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# Research Article
# Inventory of Entomofauna in Tomato (*Solanum lycopersicum* L.) Fields in the Central Plateau Agroecological Zone of Burkina Faso

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## Abstract

**Background and Objective:** Tomato production plays a crucial role in ensuring food security for the population of Burkina Faso. However, it was conducted under conditions of high pesticide use and significant pressure from insect pests. This study aimed to inventory insect species using yellow sticky traps in tomato crops, from the nursery stage to field cultivation, in the Central Plateau Region of Burkina Faso. **Materials and Methods:** Insects were sampled weekly using yellow pan traps and yellow glue traps in tomato plots belonging to the Sakata and Cobra F1 cultivars. All collected insects were counted and identified in the laboratory. The frequency and abundance were calculated for each site and then tested globally using ANOVA and Tukey's pairwise mean comparison tests. Shannon's diversity (specific richness) (H') and equity indices (E) were calculated based on the diversity of insect families collected on tomatoes. A total of 1,163 insects were captured in the field plots, representing 24 species across 20 families and 7 orders. In the nurseries, 129 insects were collected, comprising 21 species from 17 families and 5 orders. **Results:** The main pest orders identified were Lepidoptera, Homoptera, Hemiptera and Hymenoptera. Natural enemies, particularly Coleoptera and Hymenoptera, were also collected, although in low abundance. A decrease in pest abundance was followed by an increase in the population dynamics of beneficial insects. **Conclusion:** The results of this study constitute an up-to-date database on insect pests and beneficial insects affecting tomatoes in Burkina Faso, suggesting promising prospects for biological pest control.

Key words: Insect diversity, pest, natural enemies, tomato, coleoptera, hymenoptera

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

## INTRODUCTION

The agricultural sector remains a key component of Burkina Faso's economy and employs more than 80% of the country's workforce. It contributes 33% to the formation of gross domestic product (GDP) contribution[1]. An estimated 3.6 million hectares of cultivated land in Burkina Faso are primarily used for cash crops, cereal crops and vegetable production[2]. Vegetable production plays a vital role in the national supply of vegetables and contributes significantly to nutrition and poverty reduction programs by improving household incomes[3]. It is characterized by a wide diversity of cultivated vegetables, including onion, tomato, eggplant, cabbage, carrot, amaranth, lettuce, pepper, cucumber, zucchini, parsley, okra and mint, among others[4].

Among vegetable crops, tomato ranks second after onion in Burkina Faso, with an annual production of approximately 200,519 tons cultivated over 11,766 hectares[5]. As a high-value food crop, tomato plays a key role in food security[5] and contributes significantly to the improvement of social well-being and public health in both rural and urban areas[6]. Tomato cultivation also supports national economic growth[5], generating substantial employment opportunities and significant income opportunities for populations in both rural and urban settings. Additionally, it represents a valuable commodity in trade with neighboring countries such as Benin, Côte d'Ivoire, Ghana and Togo.

Despite its importance, tomato production faces numerous biotic and abiotic constraints, among which insect pests are particularly detrimental. Key pests include whiteflies, aphids, leaf miners, thrips, noctuid moths, and stink bugs[7]. These pests can cause significant damage, with crop losses estimated between 50 and 100% of the total harvest[8].

In Burkina Faso, several studies have been conducted on tomato pests such as mites, *Bemisia tabaci* and *Tuta absoluta* in the Northern, Central and upper Basin regions[1,9,10].

Unfortunately, there is limited information on the specific identity and abundance of insect pests affecting tomato crops from seedlings to harvest on fields in the Central Plateau Region of Burkina Faso. A crucial first step toward effective and sustainable pest management is a thorough understanding of the pest complex associated with the crop. Therefore, this study aims to inventory the entomofauna associated with tomato cultivation, from nurseries to production fields, to inform the development of sustainable crop protection strategies in the Central Plateau Region.

## MATERIAL AND METHODS

**Study area:** The study was carried out from May to September, 2024 at four vegetable production sites located in the communes of Ziniaré (Koissanga (N 12°39 29.1", W 1°20 8.3") and Pousg-Ziga (N 12°34 23.1", W 1°17 25.7")) and Loumbila (Bagrin (N 2°33 30.6", W 1°22 39.2") and Ramii-tenga (N 12°32 2.0", W 1°21 40.4")) within the Northern Sudanian zone of Burkina Faso (Fig. 1). Both communes were located in the Plateau Central Region of the Oubritenga Province, one of the main tomato-producing areas of the country. The climate is tropical, with two seasons: A dry season (October to April) and a rainy season (May to September), with a mean annual rainfall ranging from 600 to 900 mm[11,12]. The vegetation is dominated by savanna with annual growing grass, trees, and shrubs[13,14].

**Sampling of insects:** Insects were sampled weekly using yellow pan traps (containing soapy water) and yellow glue traps (measuring 10 cm in length and 5 cm in width) in four tomato plots belonging to Sakata and Cobra F1 cultivars. The two varieties were intercropped in the same fields. Insect trapping was conducted from the nursery stage until fruit maturation. In each production plot of approximately 500 $m^2$ in size, three yellow glue traps were installed on stakes of plant canopy height, arranged in a triangular pattern and spaced evenly. In addition, three other yellow traps filled with water and a few drops of liquid soap were installed according to the methods described by Mignon *et al.*[15]; Aroun *et al.*[16] and Allan and Gillett-Kaufman[17]. The same process was carried out in each nursery of approximately 10 $m^2$. The soapy solution was replaced after each collection and the yellow glue traps were also replaced. The insects collected in the traps were preserved in 70% ethanol until they could be identified. The yellow color attracts Homoptera and the glue traps them when they come into contact with the trap[18].

**Identification of insects:** All collected insects were counted and identified in the laboratory under a binocular microscope, based on comparison with voucher specimens previously identified by a taxonomic entomologist. They were also identified based on morphological characteristics described in various entomological classification keys[19-24] and technical publications[25]. The identified insects were grouped into functional groups: Pests, pollinators, predators, parasitoids and others.

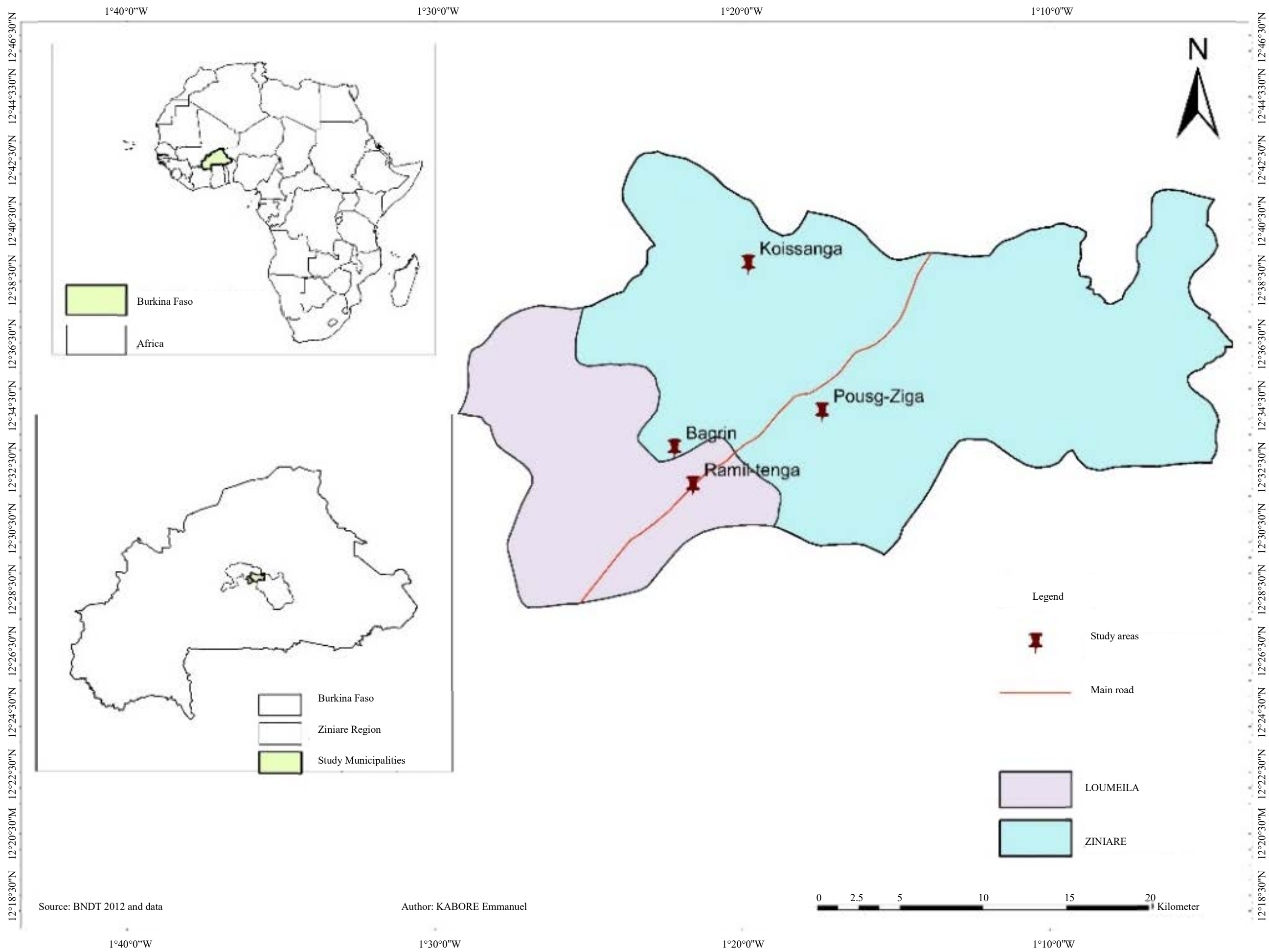


Fig. 1: Map of the study area in Burkina Faso

**Data analysis:** Statistical analyses were performed on the R software version 4.0.3. The frequency and abundance were calculated according to the site and were tested globally by ANOVA and also using Tukey's pairwise mean comparison tests.

Frequency:

$$F = \frac{n}{N}$$

and abundance:

$$A = \frac{n}{N} \times 100$$

Where:

n = Number of individuals of a taxon
N = Total number of individuals of a taxon[26]

Shannon's diversity (specific richness) (H') and equity indices (E) were calculated based on the diversity of insect families collected on tomatoes. The formulas used to calculate these indices are as follows[26]:

$$H' = -\sum_{i=1}^{s} \left(\frac{n_i}{n}\right) x \ln\left(\frac{n_i}{N}\right) (\text{Shannon diversity index})$$

where $n_i$ is number of individuals of a taxonomic level considered (the family); i is a family present in the environment, ranging from 1 to S (the total number of families observed) and N is the total number of individuals captured in the traps. When the value of H' is low, the environment is considered to be poor in families.

On the other hand, if this index is high, it indicates a great diversity of families in the environment.

And:

$$E = \frac{H'}{H'_{max}}$$

with:

$$H'_{max} = \ln s\,(\text{Shannon equity index})$$

where, H'max is the maximum Shannon diversity and S is the number of families. Its value ranges from 0 (dominance of one of the families) to 1 (equal distribution of individuals among the families).

The Simpson diversity index (D), which calculates the probability that two individuals randomly selected from a given environment belong to the same family, was calculated[26]:

$$D = 1 - \sum \left\{ \frac{\left[ n_i \left( n_i - 1 \right) \right]}{\left[ N \left( N - 1 \right) \right]} \right\}$$

where, $n_i$ is the number of individuals in a given family and N is the total number of individuals captured. This index ranges from 0 (minimum diversity) to 1 (maximum diversity).

## RESULTS

**Diversity of insects captured in tomato nursery plots:** Twenty-one insect species belonging to 17 families and 5 orders were identified in tomato nurseries (Table 1). The dominant orders reported were the Diptera (8 species followed by Hymenoptera (8 species) and Coleoptera (3 species). Among these insect species, five species were identified as nursery pests, with *Hydrophoria* sp., being the most abundant, followed by *Aphthona* sp., Furthermore, the inventory revealed the presence of three predators, two pollinators and two parasitoids, among which *Voria ruralis* was the most frequently recorded species.

**Diversity of insects captured in tomato field plots:** A total of 1,163 insects were captured using yellow water traps and yellow glue traps. The specimen was classified in to twenty-four insect species belonging to 20 families and 7 orders (Table 2). The dominant orders reported were the Diptera (6 species), Coleoptera (5 species), Homoptera (4 species) and Lepidoptera (4 species). Nine insect pests were identified, including *T. absoluta*, *H. armigera*, *B. tabaci* and *Euonthophagus* sp. Five pollinators and three predators were also identified.

Table 1: Diversity of insects captured in traps placed in tomato nursery plots

| Order | Family | Species | Number of individuals | Functional groups |
|---|---|---|---|---|
| Blattodea | Blattellidae | *Ectobius* sp. | 6 | Others |
| Coleoptera | Chrysomelidae | *Aphthona* sp. | 6 | Pest |
| | Coccinellidae | *Par Exochomus nigromaculatus* | 5 | Predator |
| | Staphylinidae | *Pinophilus* sp. | 2 | Others |
| | Anthomyiidae | *Hydrophoria* sp. | 16 | Pest |
| | Calliphoridae | *Lucilia sericata* | 12 | Pollinators |
| | Lonchaeidae | *Lonchaea* sp. | 1 | Pest |
| Diptera | Muscidae | *Musca domestica* | 16 | Others |
| | | *Morellia* sp. | 4 | Others |
| | | *Musca autumnalis* | 20 | Others |
| | Fanniidae | *Fannia canicularis* | 1 | Others |
| | Tachinidae | *Voria ruralis* | 13 | Parasitoid |
| Hymenoptera | Tephritidae | *Procecidochares* sp. | 1 | Pest |
| | Apidae | *Xylocopa* sp. | 1 | Pollinators |
| | Braconidae | *Aleiodes politiceps* | 5 | Parasitoid |
| | Formicidae | *Camponotus* sp. | 1 | Predator |
| | | *Lasius* sp. | 4 | Others |
| | Sphecidae | *Chalybion* sp. | 1 | Others |
| | | *Isodontia* sp. | 10 | Predator |
| | Vespidae | *Oxybelus* sp. | 1 | Others |
| Orthoptera | Acrididae | *Chorthippus* sp. | 5 | Pest |
| Total | | | 129 | |

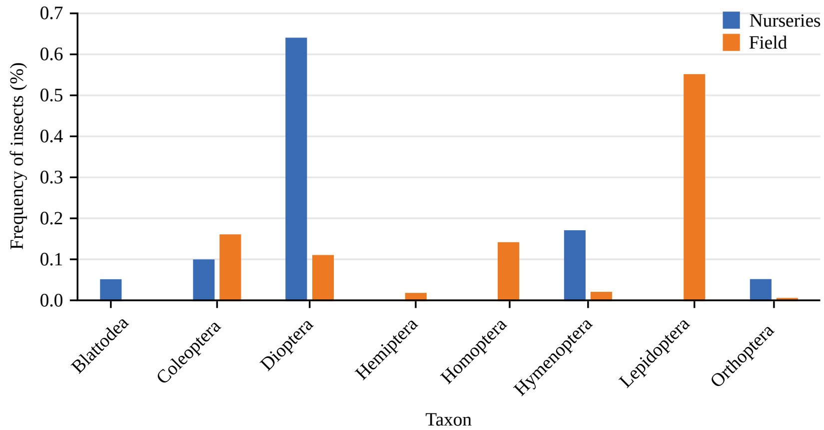


Fig. 2: Frequency of insects according to collection plots

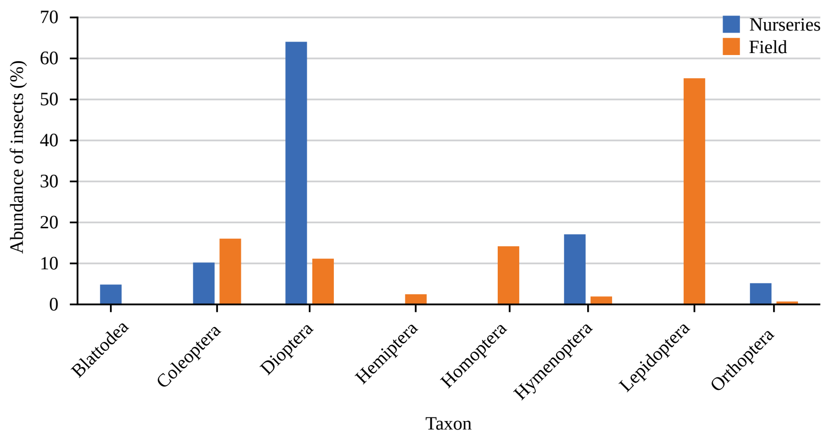


Fig. 3: Abundance of insects according to collection plots

Table 2: Diversity of insects captured by traps placed in tomato field plots

| Order | Family | Species | Number of individuals | Functional groups |
|---|---|---|---|---|
| Coleoptera | Coccinellidae | *Par Exochomus nigromaculatus* | 92 | Predator |
| | | *Harmonia axyridis* | 7 | Predator |
| | Nitidulidae | *Aethina tumida* | 16 | Others |
| | Scarabaeidae | *Euonthophagus* sp. | 52 | Pest |
| | | *Orizabus* sp. | 18 | Predator |
| Diptera | Anthomyiidae | *Hydrophoria* sp. | 6 | Pest |
| | Calliphoridae | *Lucilia sericata* | 13 | Pollinator |
| | Lonchaeidae | *Lonchaea* sp. | 1 | Pest |
| | Muscidae | *Musca domestica* | 101 | Others |
| | | *Morellia* sp. | 5 | Others |
| | Tachinidae | *Ormia* sp. | 1 | Others |
| Hemiptera | Aphrophoridae | *Aphrophora* sp. | 12 | Pest |
| | Cicadellidae | *Agalliadeleta* | 10 | Pest |
| | Pyrrhocoridae | *Pyrrhocoris apterus* | 5 | Others |
| Homoptera | Aleurodidae | *Bemisia tabaci* | 150 | Pest |
| | Apidae | *Xylocopa* sp. | 11 | Pollinator |
| | Sphecidae | *Chalybion* sp. | 1 | Others |
| | | *Isodontia* sp. | 3 | Others |
| Lepidoptera | Nymphalidae | *Acraea* sp. | 4 | Pollinator |
| | Pieridae | *Colias* sp. | 9 | Pollinator |
| | Gelechiidae | *Tuta absoluta* | 366 | Pest |
| | Noctuidae | *Helicoverpa armigera* | 258 | Pest |
| Hymenoptera | Crabronidae | *Argogorytes* sp. | 20 | Pollinator |
| Orthoptera | Acrididae | *Chorthippus* sp. | 4 | Pest |
| Total | | | 1163 | |

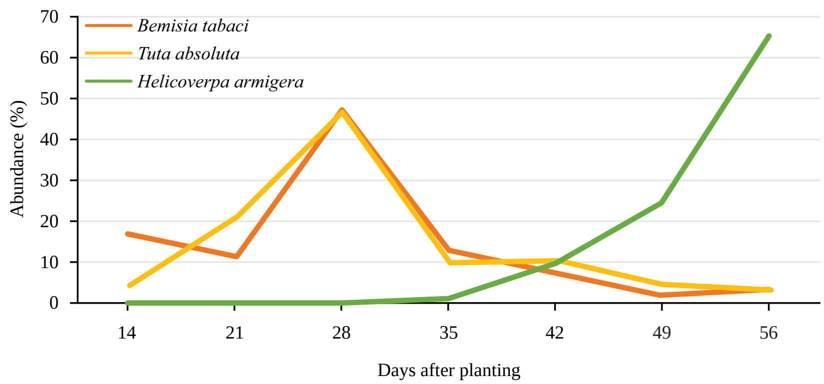


Fig. 4: Dynamics of the main insect pests in tomato fields

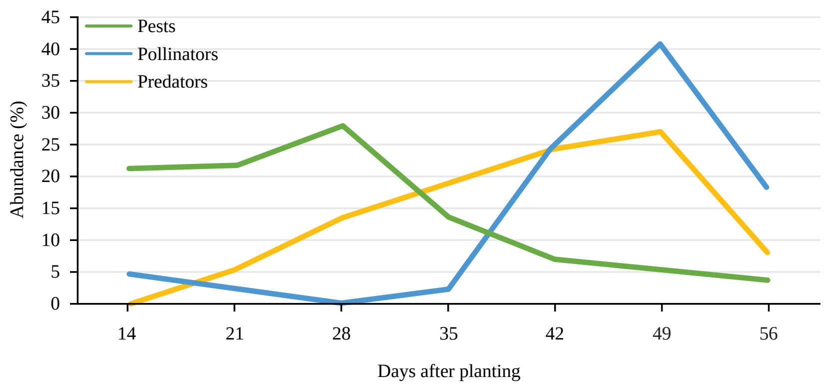


Fig. 5: Dynamics of pests and beneficial insects collected in tomato fields

Table 3: Diversity indices of insect families recorded in nurseries according to location

| Diversity index | Koissanga | Pousg-Ziga | Bagrin | Ramii-tenga |
|---|---|---|---|---|
| Shannon index (H) | 1.62 | 2.11 | 1.26 | 1.35 |
| Simpson index (D) | 0.75 | 0.86 | 0.64 | 0.68 |
| Equality of Pielou (E) | 0.78 | 0.88 | 0.78 | 0.84 |

Table 4: Diversity indices of insect families recorded in the field according to location

| Diversity index | Koissanga | Pousg-Ziga | Bagrin | Ramii-tenga |
|---|---|---|---|---|
| Shannon index (H) | 0.59 | 1.2 | 1.7 | 1.36 |
| Simpson index (D) | 0.25 | 0.62 | 0.69 | 0.59 |
| Equality of pielou (E) | 0.27 | 0.55 | 0.64 | 0.57 |

**Diversity of insect families in nurseries and fields:** The Shannon diversity index indicated variations in insect family diversity across sites in both nurseries (Table 3) and tomato fields (Table 4). The lowest diversity was recorded in the field plot at the Koissanga site (0.59), while the highest was observed in the nursery plot at the Pousg-Ziga site (2.11). The equity and Simpson indices revealed similar trends, showing maximum diversity and an even distribution of individuals across insect families except at the Koissanga site, where diversity and uniformity were markedly lower.

**Frequency and abundance of insects according to collection plots:** The composition of insect orders differed significantly between nurseries and field plots, as confirmed by statistical analysis ($p<0.0001$ and $p<0.001$, respectively (Fig. 2). In nurseries, Diptera were the most frequently recorded (0.64), followed by Hymenoptera (0.17) and Coleoptera (0.10). In field plots, Lepidoptera (*T. absoluta*, *H. armigera*) were the most frequently recorded, with 0.55, followed by Coleoptera (0.16).

Insects captured in nurseries and fields showed significantly different abundance ($p<0.0001$ and $p<0.001$, respectively) (Fig. 3). Diptera (7 species) were the most abundant (64.34%) in nurseries, whereas Lepidoptera (4 species) were the most abundant (54.77%) in tomato field plots.

**Dynamics of *T. absoluta, B. tabaci* and *H. armigera:*** Among the pest species recorded, *Tuta absoluta*, *Helicoverpa armigera* and *Bemisia tabaci* were the most prevalent. *Tuta absoluta* and *B. tabaci* exhibited early population peaks at 28 days after transplanting. In contrast, *H. armigera* appeared later, first captured at day 35 and reached its peak density by day 56, suggesting differences in phenology and colonization patterns (Fig. 4).

**Dynamics of pests and beneficial insects in tomato fields:** The pest species reached their peak abundance early, at 28 days after planting, predator populations peaked later, on day 49, followed by a decline by day 56 (Fig. 5). Pollinators exhibited a delayed response, with their abundance increasing significantly between days 35 and 49, indicating temporal variation in functional group dynamics.

## DISCUSSION

Comprehensive knowledge of insect pests affecting tomato crops from the nursery to the field stages in Oubritenga Province represents a foundational step in establishing appropriate and sustainable tomato pest control. The inventory highlighted a considerable diversity of insect pests across both nursery and field stages of tomato production. This high pest incidence could be explained by the fact that tomato plants emit volatile compounds and exhibit morphological traits that attract a broad spectrum of phytophagous insects.

The inventory insect highlighted a considerable diversity of insect pests across both nurseries and production field stages of tomato production. This high pest incidence could be explained by the fact that the strong attractiveness of tomato plants to a wide range of insect species[27,28]. They found that how volatiles emitted by tomato plants (*S. lycopersicum*) infested with the green peach aphid (*Myzus persicae*) influence the behavior of the invasive pest *B. tabaci*[27] that is active during the vegetative phase of tomato development, causing substantial damage that can impair plant growth and reduce overall plant vigor. The majority of these pest species are active during the vegetative stage of tomato development, causing serious damage that can affect its growth and development[29,30]. Their results suggest that tomato crops host a wide range of insect species across multiple orders and that this high pest diversity poses a serious threat to crop yields.

Lepidoptera, Diptera, Homoptera and Hymenoptera were the most dominant orders. The predominance of these orders in fields and nurseries could be related to the collection method. Indeed, yellow water traps and yellow glue traps are not selective. Although Traoré *et al.*[18] showed that the yellow color is particularly attractive to Homoptera and that glue effectively traps them upon contact. These traps also capture a wide range of other insect order. This likely explains the highpresence of Diptera recorded during sampling.

Results showed that, in addition to pests, many beneficial insects (pollinators, predators and parasitoids) coexist in tomato crops. Pollinating insects, which play a key role in productivity[31]. Ruhul Amin *et al.*[31] also reported on mango in Bangladesh that pollinators (8 species) included syrphid flies, Sulphur butterflies and houseflies, which varied significantly in their landing duration on mango flowers,and play a critical role in fruit production. The natural enemies, such as predators and parasitoids, contribute significantly to reducing pest populations, thereby reducing the need for external intervention to control their proliferation[32-34].

The reduction in the dynamics of *T. absoluta* and *B. tabaci* from the 28th day after planting could be explained by the intervention of predatory species, whose population peaks on the 28th day, preventing the pests from multiplying through predation[30]. As for *H. armigera*, its population dynamics continued to increase after the 35th day. This period coincides with the plant's flowering and fruiting period. These results are similar to several studies that have shown that *H. armigera* is the main pest of tomatoes during flowering and fruiting[35]. These natural enemies offer significant potential for biological control of these insect pests.

## CONCLUSION

The tomato production chain represents a major economic resource for producers in the Central Plateau Region, but numerous constraints remain to be addressed, namely the high pest pressure caused mainly by insect populations. Results showed a high diversity of insects on tomato crops. In addition to pests such as *T. absoluta* and *H. armigera*, there is a significant presence of beneficial insects such as predators, parasitoids and pollinators. This offers prospects for biological control through their use. This study has updated the database on the development dynamics of these harmful insects in the region. This serves as a warning for quantitative and qualitative improvements in tomato production.

## SIGNIFICANCE STATEMENT

This study discovered the diversity and distribution of insect species associated with tomato production in Burkina Faso that can be beneficial for developing sustainable pest management strategies. The inventory of both pests and natural enemies provides valuable insights into population dynamics, where a decline in pest abundance was followed by an increase in beneficial insects, indicating a natural regulatory mechanism. This study will help researchers to uncover the critical areas of insect biodiversity, pest pressure and natural enemy interactions that many researchers were not able to explore. Thus, a new theory on optimizing tomato production through ecological pest regulation and reduced pesticide dependency may be arrived at.

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