

Research Article

# Survey of Distribution, Infestation, and Damage Level of Major Insect Pests on Faba Bean and Field Pea Crops in the North Shewa Zone, Ethiopia

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## Abstract

Faba beans and field peas are the major pulse crops widely produced in North Shoa, Ethiopia. Despite these crops being widely grown in the northern parts of the country over a wide range of altitudes, the distribution, infestation, and damage level of the major insect that affects these crops have not been well studied. Therefore, the current study was conducted with the objective of assessing the distribution, infestation, and damaging level of major insects on faba bean and field pea crops in the North Shewa Zone, Ethiopia, during the 2022 and 2023 main cropping seasons. The survey was conducted in five selected districts: GirarJarso, Dagam, DebreLibanos, Wachale, and Jida. A total of 180 fields were randomly sampled across 30 Kebeles within these districts. The study utilized a purposive multistage sampling method, and data were collected using various sampling patterns, including —X ||, || U ||, || W || and —Z || formations, with 1m<sup>2</sup> quadrants placed at intervals. The results revealed that significant variation ( $p < 0.05$ ) in insect infestation and damage levels across the surveyed districts and insects identified. Insects recorded during this survey identified several major insect pests, including pod borer (*Maruca vitrata*), caterpillar (*Catopsilia pyranthi*), flea beetle (*Scelodonta strigicollis*), and African bollworm (*Helicoverpa armigera*) in faba bean crops, and pod borer (*Maruca vitrata*), caterpillar (*Catopsilia pyranthi*), flea beetle (*Scelodonta strigicollis*), and aphids (*Aphis craccivora*) in field pea crops. Infestation levels varied across districts, with the highest infestation for faba beans recorded in Girar Jarso (30.5%) for leaf beetles and for field peas in Jida (40%) for pod borers. Damage levels ranged from 0% to 26% for faba beans and from 0% to 29% for field peas, with significant regional variations. The results highlight the economic importance of these pests, which require urgent attention through integrated pest management (IPM) strategies. The study emphasizes the need for timely and effective pest control measures to mitigate the damage to pulse crops in the North Shewa, Oromia, Ethiopia.

## Keywords

Pulse Crops, Distribution, Infestation, Damage Level, Faba Bean and Field Pea

## 1. Introduction

Agriculture is the backbone of the Ethiopian economy, contributing 32.7% of its total gross domestic product (GDP), 87% of exports, and employing around 66% of the total working population in Ethiopia [3, 10, 14]. The two main

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pillars of Ethiopian agriculture are crop production and livestock rearing. Among the country's important crops, pulse crops such as faba beans (*Vicia faba*) and field peas (*Pisumsativum*) are particularly important for food security and economic development. Similarly, pulse crops contribute significantly to the national agricultural output, underscoring the need for effective pest management strategies to protect these essential crops [2]. Additionally, these crops are crucial in crop rotation systems, improving soil fertility by fixing nitrogen and serving as valuable protein sources for the population [4, 12]. However, the production and productivity of these crops is often affected by the infestation of various biotic and abiotic factors. Among the biotic factor's insect pests are particularly [2, 5]. The diversity and severity of insect pest damage are influenced by factors such as altitude, cropping system, local climate, and agronomic practices [6, 11].

The insect pests are not only affecting the crop health; they can also indirectly affect the public health, as some of them act as vectors for plant pathogens that affect food safety [15]. In the study area, there is lack of information on the distribution, infestation, and damage level of major insect pests that affect the production and productivity of faba bean and field peas. Therefore, the aim of this study is to assess the distribution, infestation, and damage levels of the main insect pests affecting faba beans and field peas in North Shoa during the 2022 and 2023 growing seasons. This research is important to recognize the great economic importance of

insect pests and to give them urgent attention through integrated pest management (IPM) strategies.

## 2. Materials and Methods

### 2.1. Description of the Study Areas

The insect assessments were conducted in the North Shewa Zone of Oromia region during 2022 and 2023 main cropping seasons. The survey included the major five (5) highland agro-ecological districts of pulse crops growing, namely GirarJarso, Dagam, DebreLibanos, Wachale, and Jida North ShewaOromiaShewaaOromiaZone, Ethiopia (Table 1 and Figure 1). The experiment was conducted at Fiche Agricultural Research Center North Shoa Zone of Oromia Regional-state, located in latitude and longitude range of 09001'25" N - 09048'81" N and 38032'96" E - 39026'63" E, respectively. The survey altitude (topography) is generally from 2589 m.a.s.l located in Wachale and Jida districts, and rising to high point 3290 m.a.s.l located in Dagam district (Table 1). The study area receives an average annual rainfall ranging from 1151mm to 1384 mm, with the minimum and maximum temperatures 4.51 °C and 30.37 °C, respectively (Table 1). The major soil textural classes of the zone are clay and sandy soils, and 10km far from Addis Ababa [4].

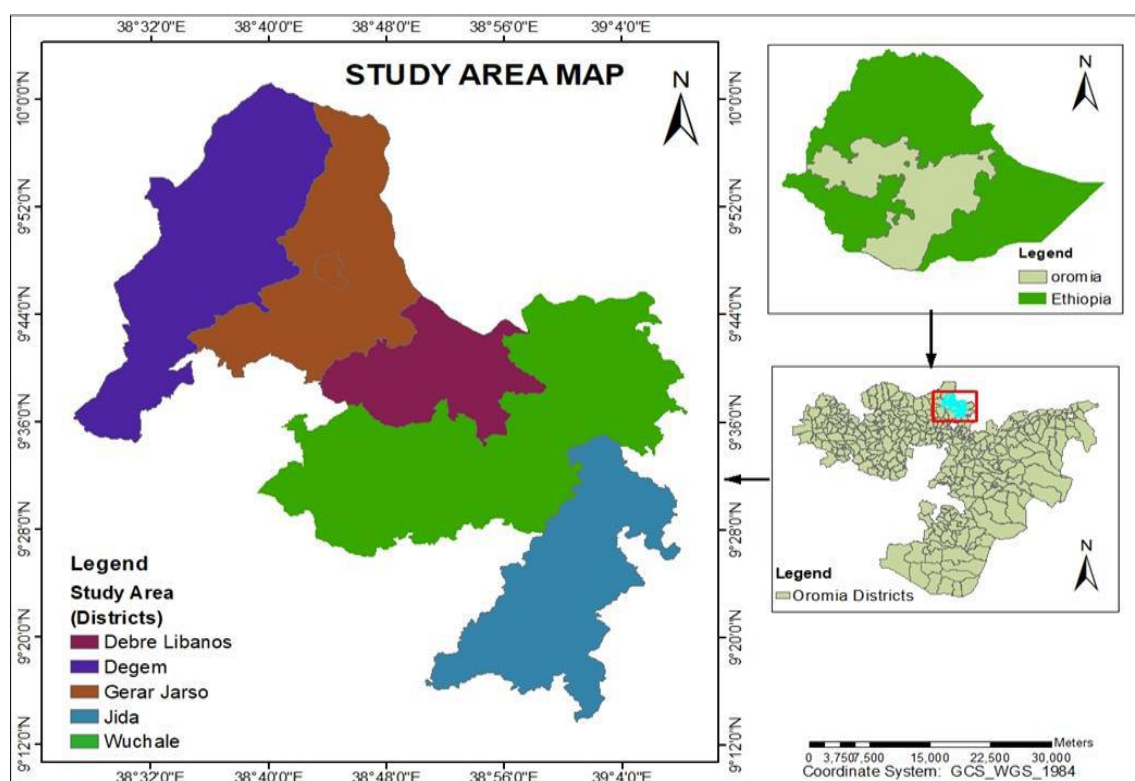


Figure 1. Map of the study area.

**Table 1.** The latitude, longitude, altitude, rainfall, and annual average temperature of the study areas.

| Survey Area | Latitude Range (E)  | Longitude Range (N) | Altitude Range (m.a.sl) | Rain fall (mm) | Annual average temperature ( °C) |       |
|-------------|---------------------|---------------------|-------------------------|----------------|----------------------------------|-------|
|             |                     |                     |                         |                | Min                              | Max   |
| G/Jarso     | 38°38'44"-38°49'33" | 9°42'10"-9°42'58"   | 2600-3256               | 1255           | 7.62                             | 32.04 |
| Degam       | 38°32'96"-38°50'97" | 9°46'35"-9°48'81"   | 3014-3290               | 1384           | 7.62                             | 32.04 |
| D/Libanos   | 38°45'22"-38°50'97" | 9°37'72"-9°42'28"   | 2618-2672               | 1197           | 2.43                             | 29.62 |
| Wachale     | 38°33'06"-38°55'42" | 9°33'06"-9°41'62"   | 2589-2680               | 1200           | 2.43                             | 29.62 |
| Jidda       | 38°47'55"-39°26'63" | 9°01'25"-9°41'62"   | 2589-2737               | 1151           | 2.43                             | 29.62 |

Note: RF=Rainfall, AAT= Average annual temperature

## 2.2. Sampling Methods

A purposive multistage sampling strategy was employed to select five main faba bean and field pea growing districts and 30 *Keble*'s within the districts across the study area. The selection of districts and *Kebeles* was carried out in consultation with the Zonal agricultural bureaus and districts agricultural offices, respectively. Within each *Kebeles*, five farmers' fields were assessed at intervals of 5 to 8 km along the main and feeder roadsides using random sampling along the pre-planned routes. Totally 180 fields were randomly sampled for the insect's assessment during 2022 and 2023 main cropping seasons. Field survey and assessment of the major agricultural land was undertaken using GPS instrument following the procedures of [9].

## 2.3. Study Design, Data Collected, Methodology, and Sampling Patterns

In each farmer's field, insect data was recorded from 5

quadrants (blocks). I was used it as randomized complete block design, with 5 replications or blocks during data analysis. The types of insects, infestation, and damage level of insects were recorded directly by observing the types of insects on plants occurred, infected plants, and number of damaged plant parts on faba bean and field pea crops. Based on the quantity and the slope of farmers field, the assessment was conducted using —X ||, —W ||, —U", and —zig-zag" or —Z || sampling pattern and 1m<sup>2</sup> quadrants at least 8m far apart from each other approximately to collect insect pests. In each field, 5 quadrants were systematically assigned to the respective points and plants within the quadrant were counted and recorded as types of insects, infected, and healthy plants. Similarly, to determine the infestation and damage level, randomly 10 plants from each quadrant and infestation percentages was calculated as percentage of infested plants out of total plants in selected quadrants. As well as, the damage level was recorded as percentages of number of damaged plant parts out of total plant parts counted.

$$\text{Infestation (\%)} = \frac{\text{Number of infected plants} \times 100}{\text{Total number of observed plants}}$$

$$\text{Damage Level (\%)} = \frac{\text{Number of damaged plant parts} \times 100}{\text{Total number of assessed plants}}$$

## 2.4. Data Analysis

Survey data were analyzed using R version 4.4.1 software. Mean comparisons for treatment parameters were done using the least significant difference (LSD) at a 5% level of significance.

### 3. Results and Discussion

**Table 2.** Common name, order, family, and scientific name of insect pests recorded on the faba bean and field pea in North Shoa of Oromia, Ethiopia.

| Common Name            | Order       | Family        | Scientific name         |
|------------------------|-------------|---------------|-------------------------|
| Pod borer              | Lepidoptera | Crambidae     | Maruca vitrata          |
| Caterpillars           | Lepidoptera | ymphalidae    | Pieridae                |
| leaf Beetle            | Coleoptera  | Chrysomelidae | Scelodonta strigicollis |
| African ball worm      | Lepidoptera | Noctuidae     | Helicoverpa armigera    |
| Leaf miner (Blanchard) | Diptera     | Agromyzidae   | Liriomyza huidobrensis  |
| Aphid (greenfly)       | Homoptera   | Aphididae     | Aphis craccivora        |

#### 3.1. Distribution of Major Faba Bean and Field Pea Insects in North Shewa, Ethiopia

The major faba bean and field pea insect survey was conducted at G/Jarso, Dagam, Debre Libanos, Wachale, and Jida districts in the Oromia regional state, North Shewa parts of Ethiopia, during the 2022 and 2023 main cropping season. The assessment result showed that there were significant variations in infestation and damaging level percentages of major insects assessed in five districts of North Shewa, Ethiopia. Combined analysis of infestation and insect-damaging plant parts percentage data revealed that there was non-significant variation between the 2022 and 2023 main cropping seasons, and therefore the data of each year were pooled together.

#### 3.2. Faba Bean Insect Pests

During this survey, the major insects recorded on faba bean crops were the gram pod borer (*Marucavitrata*), caterpillar (*Catopsiliapyranthe*), flea beetles (*Scelodontastrigicollis*), and African bollworm (*Helicoverpa armigera*) in all districts (G/Jarso, Dagam, D/Libanos, Wachale, and Jida) (Table 3, and Figure 2).

#### 3.3. Infestation

During this survey, there were significant differences in infestation percent among insects recorded and districts (Table 3). The highest infestation level of insects was recorded on the leaf beetles, African bollworm, pod borer, and caterpillar, with their values being 30.50% in Debre Libanos, 29% in Girar Jarso, 24.5% in Jida, and 11% in Debre Libanos, who indicated that pod borers and bollworms are the most destructive pests of faba bean in Ethiopian highlands [2, 7], respectively, whereas their lowest were recorded on the leaf beetles, African bollworm, pod borer, and caterpillar, which were 9% in Jida, 7% in Jida, 15% in Debre Libanos, and 0% in Dagam, respectively (Table 3). Leaf beetle infestation appeared more severe in mid-altitude zones, confirming earlier studies [13]. The result indicates that there were variations in infestation level among study areas and recorded insects. This could be due to the altitude ranges, variability of the variety grown, tillage frequency, and seed source, previous history of the farm, plant population, cropping system, crop pattern, and growth stage, weeding frequency, and sowing date difference farmers were used in their fields.

The overall maximum and lowest mean values of infestation were recorded on the leaf beetles (22.2%) and caterpillars (3.5%) in all assessed locations, respectively (Table 3).

**Table 3.** Major Faba bean insects recorded with their infestation percentages across different districts in the North Shewa Zone of Oromia in 2022 and 2023 main cropping seasons.

| Infestation (%) of Major Insects Identified |                    |                   |                    |                    |
|---------------------------------------------|--------------------|-------------------|--------------------|--------------------|
| Districts                                   | Pod borer          | Caterpillar       | Leaf beetles       | African boll worm  |
| G/Jarso                                     | 23.50 <sup>b</sup> | 2.00 <sup>c</sup> | 18.00 <sup>d</sup> | 29.00 <sup>a</sup> |

| Infestation (%) of Major Insects Identified |                      |                      |                       |                       |
|---------------------------------------------|----------------------|----------------------|-----------------------|-----------------------|
| Districts                                   | Pod borer            | Caterpillar          | Leaf beetles          | African boll worm     |
| Dagam                                       | 19.50 <sup>c</sup>   | 0.00 <sup>e</sup>    | 25.50 <sup>c</sup>    | 21.50 <sup>b</sup>    |
| D/Libanos                                   | 15.00 <sup>e</sup>   | 11.00 <sup>a</sup>   | 30.50 <sup>a</sup>    | 16.00 <sup>d</sup>    |
| Wachale                                     | 16.50 <sup>d</sup>   | 3.50 <sup>b</sup>    | 28.00 <sup>b</sup>    | 21.00 <sup>c</sup>    |
| Jida                                        | 24.50 <sup>a</sup>   | 1.00 <sup>d</sup>    | 9.00 <sup>e</sup>     | 7.00 <sup>e</sup>     |
| Mean                                        | 19.8                 | 3.5                  | 22.2                  | 18.9                  |
| LSD (P = 0.05)                              | 2.17E <sup>-15</sup> | 1.07E <sup>-15</sup> | 6.90 E <sup>-15</sup> | 9.34 E <sup>-15</sup> |

Key: Mean values in a column with different letters are significant at  $p < 0.05$ ; LSD = least significant difference.

### 3.4. Damage Levels

The result shows that significant variations of damage level of assessed insects across locations and insects recorded (Figure 2). Damage levels of leaf beetles, African bollworms, pod borers, and caterpillars generally ranged from 5.5% to 26%, 24% to 4.5%, 10% to 20%, and 0% to 9%, respectively. The maximum leaf beetle damage levels (26%) were recorded in the Debre Libanos district, followed by Wachale, Dagam, Girar Jarso, and Jida, where the damage levels were 25%, 20.5%, 13.5%, and 9%, respectively. Therefore, all the surveyed areas in this study could be categorized under

high to low leaf beetle damage levels (Figure 2). Damage variation among districts may also be linked to differences in soil texture and crop rotation frequency, as noted [4]. In the Debre Libanos district, damage levels were 26%, 13%, 10%, and 9%, whereas in the Dagam district, the damage levels were 20.5%, 17.5%, 14.5%, and 0% for leaf beetles, African bollworms, pod borers, and caterpillars, respectively (Figure 2). Likewise, leaf beetles, African bollworms, pod borers, and caterpillars were recorded in Girar Jarso, Jida, and Wachale with damage levels of 13.5%, 24%, 20%, and 5%; 5.5%, 4.5%, 20%, and 1%; and 25%, 19%, 18%, and 3%, respectively (Figure 2).

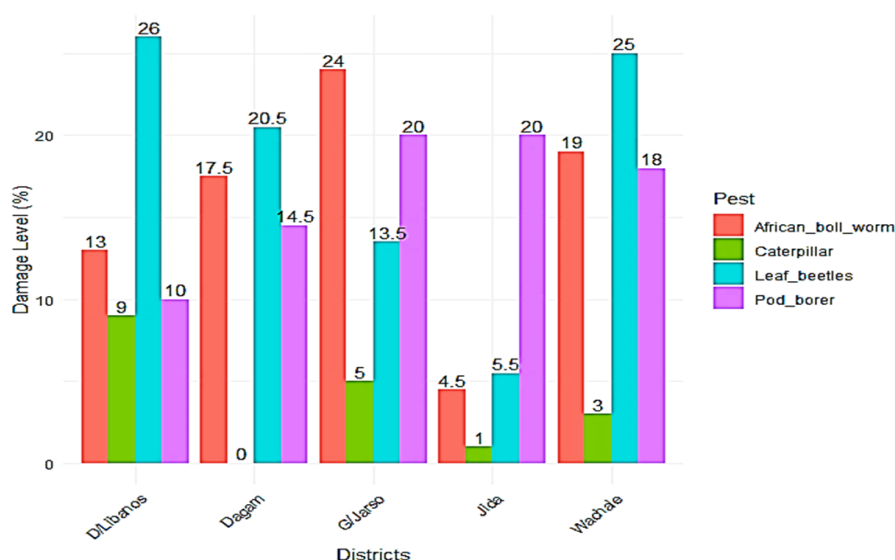


Figure 2. Damage level of major insect pests of faba bean in different districts of North Shoa.

### 3.5. Field Pea Insect Pests

Major insects of field pea recorded during this survey are indicated in Table 3 and Figure 3 along with their infestation

and damage values scored. Pod borer (*Helicoverpa armigera*), caterpillar (*Catopsiliapyranthi*), leaf beetles (*Catopsiliapyranthi*), African bollworm (*Helicoverpa armigera*), leaf miner (*Liriomyzahuidobrensis*), and aphids (*Aphis craccivora*)

were the major insect pests recorded.

### 3.6. Infestation

The following Table 4 shows that there is significant variation among the surveyed major field pea insect pests with their infestation percentages across different districts in the North Shewa Zone of Oromia in the 2022 and 2023 main cropping seasons. The overall infestation means of pod borer, aphids, leaf miner, African bollworm, and caterpillar were recorded at 28.7%, 22.8%, 19.5%, 16.3%, and 8.8%, respectively. The maximum to the lowest infestation value of pod borer was recorded in Jida, GirarJarso, Wachale, Dagam, and Debre Libanos with the values of 40%, 37%, 34%, 18.5%, and 14%, respectively. Similar infestation magnitudes were reported [4, 8]. In the central Ethiopian highlands Likewise, the highest damage level of African bollworm was recorded

in Girar Jarso, Dagam, and Debre Libanos with infestation mean values of 28%, 24%, and 24%, whereas their lowest values were in Wachale and Jidda with mean values of 3% and 2.5%, respectively. In addition, leaf miner was recorded with a mean value of 24.5% in Wachale, 20.5% in Girar Jarso, 18% in Debre Libanos and Jida, and 16.5% in Daga districts. The highest infestation of caterpillars was recorded in Girar Jarso (19.55%) and Dagam (14%), whereas in Debre Libanos (7.5%) the medium was recorded, and the lowest were collected in Jida (0%) and Wachale (3%) (Table 4). Aphids were highly recorded in all five districts, with the range values of 18.5% in Debre Libanos to 27% in Jida district. In general, almost all the recorded insects are of more economic importance in the districts assessed, and the prevalence of these insects necessitates urgent attention on integrated pest management. This result is similar to the previous report of [1, 4, 7].

**Table 4.** Major field pea insect pests with their infestation percentages across different districts in the North Shewa Zone of Oromia in 2022 and 2023 main cropping seasons.

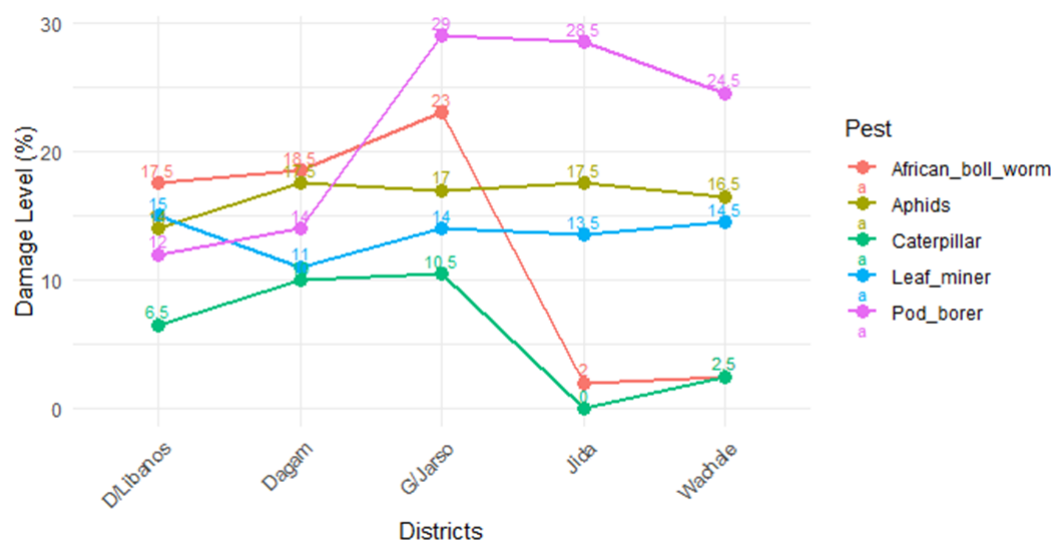
| Infestation (%) of Major Insects Identified |                      |                      |                      |                      |                      |
|---------------------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Districts                                   | Pod borer            | African ball warm    | Leaf miner           | Caterpilla           | Aphids               |
| G/Jarso                                     | 37.00 <sup>b</sup>   | 28.00 <sup>a</sup>   | 20.50 <sup>b</sup>   | 19.50 <sup>a</sup>   | 21.00 <sup>d</sup>   |
| Dagam                                       | 18.50 <sup>d</sup>   | 24.00 <sup>b</sup>   | 16.50 <sup>d</sup>   | 14.00 <sup>b</sup>   | 25.00 <sup>b</sup>   |
| D/Libanos                                   | 14.00 <sup>e</sup>   | 24.00 <sup>b</sup>   | 18.00 <sup>c</sup>   | 7.50 <sup>c</sup>    | 18.50 <sup>e</sup>   |
| Wachale                                     | 34.00 <sup>c</sup>   | 3.00 <sup>c</sup>    | 24.50 <sup>a</sup>   | 3.00 <sup>c</sup>    | 22.50 <sup>c</sup>   |
| Jida                                        | 40.00 <sup>a</sup>   | 2.50 <sup>d</sup>    | 18.00 <sup>c</sup>   | 0.00 <sup>e</sup>    | 27.00 <sup>a</sup>   |
| Mean                                        | 28.7                 | 16.3                 | 19.5                 | 8.8                  | 22.8                 |
| LSD (P = 0.05)                              | 5.46E <sup>-15</sup> | 6.60E <sup>-15</sup> | 9.18E <sup>-15</sup> | 2.39E <sup>-15</sup> | 1.12E <sup>-15</sup> |

Key: Mean values in a column with different letters are significant at  $p < 0.05$ ; LSD = least significant difference.

### 3.7. Damage Level

The following Figure 3 revealed that there are significant differences in the damage caused by various insect pests across the districts investigated. The highest damage level of Pod borer was 29%, 28% and 24.5% recorded in the Girar Jarso, Jida, and Wachale districts respectively, whereas the lowest was 12% and 14% recorded in the Debre Libanos and Dagam districts respectively. The pod borer damage directly damages seed development and yield if not properly managed [1, 5]. Likewise, a high damage level of African bollworm was 23%, 18.5% and 17.5% recorded in GirarJarso, Dagam and Debre Libanos districts respectively. This insect has the ability to adopt different control strategies. Hence, immediate effective pest management is mandatory in these districts [11, 16]. Damage level across districts assessed was

relatively similar, and the highest was recorded in Debre Libanos (15%) and Wachale (14.5%) districts. Leaf miners make significant defoliation, affecting the plant photosynthesis and overall plant health [5, 12]. Hence, it's important to manage this insect to keep crops vigorous. Similarly, the aphid field pea damage was similar in all districts investigated, where damage ranged from 14% to 17.5%. Aphids cause high damage through direct feeding and transmit viral diseases [16]. Therefore, proper integrated management was highly important in all assessed districts to maintain plant health. Additionally, caterpillar damage levels were significantly different among the districts investigated. Its damage recorded was ranged from 0% in Jida to 10.5% in Girar Jarso districts. Therefore, it's recommended for integrated pest management that includes cultural practices and biological control to reduce the pest population effectively [11].



**Figure 3.** Damage level of major insect pests of Field pea versus different Districts of North Showa zone of Oromia during 2022 and 2023 main cropping season.

Adisu Regasa: Conceptualization, study design, field survey, data collection, data analysis, manuscript writing, and overall supervision of the project.

Megersa Terafa: Assistance in data collection, field assessments, data analysis, and manuscript review.

Shellama Feyisa: Support in field data collection, data interpretation, and manuscript review.

Woubalem Abera: Preparation of study area maps, compilation of rainfall and temperature data, and technical assistance in data presentation.

## 4. Conclusion and Recommendations

During the 2022 and 2023 cropping seasons, the North Shewa zone of Oromia, Ethiopia, conducted an insect assessment that revealed significant variations in the infestation and damage levels of major insect pests affecting faba bean and field pea crops. The study identified key pests such as the pod borer, leaf beetles, and African bollworm for faba beans, while field peas were primarily affected by pod borer, African bollworm, aphids, leaf miners, and caterpillars. The findings indicated that infestation levels varied across districts, with Debre Libanos showing the highest damage from leaf beetles and Girar Jarso experiencing significant pod borer damage. The overall results underscore the economic importance of these pests, and effective pest management strategies are urgently needed. Integrated pest management (IPM) approaches, including cultural practices, biological control, and timely pesticide application, should be promoted to reduce the pest burden. Regular monitoring of pest populations and damage levels is essential to adjust management practices effectively. Furthermore, local farmers should be trained on IPM methods to mitigate the impact of these pests on crop yields and ensure sustainable agricultural practices.

## Abbreviations

|         |                              |
|---------|------------------------------|
| GDP     | Gross Domestic Product       |
| IPM     | Integrated Pest Management   |
| LSD     | Least Significant Difference |
| RF      | Rainfall                     |
| AAT     | Average Annual Temperature   |
| m.a.s.l | Meters Above Sea Level       |
| CSA     | Central Statistical Agency   |
| WHO     | World Health Organization    |
| GPS     | Global Positioning System    |
| mm      | Millimeters                  |
| °C      | Degrees Celsius              |
| E       | East (Longitude)             |
| N       | North (Latitude)             |

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## Author Contributions

**Adisu Regasa Melka:** Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft, Supervision

**Megersa Terafa Garbi:** Investigation, Formal analysis, Data curation, Writing - review & editing

**Shellama Feyisa Lelisa:** Investigation, Data curation, Writing - review & editing

**Woubalem Abera Ayansa:** Visualization and Data curation.

## Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication of this study.

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