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Survey of Major Insect Pests of Vegetable Crops and Status of Management Practices in the Highlands of Guji Zone, Southern Ethiopia

Belachew Dabalo*, Kebna Asefa, Girma Teshome, Dagne Abbu, Lulu Misgana

Oromia Agricultural Research Institute, Addis Ababa,

Bore Agricultural Research Center, P. O. Box 21, Bore, Ethiopia

*Corresponding Author E-mail: balexdebelo8@gmail.com

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ABSTRACT

Insect pests were one of the most significant constraints to vegetable production of the studarea. The study's objective was to identify and determine the economic importance of insect pests of vegetables in the highlands of the Guji zone. Four districts- Bore, Anna Sorra, Arda Jila, and Dama districts were selected, and five kebeles per district and five farmers' fields per kebele were taken as a sample. The major insect pests identified on vegetables were aphids, flea beetles, leaf miners, armyworms, diamondback moths, snails, red ants, onion thrips, and shallot aphids. Aphids, flea beetles, armyworms, diamondback moths, and red ants caused maximum devastation on cabbages at Arda Jila districts, while minimum infestation was recorded at Dama and Bore. Leaf miners and snails caused minimum infestation on cabbages at Arda Jila, but maximum infestation was recorded at Bore and Dama districts. The same damage was recorded on head cabbage by the same insect pests in the study districts. In reverse, maximum infestation by leaf miner and snails was recorded at Anna Sorra and Bore, while the lowest infestation was recorded at the Arda Jila district. The onion thrips, shallot aphids, and red ants caused maximum infestation on shallots at Arda Jila district, whereas minimum infestation was recorded at Dama district. Most of the vegetable producers of the study area were not experienced in applying management practices to control insect pests on vegetables. Therefore, research on the management practices of vegetable insect pests should be prioritized for the study area.

Keywords*: Pests, Production constraints, Infestation levels, Ethiopian cabbages, Head cabbages.*

INTRODUCTION

Globally, around 1097 different types of vegetables are grown for human consumption (Divekar et al., 2024). These vegetables are low-cost sources of vitamins and nutrients that provide farmers with both in-farm and outside farm revenue. High fibres in vegetables enhance digestion, lowers cholesterol, and reduce the risk factors for heart disease, diabetes, and obesity. Moreover, Ethiopian farmers produce vegetable crops to contribute significantly to the household budget and the national economy (Fekadu & Dandena, 2006).

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Ethiopia, with a total area of 1.1 million km^2 and an estimated population of more than 110 million, is an agrarian country where about 80% of the population is engaged in agriculture. This sector generates over 45% of the country's total gross domestic product (GDP) and 90% of the country's total export income (Belay, 2003). The major crops, which include cereals, legumes, oilseeds, roots and tubers, vegetables, fruits, stimulants, and spices, are mainly produced by subsistent farmers. In the 2013/2014 season, these crops were grown on more than 12.4 million hectares of land. Of this area, only 1.2% was covered by vegetables (CSA, 2014). But now vegetables take up about 1.68% of the total cultivated area at the national level. However, Ethiopian cabbage accounted for the largest share (20.47 %) of the total estimated area under vegetables (CSA, 2022). In Guji Zone, 566.12 hectares were covered by Ethiopian cabbage, and 50,257.71 quintals were produced in 2021/2022 (CSA, 2022). Vegetable crops contribute significantly to the household budget and the national economy in Ethiopia (Fekadu & Dandena, 2006). They are an important part of the diet and play a key role in diversifying rural farmers' economy and the agricultural sector in general. Biotic and abiotic factors are among the major constraints of vegetable production. Among the abiotic constraints, rain, heavy dews, warm temperatures, and dry climates have been reported as principal conditions that favor the establishment of pests (Bowen & Kratky, 1982; & Landston & Eaker, 2009). Among the biotic constraints, insect pests are the most serious pests that attack vegetable crops at various crop stages and cause significant reduction in yield and quality (Sharma et al., 2017). They can damage vegetables both in protected structures (net house, polyhouse) and open field with variable damage (Rai et al., 2014).

Iwuchukwu and Uzoho (2009) indicated that the most constraints associated with vegetable production were caused by the incidence of diseases and pests. Pests have been identified as major constraints to vegetable production (Ellis Jones et al., 2008). They cause both economic and health problems for vegetable farmers.

Pests are one of the major production constraints that vegetable growers face throughout Ethiopia. Insect pests alone cause crop losses on an average of 25 to 30% yield loss in vegetables (Rai et al., 2014). Apart from direct losses, many of them also serve as many plant diseases, which aggravate the problem further (Kodandaram et al., 2017). It is thus very imperative to identify and protect the plants from different insect pests to derive maximum benefit from vegetable crops. To mitigate these problems, pest control studies were undertaken, and insecticides were recommended in some places (EHSS, 2008). However, the information regarding the occurrence and economic importance of insect pests on vegetable plants in the study area is scanty. Poor information is the primary cause of bad pest management decisions (Tebkew & Getachew, 2015). So, to design an effective controlling strategy for these biotic stresses, the identification and distribution of major insect pests of vegetable crops is found essential. Therefore, the objective of this survey was to identify and determine the economic importance of insect pests of vegetables in the Guji Zone.

MATERIALS AND METHODS

Description of the study area

The study was conducted in the highlands of Guji Zone in four purposively selected districts (Bore, Anna Sorra, Arda Jila, and Dama) in the 2023 main season for one year. Bore, Anna Sorra, Dama, and Arda Jila were the most highland districts of Guji Zone. Bore, Ana Sorra, and Arda Jila were situated at a distance of 385 km, 410 km, and 427 km from Addis Ababa to the South, respectively. Dama district is found in the Southern direction of Addis Ababa.

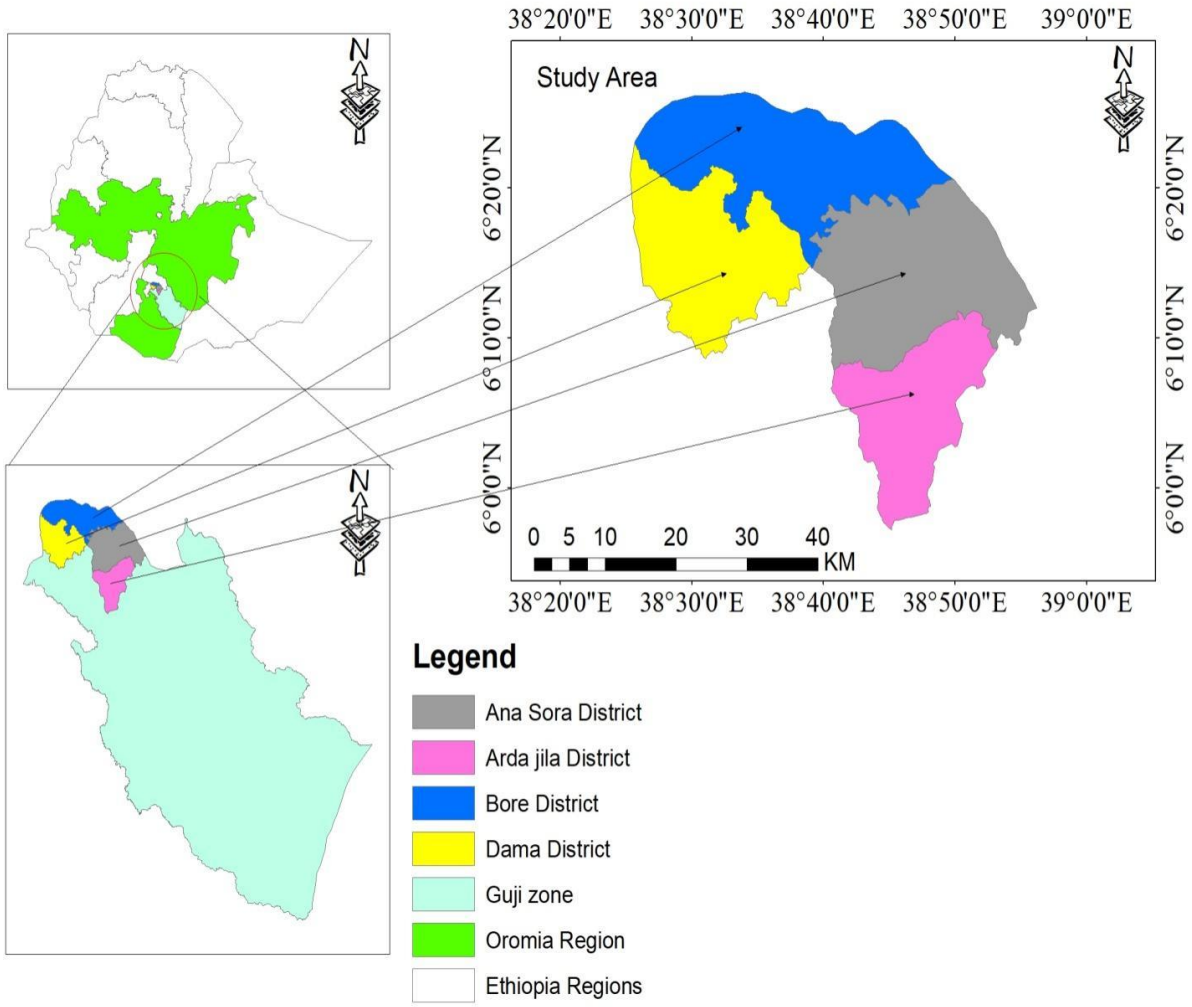

Figure 1: The geographical map of the study area in the Highlands of Guji zone

Table1. Geographical description of the study areas

Districts	Altitude Range (m.a.sl)	Rainfall (mm)	Annual average temperature (^{0}C)	
		mean	Min	Max
Anna Sorra	1200-2800m	350-1830mm	11.2^{o}c	21^{o}c
Arda Jila	1350-2340m	1300-1400mm	17.5^{o}c	28^{o}c
Bore	1800- 2900m	1400-1800mm	8.47^{o}c	18.23^{o}c
Dama	2103-2902m	1000-1500m	10.1^{o}c	20^{o}c

These districts have similar agroecology where diverse crops such as bread wheat, food barley, horticultural crops (mostly potato, enset, garlic, shallot, Ethiopian kale, and head cabbage), and highland pulse crops (faba bean and field pea) were largely produced in each district.

Sampling methods and data collection

Five(5) kebeles per district and 5 farmers' fields per kebele were assessed; in general, 25 farmers per district were assessed. The selected farmers' fields were assessed for the presence of vegetable insect pests. The fields were assessed in a diagonal pattern (X-

fashion). The structured questionnaires were used, and the farmers' field owners were interviewed for additional information. Fields were assessed at a distance of about 3-5 km apart, accordingly, i.e., based on the presence of the crop. During the assessment. A GPS map was used for the purpose of geographical data, such as elevation, latitude, and longitude of the assessed field. The sampling was done at four points (quadrats) in each field, and a 1m*1m quadrat was used during the survey. The abundance level and infested plants by the identified insect pest were recorded from each quadrat. When the assessment was done, the crops were at the vegetative to maturity stage. The infestation percentage of the insects on the crop was recorded specifically for each crop, as well as the infesting insects.

The percentage of the infestation level was calculated using the formula:

$$\text{Percent Infestation} = \frac{\text{No of Infested Plants per quadrat}}{\text{Total number of observed plants per quadrat}} \times 100$$

Data analysis

The collected data were arranged and analyzed by SPSS, and particularly the infestation percentages were analyzed by R in a nested design.

Table 2: List of Insect pests recorded in the study areas with their common name, order, family, and scientific names

Common Name	Order	Family	Scientific name
Cabbage aphids	Hemiptera	Aphididae	*Brevicoryne brassicae*
Flea beetle	Coleoptera	chrysomelidae	*Psylliodes chrysocephalus*
Leaf miner	Diptera	agromyzidae	Chromatomyi*a horticola*
armyworms	Lepidoptera	Noctuidae	*Mamestra brassicae*
Diamondback moth	Lepidoptera	plutellidae	*Plutella xylostella*
Red ant	Hymenoptera	Formicidae	*Solenopsis invicta*
Onion thrips	Thysanoptera	Thripidae	*Thrips tabaci*
Shallot aphids	Hemiptera	Aphididae	*Myzus ascalonicus*
Snail	Gastropoda	Helicinidae	*Delinitesta gayndahensis*

RESULTS AND DISCUSSIONS

The major insect pest of vegetables in the study area

The result showed that the vegetable growers in the study area were challenged by the number of insect pests. The most common insect pests were aphids, armyworms, flea beetles, leaf miners, red ants, onion thrips, shallot aphids, snails, and Diamondback moth (Table 1). Ethiopian kale or cabbages are mostly devastated by aphids, armyworms, flea beetles, leaf miners, diamondback moth, red ants, and snails. Head cabbages were also attacked by the same insect pests as cabbages, while shallots/leeks were devastated by onion thrips, shallot aphids, and red ants in the study districts. Gashawbeza et al. (2009) supported this finding that diamondback moth (DBM), cabbage aphid, flea beetles, and cabbage leaf miner are of economic importance. Katsaruware-Chapoto et al. (2017) reported that 24% of the farmers were complaining about the insect pests as a major challenge to vegetable production.

The same author also stated that aphids, armyworms, and flea beetles were the most devastating pests on vegetables. Ayalew and Azerefegne (2019) reported the same finding that a large number of insect pests (aphids, flea beetles, onion thrips, armyworms, and leaf miners) are found associated with a

variety of vegetable crops cultivated in different agro-ecologies, both in irrigated and rainfed production systems in Ethiopia. In the same way, insect pests are one of the major yield-limiting factors of Brassica crops and have the potential of reducing the marketable yield severely or completely destroying the crop if not managed (Mpumi et al., 2020). Kumar (2017) and Reddy (2017) also found the same result that flea beetles and cabbage aphids are among the major insect pests of Ethiopian kales/cabbages.

Table 3: Infestation levels of major insect pests of vegetables on Ethiopian cabbages in the study districts

Districts	Major Insect pests observed and caused damages on Cabbages (%)						
	Aphids	Flea beetle	Leaf miner	Armyworms	DBM	Red ant	Snail
Arda Jila	57.04a	49.04a	4.68c	48.44a	31.60a	40.88a	0.00c
Anna Sorra	42.04b	37.36b	35.24a	43.64b	21.20b	32.28b	3.12b
Bore	31.72c	27.20c	22.80b	33.48c	6.54c	7.40c	9.64a
Dama	31.32c	26.20c	21.80b	34.68c	7.54c	6.40c	9.56a
LSD	5.24	4.67	3.72	3.93	2.61	5.43	2.26
CV (%)	22.98	23.76	31.31	17.41	27.77	44.34	71.93

Means assigned with the same letter have no significance difference. LSD, Least significance difference; CV (%), Coefficient of variation

Infestation status of Major Insect Pests of Vegetables recorded across Study districts

The result revealed that there are significant differences in the level of infestation in the study areas. The major important harmful insect pests includes, aphids, flea beetle, armyworms, DBM, red ants were caused the highest infestation in cabbage production in the Arda Jila district, whereas the lowest infestation was recorded in the Bore district, which is statistically similar with Dama district. Conversely, leaf miners and snails were the minimum at the Arda Jila district, while the Anna Sorra district had the highest infestation of leaf miners, followed by the Bore and Dama districts. The maximum snail infestations were recorded in the Bore and Dama districts. The maximum infestation recorded in Arda Jila could be the agriculturally justifiable limit of the area for harmful insects due to the falling altitude and the rise in temperature in the districts. The leaf miners and snails were low in infestation at Arda Jila; which may be due to the fact that these harmful insect are sensitive to moisture and humidity. The drier the air, the lower population of these pests was, with fewer infestations. The same to this finding, Cabbage aphid is one of the most important insects that attack brassica leafy vegetables (Munthali & Tshegofatso, 2014). In addition, the major insect pests of Ethiopian cabbages are flea beetles, cabbage aphid, and green peach aphid (*Myzus persicae* (Hemiptera: Aphididae)) (Kumar, 2017; & Reddy, 2017). Katsaruware-Chapoto et al. (2017) found that aphids, armyworms, DBM, and leaf miners were important insect pests of leafy vegetables such as rape, kale, cabbage, and cauliflower. Also, Baidoo and Mochiah (2016) reported that major insect pests infesting cabbages in Africa include the diamondback moth (*Plutella xylostella*), the cabbage armyworms (*Helicoverpa undalis*), cabbage aphid (*Brevicoryne brassicae*), and cabbage looper (*Trichoplusia* ni) (*Myzus persicae*). In support of this finding, DBM and cabbage aphids are important multicultural insect pests that feed exclusively on cruciferous vegetables, especially cabbage.

Table 4: Damage levels (%) of major Insect pests of vegetables on cabbage in the study districts

Districts	Major Insect pests observed and caused damage on Head cabbage (%)						
	Aphids	Flea beetle	Leaf miner	Armyworms	DBM	Red ant	Snail
Arda Jila	60.48a	47.92a	4.24c	41.64a	31.24a	38.48a	0.00c
Anna Sorra	43.48b	33.88b	23.16a	36.24b	22.84b	29.28b	3.28b
Bore	36.60c	23.64c	16.40b	17.52c	8.4c	6.52c	6.56a
Dama	34.40c	25.44c	14.32b	17.12c	9.00c	7.16c	6.96a
LSD	5.11	4.87	3.69	4.33	2.95	3.77	1.35
CV (%)	20.74	26.45	45.11	27.37	29.35	32.95	57.02

Means with the same letter indicate there is no significant difference among treatments.
LSD, Least Significant Difference; CV (%), Coefficient of variation

The result stated that the insect pests recorded in the study area significantly impacted the head cabbage production in the study districts (Please put the table you are going to write the result and discussion). Aphids highly infested the cabbage heads at Arda Jila, whereas the lowest infestation was recorded in Dama district, which was statistically similar to Bore. Flea beetle infestation was maximum at Arda Jila, whereas minimum at Bore, similar to Dama district. The highest leaf miner infestation was recorded at Anna Sorra district, whereas the lowest infestation was at Arda Jila district. Head cabbages were highly devastated by Armyworms at Arda Jila district, whereas the lowest infestation recorded was at Dama, which was statistically similar to Bore district. DBM and red ant-infested head cabbages were at the highest level at Arda Jila, whereas the lowest infestation level was recorded at Bore, which was similar to Dama district. The maximum infestation caused by snails was recorded at Dama and Bore, whereas the minimum infestation was at Arda Jila district. The same as these findings, insect pests, especially cabbage aphids, were very serious in head cabbage growing areas in Ethiopia (Shibru & Negeri, 2016). In addition, the study conducted by Kidanie et al. (2016) showed that aphids, armyworms, and flea beetles were among the most serious insect pests recorded on head cabbage crops in the study area. In other words, diamondback moth(*Plutella xylostella*) and cabbage webworm (*Helicoverpa undalis*) are the most destructive insect pests of brassica vegetable crops in many parts of African countries and are mostly damaging in the tropics and subtropics (Labou et al., 2017). Moreover, flea beetles, *Phyllotreta spp.* (Coleoptera: Chrysomelidae) are the major insect pests of Brassica worldwide (Anonymous, 2009). The flea beetles are active leaf-feeders that can, in large numbers, rapidly defoliate and kill plants (Kuepper, 2003). Different infestation levels may be seen from district to district; this might be due to variability of agroclimatic conditions as of Atsebeha et al. (2009) and Pal and Singh (2012). Wubie et al. (2014) also reported that one of the constraints for the production and use of cabbage is cabbage aphids, which damage cabbage from the seedling to the final growth (head formation) stage. Furthermore, the leaf miner infestation at Arda Jila district was minimal, while the other major insect pest infestations at Arda Jila district were maximum except for snails. These arthropods need high humidity and moisture for their reproduction and survival. This may be based on the less availability of moisture and humidity at the Arda Jila district compared to other districts. This could mean that the moisture-loving insect pests were shifting to the feasible environment, high high-temperature and dry-air-tolerant insect pests develop faster with increased numbers of generations with populations, leading to high infestation of the crop in the area (Wilstermann & Vidal, 2013).

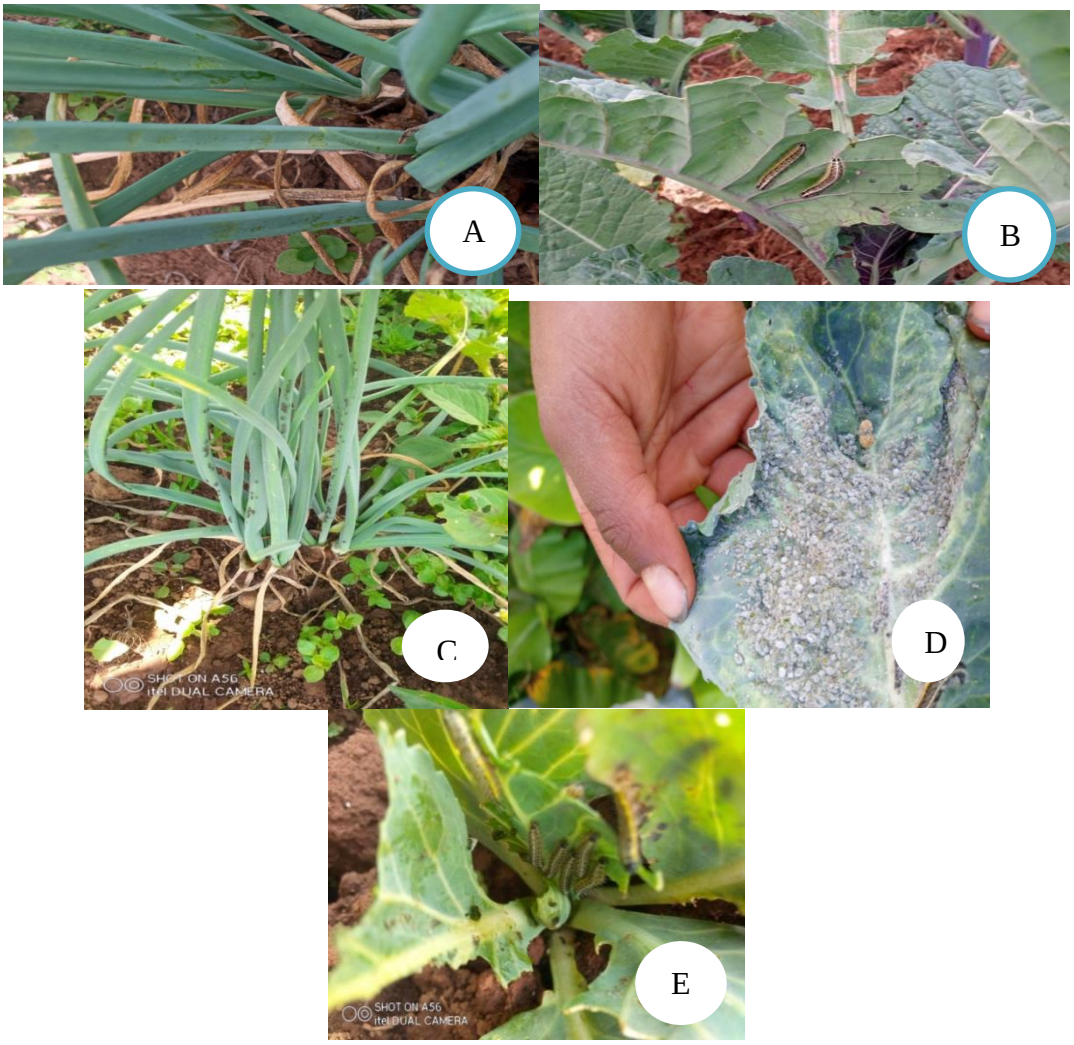

Figure 1: (A) Symptoms of onion thrips infestation in Bore districts of Gutu Reji Kebele. (B) Armyworms infestation on Ethiopian cabbages in Bore districts of Higate Kebele. (C) Shallot aphids' infestation on shallots in Bore district of Songo Baricha Kebele.(D) armyworm infestation on head cabbages in Anna Sorra distirct of Yirba Buliyo Kebele; (E) Aphid infestation on Ethiopian cabbages in Anna Sorra district of Raya Boda Kebele.

Table 5: Damage levels of major Insect pests of vegetables on Shallots in the study areas

Districts	Major Insect pests observed and caused damage to Shallots (%)		
	Onion thrips	Shallot Aphids	Red ant
Arda Jila	45.20a	39.72a	29.76a
Anna Sorra	38.80b	27.12b	20.00b
Bore	27.76c	28.80b	11.52c
Dama	28.04c	27.40b	11.60c
LSD	4.03	4.59	3.95
CV (%)	20.47	26.64	38.47

Means with the same letter indicate there is no significant difference among treatments.
LSD, Least Significant Difference; CV (%), Coefficient of variation

The result showed that there is a significant difference among the districts in shallots the major insect pest damage and infestation. Onion thrips caused the highest infestation levels in Arda Jila district (45.20%), and the lowest infestation was recorded in Bore (27.76%) and Dama (28.04%) districts. The same as onion thrips, shallot aphids, and red/black ants caused the maximum infestation/damages in Arda Jila districts, followed by Anna Sorra district, whereas the lowest infestation of shallot aphids was at

Anna Sorra and red ants at Bore district. This result showed that insect pest abundances varied from place to place. These findings demonstrated that insect pest abundances varied by location, which is consistent with Divekar et al. (2024) conclusion that crop losses in vegetables vary significantly based on plant variety, cropping season, geographic location, and susceptibility to pest damage. Onion thrips, *Thrips tabaci* (Thysanoptera: Thripidae), is a pest of alliums in different parts of Ethiopia (Tebkew et al., 2011). Begna (2019) also found that onions are often fed by thrips, rasping the leaves and other tissues of plants to release the sap, which they then consume. Shiberu and Mohammed (2014) also reported that thrips attack a number of vegetable crops, particularly onion thrips, causing considerable economic damage to onion crops. These insect pests' infestations varied greatly in study districts based on the altitude range of 2200-2800 m. This finding was in concurrence with the work of Wilstermann & Vidal (2013), who stated that weather variables such as temperature, rainfall, and relative humidity strongly affect the survival, development, fecundity, and behavior of individual insects. It is a well-established fact that the incidence of insect pests depends upon climatic conditions, crop growth stages, and natural enemies of a pest at a particular time (Kumawat et al., 2018).

Table 6: The Frequency status of farmers' management practices application across vegetables in the study areas

Type of crop inspected	Management practices application status among farmers (%)	
	Yes	No
Cabbage	37.33	62.67
head cabbage	54.67	45.33
Shallot	0	100

Yes = Farmers who applied management practices for insect pest control on vegetables,
No = Farmers who did not apply any control measures for insect pest control on vegetables

The Frequency Status of farmers' management practices in the study area

The result revealed that there are significant differences among farmers of the study area in management practices on the inspected vegetable (Put the table you are going to write results and discussion). 62.67% of the farmers in the study area were not applying any control measures to control insect pests on Ethiopian cabbages, while 37.33% of the farmers understood well the damage of insect pests on cabbages and applied management practices to benefit from their cabbage production.

54.67% of head cabbage producing farmers of the study area were applying management practices to secure their production from insect pests, whereas 45.33% farmers were not aware of insect pest damages to head cabbages and did not use any control measures in their head cabbage fields. The entire group of shallot-producing farmers (100%) of the study area were not applying any management practices to control insect pests on shallots. These shallot-producing farmers were suffering from the insect pests devastating their crop, with locals saying "Yoo ofiif jette haa galtu!". This may be their misunderstanding of insect pests of shallots and thinking of substituting the damaged crop with other cereal or pulse crops. In head cabbage production, nearly more than half (>50%) of the producers were managing insect pests on their cabbage fields because they expected not to get any profit unless insect pests were controlled, due to denying heading if the crop was damaged. The farmers who were applying management practices thought that no other control measures existed for control of insect pests other than synthetic pesticides. In the study areas, most of the vegetable producers were not informed about the damage/ yield losses caused by insect pests, and their production was decreasing. Because of this, some farmers were reluctant to produce the vegetables and changed to other field crop productions.

Table 7: The Frequency Status of vegetable insect pest management practices across Districts

Locations	Status of farmer's management practices application (%)	
Dustricts	Yes	No
Annasora	44	56
Arda Jila	10.67	89.33
Bore	44	56
Dama	8	92

Yes = Farmers who applied management practices for insect pest control on vegetables,
No = Farmers who did not apply any control measures for insect pest control on vegetables

From this result, 44% of farmers in the Anna Sorra district were applying management practices to their vegetable production, while 56% farmers were not experienced with the damage of vegetable insect pests and did not apply any control measures. In the Arda Jila district, 89.33% farmers were not applying any control measures on their vegetables to manage insect pests, but only 10.67% farmers were experienced in vegetable insect pests management practices. Almost all vegetable-producing farmers (92%) were not applying insect pest management practices to their vegetable fields in the Dama district. In the Bore district, 44% vegetable producers were well experienced with vegetable insect pests and applied management practices to their vegetable fields, whereas 56% vegetable producers were not experienced with vegetable insect pests and did not apply control measures. For the needs of family consumption, non-experienced farmers substitute other garden crops or field crops rather than controlling the pests devastating. The others are reluctant to produce these vegetables due to insect pests attacking. Therefore, research on management practices of vegetable insect pests and demonstrating the new technologies, such as insecticides, IPM strategies for such problems, is paramount important for the farmers of the study area.

CONCLUSION AND RECOMMENDATION

This study identified and assessed the major economic importance of insect pests affecting the vegetable production in the highlands of Guji Zone. The vegetables are susceptible to major insect pests such as aphids, flea beetles, armyworms, leaf miners, DBM, red ants, onion thrips, shallot aphids, and snails. The damage status of insect pests on vegetables differed from insect to insect and location variability. This is based on the insect pest damage potential and the feasible agroecology of the study area. These insect pests can cause huge yield losses if not managed timely and proper. Most of the farmers in the study area were not well experienced with vegetable insect pest damage and consequently did not apply proper management practices. Because of a lack of knowledge on insect pest management practices, some farmers were reluctant to produce vegetables. Therefore, research on the management practices of vegetable insect pests should be prioritized for the study area. Demonstrating the new technologies, such as insecticides and IPM strategies, is very important for the farmers of the study area. There is a need to train smallholder farmers or improve their understanding of the insect pest damage symptoms, outbreaks, and management practices so as to manage the insect pests timely.

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Author Contribution:

All authors have participated in critically revising of the entire manuscript and approval of the final manuscript.

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