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Research Article

Field based assessment of insect pest dynamics in Egyptian clover crop within a rice-wheat cropping system

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ABSTRACT

Egyptian clover (*Trifolium alexandrinum*) is an important forage crop in the rice–wheat cropping system but is vulnerable to diverse insect pests. A field-based assessment was carried out during February-March 2025 to investigate insect pest dynamics and their natural enemies under field conditions. Systematic sampling revealed that thrips were the dominant pest, total counts during 50 sweeps (mean per sweep: 7.20 to 185.72 to 14.52) increased from 360 individuals on 22.02.2025 to a high level of 9286 individuals on 25.02.2025 before falling to 726 individuals by 03.03.2025. Aphids were the second most significant pest with a maximum of 6.80 individuals (over 50 sweeps) on February 28, 2025 (mean per sweep: 0.136), followed by a rapid decline and complete disappearance by early March. Other pest groups, including grasshoppers, field crickets, houseflies, leafhoppers, butterflies, and bluemilk weed beetles, appeared sporadically and never exceeded 5.60 individuals. Insects like rove beetles and spiders had also been recorded to be beneficial in the sampling period with a maximum of 11.60 and 5.20 individuals recorded, respectively; this was not enough to control the severity of thrips and aphid infestation. Overall, the experiment shows that thrips pressure is much stronger in the Egyptian clover as compared to aphids, and the natural enemies do not have a significant effect. It is important to note that there is need to monitor time promptly and adopt integrated pest management control approaches to reduce yield losses that may be realized in clover planting in the rice-wheat system.

Keywords: Egyptian clover; population fluctuation; thrips; aphids; natural enemies; rice-wheat system; integrated pest management.

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INTRODUCTION

Egyptian clover (*Trifolium alexandrinum* L.) also referred to as berseem, is a much-desired winter forage crop that is widely commercialized in the agricultural environment of Punjab, Pakistan (Tufail et al., 2019). It is very important in aiding livestock production through provision of high-quality green fodder throughout the winter period (Haq et al., 2021). Besides its forage value, Egyptian clover can be valuable in the agricultural sustainability program as it improves soil fertility through biological fixation of nitrogen, improves the soil texture, and boosts the quantity of organic matter in the soil (Abdelrazek et al., 2022). The fact that it is an important crop in the rice-wheat rotation further supports the use of the crop in the Punjab and South Asian regions where this crop is the predominant in the agriculture industry (Tufail et al., 2020). The rice-wheat cropping involves first growing rice (*Oryza sativa*

L.) in the monsoon season (Kharif), and wheat (*Triticum aestivum* L.) in the winter season (Rabi) (Shehzad et al., 2022). Rotation is the staple of food security in the area because it is the source of staple cereal which nourishes millions of human beings (Mahajan et al., 2009). But because of this system's intensive and ongoing nature, which is marked by short fallow intervals, high input consumption, and a reliance on monoculture practice, it fosters an environment that is conducive to insect pest populations' growth and survival (Andargie et al., 2024). The overlapping growth periods and minimal soil disturbance further support the persistence of pest populations, which can result in significant yield losses if not effectively managed (Shah et al., 2025).

The Egyptian clover offers even more ecological complexity to the rice- wheat rotation (Ouda et al., 2024). During the winter season its lush and succulent vegetative growth creates an attractive environment for a variety of phytophagous (plant-feeding) insects (Wagan et al., 2015). Aphids (*Aphis* spp.), cutworms (*Agrotis* spp.) and leafhoppers (*Empoasca* spp.) found to be infested are among the pests have been known to infest Egyptian clover, that reduce nutritional quality and biomass (Kumar et al., 2020). These pests have ability to spread plant diseases and cause direct crop damage, which could affect the production and health of later crop in the rotation, especially wheat (Iida et al., 2023).

An important aspect of Egyptian clover production is the minimal or nonexistent usage of insecticide, because it is used as feed for livestock (Iqbal et al., 2025). This absence of treatment with chemicals gives pest populations an area where they may grow unchecked and impact on other crops (Kumar et al., 2022). Furthermore, year-round cropping, reduced tillage, residue retention, and other conservation agriculture techniques frequently used in the rice-wheat system can have an additional impact on insect dynamics (Jasrotia et al., 2023).

These methods create ideal conditions for the overwintering and early-season generation of pest populations, including dangerous pests like mealybugs (*Brevennia rehi*) and oriental armyworms (*Mythimna separata*) (Lv et al., 2022). Consequently, it emphasizes the importance of routine field observations to understand insect emergence patterns and their ecological impacts in untreated forage crops like Egyptian clover (Khalifa et al., 2024).

In the Punjab the subtropical climate is characterized by mild winters, monsoon rainfall and hot summers that support continuous biological activity of the many insect pests (Akhtar et al., 2025). This climate makes it more feasible for pests to be active all year round, especially in irrigated agriculture systems like the rice-wheat rotation (Nawaz et al., 2019). Furthermore, pest-related problems are likely to increase due to the ongoing effects of climate change, which include altered precipitation patterns, higher temperatures, and unpredictable weather (Skendzic et al., 2021). For instance, while unpredictable monsoon patterns can negatively affect the number and activity of beneficial organisms like lacewings, spiders (like Lycosidae), and predatory beetles (like Coccinella spp.), warmer winters may boost the overwintering survival rates of insect pests (Pareek et al., 2017). These natural enemies are essential for controlling pest populations, especially in agricultural systems without the use of chemical control methods (Dainese et al., 2017). Factors that lower biodiversity and lead to lower ecological resilience, including habitat fragmentation, pesticide spraying by adjacent fields, and monoculture planting constantly, may decrease their efficacy (Sud et al., 2020).

In this respect, IPM has become a feasible field of pest control in a long-term vision (Zhou et al., 2024). IPM also has a high priority on ecologically oriented methods, which include mechanical treatments, cultural methods, biological control, and the sparing use of pesticides (Ilieva et al., 2024). The special agronomic and ecological characteristics of Egyptian clover could be adjusted to IPM techniques (Jabbar et al., 2022). As an example, it is possible to change the date of planting, cover field margins, plant trap crops and keep natural enemies, which will reduce the number of pests and ensure their distribution to other crops (Crowther et al., 2023). However, the effectiveness of IPM methods is based on in-depth knowledge of the pest complex, pest population, and interactions between the pest and the local agroecosystem parasitoids and predators (Sharma et al., 2023).

Despite the fact that several studies have reported insect fauna of some of the main crops such as rice and wheat in Pakistan, there is a dire need of field-based studies on Egyptian clover, especially in reference to rice-wheat cropping combination (Bodlah et al., 2023). Most of the fragmented information that is currently available does not consider the seasonal interactions between pests and their natural enemies (Pradhan et al., 2020). Even though the Egyptian clover can impact the insect population dynamics during the entire cropping process, the ecological role of the plant in the maintenance of both the pests and the beneficial insects is not well studied (Khalifa et al., 2024).

To fill these information gaps, this study was conducted by carrying out comprehensive research on the insect pest relationship with the Egyptian clover growing within the rice-wheat rotation in the Punjab cropping system. Review in details insect pests of Egyptian clover grown in the rice-wheat crop system in Punjab (Govindasamy et al., 2021). Without any chemical control interventions, the study is expected to accurately determine and describe the pest species that infest Egyptian clover, to determine seasonal changes in the population and abundance, and to assess their ecological relationships with their natural predators (Husseini et al., 2018). Among the primary aims of this study, there is the understanding of the influence of the pest accumulation and the overall ecological balance of the cultivation system when the fodder crops such as Egyptian clover are not sprayed with insecticides.

Several ecological indices were used in the study to provide insight into diversity, dominance, and dispersion of the species to acquire a comprehensive image of the dynamics and structure of the pest communities. Insect diversity in general was quantified by the Shannon -Wiener diversity index (H) which takes into consideration species evenness and richness to control variability in complexity of the community across time. The relative degree of domination in the insect community was quantified by the Simpson dominance index (D) which particularly focused on the effect of numerically dominant pests such as thrips. Although Margalef species richness index (d) and Menhinick species richness index (D) were used to explore the species richness including the consideration of sample size variability, Pielou evenness (J 7) was calculated to express the precision of single distribution between the known species. The gains associated with the most common species to the total insect population were determined in the form of the Berger-Parker dominance index (BPI). Insect density and relative abundance were also computed to characterize species dominance and population dynamics across time. The balance between herbivorous pests and their natural enemies was assessed using the pest-to-predator ratio (PPR), which shed light on the possible efficacy of biological management in the ecosystem. All these factors combine to provide a strong ecological model of the relevance of studying the dynamics of insect pests in Egyptian clover and contribute to the development of long-term pest control measures that could be specific to the rice-wheat cropping system. The paper presents the inaugural daily-resolution assessment of insect population in Egyptian clover rice-wheat system of Punjab, Pakistan. The work surpasses earlier descriptive species lists and short-term surveys by describing an extreme thrips outbreak under normal insecticide-free conditions for forage crops and measuring the limited suppressive role of natural enemies using multiple diversity, dominance, and trophic indices. The findings bridging the most important knowledge gaps in one of the most important agricultural zones in Pakistan form the basis of the ecologically viable, system-specific methods of pest control.

MATERIALS AND METHODS

Study location

The research was conducted between 21 February-7 March 2025 in Rice Research Institute, Kala Shah Kaku, Punjab in Pakistan. The experiment was held in a semi-arid area that is characteristic of rice-wheat rotation crop, Punjab, and was aimed at examining the dynamics of insect pests in Egyptian clover (*T. alexandrinum*), which is a vital forage crop that is planted in rotation with rice and wheat.

Experimental design

The rice-wheat cropping system was selected to be shown on a one-acre field of Egyptian clover in the Rice Research Institute of Kala Shah Kaku, Punjab, Pakistan. In order to maintain representative geographic coverage, minimize edge effects and capture within-field variability in insect population, five sample locations were selected within the field and laid out in a systematic grid (around 2025 m along both diagonals and the center). In order to facilitate accurate tracking of population patterns across time, the samples in the sample days had their points assigned. This was an objective procedure that offered adequate regional replication given the limited size of the field with minimization of sample bias.

Insect pest collection

The sample was conducted daily, between 9: 00 and 11: 00, in a quiet place where there was no wind or precipitation. The samples of insect pests were collected with a normal sweep net (38 cm in diameter, 1 mm mesh). A total of 50 sweeps were performed on each of the five sampling sites in a row of 15 days. Every sweep was made through the crop canopy in a 180-degree circle in order to collect as many insects as possible. All the samples were taken to the laboratory and examined under a stereomicroscope (10× 0-40x magnification) to ensure that they were counted correctly and not underestimated since the aphids and thrips were too minute to be counted properly in the field.

Next, the number of people was counted and classified manually. After being collected, the insects were put in death jars that contained potassium cyanide (KCN). The death jars were covered with a cover of cotton and blotting paper to ensure that the specimens did not come into direct contact with the death jars since they contained 1-2 grams of potassium cyanide on the bottom. The insects were kept in cyanide between two and five minutes, which was sufficient to ensure the insects died instantly and still maintained its appearance to be identified accurately. All the operations that required the use of potassium cyanide were conducted as per the safety guidelines of the laboratory. Jars were killed and in a well-ventilated environment with the relevant personal protective equipment and the chemical waste was disposed of as per the established biosafety guidelines. Samples of different sampling locations were kept in different labeled containers to preserve space.

Laboratory processing and identification

The collected insects were put into different plastic bottles and taken to the laboratory. They were sorted and cleaned there to make them recognizable. The morphological characteristics that were examined under a stereomicroscope (10x40x magnified) were body shape, pigmentation, wing venation, and antennae. To identify the species, the Picture Insect: Spiders & Bugs application with version 2.18.6 was used in the Apple Playstore. This was a technology which utilized an image recognition system to compare specimens to a large database of insects. Each point in time during the day was entered into Microsoft excel to give the name of the species, date, location and abundance of the insects to be further studied.

Ecological indices and parameters

To comprehend the dynamics of insect pests, a number of ecological indices were calculated:

a) Insect Density

$$\mathrm{ID} = \frac{\mathrm{TN_{ic}}}{\mathrm{TN_{su}}}$$

where: TN_{ic} = Total number of insects collected; TN_{su} = Total number of sampling units

b) Relative Abundance

$$\mathrm{RA} = \frac{\mathrm{N_{is}}}{\mathrm{TN_{ias}}} \times 100$$

where: N_{is} = Number of specimens of a species; TN_{ias} = The total number of specimens of every species gathered on that sampling day during all 50 sweeps.

The percentage contribution of each taxon to the total number of insects gathered on that sample day was used to compute relative abundance (sum across all taxa = 100%). To maintain mathematical consistency, values were calculated using the overall population rather than means per sweep.

c) Shannon-Wiener Index (H')

$$H' = -\sum_{i=1}^{S} (p_i \,.\ln p_i)$$

$$p_i = \frac{n_i}{N}$$

where: p_i = Proportion of specimens of species *i* relative to the total number of specimens; *S* = Total number of species; ln = Natural logarithm; n_i = Number of specimens of species *i*; *N* = Total number of specimens of all species

d) Simpson's Index (D)

$$D = \sum_{i=1}^{S} (p_i)^2$$

where: p_i = Proportion of specimens of species *i*

e) Pielou's Evenness Index (J')

$$J' = \frac{H'}{\ln S}$$

where: *H'* = Shannon-Wiener index; *S* = Total number of species

f) Margalef's Index (d)

$$d = \frac{S-1}{\ln N}$$

where: *S* = Total number of species; N = Total number of specimens

g) Menhinick's Index (D)

$$D = \frac{S}{\sqrt{N}}$$

where: *S* = Total number of species; N = Total number of specimens

h) Berger-Parker Index (BPI)

$$BPI = \frac{N_{\max}}{N}$$

where: N_{max} = Number of specimens of the most abundant species; N = Total number of specimens

i) Pest to Predator Ratio (PPR)

According to previous research on pasture and field crops, insects gathered from the field were divided into groups of pests and predators according to their ecological importance and dominating feeding habit. Pests were defined as species that predominantly consume plant tissues, sap, or foliage, whereas natural enemies (predators) were defined as species that are known to prey on other insects.

Predator efficiency was not overestimated or biased by excluding insects with omnivorous or unclear feeding preferences from the pest-to-predator ratio (PPR) analysis. A more accurate evaluation of the trophic interactions and pest-predator balance in the Egyptian clover agroecosystem was guaranteed by this classification method.

$$\mathrm{PPR} = \frac{\mathrm{TN_{pi}}}{\mathrm{TN_{pdi}}}$$

where: TN_{pi} = Total number of pest insects; TN_{pdi} = Total number of predator insects

Statistical analysis

For every sampling date and insect group, the raw data on insect abundance were first arranged in Microsoft Excel. Using standard mathematical formulae based on species abundance data, ecological indices such as Shannon-Wiener (H′), Simpson's (D), Pielou's evenness (J′), Margalef's richness (d), Menhinick's index (D), Berger-Parker dominance index (BPI), and pest-to-predator ratio (PPR) were manually calculated (Magurran, 2004; Krebs, 1999). Means, standard deviations, and coefficients of variation were among the descriptive statistics that were calculated. To guarantee compliance to the parametric analysis assumptions, the data were examined for normality and homogeneity of variance prior to analysis of variance (ANOVA). Mean insect densities were determined at five sampling points every day, using the sample day as the experimental unit. The Least Significant Difference (LSD) test was used to evaluate differences between sampling days at a 0.05 significance level after the analysis of variance (ANOVA). All the calculations were performed with the help of Statistix 8.1, and Microsoft Excel was the tool of primary importance in terms of data organization and ecological indicators calculation.

RESULTS AND DISCUSSION

It was proposed that a systematic examination of Egyptian clover in February and March 2025 would reveal that there is a considerable volatility in the insect populations and that there would be clear differences between natural enemies and the pest species. The most common insect was the thrips during the investigation. They started with a relatively small density (that is, 7.20 on February 22 and 7.80 on February 23, 2025), but shot up quickly, reaching a high of 47.80 on February 25, 2025. This was the highest documented insect peak by a factor of several. After then, thrips numbers dropped once more to levels below 10.00 by early March (they were as low as 5.40 on 03.03.2025), suggesting a sharp increase and decrease over the brief crop window. In terms of density, aphids were listed as the second most significant pest, but on a far smaller scale than thrips. Aphid populations showed a total fall towards the end of the research, with the peak recorded at 1.00 on 28.02.2025 and the lowest recorded at 0.00 on 07 March 2025. This implies that while aphid infestation was less permanent and widespread than thrips, it was nonetheless a significant hazard. Other pest groups such field crickets, butterflies, blue milk weed beetles, grasshoppers, and stick insects only sometimes showed up and never reached concentrations higher than 1.20. Grasshoppers, for instance, peaked at 1.00 on February 23, 2025, but were absent on many other days. Field crickets, on the other hand, peaked at 0.00 on the majority of other days. Blue milk weed beetles were also present at 0.20 on 25.02.2025 and 01.03.2025, but they were absent for the remainder of the period, and butterflies only reached 0.20 on 28 February. As a result, these insects were only slightly involved in the entire pest complex. Although they were noted, beneficial insects and predators had far lower populations than the main pests.

The Rove beetle population peaked at 1.80 on February 21, 2025, and then declined and fluctuated, reaching a minimum of 0.00 on February 23, 2025. Another significant predator, spiders, were observed on several dates, peaking at 1.00 on March 3, 2025, although they were also absent on four other days. This suggests that although natural enemies existed, they did not significantly increase in number in reaction to insect outbreaks. Other minor groups had moderate variations, including leafhoppers and houseflies. While houseflies peaked at 1.00 on March 6, 2025, but were absent on other dates, leafhoppers displayed minor peaks of 0.80 on March 3, 2025, and March 6, 2025, and were completely absent on other days. This implies that such insects were secondary to aphids and thrips with regard to their effects and population. Based on the findings of the study, the total number of insects was the greatest in thrips (47.80 on February 25, 2025), so thrips is the primary pest of the Egyptian clover in the rice-wheat system. In second place, there was Aphids (1.00 on February 28, 2025). Conversely, other insect species such as grasshoppers, butterflies, bluemilk weed beetles, stick insects, and even aphids at the conclusion of the study had the least densities (0.00). The predator numbers such as rove beetles and spiders were always low thus highlighting the absence of natural biological control at the time of the sample. The Egyptian clover in this type of crop is very susceptible to insect pests, particularly to the use of thrips and aphids as the difference of low predator pressure rates and high pest rates suggest (Table 1). The field-based investigation of insect pest movement in Egyptian clover in a rice-wheat crop arrangement demonstrated that the beneficial and the pest insect population changes considerably across the seasons. Among the insect species observed, the most frequent species was the thrips. The most abundant taxon was thrips (99.85%), which was relatively abundant on February 25, 2025 (the rest of the sample consisted of a combination of species). This peak that was multiple times greater than any other bug species displayed the significant pest burden on the crop. Nevertheless, the number of thrips decreased to a minimum of 5.40 people on March 3, 2025, with only a relative abundance of 20.77. This suggests that the infection was primarily concentrated in late February before decreasing in March. Aphids were identified as the second largest pest, while having a far smaller population than thrips. With a peak density of 1.00 individuals on 28.02.2025, their numbers gradually declined and eventually disappeared by 07.03.2025, showing a relative abundance of 3.85%. This suggests that despite briefly becoming a secondary pest, aphids' abundance was not maintained. Grasshoppers appeared occasionally, with a maximum density of 1.20 individuals and the highest relative abundance of 4.61% on February 21, 2025. They were generally absent at the start and finish of the study, and their populations fluctuated at low levels. Similar to stick insects, which were hardly present and only displayed 0.60 individuals on 04.03.2025 with 2.31% abundance, field crickets peaked at 1.00 individuals on 23.02.2025 with 3.85% relative abundance instead. These findings show that, in comparison to the main pests, sporadic pests had very little effect. Although beneficial insects were found, their numbers were comparatively low, indicating a lack of natural control pressure in the field. The most prevalent predator was the roving beetle, which peaked at 1.80 individuals on 21.02.2025 and had a relative abundance of 6.92%. Spiders, on the other hand, peaked at 1.00 individuals on 03.03.2025 and had an abundance of 3.85%. Even if they were present when some pest activity was occurring, their total population was still too little to offset the considerably bigger infestations of aphids and thrips.

Other insects, such as bluemilk weed beetles, houseflies, butterflies, and leafhoppers, appeared rarely. One housefly was seen on March 6, 2025, which added to the 3.85% abundance on March 5, 2025. With an abundance of 3.08% on March 3, 2025, and 0.80 individuals during March 3–06, 2025, leafhoppers were marginally more reliable. Butterflies and bluemilk weed beetles had virtually no effect on crops, with maximum values of only 0.20 individuals and 0.77% abundance. Thrips (47.80 individuals; 99.85% abundance) were by far the most damaging pest of Egyptian clover under the rice–wheat cropping system, according to the integrated study of both density and relative abundance. Although at far lower levels (1.00 individual; 3.85% abundance), aphids came next as a secondary pest. Stick insects, field crickets, grasshoppers, and other minor pests were all intermittent and contributed little to the overall pest impact. Although they were present, beneficial insects like spiders and rove beetles were insufficient in number to offer efficient biological control (Table 2).

A field-based assessment of insect pest dynamics in Egyptian clover under a rice–wheat cropping system in late February and early March 2025 made evident the diversity and volatility of insect populations. The study using Shannon–Wiener Index (H') values found that thrips were the most common pest category. The number of groups of bugs that would occasionally appear had very low values of diversity, and there were other pest species that made moderate contributions such as houseflies, aphids and leafhoppers. Thrips were outstanding dominators of all other recorded insects throughout the period of the study. Their diversity was highest in the period of the study (25 February 2025), at 1.14. On the other hand, the lowest value of thrips was 0.11 on February 24, 2025, which exhibits a significant daily variability. The Egyptian clover is vulnerable to thrips due to their high accumulation within a limited duration and their extreme sensitivity to climatic conditions such as temperature and humidity as this sharp variance suggests. Aphids were also found to be another important pest with the degree of diversity ranging between 0.00 and 0.10. The largest indices, both of which were 0.10, were observed on February 2728, 2025, and March 3, 2025. This demonstrates that although aphid pressure was not steady, it could lead to extreme levels that would affect crop well-being particularly during peak observation. The same was observed in leafhoppers whose diversity reached its highest point of 0.10 on March 3, 2025, and March 6, 2025, and was completely absent on the first 2 days of observation (February 21 and 22). This trend suggests that the leafhopper population came out late into the season, presumably due to crop development stage and present weather conditions. Houseflies also contributed significantly, as they did not occur on several of the earlier days but they had the highest diversity value of 0.12 on March 6, 2025. The sluggish

Table 1. Insect density in Egyptian clover assessed through systematic sampling during the study period.

Days	Thrips	Rove beetle	Grasshopper	Spiders	Stick insect	Field cricket	Black solider fly	Bluemilk weed beetle	Housefly	Leaf hopper	Butterfly	Aphid
21.02.2025	9.60 e	1.80 a	1.20 a	0.80 ab	0.00 b	0.00 b	0.00 a	0.00 b	0.00 c	0.00 c	0.00 b	0.20 ab
22.02.2025	7.20 e	1.20 ab	1.20 a	0.60 abc	0.40 ab	0.00 b	0.00 a	0.00 b	0.00 c	0.00 c	0.00 b	0.60 ab
23.02.2025	7.80 e	0.00 c	0.80 ab	0.00 c	0.00 b	1.00 a	0.00 a	0.00 b	0.00 c	0.00 c	0.00 b	0.20 ab
24.02.2025	23.40 b	1.00 ab	0.40 bc	0.60 abc	0.00 b	0.00 b	0.40 a	0.00 b	0.40 bc	0.40 abc	0.00 b	0.60 ab
25.02.2025	47.80 a	0.40 bc	0.00 c	0.20 bc	0.20 ab	0.00 b	0.40 a	0.20 a	0.60 ab	0.60 ab	0.00 b	0.40 ab
26.02.2025	22.40 bc	0.80 bc	0.00 c	0.40 abc	0.60 a	0.00 b	0.00 a	0.00 b	0.00 c	0.40 abc	0.00 b	0.60 ab
27.02.2025	19.60 bc	1.00 ab	0.80 ab	0.60 abc	0.40 ab	0.00 b	0.60 a	0.00 b	0.40 bc	0.00 c	0.00 b	0.80 ab
28.02.2025	16.40 cd	0.60 bc	0.40 bc	0.20 bc	0.00 b	0.60 a	0.40 a	0.00 b	0.20 bc	0.00 c	0.20 a	1.00 a
01.03.2025	11.20 de	0.60 bc	0.60 abc	0.00 c	0.00 b	0.00 b	0.00 a	0.20 a	0.40 bc	0.20 bc	0.00 b	0.80 ab
02.03.2025	7.20 e	1.20 ab	0.00 c	0.80 ab	0.40 ab	0.00 b	0.40 a	0.00 b	0.00 c	0.00 c	0.00 b	0.60 ab
03.03.2025	5.40 e	0.40 bc	0.00 c	1.00 a	0.00 b	0.00 b	0.60 a	0.00 b	0.00 c	0.80 a	0.00 b	0.80 ab
04.03.2025	9.60 e	0.60 bc	0.00 c	0.00 c	0.60 a	0.00 b	0.40 a	0.00 b	0.00 c	0.00 c	0.00 b	0.60 ab
05.03.2025	10.20 e	0.60 bc	0.60 abc	0.60 abc	0.00 b	0.00 b	0.40 a	0.00 b	0.00 c	0.60 ab	0.00 b	0.00 b
06.03.2025	6.60 e	0.60 bc	0.80 ab	0.00 c	0.00 b	0.00 b	0.00 a	0.00 b	1.00 a	0.80 a	0.00 b	0.40 ab
07.03.2025	6.80 e	0.60 bc	0.40 bc	0.00 c	0.20 ab	0.00 b	0.20 a	0.00 b	0.60 ab	0.20 bc	0.00 b	0.00 b

Table 2. Relative abundance (%) of insect pest species in Egyptian clover observed during the sampling period.

Days	Thrips	Rove beetle	Grasshopper	Spiders	Stick insect	Field cricket	Black solider fly	Bluemilk weed beetle	Housefly	Leaf hopper	Butterfly	Aphid
21.02.2025	36.92 e	6.92 a	4.61 a	3.08 ab	0.00 b	0.00 b	0.00 c	0.00 b	0.00 c	0.00 c	0.00 b	0.77 ab
22.02.2025	27.69 e	4.61 ab	4.61 a	2.31 abc	1.54 ab	0.00 b	0.00 c	0.00 b	0.00 c	0.00 c	0.00 b	2.31 ab
23.02.2025	30.00 e	0.00 c	3.08 ab	0.00 c	0.00 b	3.85 a	0.00 c	0.00 b	0.00 c	0.00 c	0.00 b	0.77 ab
24.02.2025	90.00 b	3.85 ab	1.54 bc	2.31 abc	0.00 b	0.00 b	1.54 a	0.00 b	1.54 bc	1.54 abc	0.00 b	2.31 ab
25.02.2025	99.85 a	1.54 bc	0.00 c	0.77 bc	0.77 ab	0.00 b	1.54 a	0.77 a	2.31 ab	2.31 ab	0.00 b	1.54 ab
26.02.2025	86.15 bc	3.08 bc	0.00 c	1.54 abc	2.31 a	0.00 b	0.00 c	0.00 b	0.00 c	1.54 abc	0.00 b	2.31 ab
27.02.2025	75.38 bc	3.85 ab	3.08 ab	2.31 abc	1.54 ab	0.00 b	2.31 a	0.00 b	1.54 bc	0.00 c	0.00 b	3.08 ab
28.02.2025	63.08 cd	2.31 bc	1.54 bc	0.77 bc	0.00 b	2.31 a	1.54 a	0.00 b	0.77 bc	0.00 c	0.77 a	3.85 a
01.03.2025	43.08 de	2.31 bc	2.31 abc	0.00 c	0.00 b	0.00 b	0.00 c	0.77 a	1.54 bc	0.77 bc	0.00 b	3.08 ab
02.03.2025	27.69 e	6.61 ab	0.00 c	3.08 ab	1.54 ab	0.00 b	1.54 a	0.00 b	0.00 c	0.00 c	0.00 b	3.31 ab
03.03.2025	20.77 e	1.54 bc	0.00 c	3.85 a	0.00 b	0.00 b	2.31 a	0.00 b	0.00 c	3.08 a	0.00 b	3.08 ab
04.03.2025	36.92 e	2.31 bc	0.00 c	0.00 c	2.31 a	0.00 b	1.54 a	0.00 b	0.00 c	0.00 c	0.00 b	2.31 ab
05.03.2025	39.23 e	2.31 bc	2.31 abc	2.31 abc	0.00 b	0.00 b	1.54 a	0.00 b	0.00 c	2.31 ab	0.00 b	0.00 b
06.03.2025	25.38 e	2.31 bc	3.08 ab	0.00 c	0.00 b	0.00 b	0.00 c	0.00 b	3.85 a	3.08 a	0.00 b	1.54 ab
07.03.2025	26.15 e	2.31 bc	1.54 bc	0.00 c	0.77 ab	0.00 b	0.77 b	0.00 b	2.31 ab	0.77 bc	0.00 b	0.00 b

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rise in the prevalence of houseflies is also a sign of their opportunistic nature, but it can be explained by the fact that organic accretion of the agricultural environment predisposes them. Contributions were made by field crickets, stick insects, spiders, rove beetles, and grasshoppers, however, in a relatively minor way. The maximum and minimum of the range of roving beetles were 0.05 and 0.12 respectively and the range was highest on February 21, 2025, at 0.17. Between 21 February and 22 March 2025, grasshoppers were at 0.12. March 3, 2025, recorded the highest maximum of 0.10 of spiders, which are normally thought of as natural enemies, and this could indicate that they can help to control some pests even though they are unpredictable. Stick insects were minor, and in no case were above 0.07 and the highest field crickets were only 0.10 on February 23, 2025, but were otherwise generally absent. There were minor insect groups such as the black army fly, the blue milk weed beetle and the butterfly. On 25 and 1 March, the blue milk weed beetle, the black army fly, and butterflies noted 0.02 on these dates. They have negligible values, which means that they do not have much impact on the dynamics of the Egyptian clover pest in this system. However, the general result of the study indicates that thrips was the most common pest followed by aphid infection, leafhopper and housefly infections, respectively. Other pests had little impact on the overall diversity (Table 3).

The dynamics of insect pests of Egyptian clover growing in a rice-wheat cropping system sampled using a field-based method reveal the changes in pest species richness and dominance throughout the sample period. The findings reveal that there was a significant difference in population of the insects between the two dates and some of the pests had a definite preponderance and others appeared in exquisite traces. Among the insects observed, thrips were the most prevalent and abundant in number by far; on February 25, 2025, they arrived with the horrifying result of 9286.00. This outbreak has the maximum value in all the data, and this means that thrips have the most destructive impact on Egyptian clover in this system. Their population is dynamic, as evidenced by the sharp decline in numbers at different points in time, which peaked on March 3, 2025, at 145.20. The pest's rapid growth in favorable conditions and equally rapid decline in unfavorable ones are reflected in these variants. Other insect groups had relatively smaller numbers. Beneficial predators, roaming beetles, were consistently found during the sampling days, albeit at much lower quantities than thrips. Their highest value was 11.60 on February 21, 2025, however they usually ranged between 1.20 and 7.20, suggesting a notable but steady contribution to natural pest control. The majority of grasshoppers were observed at the beginning of the sampling period, when their numbers were 5.60 on February 21 and 22, 2025. After that, they declined to very negligible levels. Spiders, another beneficial predator group, peaked at 5.20 on March 3, 2025, with values typically falling between 1.20 and 3.20 on later occasions. This implies that there were still natural enemies that were present but in relatively small numbers. Some insect species were only sporadically and in low numbers present. As an illustration, field crickets never occurred on any date except on February 23, 2025, and the value was 5.20. In the same way, black soldier flies reached their highest levels on 27 February 2025 with the highest being 2.80; the remainder were extremely low or even nonexistent. There was a least represented insect of the blue milk weed beetle, which never attained population levels exceeding 0.40. Moreover, the butterflies served as a very small part of the pest range; their tiny ecological superiority was manifested by the fact that they were found only once, on February 28, 2025, at 0.40. Instead, aphids were made the second most significant group of pests, next to the thrips. On other occasions, they had a range of between 0.40 and 3.20, but in late February, they had an explosion of up to 6.80 on 28.02.2025 and 6.40 on 01.03. 2025. This indicates that aphids may cause serious damage when they are not managed early enough, but they are not as out bursting as thrips. The houseflies and leafhoppers were informal but clear, with their highest values of 2.00 and 1.60, respectively, on March 6, 2025, and this is the evidence of a small, but not completely absent presence in the insect community of clover fields. Overall, it is seen in the assessment that thrips is the most prevalent insect pest complex of Egyptian clover followed by aphids. Insects such as field crickets, butterflies and weed beetles were seen occasionally, whereas other insects such as rove beetles, spiders and the grasshoppers were moderately abundant. The hysterical changes in population through time create an understanding in the fact that it is important to carry out continuous surveillance to determine the time of outbreak. In addition, the presence of natural predators, though in small proportions, e.g., spiders and rove beetles, highlights the ecological importance in the management of pests (Table 4).

The field test of the dynamic of the Egyptian clover insect pests under a rice-wheat crop demonstrates distinct changes in the number of pests and predators during the sampling time with some species becoming dominant and others minor or occasional. Thrips were the most common insect group that was observed as well as exhibited the strongest variations. Their highest population was on February 25, 2025, to a shocking 9286.00, that was far higher than any other bug species that was pronounced in the study. Nevertheless, the fact that the lowest value of the thrips was 145.20 on March 3, 2025, means that they can change their abundance in a drastic and unexpected manner,

Table 3. Shannon-Wiener Index (H') values quantifying insect pest diversity in Egyptian clover across the study duration.

Days	Thrips	Rove beetle	Grasshopper	Spiders	Stick insect	Field cricket	Black solider fly	Bluemilk weed beetle	Housefly	Leaf hopper	Butterfly	Aphid
21.02.2025	0.30 bc	0.17 a	0.12 a	0.08 a	0.00 b	0.00 b	0.00 b	0.00 b	0.00 c	0.00 c	0.00 b	0.02 ab
22.02.2025	0.33 b	0.12 ab	0.12 a	0.06 ab	0.05 ab	0.00 b	0.00 b	0.00 b	0.00 c	0.00 c	0.00 b	0.07 ab
23.02.2025	0.35 b	0.00 c	0.08 ab	0.00 b	0.00 b	0.10 a	0.00 b	0.00 b	0.00 c	0.00 c	0.00 b	0.02 ab
24.02.2025	0.11 c	0.11 ab	0.05 bc	0.07 ab	0.00 b	0.00 b	0.05 ab	0.00 b	0.05 bc	0.05 abc	0.00 b	0.07 ab
25.02.2025	1.14 a	0.05 bc	0.00 c	0.02 ab	0.02 ab	0.00 b	0.05 ab	0.02 a	0.07 ab	0.07 ab	0.00 b	0.05 ab
26.02.2025	0.23 bc	0.08 abc	0.00 c	0.05 ab	0.07 a	0.00 b	0.00 b	0.00 b	0.00 c	0.05 abc	0.00 b	0.07 ab
27.02.2025	0.20 bc	0.10 ab	0.08 ab	0.07 ab	0.05 ab	0.00 b	0.06 ab	0.00 b	0.05 bc	0.00 c	0.00 b	0.08 a
28.02.2025	0.26 bc	0.06 bc	0.05 bc	0.02 ab	0.00 b	0.06 a	0.03 ab	0.00 b	0.02 bc	0.00 c	0.02 a	0.10 a
01.03.2025	0.32 b	0.06 bc	0.07 abc	0.00 b	0.00 b	0.00 b	0.00 b	0.02 a	0.05 bc	0.02 bc	0.00 b	0.07 ab
02.03.2025	0.33 b	0.12 ab	0.00 c	0.08 a	0.05 ab	0.00 b	0.05 ab	0.00 b	0.00 c	0.00 c	0.00 b	0.07 ab
03.03.2025	0.29 bc	0.05 bc	0.00 c	0.10 a	0.00 b	0.00 b	0.07 a	0.00 b	0.00 c	0.10 a	0.00 b	0.10 a
04.03.2025	0.34 b	0.07 bc	0.00 c	0.00 b	0.07 a	0.00 b	0.05 ab	0.00 b	0.00 c	0.00 c	0.00 b	0.07 ab
05.03.2025	0.35 b	0.07 bc	0.07 abc	0.07 ab	0.00 b	0.00 b	0.05 ab	0.00 b	0.00 c	0.07 ab	0.00 b	0.00 b
06.03.2025	0.32 b	0.07 bc	0.10 ab	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b	0.12 a	0.10 a	0.00 b	0.05 ab
07.03.2025	0.33 b	0.07 bc	0.05 bc	0.00 b	0.02 ab	0.00 b	0.02 ab	0.00 b	0.07 ab	0.02 bc	0.00 b	0.00 b

Table 4. Simpson's Index (D) values representing insect pest diversity and dominance in Egyptian clover over the sampling period.

Days	Thrips	Rove beetle	Grasshopper	Spiders	Stick insect	Field cricket	Black solider fly	Bluemilk weed beetle	Housefly	Leaf hopper	Butterfly	Aphid
21.02.2025	496.00 cd	11.60 a	5.60 a	3.20 ab	0.00 b	0.00 b	0.00 b	0.00 b	0.00 c	0.00 c	0.00 b	1.40 bc
22.02.2025	233.60 d	5.60 ab	5.60 a	2.80 ab	0.80 ab	0.00 b	0.00 b	0.00 b	0.00 c	0.00 c	0.00 b	1.20 abc
23.02.2025	238.00 d	0.00 b	3.20 ab	0.00 b	0.00 b	5.20 a	0.00 b	0.00 b	0.00 c	0.00 c	0.00 b	0.40 bc
24.02.2025	2187.60 b	3.60 ab	0.80 b	1.20 b	0.00 b	0.00 b	0.80 ab	0.00 b	0.80 bc	0.80 abc	0.00 b	1.20 abc
25.02.2025	9286.00 a	0.80 b	0.00 b	0.40 b	0.40 ab	0.00 b	0.80 ab	0.40 a	1.20 ab	1.20 ab	0.00 b	0.80 abc
26.02.2025	2203.00 b	3.20 b	0.00 b	0.80 b	1.20 a	0.00 b	0.00 b	0.00 b	0.00 c	0.80 abc	0.00 b	1.20 abc
27.02.2025	1642.40 bc	6.80 ab	3.20 ab	1.20 b	0.80 ab	0.00 b	2.80 a	0.00 b	0.80 bc	0.00 c	0.00 b	3.20 abc
28.02.2025	1117.60 bcd	2.80 b	0.80 b	0.40 b	0.00 b	2.80 a	2.40 ab	0.00 b	0.40 bc	0.00 c	0.40 a	6.80 a
01.03.2025	569.60 cd	2.80 b	1.20 b	0.00 b	0.00 b	0.00 b	0.00 b	0.40 a	0.80 bc	0.40 bc	0.00 b	6.40 ab
02.03.2025	225.60 d	7.20 ab	0.00 b	3.20 ab	0.80 ab	0.00 b	0.80 ab	0.00 b	0.00 c	0.00 c	0.00 b	1.20 abc
03.03.2025	145.20 d	0.80 b	0.00 b	5.20 a	0.00 b	0.00 b	1.20 ab	0.00 b	0.00 c	1.60 a	0.00 b	1.60 abc
04.03.2025	385.60 cd	1.20 b	0.00 b	0.00 b	1.20 a	0.00 b	0.80 ab	0.00 b	0.00 c	0.00 c	0.00 b	1.20 abc
05.03.2025	428.40 cd	1.20 b	1.20 b	1.20 b	0.00 b	0.00 b	0.80 ab	0.00 b	0.00 c	1.20 ab	0.00 b	0.00 c
06.03.2025	190.80 d	1.20 b	1.60 b	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b	2.00 a	1.60 a	0.00 b	0.80 abc
07.03.2025	192.80 d	1.20 b	0.80 b	0.00 b	0.40 ab	0.00 b	0.40 b	0.00 b	1.20 ab	0.40 bc	0.00 b	0.00 c

depending on environmental conditions. The second significant pest was aphids as the highest count was registered on February 28, 2025, at 6.80, and March 1, 2025, at 6.40. Their numbers (between 0.40 and 3.20) were, however, very humble at other times. Such discrepancies indicate that even though aphids did not occur as frequently as thrips, they still posed significant threat at the peak time. The system also had beneficial insects that helped in controlling pest populations. The highest density of beetles was 11.60 at the date of 21 February 2025, i.e., rove beetles, which are very important predators. On other occasions, they ranged between 1.20 and 7.20, which indicated that they were regular in the field but not extremely high.

The next group of predators, spiders, had a minimum of 1.20 and maximum of 3.20 on various dates with highest of 5.20 on March 3, 2025. Even though they were not as widespread as aphids or thrips, the ecological balance of clover fields was also ensured by them. Other insect species could be only sporadically or sparsely reported. Before plummeting drastically, grasshoppers were mostly seen in the initial stages of the season with 5.60 being recorded on 21 and 22 February 2025. Field crickets only occurred once (at 5.20 on 23 February 2025%), but black soldier flies did not appear at all on most days but reached its highest point at 2.80 on 27 February 2025. The blue milk weed beetle had a very low level and it was never higher than 0.40, and butterflies were practically nonexistent with at most only one instance of 0.40 on February 28, 2025. Houseflies and leafhoppers were also present in small numbers, with highest values of 2.00 and 1.60 respectively, but were often below 1.20 throughout the rest of the sample period. The second most common hazard, as the data showed, was aphids, whereas the most common bug overall was the thrips. The rest of the insects were either rare or only in some days. The moderate prevalence of natural enemies like the rove beetles and spiders is an indicator of the role of beneficial insects in the control of pests. This dynamic relationship between predators and pests allows identifying the urgency of constant monitoring because unexpected cases of pests are particularly dangerous to combat, and thrips and aphids can be highly harmful without timely treatment (Table 5).

The dynamic analysis of pests of insect in Egyptian clover planted in a rice-wheat cropping system indicated the evident variability in the density and activity of insect species throughout the study. The most outrageous finding was that thrips was much more prevalent compared to any other bug. On February 25, 2025, their population of 9286.00 hit an incredible high peak and the pest became the most harmful one that has ever existed in the wild. However, their numbers working down on March 3, 2025, to a paltry 145.20, thereafter, show significant variation and their capability to multiply within favorable conditions. The second most important pest was aphids, even though their numbers were much less. Their range was between 0.40 and 3.20 on the other days with the highest densities of 6.80 on February 28, 2025, and 6.40 on March 1, 2025. This means that even with the low number of aphids, they could still be dangerous to the plants in case the population increases. There were also advantageous insects, benefiting the ecological contribution significantly.

The number of roving beetles, which are naturally occurring predators, fluctuated between 1.20 and 7.20 on various days, reaching a maximum density of 11.60 on February 21, 2025. Spiders, another predator group, peaked at 5.20 on March 3, 2025, and then had lower values between 1.20 and 3.20. These natural enemies, however less common than thrips, served as a representation of the biological controls operating in the field and assisted in reducing the number of pests. Other insects were either rare or very seldom observed. Grasshoppers were more noticeable early in the season, with 5.60 recorded on February 21 and 22, 2025, but their numbers quickly declined after that. Black soldier flies were absent on most of the following dates after reaching a peak of 2.80 on February 27, 2025. Only once, on February 23, 2025, did field crickets appear, with a total of 5.20. The sporadic appearance of black soldier fly adults in the field is likely associated with the presence of decomposing organic materials, such as organic inputs related to adjacent livestock or crop residues. Although they are not phytophagous pests, black soldier fly larvae develop on decomposing organic substrates. Instead of directly putting Egyptian clover under pest pressure, their presence shows that there is organic matter present in the agroecosystem. There were hardly any butterflies, with only one observation at 0.40 on February 28, 2025, and very little blue milk weed beetle activity, never surpassing 0.40. Houseflies and leafhoppers also showed some little insect activity, reaching maximum counts of 2.00 and 1.60 on March 6, 2025, respectively, however they mostly stayed below 1.20 for the remainder of the time. The numerical data showed that thrips were the most prevalent pest in Egyptian clover fields, followed by aphids, which were nevertheless significant. The moderate numbers of beneficial insects, such as rove beetles and spiders, most likely helped to limit the pest population to some extent. Other insects like army flies, butterflies, crickets, and grasshoppers were not very important because of their sporadic and little presence. This active pattern proves the necessity of constant observation in the fields, which is the fact that the outbreak of thrips and aphids may lead to serious damage in case it is not controlled in time. The occurrence of natural enemies, though, brings out the possible implication of the application of biological

Table 5. Pielou's Evenness Index (J') values indicating the distribution uniformity of insect pest species in Egyptian clover crop.

Days	Thrips	Rove beetle	Grasshopper	Spiders	Stick insect	Field cricket	Black solider fly	Bluemilk weed beetle	Housefly	Leaf hopper	Butterfly	Aphid
21.02.2025	0.12 bc	0.07 a	0.05 a	0.03 a	0.00 b	0.00 b	0.00 b	0.00 b	0.00 c	0.00 c	0.00 b	0.01 ab
22.02.2025	0.13 b	0.05 ab	0.05 a	0.02 ab	0.02 ab	0.00 b	0.00 b	0.00 b	0.00 c	0.00 c	0.00 b	0.03 ab
23.02.2025	0.14 b	0.00 c	0.03 ab	0.00 b	0.00 b	0.04 a	0.00 b	0.00 b	0.00 c	0.00 c	0.00 b	0.01 ab
24.02.2025	0.04 c	0.04 ab	0.02 bc	0.03 ab	0.00 b	0.00 b	0.02 ab	0.00 b	0.02 bc	0.02 abc	0.00 b	0.03 ab
25.02.2025	0.46 a	0.02 bc	0.00 c	0.01 ab	0.01 ab	0.00 b	0.02 ab	0.01 a	0.03 ab	0.03 ab	0.00 b	0.02 ab
26.02.2025	0.09 bc	0.03 abc	0.00 c	0.02 ab	0.03 a	0.00 b	0.00 b	0.00 b	0.00 c	0.02 abc	0.00 b	0.03 ab
27.02.2025	0.08 bc	0.04 ab	0.03 ab	0.03 ab	0.02 ab	0.00 b	0.02 ab	0.00 b	0.02 bc	0.00 c	0.00 b	0.03 a
28.02.2025	0.10 bc	0.02 bc	0.02 bc	0.01 ab	0.00 b	0.02 a	0.01 ab	0.00 b	0.01 bc	0.00 c	0.01 a	0.04 a
01.03.2025	0.13 b	0.02 bc	0.03 abc	0.00 b	0.00 b	0.00 b	0.00 b	0.01 a	0.02 bc	0.01 bc	0.00 b	0.03 ab
02.03.2025	0.13 b	0.05 ab	0.00 c	0.03 a	0.02 ab	0.00 b	0.02 ab	0.00 b	0.00 c	0.00 c	0.00 b	0.03 ab
03.03.2025	0.11 bc	0.02 bc	0.00 c	0.04 a	0.00 b	0.00 b	0.03 a	0.00 b	0.00 c	0.04 a	0.00 b	0.04 a
04.03.2025	0.14 b	0.03 bc	0.00 c	0.00 b	0.03 a	0.00 b	0.02 ab	0.00 b	0.00 c	0.00 c	0.00 b	0.03 ab
05.03.2025	0.14 b	0.03 bc	0.03 abc	0.03 ab	0.00 b	0.00 b	0.02 ab	0.00 b	0.00 c	0.03 ab	0.00 b	0.00 b
06.03.2025	0.13 b	0.03 bc	0.04 ab	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b	0.05 a	0.04 a	0.00 b	0.02 ab
07.03.2025	0.13 b	0.03 bc	0.02 bc	0.00 b	0.01 ab	0.00 b	0.01 ab	0.00 b	0.03 ab	0.01 bc	0.00 b	0.00 b

Table 6. Ecological indices [Margalef's Index (d), Menhinick's Index (D), Berger-Parker Index (BPI), and Pest to Predator Ratio] characterizing insect pest community structure in Egyptian clover crop.

Days	Margalef's Index (d)	Menhinick's Index (D)	Berger-Parker Index (BPI)	Pest to Predator Ratio
21.02.2025	3.54 ab	3.57 ab	0.67 cdef	5.10 cde
22.02.2025	3.60 ab	3.68 ab	0.63 def	3.96 de
23.02.2025	3.79 ab	3.96 ab	0.82 abc	0.00 e
24.02.2025	2.76 de	2.31 de	0.85 ab	14.63 b
25.02.2025	2.39 e	1.70 e	0.94 a	49.80 a
26.02.2025	2.88 d	2.52 d	0.89 ab	8.90 bcd
27.02.2025	2.88 d	2.51 d	0.80 abc	11.56 bc
28.02.2025	3.02 cd	2.75 cd	0.82 abc	5.00 cde
01.03.2025	3.38 bc	3.33 bc	0.78 abcde	2.80 de
02.03.2025	3.78 ab	3.93 ab	0.67 cdef	4.55 cde
03.03.2025	3.88 a	4.10 a	0.56 f	5.88 cde
04.03.2025	3.51 ab	3.54 ab	0.79 abcd	7.10 cde
05.03.2025	3.40 bc	3.36 bc	0.76 bcde	9.56 bcd
06.03.2025	3.67 ab	3.79 ab	0.62 ef	4.80 cde
07.03.2025	3.90 a	4.12 a	0.74 bcde	3.40 de

control in ensuring ecological balance on clover-based crop systems (Table 6). The field screening of the Egyptian clover in a rice-wheat rotation showed that the pest complex was highly skewed (thrips), followed by aphids at a great distance and other taxa were considered negligible. This is the first daily-resolution study to examine the dynamics of insect populations in Egyptian clover grown in Punjab, Pakistan, using the rice–wheat cropping system. Using a variety of ecological indices (Shannon–Wiener, Simpson, Pielou, Margalef, Menhinick, Berger–Parker, and pest-to-predator ratio), it quantifies the limited role of natural enemies and documents an extreme thrips outbreak in an insecticide-free environment, which is typical for forage crops used as livestock feed. Stronger evidence of Egyptian clover's susceptibility to sap-feeding pests and the lack of natural biological control in intensive cereal-based rotations is provided by these high-resolution temporal data and multi-index analyses, which go beyond the primarily descriptive or sporadic surveys that were previously available for the crop in the area (e.g., Wagan et al., 2015; Arshad et al., 2018).

Such dominance of sap-feeding pests has also been reported in forage legumes, where thrips and aphids are the key contributors to yield loss (Wagan et al., 2015; Arshad et al., 2018). A multi-site study on soybean found thrips abundance and species composition were strongly affected by plant spacing and phenological stage, which altered canopy microclimates and resource concentration for thrips (Twardowski, 2024).

Thrips populations showed a characteristic outbreak pattern, starting from 7.20–7.80 insects on 22.02.2025–23.02.2025 and rising sharply to a peak of 47.80 on 25.02.2025 before declining below 10.00 by early March. The biology of thrips is characterized by rapid rise and fall because, under favorable weather conditions, their short life cycle allows for exponential population growth (Kumar et al., 2022). Many thrips species show such quick rise-fall oscillations because they exploit brief windows of favorable microclimate and host phenology (2025) Adhikari and (2024) Twardowski. Within this system, thrips are the primary pest of Egyptian clover, causing significant feeding damage, leaf curling, and a decrease in biomass at susceptible crop stages (Sharma et al., 2023; Arif et al., 2018). Aphids appeared to be the second most important pest, while having far lower densities than thrips. On February 28, 2025, the population peaked at 1.00, and by March 7, 2025, it had completely disappeared. These tiny spurts of activity are quite typical of forage legumes, where the constant development of aphis is frequently constrained by a shift in climate or maturity of plants and response by natural predators (Wagan et al., 2015; Arshad et al., 2018). This infection is a sign of short-lived aphid outbreak on clover and other similar legumes (Arshad et al., 2018). The same observation in fields of berseem clover has revealed that aphids, though they may be in small numbers, are still capable of causing damage to plants at the time when they are in bloom (Wagan et al., 2015). Other chewing pests included grasshoppers, field crickets, butterflies, and bluemilk weed beetles which were scarcely present on several days and never more than 1.20 individuals per sweep of an individual. The low number of chewing pests in the Egyptian clover proved to be backed by the fact that they rarely become economically significant, as said by Wagan et al. (2015). The same has been evident in berseem/forage research, in which chewing pests are minor and sap-feeding insects (aphids, thrips) are predominant in the pest complex (Wagan et al., 2015). The highest of grasshoppers was on the 21st of February, at 1.20, and the highest of crickets, on the 23rd of the same month, at 1.00. But neither of them quickly answered 0, indicating that they were minimally contributing (Wiegert et al., 1965).

Nevertheless, the numbers of bugs could not be managed even with the existence of natural enemies. Through thrips outbreaks, there was no increase in the population of spiders, and the peak of the beetle population roaming was 1.80 on February 21 and 1.00 on March 3. Such low predator observation is indicative of one of the weaknesses of biological control in pasture and monocropping systems in the past (Arshad et al., 2018; Gurr et al., 2017). In other cases, predators are not the best biocontrol agents due to the maxima that they follow the pests (Landis et al., 2000).

Other insects like the leafhoppers and houseflies were sporadically active with highest concentration of 0.80 and 1.00 respectively. They are rarely seen, implying that they are occasional clover pests, which are not economically meaningful (Latif et al., 2023; Wagan et al., 2015).

Altogether, the difference between low predation and a high population of pests underlines the vulnerability of Egyptian clover to insect's invasion. Although natural enemies did not exceed 1.80, thrips attained an exceptionally high peak of 47.80, which is an indication of poor natural control. Similar imbalances in berseem-wheat systems were also identified, and the need to implement integrated pest management (IPM) strategies (Arshad et al., 2018; Arif et al., 2018). It has also been suggested that aphid and thrip outbreak can be minimized with cultural practices such as habitat management, intercropping, and altered sowing date without reducing predators (Gurr et al., 2017).

It is important to note that the present research is a rapid field experiment conducted in one of the most important stages of growing Egyptian clover. Even though this period showed peak pest activity, particularly thrips outbreaks, longer-term and multi-seasonal study is required to fully understand seasonal and annual variation in insect population dynamics. Therefore, the study's findings should be viewed as a baseline assessment that prioritizes present pest problems over long-term population trends.

CONCLUSION

In conclusion, it was determined that thrips were the main pest of Egyptian clover in rice-wheat environments, with aphids coming in second and other insects having a minor impact. In line with patterns documented in the ecology of fodder pests, natural enemies were present but insufficient to offer efficient management. To lessen pest-induced yield losses in Egyptian clover, IPM must be strengthened with timely monitoring. The foundation of an IPM program should be habitat protection, targeted microbial or botanical control, and varietal resistance in order to lower thrips peaks while maintaining beneficial arthropods.

AUTHOR’S CONTRIBUTION

AMS and BA designed and conducted the experiment, collected and analysed the data, and wrote manuscript; MDG, and MAF helped in apprehending the idea of this research, designing the layout of experiment and improving the write-up, format and language of this manuscript; MAA and MUS reviewed the manuscript, added and improved declaration section, edited the format of the tables according to the format of the journal; AMS and BA contributed in data setting for analysis, reviewed the final manuscript and made the format of this manuscript according to the format of the journal; This final manuscript was ultimately perused, scrutinized and approved for final submission by all the authors.

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AVAILABILITY OF DATA AND MATERIAL

All data generated or analyzed in this study are presented within this article in the form of tables.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the relevant forum.

CONSENT FOR PUBLICATION

All the authors are agreed on the publication.

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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