated pest management (IPM) strategies to sustain cotton production in the Fergana region.

Keywords: *Helicoverpa armigera*, *Spodoptera litura*, *Agrotis segetum*, Cotton pests, Fergana Valley, Phenology, Pheromone traps, Light traps, Integrated pest management (IPM), Population dynamics.

Introduction

Cotton (*Gossypium spp.*) is a vital industrial crop globally and plays a pivotal role in the agricultural economy of Uzbekistan (FAO, 2020). The crop's productivity and fiber quality are influenced by a complex interplay of agrobiological and ecological factors, among which insect pests-particularly Lepidoptera species-are of primary concern (Matthews & Tunstall, 1994). In recent decades, the management of lepidopteran pests has become increasingly challenging due to climatic changes, reduced biodiversity, and the misuse of agrochemical control methods (Sharma et al., 2017). In the agro-ecological conditions of the Beshariq district of the Fergana Valley, cotton production is one of the major agricultural activities. The region's warm climate and soil types create favorable conditions for the development and spread of several lepidopteran pests, notably *Helicoverpa armigera* (cotton bollworm), *Spodoptera exigua* (beet armyworm), and *Agrotis segetum* (turnip moth) (CABI, 2022). These pests are known to attack cotton at various growth stages, with the most severe damage occurring during the flowering and boll formation stages (Kranthi et al., 2005). *Helicoverpa armigera*, in particular, is recognized as one of the most destructive polyphagous pests affecting a wide range of crops, including cotton, due to its high reproductive potential, migratory behavior, and ability to develop resistance to various insecticides (Fitt, 1989; Tay et al., 2013). Likewise, *Spodoptera* species are known for their defoliating behavior and rapid population growth under favorable conditions (Capinera, 2008). *Agrotis segetum*, although often overlooked, poses a significant threat during early seedling stages, especially when soil moisture and temperature conditions support larval development (Seitz, 2016). Moreover, shifts in local climate patterns, such as increased average temperatures and changes in precipitation, have further contributed to prolonged activity periods and expanded geographic ranges of these pests (Dhawan & Simwat, 2012). These

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changes underscore the urgent need for region-specific pest surveillance and management systems. Recent advances in pest monitoring tools, such as pheromone traps and mercury vapor light traps, have provided reliable methods for tracking moth populations and understanding their phenological trends (Broughton & Harrison, 2012). The integration of such tools into local pest management programs enables more effective and timely interventions, especially when synchronized with the pests' population peaks. Given these concerns, the present study aims to investigate the diversity and population dynamics of major lepidopteran pests in cotton agroecosystems of the Beshariq district. The research focuses on identifying dominant species, analyzing their seasonal activity using pheromone and light traps, and assessing how climatic and edaphic conditions influence pest behavior. This work is intended to contribute to the development of effective, ecologically sound pest management strategies for sustainable cotton production in the Fergana region.

Materials and Methods

This study was conducted in the cotton agroecosystems of Beshariq district, Fergana region, Uzbekistan, during the 2023–2024 period, covering the entire vegetation cycle of cotton. The main objective of the study was to identify Lepidoptera pests in cotton fields and assess their developmental stages, distribution, and population dynamics.

Field Surveys and Monitoring: Regular field surveys were conducted every 10–15 days to observe and record the number of damaged plants, larvae at various developmental stages, and adult moths. The development stages of pests were documented to analyze their population dynamics over time. In addition, pheromone traps were used to monitor specific pest species such as *Helicoverpa armigera*. These traps tracked moth flight activity, the number of generations, and the peak flight periods throughout the cotton growing season.

Night-Time Moth Collection: To capture moths at night, DRL-250 mercury vapor lamps were utilized. These lamps attracted moths with their light, and the number and types of moths captured were recorded at regular intervals for species identification and population analysis (Fitt & Maelzer, 2014).

Soil Sampling: Soil samples were taken from a depth of 20–30 cm to identify overwintering larvae and pupae in the soil. The samples were analyzed in the laboratory to determine the presence of pest stages that might be overwintering in the soil, which could affect the following season's pest population.

Climatic Data Collection: Meteorological factors such as temperature, humidity, precipitation, and wind speed were continuously monitored, as they play a crucial role in pest development and population dynamics.

Online Moth Identification: To accurately identify moth species, several online resources and identification databases were used, including **BOLBase (Butterfly Online Identification)**, an interactive online tool for identifying butterflies and moths using images and descriptions (<https://www.butterflybase.org>); **BugGuide.net**, a platform that provides photographs and identification guides for various insect species, including moths (<https://www.bugguide.net>); and **iNaturalist**, a global platform for identifying plants, animals, and insects, including moths (<https://www.inaturalist.org>).

Data Analysis: Data collected from field observations, traps, and meteorological conditions were processed and analyzed using Microsoft Excel and OriginPro software. Statistical methods were applied to assess the population dynamics of pests and their correlation with environmental factors.

Results

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The study conducted in the cotton agrocenoses of the Beshariq district in Fergana region during the 2023–2024 period yielded significant insights into the population dynamics, developmental stages, and ecological interactions of Lepidoptera pests. The results are presented below, encompassing pest species identification, population fluctuations, the influence of meteorological and environmental factors, and validation of species through online platforms. A total of seven Lepidoptera species were identified in the cotton fields during the study period. Among these, *Helicoverpa armigera*, *Spodoptera litura*, and *Agrotis segetum* were the most prevalent, with *Helicoverpa armigera* exhibiting the highest frequency across various developmental stages. The presence of these species was recorded throughout the growing season, with specific attention given to their peak activity periods in relation to the cotton plant's phenological stages. *Helicoverpa armigera* reached its highest population density during late July to early August, corresponding to the cotton's flowering and boll development stages. *Spodoptera litura* showed an increase in population in late summer, with a peak during the flowering period, though the peak was slightly delayed compared to *Helicoverpa armigera*. *Agrotis segetum* larvae were most abundant during the seedling phase of cotton, with a noticeable decrease as the plant matured.

The population dynamics for these species are summarized in **Table 1**

Table 1: Pest species population dynamics

Pest Species	Late July - Early August	September	October
<i>Helicoverpa armigera</i>	High	Medium	Low
<i>Spodoptera litura</i>	Medium	High	Low
<i>Agrotis segetum</i>	Low	Medium	Medium

Pheromone traps were deployed to monitor the flight activity of *Helicoverpa armigera*. The data revealed periodic peaks in moth flight activity, occurring approximately every 10–15 days. The capture rate was influenced by environmental conditions, particularly temperature and humidity. Moths were most frequently captured during warmer periods with high humidity, consistent with the known behavioral patterns of this species.

Table 2: Moths Caught Using Pheromone Traps

Pheromone Type	July	August	September
<i>Helicoverpa armigera</i>	150	200	120
<i>Agrotis segetum</i>	90	130	80

The use of DRL-250 mercury vapor lamps for nocturnal moth collection revealed that the highest capture rates occurred during evening and nighttime hours, especially under clear sky conditions. *Helicoverpa armigera* was the most abundant species collected, confirming its peak activity during these periods.

Soil samples were taken from a depth of 20–30 cm to assess the presence of *Agrotis segetum* pupae. The results showed a higher abundance of larvae and pupae in soil samples collected from areas where cotton had been grown in previous seasons. This indicates that these regions harbor a significant pest population, which may contribute to increased pest pressure in the subsequent growing season.

Table 3: Soil sample and number of pupae

Sample Location	

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	Number of Pupae
Cotton Field (Seedling Stage)	35
Cotton Field (Flowering Stage)	15

Meteorological data analysis showed that temperature and humidity significantly impacted pest population dynamics. Increased pest densities were recorded during periods of elevated temperatures and higher humidity, which align with the environmental preferences of the studied species.

Discussion

The seasonal dynamics of pest populations, specifically *Helicoverpa armigera*, *Spodoptera litura*, and *Agrotis segetum*, revealed significant variations in their temporal and spatial distribution, aligning with findings from previous studies in similar agroecosystems. The combination of different monitoring techniques, such as pheromone traps and mercury vapor lamps, offered a comprehensive understanding of moth population trends, allowing for more targeted and efficient pest management strategies in cotton cultivation. The population dynamics of *Helicoverpa armigera* in this study were consistent with earlier research, where peaks in its population were observed around the flowering and boll formation stages of cotton, particularly in late July and early August (Badiane et al., 2017). This aligns with the life cycle of *Helicoverpa armigera*, which tends to coincide with key crop growth stages, making it a critical pest to manage during this time. The peak in *Spodoptera litura* populations, observed later in the growing season, corroborates the findings of Hossain et al. (2020), who noted that this species generally shows increased activity during the later stages of crop development. Similarly, *Agrotis segetum* larvae were primarily observed in the early growth stages of cotton, particularly at the seedling stage, which corresponds with Seitz's (2016) observations on the early-season activity of *Agrotis* larvae. Pheromone traps proved to be an invaluable tool in monitoring the flight activity of *Helicoverpa armigera*. The peaks in moth activity, occurring approximately every 10–15 days, were influenced by environmental factors such as temperature and humidity, with increased activity noted under warm and humid conditions (Kamble et al., 2020; Ata et al., 2017). These results are consistent with previous studies that identified *Helicoverpa armigera* as more active under such conditions. The data further confirmed that *Helicoverpa armigera* was the most abundant moth species during the monitoring period, underscoring its significance in cotton pest management. The use of mercury vapor lamps for nocturnal moth collection also revealed that the highest moth activity occurred during the evening and at night, particularly under clear sky conditions. These findings are in line with those of Popov et al. (2015), who documented that moths, including *Helicoverpa armigera*, are most active during nighttime. The efficiency of the DRL-250 mercury vapor lamps in attracting moths further confirmed the dominance of *Helicoverpa armigera* as the most frequently trapped species, aligning with the results of Mesquita et al. (2018). These findings highlight the effectiveness of light traps in capturing nocturnal moths, providing an additional tool for pest surveillance and control. The integration of data from both pheromone traps and mercury vapor lamps presents a holistic view of moth population dynamics, enabling more precise pest monitoring. By tracking the seasonal variations in pest populations, it is possible to develop more targeted pest management strategies, particularly by timing interventions during peak activity periods of these species. Early-season larvae of *Agrotis segetum*, if left unchecked, can lead to significant crop damage, while the later-season peaks of *Spodoptera litura* and *Helicoverpa armigera* require interventions to prevent boll damage. These insights are crucial for developing integrated pest

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management (IPM) strategies that utilize both chemical and biological control methods, tailored to the specific pest species and growth stages of the crop. In conclusion, the combination of pheromone traps and mercury vapor lamps has proven to be an effective and reliable approach for monitoring moth populations in cotton agroecosystems. This study emphasizes the need for precise pest management strategies based on the temporal distribution of key pest species. By integrating these monitoring tools into pest management practices, it is possible to improve the timing and effectiveness of control measures, ultimately minimizing crop damage and enhancing cotton yield. These findings are consistent with the broader literature on pest management and provide a strong foundation for future pest monitoring and control strategies in cotton farming.

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