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Assessment of Incidence of Sesame Webworm *Antigastra catalaunalis* (Duponchel) in Western Tigray, North Ethiopia

Zenawi Gebregergis[1*], Dereje Assefa[2] and Ibrahim Fitwy[2]

[1]Department of Crop, Humera Agricultural Research Center (HuARC)/TARI, Ethiopia.
[2]Department of Crop and Horticultural Science, Mekelle University, Ethiopia.

Authors' contributions

This work was carried out in collaboration between all authors. Author ZG designed the study, wrote the protocol and wrote the first draft of the manuscript. Author DA managed the literature searches, analyses of the study performed the structural equation modeling and discuss the conclusion. All authors read and approved the final manuscript.

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ABSTRACT

Sesame (*Sesamum indicum L*.) is one of the important oil seed crops in Ethiopia. It is famous for international market and its production is challenged by inappropriate agronomic practices, insect pest infestation and weather uncertainties. *Sesame webworm, Antigastra catalaunalis* is a major pest in western Tigray. To assess the incidence and severity *of A. catalaunalis,* a survey was conducted in western zone of Tigray (Kafta Humera, Tsegede and Welkait) in 2015 cropping season starting from seedling up to capsule development stages. A total of 48 farm plots was assessed for prevalence, incidence and severity. All surveyed farm plots were infested at all stages of the crop. In the study area incidence of the pest was 66% and 15% capsule damage/severity. Capsule developmental stage of the crop was the most infested crop growth stage in the surveyed

**Corresponding author: E-mail: zenawigg@gmail.com;*

area and 100% incidence was also observed in late sown sesame (end of July). An increasing infestation trend of the pest was also observed as altitude is decreased. Therefore, *A. catalaunalis* is an economic pest in western zone of Tigray.

Keywords: Antigastra catalaunalis; Sesamum indicum; survey; incidence; severity.

1. INTRODUCTION

Sesame (*Sesamum indicum L.*) is an annual plant that belongs to the family *Pedaliaceae*. It is one of the world's oldest oil seed crop grown mainly for its high oil content of the seeds that contain 52 to 57% oil and 25% protein content [1,2]. Sesame is mainly cultivated between the 25° N and 25° S latitudes. It is productive under high temperature condition and can grow on residual moisture at the end of a rainy season. Despite its ideal adaptation to dry sites, sesame can also be cultivated in humid, tropical and sub-tropical regions. Although, the order of leading sesame producer countries is changing from time to time but Ethiopia is the Sixth largest sesame producer in the world following Myanmar, India, China, Sudan and Tanzania, respectively and third in Africa preceding Uganda and Nigeria, respectively [3,4].

In Ethiopia, sesame seed production is the leading oil crop and more than four million smallholder farmers are relying on the sesame production for their livelihood [5]. It is mainly being produced in Tigray (36%), Oromia (17%) Benishangul Gumuz (15%), Amara (31%) in the country [6].

Within Tigray the Western zone is the main production area with many large commercial and small scale farmers (about 90,000 producers) and it is a good source of income in these areas. Production of sesame in the country is very crucial in many aspects, but there are many hurdles for its production and productivity, such as pest infestation, seasonal delay, low yielding, post-harvest lost, poor storage facility, low fertilizer response, difference in capsule maturity, shattering etc. Of these, insect pest is one of the most important factor affecting production of sesame both in quality and quantity [1,7].

Insect pests such as Sesame webworm *(Antigastra catalaunalis)*, sesame seed bug (*Elasmolomus sordidus*), gall midge (*Asphondilia sesami*), and Indian meal moth (*Plodia interpunctella*) are the major insects of sesame during its different growing stages and post-harvest. Sesame webworm (*Antigastra catalaunalis)* is the most serious pest during various sesame growth stages starting 2-3 weeks after emergence up to harvesting [8-15].

The objective of this study was to assess infestation level of sesame webworm in different locations, growth stages and sowing dates of sesame in western Tigray.

2. MATERIALS AND METHODS

2.1 Description of the Study Areas

The Tigray regional state, where the study was conducted is located in the northern tip of Ethiopia and is bordered by Eritrea in the north, Sudan in the west, Afar region in the east, and Amhara region in the south. The survey districts included *Kafta Humera,* lowlands of *Tsege*de and *Wolkait* extends from 13°26' to 14°05'N latitude and 36°57' to 37°27' E longitude. Mixed farming system is the main occupation of the households. The districts are known for their high potential for sesame, sorghum and cotton production. Except for the very small areas under vegetables and fruits, crops are grown under rain fed condition. According to the Zonal Offices of Agriculture, western zone of Tigray has a total of 582,030.8 ha agricultural land, of which about 305,065 ha (99,704 ha of investors) is conducive for sesame production and has 89,974 (577 investors) producers. *Kafta Humera* has an average monthly temperature and average annual rainfall of 28.2°C and 576.4 mm, respectively. The lowlands of *Tsege*de and *Wolkait* have an average monthly temperature and annual rainfall of 27°C and 888.4 mm and 24.3°C and 750 mm, correspondingly. And the altitude of the surveying district ranges from 582 to 1063 m.

2.2 Surveying Method

Survey of *A. catalaunalis* was conducted in western Tigray, north Ethiopia (Fig. 1) four times starting from seedling up to maturity (Fig. 2). From the three *Woreda* (districts) four *Tabia (*localitie*s)* each were selected purposely (sesame growing areas) and from each *Tabi*a four farms/farm plots were selected randomly.

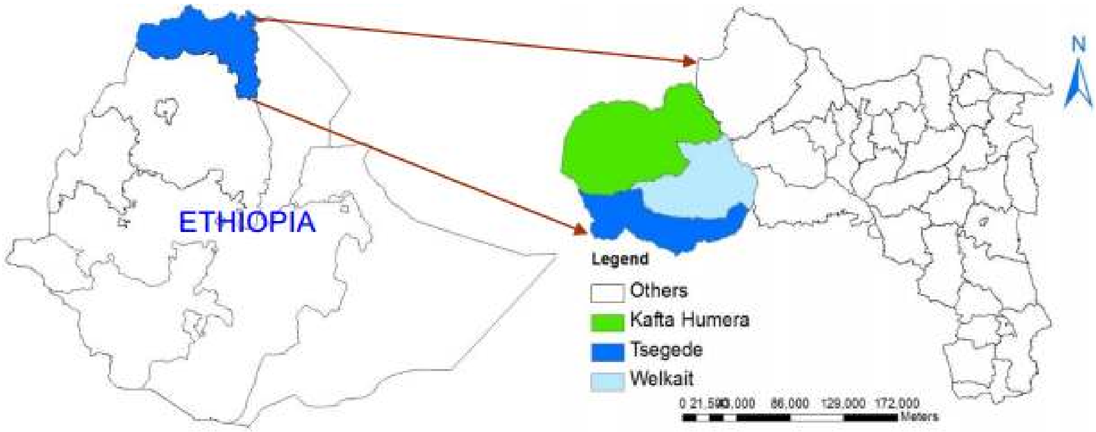

Fig. 1. Map of the study areas

Generally, a total of 48 sesame farm plots were assessed from both small scale farmers and investors and in each growth stage data was recorded from same farm plots. The farm plots were sampled randomly at intervals of about 5-10 km [16] along accessible roads until sesame field are found nearby, starting from *Maygeba* to *Maydelie*. In each farm plot, to assess the plot level of *A. catalaunalis* infestation at various crop growth stages, sample were taken at 10-20-meterinterval once at four points diagonally along the field using 1 x 1 m quadrant randomly (Fig. 1). The quadrant was thrown randomly and plants inside the quadrant (both healthy and sesame-webworm infested) were counted to determine the incidence of the pest. In addition to incidence, capsule damage was recorded during capsule development and/or maturity stage through selection of five infested plants with in the quadrant; then infested and non-infested capsules were counted for each of the five plants in order to calculate capsule damage by dividing the infested capsules to the total capsules in all the five plants. Infestation of *A. catalaunalis* was assessed also on early and late grown cultivated and uncultivated sesame. During surveying elevation (altitude) was measured using Garmin GPS for each location (farm plots).

2.3 Data Collection

2.3.1 Prevalence

Measures occurrence of the pest (*A. catalaunalis*) in the area (location) that sample has taken.

2.3.2 Incidence

Measures the size of pest occurrence in the sampling unit (farm plot). Mean percentage of infested plants showing typical symptoms (like webbed leaf and/or flower, leaf feeding, hole in capsule, the larva it self.) of sesame webworm per total plant in the quadrant was recorded (Fig. 3a) so as to calculate incidence as follow:

$$\text{Incidence} = \frac{\text{infested plants}}{\textit{total visited plants}} * 100 \qquad (1)$$

2.3.3 Severity

Severity is size of the damage (level of capsule damage). Any capsule that showed sesame webworm symptom like bored hole was considered as a damaged capsule (Fig. 3b). Percentage of damaged capsules by sesame webworm was calculated by counting the total damaged capsules of five plants in the quadrant using the following equation:

$$\text{Capsule Damage} = \frac{\text{no.of bored capsules}}{\textit{total visited capsules}} * 100 \qquad (2)$$

2.3.4 Agronomic data

Planting date, growth stage of the crop and altitude of the fields were recorded.

2.4 Data Analysis

Survey data was analyzed by Genstat-14 in split plot design arrangement. *Woredas* were taken as whole plots, while *Tabias*/localities were considered as sub plots, and means were compared through Fisher's LSD. And micro soft excel was used to make graphs for growth stages and planting dates.

Fig. 2. Sampling for *A. catalaunalis* infestation at different growth stages of sesame

Fig. 3. Damaged sesame leaf, shoot and flower (A); damage sesame capsule and seed (B) by *A. catalaunalis*

3. RESULTS AND DISCUSSION

3.1 Prevalence of *Antigastra catalaunalis* in Western Tigray

All the 12 specific locations (each containing 4 farm plots) assessed from the three major sesame producing districts were found to be affected by *A. catalaunalis*, which clearly indicated that buildup of the pest across the districts (Table 1). The survey result showed that in all the crop growth stages (at seedling, vegetative, flowering and fruiting stages) (Fig. 5) and irrespective of locations all the sesame fields were found positive to *A. catalaunalis*.

3.2 Incidence of *A. catalaunalis as* Affected by Sowing Time of Sesame (Cultivated and Uncultivated)

In addition to the cultivated one, sesame is also found as a wild (uncultivated) in road sides, fallow lands and forest areas in western Tigray, north Ethiopia. And infestation of *A. catalaunalis* was observed in both cultivated and uncultivated sesame. The response of *A. catalaunalis* incidence to sowing/growing time of cultivated and uncultivated sesame is demonstrated in (Fig. 4). In the surveying areas 100% incidence was recorded from late sowing and late grows (end of July) in both farm and wild grown sesame, when a minimum incidence was recorded on the early sowing (early July) and a negligible incidence (less than 5%) was observed in the mid-June grown uncultivated sesame (Fig. 4). There were no sesame fields sown in mid-June, because there was no ample rainfall during the specified month in the surveyed areas. The overall *A. catalaunalis* incidence was higher (68.12%) for cultivated sesame, when a minimal incidence (41.67%) was recorded for uncultivated sesame. The point behind the lower incidence on the uncultivated sesame could be that uncultivated sesame might grow early

(June), because they do not demand too much rainfall/moisture like that of the cultivated sesame for emergence since they were buried shallowly in the soil and might emerge as immediate as the first shower since there were no soil disturbance also. Finally, incidence become lower because of the unfavorable weather conditions in the early grown/sown sesame. This study is in harmony with Abdel-rahman [17] who reported that delay in sesame sowing increased incidence of *A. catalaunalis*. Similarly investigations on the effect of sowing time of sesame on the occurrence of *A. catalaunalis* revealed that the incidence of the pest was highest (19.5%) in sesame sown late and lowest (8%) in early sown (June) [18].

3.3 Response of *A. catalaunalis* Incidence to Sesame Growth Stages

The means and significant variations (p<0.01) of *A. catalaunalis* incidence, among the growth stages (Fig. 5), districts and specific locations (Table 1) surveyed are illustrated. The highest incidence (65.79%) of *A. catalaunalis* was observed during the capsule developmental stage, while the lowest (15.04%) was at seedling stage in the area of survey. The point behind the higher infestation at the later growth stage of the plant could be that the pest reproduced with in short period of time as per the favored weather conditions and the pest might prefer to feed on young capsules and flowers. In a sense the pest is serious at pod developmental stage. This is in line with Muzaffar [19] who reported that during capsule formation phase of the crop infestation of the pest was higher than vegetative growth and flowering stages. Ahirwar et al. [8] also reported higher incidence of *A. catalaunalis* during flowering and pod formation than the other crop stages. Similarly Egonyu et al. [20] reported that the larvae spin silken webs around terminal leaves, eat the foliage and bore pods (causing substantial capsule damage). Lambda-cyhalothrin application significantly reduced the pest density in the early stage but not reduced at capsule damage [21].

With regard to *A. catalaunalis* infestation in the different locations *Kafta Humera* had the highest incidence, while *Welkait* had the lowest at all growth stages of the plant (seedling, vegetative growth, flowering and capsule development stages) (Fig. 5). This could be because of the limited rainfall and higher temperature in *Kafta Humera* compared to the lowlands of *Tsegede* and *Welkait.*

3.4 *A. catalaunalis* Incidence and Damage in Sesame as Affected by Locations

The means and significant variations (p<0.01) of incidence and capsule damage caused by *A. catalaunalis* among districts and specific locations is illustrated in (Table 1). *A. catalaunalis* was observed in all surveyed

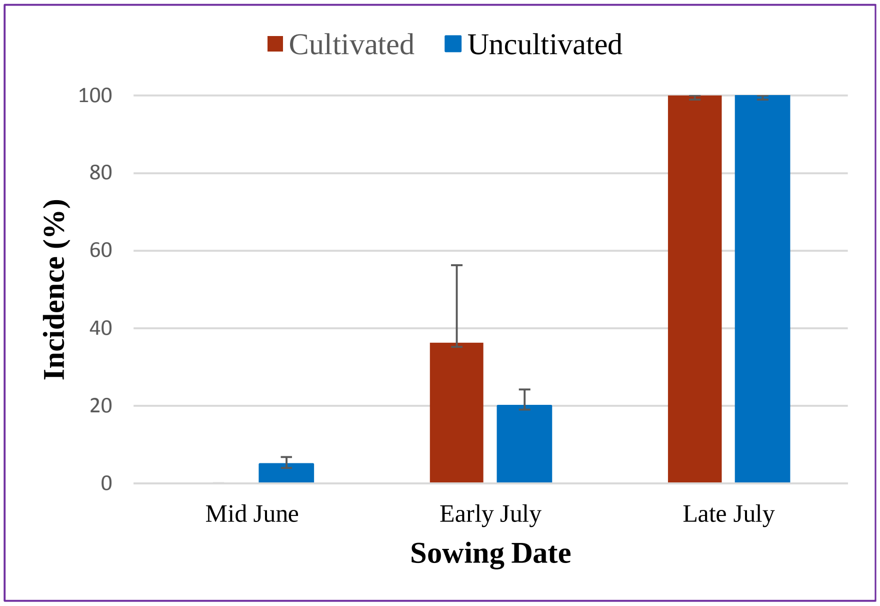

Fig. 4. Response of *A. catalaunalis* incidence to sowing time farm and wild grown sesame in western Tigray

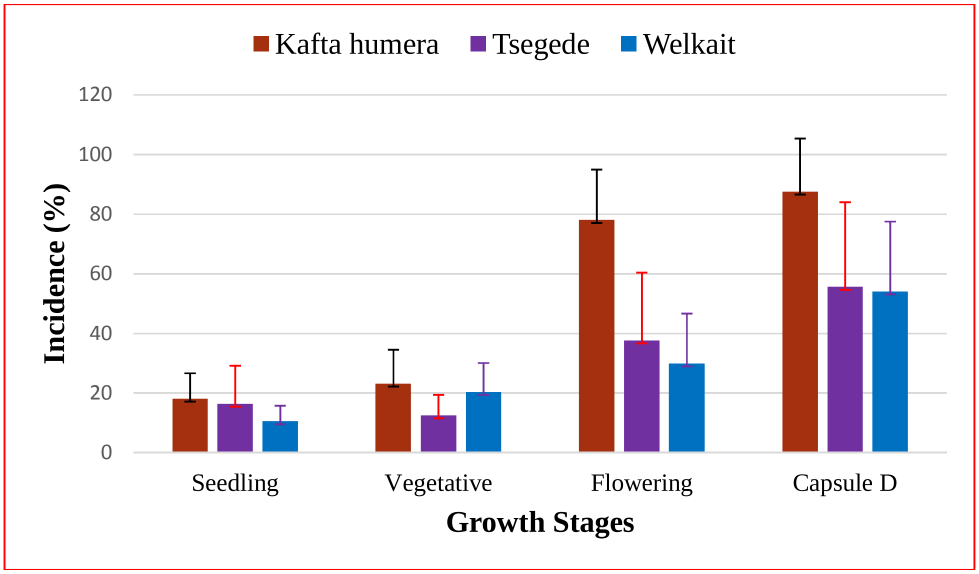

Fig. 5. *A. catalaunalis* incidence at various growth stages and across the three districts in western Tigray

fields of the three districts of sesame producing areas, however, higher incidence was recorded at *Kafta Humera* as compared to the other two districts. The average mean incidence over the districts varied from 54.14% at *Welkait* Woreda to 87.58% at *Kafta Humera*. A minimum of mean incidence 26.78% was recorded for the locality *Maidelie (tsegede),* while the maximum mean incidence of 100% was recorded at *Rawian* and *Lugdi* localities of *Kafta Humera*. The relatively higher incidence of *A. catalaunalis* in *Kafta Humera* could be due to the lower elevation (628m) and weather conditions of the area (higher temperature and low rainfall) as compared to the other two districts, which are located in high elevation (838.2 m) for *Welkait* and (764.3m) for *Tsegede* (Table 1). *Kafta Humera* has higher temperature and lower rainfall than *Welkait* and *Tsegede*. It is noticeable that the higher the altitude the cooler the weather condition and the lower the altitude the warmer the weather condition. Temperature decrease with altitude raise at a constant rate of -1^{o}c per 150 m up to tropopause [22] and the pest is in favor of warmer temperature. According to Ahirwar et al. [8], the level of incidence caused by the *A. catalaunalis* larvae is higher at higher temperature and dry weather conditions.

The overall pest incidence of 66% was recorded at fruiting stages of the crop in western zone of Tigray. Therefore, the pest is economically very important in western Tigray. The economic threshold level for *A. catalaunalis* was reported as 10% of incidence [23] and in Ethiopia Mandefro et al. [24] was stated that the economic injury level of the pest is 2-3% of infestation and Sesame Business Network [25] has reported that control measure should started, when incidence of *A. catalaunalis* reached about 3 to 5 percent.

A minimum capsule damage caused by *A. catalaunalis* (7.11%) was noted in *Welkait Woreda,* while the highest (25.42%) was recorded in *Kafta Humera*. The districts of *Tsegede* and *Welkait* was similar in *A. catalaunalis* incidence (Table 1), but different in capsule damage, possibly because of the higher temperature for the low lands of *Tsegede,* which resulted in higher capsule damage next to *Kafta Humera*. Among the sesame fields surveyed (specific location) the minimum mean of severity/capsule damage (6.24%) was recorded in *Mogue* locality and the highest (28.87%) was recorded in *Rawian*. Sesame fields cultivated an altitude below 700m, had the highest capsule damage as compared to other higher altitude areas (Table1). Similar to the incidence, high severity of damage by *A. catalaunalis* in the lowlands was observed and may be because of higher temperature and lower rainfall. As altitude increases Temperature is getting decreased and this may have an impact on the duration and speed of *A. catalaunalis* reproduction, which clearly indicated that increment in altitude reduces reproduction rate of the pest.

Table 1. Means of incidence and capsule damage ± (SD) of *A. catalaunalis* in western Tigray

Districts	Specific locations	Altitude (m)	Incidence (%)	Capsule damage (%)
Kafta Humera	Rawian	592.8	$100.00^{e} \pm 0.0$	$28.87^{f} \pm 4.8$
	Lugdi	621.2	$100.00^{e} \pm 0.0$	$23.45^{def} \pm 14.5$
	Mikadira	624.0	$86.07^{cde} \pm 17.3$	$28.77^{ef} \pm 12.3$
	Adebay	674.0	$64.26^{bc} \pm 11.9$	$20.61^{c-f} \pm 8.7$
Mean		628.0	$87.58^{B} \pm 17.8$	$25.42^{C} \pm 10.4$
Tsegede	Rubalemin	645.2	$46.70^{bc} \pm 17.2$	$13.89^{b-e} \pm 1.1$
	Dansha	673.8	$94.57^{de} \pm 10.9$	$10.17^{abc} \pm 3.0$
	Kebabo	729.0	$54.53^{b} \pm 18.6$	$14.58^{b-e} \pm 3.5$
	Maydelie	1009.2	$26.78^{a} \pm 5.2$	$10.99^{a-d} \pm 4.5$
Mean		764.3	$55.64^{A} \pm 28.4$	$12.41^{B} \pm 3.5$
Welkait	Maylemin	744.0	$56.78^{b} \pm 30.4$	$9.15^{ab} \pm 3.3$
	Selam	816.0	$33.12^{a} \pm 20.9$	$6.75^{a} \pm 3.4$
	Maygeba	859.8	$59.51^{bc} \pm 21.0$	$6.31^{a} \pm 1.9$
	Mogue	933.0	$67.14^{bcd} \pm 8.7$	$6.24^{a} \pm 3.5$
Mean		838.2	$54.14^{A} \pm 23.4$	$7.11^{A} \pm 3.0$
Grand mean		**743.5**	**65.79 ± 27.8**	**14.98 ± 10.1**
CV (%)			13.8	17.3

Means followed by the same superscript are not statistically different from each other (at p< 0.01), superscript (capital letters) = Woreda, superscript (small letters) = specific location (Tabia)

3.5 Correlation of Incidence, Capsule Damage and Altitude

Capsule damage/severity was significantly related to incidence and altitude (Table 2). Capsule damage was negatively and strongly correlated with altitude (r=-0.5719) and positively with incidence (r=0.4704), *A. catalaunalis* incidence correlated negatively and strongly with altitude (r=-0.5779). Therefore, variations (increase) in altitude aggravates incidence and have great contribution to the severity of sesame capsules. According to Reddy [26] incidence of *A. catalaunalis* correlated positively with temperature and sunshine hours and negative correlation with the rainfall.

Table 2. Correlation of incidence, capsule damage and altitude

	INC (%)	CD (%)	ALT(m)
INC (%)	_		
CD (%)	0.4704**	_	
ALT(m)	-0.5779**	-0.5719**	_

*** Indicates highly significant at 0.001% probability, INC=incidence, CD= capsule damage, ALT=altitude*

4. CONCLUSIONS

All surveyed fields of the three districts are found to be positive to *A. catalaunalis* in all growth stages of sesame. Late sown (end of July) sesame fields are totally infested by the pest. An increased trend of infestation observed as altitude is decreasing. *A. catalaunalis* is economically very important pest in western Tigray. Early sowing has about 64% reduction in pest incidence. Therefore, planting of sesame should be on the onset of rainfall to minimize *A. catalaunalis* infestation and to boost sesame productivity. And further studies should be carried out on its biology, ecology, distribution across years and integrated managements.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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