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Assessment of Major Insect Pests and Diseases of Sesame (*Sesamum orientale* L) in West Gondar Zone, Ethiopia

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ABSTRACT

The field survey was conducted in four districts of western Gondar Zone during 2018 and 2019 cropping seasons at 3-5 km intervals with the objective of assessing and identifying major insect pests and diseases and their intensity on sesame. Data were collected using 0.25 m^2 quadrate. Among insect pests, sesame webworm (86.2%) and aphid (86.2%) were the most prevalent and severe followed by thrips, mealybug, and gallmaige with a prevalence of 62.5%, 44.5% and 2.25%, respectively. The prevalence of webworm was 100% in West Armachiho district. Only altitude and growth stage were significantly associated with the intensity of insect pests. Bacterial blight, Cercospora leaf spot, wilt, and phyllody were identified with different levels of intensity across districts. The highest mean prevalence of bacterial blight (88.5%) and Cercospora leaf spot (90.4%) were recorded at Metema and Tegede districts, respectively. The association of independent variables varies with the intensity of sesame diseases. Variables such as altitude, variety, the growth stage of the crop and previous crop were significantly associated with bacterial blight, Cercospora leaf spot, and wilt severity. Therefore, management options should be developed for those most prevalent and severe insect pests and diseases in the future.

Keywords: Disease, Insect pest, Prevalence, Sesame, Severity

INTRODUCTION

Sesame (*Sesamum orientale*) is the most important cash crop grown extensively for its seeds in west Gondar Zone. Ethiopia stands at 6thposition amongst 76 sesame growing countries of the world. Sesame is an annual plant that belongs to the Pedaliaceae family. It is a short-day plant and is normally self-pollinated although it has cross pollination ranging from 5 to over 50% (Pathirana, 1994). The growth period ranges from 70 to 150 days; depending on the variety and the conditions of cultivation (Ashri, 1998). Sesame is the second largest agricultural commodity for the source of foreign currency and good source of cooking oil through local extraction. Despite its importance as source of cooking oil and foreign currency earning, sesame productivity has been low.

In Ethiopia, sesame is the first among oil crops in area coverage and total production. It covers nearly 370, 141.06 hectare (ha) of land with annual production of about 2,559,034.30 quintal with average production of 6.91 per hectare. The Amhara region account for 171,878.62 ha with 1,237,277.84 quintal and North Gondar covers 104,131.03 ha of sesame land (CSA, 2017).

Production of sesame in the country is very crucial in many aspects, but there are many hurdles for its production and productivity, like pest infestation, seasonal delay, low yielding, postharvest loss, poor storage facility, difference in capsule maturity, shattering, and so on. Insect pests such as sesame webworm (*Antigastra catalaunalis*), sesame seed bug (*Elasmolomus sordidus*), and gall midge (*Asphondylia sesami*) are the most important insects that affect production of sesame during its different growing stages (Gebregergis et al., 2016). Sesame also suffers from many diseases like leaf spot (Ojiambo et al., 2003), leaf and stem blights, Fusarium wilt (El-Bramawy, 2006), charcoal rot and root rot. Among the major constraints, bacterial blight and bacterial spot caused by *Xanthomonas campestrispv* sesame and *Pseudomonas syringaepv* Sesami, respectively are very serious diseases in most sesame growing regions and dramatically decrease the sesame yields during monsoon. Although the study area is a potential area for sesame production, in recent years, information on the importance of sesame insect pests and diseases has not been assessed so far and there is no detailed quantitative information of their intensity. Survey of insect pest, weeds and diseases are useful for determining the occurrence and relative importance of insects and diseases in crop production systems (Frick & Thomas, 1992; McCully et al., 1991). Moreover, pest survey on

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farm basis is needed to establish efficient pest management and decision making mechanism and to evaluate pest control measures. Hence, it is important to identify the insect pests and disease associated with sesame crop to fill its protection research gap specifically in the study area and in the country as the whole. Therefore, the survey was done to assess and identify major insect pests and diseases and their intensity on sesame production in west Gondar Zone

MATERIALS AND METHODS

Study area:

The survey was conducted in low land areas of west Gondar Zone districts (Metema, Tach Armachiho, Tegede and West Armachiho) which are major growers of sesame (Fig. 1). The altitude of Metema district ranges from 550 to 1608 meter above sea level (masl) and located $12^0$47'N latitude to 38^0 27' longitude (IPMS, 2005) and Tach Armachiho is located $13^0$19'60'' latitude to $36^0$44'60'' longitude. Elevations of the district range from 550 to 1600 masl. Tegedie is also one of the districts in west Gondar Administrative Zone, is located $13^0$21'1'' latitude to $37^0$23'9'' longitude. The altitude of west Armachiho district ranges from 620 to 850 masl and the town of the district, Abrhajira, is located $13^0$28'35'' latitude to $36^0$28'35'' longitude.

Insect Pests and diseases assessment:

The surveyed districts were selected purposively. Using systematic sampling procedure about 129 fields, 49 in 2018 and 80 in 2019 farmers' fields were examined for prevalence and severity of insect pests and disease and related parameters in every 3-5 km interval in X sampling fashion along the roadside. Intensity of insect pests was worked by counting infested plants and dividing to the total number of plants in 0.25 m^2 quadrant. The pests' prevalence has been taken as the proportion or percentage infected areas/ fields from the total assessed areas. It is calculated as the ratio of total infected area to total assessed area. Severity of the disease was assessed on the area coverage of the symptom to the total area unit for each disease with their own method of scoring. And insect pests severity was (1-5 scale); where 1=no damage, 2=1-10%, 3=11-25%, 4=26-45% and 5=above 45% damage. Data on agronomic practices, basic information and history of the farm field were collected. To do an association of sesame insect pests and diseases intensity data, agronomic practices were also recorded on each field collected through interview and visual assessment. The geographical coordinates and altitudes of every field assessed were recorded using a GPS receiver.

Data analysis:

The descriptive analysis of the data collected from the field survey and the prevalence and distribution of the pest was done using SPSS version 20.

The association of independent variables with insect pests and disease were analyzed using logistic regression by the procedure GENMOND

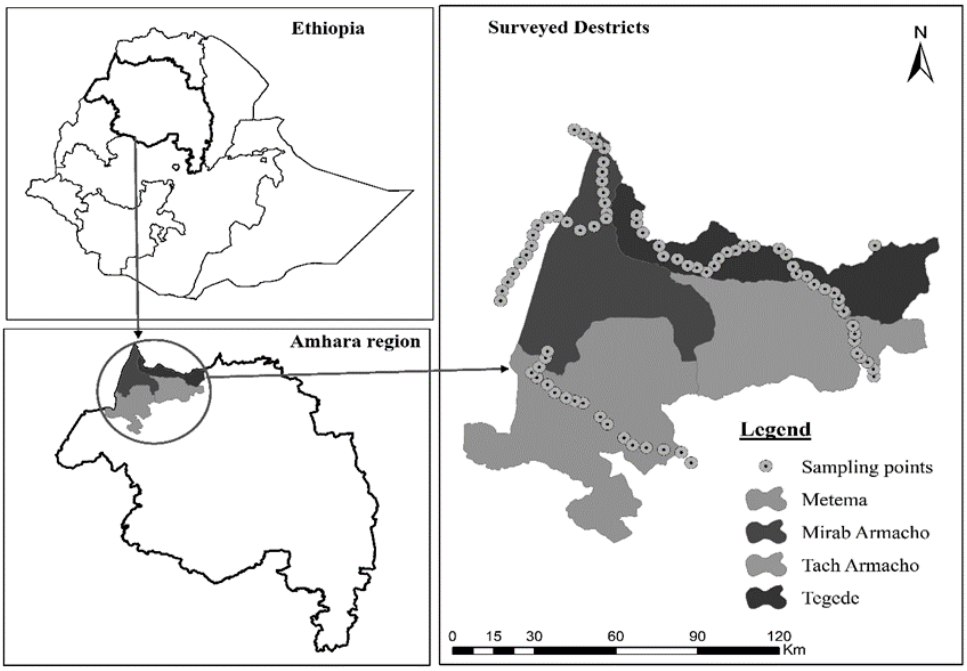

Fig.1: Map of the study area

using SAS version 9.0 (McCullagh & Nelder, 1989; Fininsa & Yuen, 2001). Logistic were used to estimate the parameter estimates. Exponentiation the parameter estimates of each variable class results in the odds ratio, which is interpreted as relative risk. The importance of the independent variables (risk factors) has been evaluated in two ways; first, the association of an independent variable alone with insect pests and diseases severity was examined. In the other method, independent variables with a high association to pests' severity were added to reduce multiple variable model. Deviance reduction was calculated for each variable as it was added to the reduced model and likelihood ratio test was used to examine the importance of the variable and was tested against $\chi 2$- value (McCullagh & Nelder, 1989).

RESULTS

Prevalence and severity of sesame insect pests and diseases' distribution:

The current survey result revealed that there were many insect pests that visit sesame fields at different agro ecology. In the two year survey, the common insect pests like sesame web worm, sesame mealybug, aphid, gall maige and thrips were identified and quantified in West Gondar Zone sesame growing areas. The mean prevalence of Webworm, aphids, thrips, mealy bug and gallmaige in West Gondar administrative Zone was 86.2%, 86.2%, 62.5, 44.5% and 2.25%, respectively. Among the five identified insect pests' sesame webworm and aphids were the most prevalent and sever insect pests in West Gondar Zone sesame growing areas (Table 1) followed by sesame mealybug and thrips. Geremew et al. (2012) has reported the importance of those insect pests.

The intensity of those insect pests varied from season to season and also across and within districts. Among the surveyed districts West Armachiho has got the highest prevalence of webworm (100) followed by Tegede (95.2%) and Metema (84.6) districts. In such cases of sever infestation it could cause higher losses which could inflict pod damage up to 100% (Geremew et al, 2012).

Aphid had the highest mean prevalence (95.2%) and (94.4%) at Tegede and West Armachiho, respectively as compared to other districts (Table1). The survey revealed that the distribution and intensity of insect pests were different in agro ecology. Gebregergis et al. (2016) also reported the importance of sesame webworm in Ethiopia in 2018. Their high prevalence can cause high loss in favorable condition. Sesame webworm mean severity ranged from 0% to 15% was recorded from Metema and West Armachiho districts. While lowest mean severity was recorded in Tach Armachiho district (Table 1). The severity of major identified insect pests ranges from 0% to 25%. Metema and west Armachiho were most severely affected by webworm followed by aphid. In all surveyed districts, thrips and galmaige were with the lowest mean severity (Table 1).

Prevalence and severity of sesame diseases in major sesame growing areas of West Gondar Zone:

The survey result revealed that there were four major sesame diseases identified in West Gondar sesame growing areas. These were bacterial blight, wilt, Cercospora leaf spot and phyllody. Their intensities were different among the districts. Mean prevalence of bacterial blight, Cercospora leaf spot, wilt and phyllody in West Gondar Zone were 72.5%, 56.4%, 40% and 7%. Among the districts, Metema (88.5%) and West Armachiho (83.3%) recorded the highest prevalence of bacterial blight. This result is in conformity with Geremew et al. (2012) report that sesame blight incidence varied from 25% to 99% in Ethiopia (Table 2). Highest prevalence of Cercospora leaf spot (90.4%) was recorded in Tegede followed by Tach Armachiho (73.3%). Bacterial blight and Cercospora leaf spot were the most dominate and frequently occurring diseases of sesame during survey.

Bacterial blight mean severity of 0% to 68.3% were recorded at Metema and West Armachiho, while the lowest mean severity of bacterial blight (15.3%) was recorded in Tach Armachiho. Cercospora leaf spot is a new disease in sesame fields in sesame growing areas of West Gondar Zone. Its highest mean severity (42.7%) was recorded at Tegede followed by Tach Armachiho (28.7%). The other disease identified (phyllody

Table 1: Mean prevalence and severity of major insect pests across the surveyed districts

District	Insect pests									
	Web worm		Aphid		Mealybug		Thrips		Gall maige	
	P	Se	P	Se	P	Se	P	Se	P	se
Tach Armachiho	60	2.3	60	2	40	2	0	0	60	2
Tegede	95.2	2.3	95.2	2.3	38.1	2	57.1	2	0	0
West Armachio	100	2.95	94.4	2.8	94.4	3	94.4	2	0	0
Metema	84.6	2.95	88.8	2.8	73.1	2	80	2	3	2

P=prevalence (%); Se=severity (%)

Table 2: Prevalence and severity of major sesame diseases across the districts

District	Diseases type							
	Bacterial blight		Wilt		Phyllody		Cercospora leaf spot	
	P	S	P	S	P	S	P	S
Tach Armachiho	73.3	0-40%	6	0-8	0	0	73.3	0-56.7
Tegede	42.8	0-40%	4	0-6.7	4	1	90.4	0-68
West Armachio	83.3	0-68.3%	66.6	0-28.3	27.7	1	38.8	0
Metema	88.5	0-68%	69.2	0-40	3.8	0-8.6	23	0-28

P=prevalence; S=severity

Table 3: Association of independent variables with the sesame insect pests' severity

Variable	Web worm	Aphid	Mealy bug	Thrips
	Pr > ChiSq	Pr > ChiSq	Pr > ChiSq	Pr > ChiSq
Altitude	0.0173	0.0642	0.0293	0.0775
variety	0.4718	0.8398	0.6070	0.4561
Growth stage	0.7633	0.9068	0.0417	0.4944
Previous crop	0.9139	0.5587	0.9458	0.4758
Soil type	0.1423	0.8391	0.3510	0.3941

Table 4: Analysis of odds ratios of added variables in a reduced model predicting sesame insect pest's severity

Variable	Variable class	DF	Web worm		Mealy bug	
			DR	Odds ratio	DR	Odds ratio
Altitude	500-800	1	58.4395	1.66	80.5125	1.85
	801-1500			1.00		1.00
Growth stage	Flowering	2	NS	NS	73.8948	0.24
	Pod setting			NS		0.88
	maturity			NS		1.00

DR= deviance reduction; DF= degree of freedom

Table 5: Association of independent variables with the sesame diseases severity

Variables	Bacterial blight	Cercospora spot	Wilt	Phyllody
	Pr > ChiSq	Pr > ChiSq	Pr > ChiSq	Pr > ChiSq
Altitude	<.0001	<.0001	<.0001	0.0143
variety	<.0001	<.0001	<.0001	<.0001
Growth stage	<.0001	<.0001	<.0001	0.0057
Soil type	<.0001	0.0115	0.0115	0.7499
Cropping pattern	0.0003	0.0118	0.1045	1.0000

and wilt) were less frequently occurred and distributed in the assessed areas (Table 2).

The association of independent variables and analysis of added variables with diseases and insect pests:

The association of independent variables with the sesame insect pests' severity is indicated in Table 3. All the independent variables were not risk factor for the severity of aphids and thrips.

The analysis of odds ratios of added variables in a reduced model predicting sesame insect pest's severity is indicated in Table 4. High severity of webworm and mealy bug were recorded with altitude range of 500 to 800 meters above sea level (masl).

The association of independent variables with the sesame disease severity is indicated in Table 5. All independent variables were significantly associated with phyllody severity except soil, type and cropping pattern.

The analysis of odds ratios of added variables in a reduced model predicting sesame diseases severity is indicated in Table 6. The highest severity of bacterial blight and Cercospora leaf spot was recorded in a mixed cropping pattern than soil cropping.

DISCUSSION

The association of independent variables with sesame insects' severity was done. Only the variable altitude was significantly associated with webworm severity. Similarly only altitude and growth stage were significantly associated with mealy bug severity. However, all independent variables had no significantly associated with Aphid and Thrips damage. This implies that all the described independent variables were not risk factor for the severity of aphids and thrips (Table 3).

Since altitude and growth stage were significantly associated for the severity of sesame insect pests, they were tested in reduced multiple variable model for sesame web worm and mealy bug severity. High severity of webworm and mealy bug were recorded with altitude range of 500 to 800 meters above sea level (masl). Therefore, sesame webworm and mealybug were less likely to infest fields with altitudes greater than 801 masl. In addition, high severity of sesame mealybug was recorded in maturity growth of sesame (Table 4). The association of independent variables with sesame disease intensity varied among themselves. Variables such as altitude, variety, growth stage of the crop and previous crop were significantly associated with bacterial blight, Cercospora leaf spot and wilt. This implies that all the described independent variables were risk factors and the different variable classes have showed different risk levels for the sesame bacterial blight, Cercospora leaf spot and wilt. Except soil, type and cropping pattern all independent variables were significantly associated with phyllody severity (Table 5).

All variables were tested in reduced multiple variable model for bacterial blight and Cercospora leaf spot. However, in the case of wilt, all variables were tested except cropping pattern and in phyllody except soil type and cropping pattern all variables were tested. The highest severity of bacterial blight recorded at West Armachiho and Metema in altitude ranges of 500 to 800 masl. Bacterial blight intensity had a direct correlation with rain fall and relative humidity (Girma, 2010) in West Armachiho and in Metema there was high rainfall distribution during the survey this favors for high development of disease intensity in the area as to the rain splash is secondary source to the pathogen. On the other hand, highest severity of Cercospora leaf spot was recorded in altitude range

Table 6: Analysis of odds ratios of added variables in a reduced model predicting sesame diseases severity

Variable	Variable class	DF	Bacterial blight		Cercospora spot		Wilt		Phyllody	
			DR	Odds ratio	DR	Odds ratio	DR	Odds ratio	DR	Odds ratio
Altitude	500-800	1	370.86	1.50	1806.87	0.89	370.84	$1.04E^{+10}$	69.71	$3.03\ E^{+5}$
	801-1500			1.00		1.00		1.00		1.00
Variety	Improved	1	1764.11	0.55	1691.67	0.42	343.26	0.21	54.34	$8.65E^{-10}$
	Local			1.00		1		1		1.00
Growth stage	Flowering	2	1702.06	0.35	1624.23	0.54	324.86	0.40	44.01	$2.65E^{-10}$
	Pod setting			0.76		0.56		1.15		2.37
	Maturity			1.00		1.00		1.00		1.00
Soil type	Black	3	1603.01	$2.4E^{+8}$	1489.6	1.706	279.87	$1.37E^{+9}$	NS	NS
	Light			$2.3E^{+9}$		2.68		$1.1E^{+9}$		
	Red			$3.2E^{+8}$		1.47		$8.52E^{+8}$		
	Brown			1.00		1.00		1.00		
Cropping pattern	Sole	1	1579.1		1489.57		NS		NS	NS
	Mixed			0.38		0.86				
				1.00		1.00				

of 801 to 1500 masl. Variety was highly associated with severity of sesame identified diseases. Hence, the highest severity of bacterial blight, C. leaf spot, wilt and phyllody were recorded in local variety than improved. This is due to the inherited characteristics. The highest severity of bacterial blight and Cercospora leaf spot were recorded in maturity growth stage of the crop, while in wilt and phyllody case the highest severity was at pod setting stage. In soil type, the highest severity of bacterial blight was recorded at red soil, for Cercospora leaf spot in light soil and in wilt in red soil. The highest severity of bacterial blight and Cercospora leaf spot was recorded in mixed cropping pattern than soil cropping (Table 6).

In conclusion, sesame web worm and aphid were the most prevalent pests across the districts followed by mealybug. The severity of insects varied among altitude. Sesame webworm and aphid severely affected Metema and West Armachiho and mealybug in West Armachiho. Insect pests severity was increased as the altitude decreased and except altitude and growth stage all independent variables were not associated with the severity of sesame insect pests. An altitude less than 800 masl had showed high association with sesame webworm severity. In sesame mealybug in addition to altitude; maturity, growth stage was highly associated with its severity. Cercospora leafspot and Bacterial blight were the most prevalent and severe diseases in Tegede and T/Armachiho; west Armachiho and Metema, respectively. While wilt was the most prevalent and severe disease in West Armachiho and Metema districts. All variables have showed significant association with bacterial blight and Cercospora leaf spot severity. However, in wilt except the cropping pattern the tested variables were significantly associated and in phyllody soil type and cropping pattern were not showed a significant association. Therefore, management options should be developed for those most severe insect pests and diseases in the future.

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