Assessment of Prevalence and Incidence of Sesame Gall Midge (*Asphondyilia sesami* Felt) in Kafta-Humera District Tigray, Ethiopia

Assefa Abadi Kebede1*, Zerabruk Geremedhin Tafere1 and Weres Negash Golla1

1Crop Research Core Process, Humera Agricultural Research Centre, Tigray Agricultural Research Institute, P.O. Box 62, Humera, Tigray, Ethiopia.

**Authors’ contributions**

This work was carried out in collaboration among all authors. Author AAK designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ZGT and WNG managed the analyses of the study. All authors read and approved the final manuscript.

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(1) Professor Daniele De Wrachien (Rtd), University of Milan, Italy.

(1) O. Adeleye Adeoluwa, Obafemi Awolowo University, Nigeria.

(2) M. Baranitharan, Annamalai University, India.

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**ABSTRACT**

Gall midge (*Asphondyilia sesami* Felt) is one of the most serious insect pests of sesame threatening sesame production in Tigray, Ethiopia. The aim of the present study was to assess distribution and incidence of sesame gall midge and its association with different agronomic practices. Field survey was conducted in Kafta-Humera, districts in 2019 cropping season. A total of 60 farmers' fields were assessed for the prevalence and incidence of the insect. Results indicated that 94% of farmers' fields were infected by sesame gall midge from the total assessed fields. Sesame gall midge incidence ranged from 33.33-100% in the assessed Kebelles. The mean incidence gall midge was 81.74%. The highest mean incidences were recorded from Bereket, Adebay, Lugdi, Rawuyan. However, the lowest was recorded from Freselam. Mean incidence of sesame gall midge was significantly (p < 0.05) variation with the sowing date, altitude and crop rotation. The lowest mean incidences of sesame gall midge, flower abortion and galled capsule were recorded from the early sowing date, lower altitude and previous grown with sorghum. Overall
results of the present study indicated that sesame gall midge is one of the major challenges to sesame production in study areas. Therefore, efforts should be put in place to manage the insect via integration of appropriate management.

Keywords: Gall midge; incidence; independent variable; sesame; survey.

1. INTRODUCTION

Sesame belongs to family Pedaliaceae and genus Sesamum. The genus Sesamum comprises about 20 species native to Africa and Asia [1]. However, only Sesamum indicum is recognized as a cultivated species in the family. Sesame is a broad leaf plant that grows to a height of 1.1 to 2 meters, depending on the variety and growing conditions. It is a warm season annual crop and it is considered as drought tolerant, but needs good soil moisture for establishment and for high yield. Soil type and moisture influence growth and productivity of varieties [2]. The pollination process occurs at the time the flowers open [2,3]. Sesame seed comprises 40%-60% oil and 40% protein [2,4]. Ethiopia is among the leading sesame producers countries in the world. Total sesame production in the country was 2.56 million tons harvested from about 0.37 million hectares (ha) of land [5]. It is the second largest export commodity from Ethiopia, generating a substantial amount of foreign currency and creating rural jobs [6]. However, the country is not using its potential due to a number of biotic and abiotic factors which are responsible for the low productivity of sesame. Sesame webworm (Antigastra catalaunalis), sesame seed bug (Elasmolomus sordidus), gall midge (Asphondilia sesame Felt), termites, green vegetable bug (Nezara viridula), African bollworm (Helicoverpa armiger), grasshoppers, aphids, jassids, whitefly, field crickets, warehouse moth and red flour beetle are some to be mentioned are the most common insect pest of sesame [2,7]. Among these sesame insect pests sesame gall midge (Asphondilia sesame Felt) is the most serious; it affects leaves and, aborts the flower with result heavy yield losses [8]. It is serious insect pest from time to time and currently the pest is currently a key pest mainly due to continuously mono-cropping of sesame production [2]. Where it occurs, the sesame gall midge causes extensive damage and the larvae are the damaging stage. Eggs are laid in ovaries of flowers and the gall begins to develop before the petals wither or become twisted and stunted and do not develop into flower or capsules [2,9].

Although Kafta-Humera district is potential (more than 60% western Tigray) areas for sesame production, very little is known regarding the prevalence and distribution of gall midge insect pest under varying production or farming systems. There is no detailed quantitative information about the insect. In view of this, the present study was undertaken: 1) to assess the incidence and prevalence of sesame gall midge in the major sesame growing areas; 2) to investigate the influence of agronomic practices on sesame gall midge insect infestation in sesame growing areas of Kafta-Humera district, Ethiopia.

2. MATERIALS AND METHODS

2.1 Experimental Site

Survey on the prevalence, distribution and incidence of sesame gall midge was conducted in Kafta-Humera district during 2019 main cropping season (Fig. 1). The area received a total of rainfall ranges from 400-650 mm. The mean maximum temperature varied between 33°C in April and 41.7°C in May, while the mean minimum temperature is between 17.5°C in August and 22.2°C in July. The rainy season of the study area is from June to September. The remaining 8-9 months are dry and hot [10]. The district has a unimodal rainfall that extends from June to September months [2,11]. The soils in the area are predominantly chronic vertisol types mostly with clay and clay loam texture [11].

2.2 Assessment and Sampling Techniques of Sesame Gall Midge (Asphondilia sesame Felt)

To determine the prevalence/incidence of gall midge in sesame a total of 60 fields were randomly assessed from the Kafta-Humera districts. A total of eight Kebelles such as Rawuyan, Bereket, Lugdi, Adebay, May-kadra, Banat, Freselam and Mayweyni (the lowest administrative unit) were assessed. Initially major sesame growing areas were selected purposely based on extent of area coverage under sesame production, then each farmers fields assessed were selected randomly.
Assessment for sesame gall-midge (Asphondilia sesami Felt) incidence was conducted on farmer’s fields. The survey/assessment was conducted once per growing season at reproductive stage (flowering and capsule growth stage). Sampling sites within each Kebelle were separated by at least 1 km and at most 5 km apart from each other depending survey area. In each field, sampling (data) was taken at 15 meters interval at 5 points along the diagonal of the selected field/farm using 1 m x 1 m quadrant by randomly throwing in the field. Number of healthy and infected flowers and capsules of each plant within the quadrant was counted and recorded. Infected flower and galled capsules were recorded by counting the number of infected flower and galled capsules on five randomly selected plants per quadrant in each sample point.

2.3 Data Collected

2.3.1 Survey of sesame gall-midge (Asphondilia sesami Felt)

Prevalence: Proportion or percentage of sesame growing areas/fields infected by sesame gall midge (Asphondilia sesami Felt) to the total assessed areas/fields. Insect prevalence tells us the geographic or spatial distribution of the insect. The prevalence percentage gall midge was calculated as follows using the following formula;

\[
\text{Gall midge prevalence} (\%) = \left( \frac{\text{number of infected areas/fields}}{\text{total number of areas or fields assessed}} \right) \times 100
\]

Incidence: The levels of incidences were obtained by dividing the number of infested plant by the total number assessed plant and multiply by 100. The percentage incidence of gall midge (Asphondilia sesami Felt) was calculated as follows using the following formula;

\[
\text{Incidence of gall midge} (\%) = \left( \frac{\text{number of infected plant}}{\text{total number of assessed plant}} \right) \times 100
\]

\[
\text{Incidence of flower abortion} (\%) = \left( \frac{\text{number of infected flower per plant}}{\text{total number of flower per plant}} \right) \times 100
\]

\[
\text{Incidence of galled capsule} (\%) = \left( \frac{\text{number of galled capsules per plant}}{\text{total number of capsules per plant}} \right) \times 100
\]
Agronomic data: In each surveyed are additional detailed information such as planting date (late June, early July and mid-July), previous crop (sesame and sorghum) were recorded. Altitude (≤ 700 m.a.s.l and >700 m.a.s.l), longitude and latitude of each assessed field was recorded using GPS.

2.4 Data Analysis

Data’s of sesame gall midge (Asphondilia sesami Felt) per assessed field was used for analysis of variance. Data was analysed using R-3.6.2 software. Means were separated using Fisher’s protected Least Significant Difference test, at 5% probability level.

3. RESULTS AND DISCUSSION

3.1 Distribution and Incidence of Sesame Gall Midge (Asphondilia sesami Felt)

Results of the present study indicated that gall midge (Asphondilia sesami Felt) is the major constraints and challenge to sesame production in Kafta-Humera Tigray, Ethiopian. Sesame gall midge causes extensive and sever damage on sesame production areas. The larvae are the damaging stage of the insect. It was observed that external symptom of sesame plant damage caused by insect gall midge (Asphondilia sesami Felt) is the production of abnormal stem shape, abortion of flower, forming gall in stem and capsule, stunted growth and bushy appearance of the plant. This is due to the feeding of the flowers by the larvae as shown below which was taken during the survey assessment (Fig. 2).

The incidence of sesame gall midge (Asphondilia sesami Felt) showed highly significance (p < 0.001) difference among the assessed locations. Prevalence of insect pest was 94%. However, the level of from fields free of the gall midge to fields to 100% of the fields affected by the insect. The mean incidences percentage of sesame gall midge (Asphondilia sesami Felt) was also varied from 33.33 to 100%. The mean incidence of the surveyed Kebelles was 81.74%. The highest mean (100%) sesame gall midge was recorded in Bereket, Adebay, Lugdi and Rawuyan. While, the lowest mean incidence was recorded from Freselam (33.33%) and May-kadra (67.5%) (Fig. 3). The variation of mean incidence percentage was observed on the Kebelles. This could be partly due to variation and difference in climatic condition such as temperature, relative humidity, moisture/rainfall and altitude as well as differences among sesame cultivars in the grown Kebelles and farmers. In addition to climatic, agricultural practices such as previous crop and planting time applied by different sesame growers may have great impact on the amount of inoculum and incidence of sesame gall midge infestation. The present result is supported by [12] reported that high relative humidity, frequent rain or moist and high temperature are conducive for gall midge epidemic. Understanding the influence of abiotic factor on distribution and abundance of insect is important and fundamental.

Midge fly lays eggs on the flower buds; the eggs develop into larvae and start feeding from inside flowers, resulting in the flower abortion or developing abnormal capsules. High mean percentage abortion of flower and galled capsule was observed across all the assessed Kebelles included in this study indicating a substantial sesame loss, as the insect abort flower and galled capsule which directly translated into yield losses. The result showed there was great variation (p < 0.001) incidence of sesame gall

![Fig. 2. Sesame gall midge (Asphondilia sesami Felt) insect affected sesame plants in the areas surveyed](image-url)
midge (*Asphondilia sesami* Felt) among the assessed Kebelles. The highest flower abortion was recorded from Bereket 37.3% followed by Adebay 25.03%. However, the lowest was recorded from Freselam 1.17% (Table 1). The galled capsule showed significant variation (*p* < 0.05) among the assessed Kebelles. The highest galled capsule was recorded from the Bereket 5.09%. While, the lowest galled capsule was recorded from Freselam 0.13% (Table 1). The current result is supported by Egonyu et al. [8] who reported that sesame flower and capsule damage due to gall midge it reaches up to 34.3%. In addition, [13] found that under favourable conditions gall midge reduce sesame seed yield up to 100%.

### 3.2 Association of Altitude and Sowing Date with Gall Midge (*Asphondilia sesami* Felt) Incidence

It was observed that; incidence of sesame gall midge was significant (*p* < 0.05) variation among the sowing date. The lowest mean percentage incidence of sesame gall midge was recorded from sesame planed in mid-July (76.47%) and the highest was recorded from early July (96.46%). Lowest mean flower abortion (4.6%) and galled capsules (0.8%) were recorded from sesame sown in late June. However, the highest mean flower injury (23.4%) and galled capsule (2.57%) were recorded from early July planted (Fig. 4a). It could be due to the small amount of insect population at early growth stage of the plant and the plant becomes escape before the insect epidemic. This result is in line with the recommendation by Harvir and Yadava [14] early planting of sesame soon after rain fall is the main option to manage incidence of gall midge. In addition, several authors [12,15,16] reported that early planting is the main strategy for control of gall midge. Egonyu et al. [17] and Schmid et al. [18] also reported that delaying of planting increase incidence of gall midge due to start reproducing newly emerged gall midge adults.

The result showed that there is not significance (*p* < 0.05) difference on mean incidence percentage of sesame gall midge among
altitudes. However, altitude is significantly (p < 0.01) affect the incidence of flower abortion and galled capsule. The highest mean flower abortion (20.14%) and galled capsule (2.45%) due to sesame gall midge was recorded from an altitude less than 700 meter above sea level while the lowest was recorded from the higher altitude (Fig. 4b). It could be due to difference in temperature and rainfall/moisture level in the lower altitude this may leads to increase infestation of gall midge. The current result concurs with [9] found that rain-fed lowland areas are higher incidence level of gall midge than upland areas.

![Graph](image1)

Fig. 4. Influence of sowing date (a) and altitude (b) on incidence of gall midge (*Asphondilia sesami* Felt) during the 2019 cropping season
3.3 Effect of Crop Rotation on Incidence of Sesame Gall Midge (*Asphondilia sesami Felt*)

Incidence of sesame gall midge was not affected significantly (p < 0.05) by previous crop. There was higher flower abortion (21.49%) and galled capsule (7.36%) in fields previously grown with sesame than grown with sorghum having low flower abortion (7.37%) and galled capsule (2.53%) (Table 2). This could be due to the mono-cropping farming system of the district. There is a probability of high gall midge inoculum in the soils in fields grown frequently by sesame which provides a chance for high gall midge infestation in the next season. The result is similar with [9] mono-cropping is one the main important factor to increase the amount of inoculum. Due such problem identification host rage is critical issue for control of gall midge insect pest.

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### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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