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The need for short term training on sesame seedbug (*Elasmolomus Sordidus* Forsk) control to farmers and agricultural extension workers: A case study at Kafta-Humera Seasame fields, Northern Ethiopia

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For many years, Sesame producing farmers in Kafta–Humera, northern Ethiopia had been trying to protect their Sesame crop from infestation. However, it was not effective because of re-infestation by pest within a few days after pesticide spray. As a result. in the area, where this research was conducted, the infestation and damage level of the pest were increasing year after year. This study assessed farmers' and agricultural extension workers' perception on Sesame Seedbug identity, biology, ecophysiology and possible control methods by employing quantitative and qualitative research designs. Findings indicated that farmers and agricultural extension workers were well aware of the identity and the danger of the bug but did not know its biology and where and how it passes the whole year until Sesame fields are covered by the crop. Hence farmers were unable to look for preventive measures other than insecticides. More than 80% of the farmers said that they are using chemicals, mostly Malathion to protect their crops from the pest. There was a knowledge gap about sesame seedbug among farmers as well as the agricultural development workers (agriculture personnel). As agrarian country, this gap should be abridged and emphasis should be given even to primary and secondary education students in rural areas, where dropout rate is considerable and most of the dropouts join the farming sector. It is also necessary that short term training be arranged on pest control in particular and agricultural adult education in general to the farmer community in the district.

Key word: Awareness, infestation, perception, pest, weight loss.

INTRODUCTION

The major cash crops that are produced in Ethiopia include sesame seed, ground nut, linseed, lentils, niger seed, rape seed, sunflower, caster seed, pumpkin, and mustard seed. Among these sesame and niger seeds dominate in boosting Ethiopian economy. Most of with the sesame production which is the focus of this study is for export and for its by-product (oil cake) that is sold as animal feed.

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Sesame (*Sesame indicum* L.) belongs to the order Lamiales and family Pedaliaceae. In Ethiopia, sesame grows mostly in the West and North West parts of the country. According to Elias (1988), it grows all along the low lying regions of Ethiopia bordering the Republic of Sudan. Tigray (Humera) and Amhara (Metema) regions are among the major sesame growing areas in Ethiopia. The seed also grows in Gambella, Benshangul Gumuz and some areas of Oromia and Amhara (Hararghe and Wollo) regions where it is sown as a mixed crop with Teff, Sorghum and Cotton.

The world of sesame sector is a billion dollar industry that supports the livelihoods of millions of farmers throughout the world (USAID, 2010). World production of sesame seeds is estimated at 3 million tones, and is steadily growing. Currently, Ethiopia is among the top five producers of sesame seed in the world, ranked at fourth place by covering about 8.18 percent of the total world production (FAOSTAT, 2012).

Due to its attractiveness in its export market, the area covered by sesame and the total production in Ethiopia has been shown an increment for the last ten years. According CSA 2013, In 2002/2003, the area under sesame in small private holders was estimated to be 91,520.00 ha with 614,600.00 quintal and productivity of about 6.7 quintal/ha. In 2012/2013, the area under sesame was 337,500.00 ha with total production of 2,447, 800.00 quintals and productivity of 7.3 quintals/ha. The increase in production has come clearly from area expansion than productivity that comes largely from North West and Western Ethiopia. Sesame production in Ethiopia grew by about 22% during 2007 to 2011 primarily due to area expansion.

Though the interest for sesame production has been increasing from time to time globally, insect pests, weeds and diseases are challenging sesame growing farmers. Because sesame grows slowly during its early stage and it is not strongly competitive with weeds, poor weed control early in the life of the crop can result in greatly reduced yield. Insect pests also threaten it and cause economic losses as a result of foliar feeding or damage to seed or other harvestable portions of the plant. According to the Ethiopian National Urban Planning Institute (ENUPI) (2002), damage by insect pests range from 5 to 50% of the total sesame production in Kafta Humera area. Similarly. Weiss (2000) reported that insects reduce about 25% of the potential yield of Sesame in the world. A number of pests are known to attack sesame in Ethiopia (Tadele, 2004; MoARD, 2007) among which the most common pest in Kafta-Humera is a species of seedbug locally known as "Setayto".

The sesame seedbug *(Elasmolomus Sordidus* F.) damage is high at harvest and threshing time, when the seeds are openly exposed to the pests. Both the adult as well as the nymph cause a large weight loss of 94.7%, on the harvested sesame by sucking the seed contents and/or taking away the whole seed to their resting or sheltering areas (Muez et al., 2008). The loss the pest incurs is enormous especially when the crop is prepared in a bunch (Hilla) for drying at field conditions. For many years, sesame producing farmers in Kafta–Humera had been trying to protect the crop from infestation. However, it was not effective because of re-infestation of the pest within a few days after pesticide spray. As a result, in the area where this research was conducted, the infestation and damage level of the pest were increasing year after year. This suggests the knowledge related to biology and behavior of the pest is important in devising successful control methods. This study assessed the knowledge farmers and agricultural extension workers have on the identity, biology and ecophysiology of the pest so that biological mechanisms of dealing with it could be devised. In the course of the study answers had been sought for the following research questions: What is the level of Farmers’ perception of sesame pest (Seedbug) as a threat to sesame yield? What control methods do farmers apply to control the damage caused by sesame seedbug? What is the level of farmers knowledge about the origin, identity, biology, ecophysiology and controlling mechanisms of sesame seedbug? What is the level of agriculture development workers’ (extension workers’) knowledge of sesame seedbug?

MATERIALS AND METHODS

Description of the study area

The research area, Kafta-Humera (Figure 1), is located in western zone of Tigray Region, Ethiopia. It is found at the extreme North Western tip lowlands of Ethiopia and is bordered by Eritrea and the Republic of Sudan in the north and west, respectively. It is located at 13°45’ to 14°28’N latitude and 36°20’ to 37°31’E longitude (ENUPI, 2002). The area has a flat topography with an altitude range between 500 to 800 m above sea level (m.a.s.l). The area is generally characterized by arid climatic condition with annual mean temperature of about 30°C and mean annual rainfall of about 581.2 mm, ranging from 380 to 870 mm. The rainfall distribution is limited to four months in a year, June to September.

Samples and sampling methods

Samples of this study were 207 farmers and 22 agricultural extension workers. Because of the multiplicity of the source of data, different sampling methods were used. The selection of farmers was made by cluster/area sampling methods. This was done by classifying farmers based on their living and/ or farming locations. Out of the total six living and/ or Sesame farming localities found in the study area, four (Humera, Mycadra, Rawyan and Adebay) were selected randomly to guarantee the representation of each Sesame growing field. Then convenient sampling method was employed to select the representative sample farmers. On the other hand, a comprehensive sampling technique was used for selecting samples from agricultural experts (agricultural development workers).

Data collection methods and instruments

The main purpose of this study was to survey the knowledge of

Figure 1. Map of Ethiopia. The arrow indicates the study area (Kafta-Humera District).

farmers and agricultural extension workers about sesame seedbug. To meet this purpose primary and secondary data were collected.

To gather the primary data, open and closed ended questionnaire were distributed. With the aim of soliciting data from farmers and agricultural experts in relation to their personal information, educational background and the perception they have about the identity, biology, and ecophysiology as well as control measures of the pest. Moreover field observation was conducted on 11 sesame fields. To ease communication between the researchers and the respondents the questionnaires were translated from English to Amharic (the official language of Ethiopia). Secondary data were collected from agricultural development agent reports, and papers prepared for workshops and/or seminars held in that area related to Sesame and other crop pests.

Data analyses

Data on distribution of farmers' response in relation to the type and application of control methods of the seed-bug were analyzed using descriptive statistics. Single and paired sample t - tests were used to check for statistical significance of differences between mean scores of respondents on the issues under consideration. The chi-square, χ^2, test was conducted to compare some qualitative characteristics or opinions based on the percentages of responses for various questions.

Ethical considerations

As there was no any ethical review committee centrally functioning at Bahir Dar university, upon the request of researchers each college and faculty gives a permission letter requesting institutions and people to facilitate the data collection process by researchers. Accordingly, to collect data for the present study a permission and cooperation request letter was collected from College of Science, Bahir Dar University. Then questionnaires were administered to participants after the purpose of the questionnaire was explained. Respondents were told both orally in the orientation and in written form in the questionnaire that their responses will be kept confidential and will be treated anonymously. They were also informed that they can withdraw from the study should they need. Hence, respondents' agreement to fill in the questionnaire was taken as consent to participate in the study.

RESULTS AND DISCUSSION

General information

Among the sample farmers who answered this items (N = 202), it was observed that about 81.2% had primary education (grades 1 – 8) while about 18.3% had secondary education (grades 9 - 12). No farmer, except one who completed a two year college (diploma), attended post secondary education. Educational level of farmers is believed to play a great role in increasing land productivity and controlling outbreak of insect pests by applying general theories and principles of agricultural management and production that could be offered at different school levels. Moreover, it may also enhance the ability of processing and effectively using agriculture related information as well as new technologies.

Major staple cash crops cultivated at Kafta-Humera

The major crops in Kafta-Humera are sesame, which is cultivated by about 99% of the sampled farmers (N = 207), sorghum and cotton. Sesame, as a monoculture, was cultivated by about 70.5% of the farmers. About 24% of the farmers cultivated a mixture of sesame and sorghum. Sorghum and cotton as monoculture are each

Table 1. Farmers' perception of threat caused by sesame seedbug.

	Farmers' perception of threat				χ^2 - value
	High	Medium	low	Total	
N	129	38	36	203	
%	63.55	18.72	17.73	100	83.42*

$p < 0.05$. Among the 207 farmer respondents 203 of them responded to the item pertaining to perception of threat caused by Sesame seedbug.

cultivated by 0.5% of the farmers. The rest 4.5% practices mixed farming. That means the economic development of farmers in Kafta - Humera is based on the production of sesame crop.

Farmers' perception of sesame yield and productivity in the years 2009 – 2013

Although almost all the farmers were involved in sesame cultivation, the productivity was not satisfactory. About 21.3% of the 207 respondent farmers believed that there was increment in Sesame productivity while 40.1% indicated that their sesame production was decreasing up to the year 2007. The rest 12.6% said no change in productivity while 26.1% had no idea about it. Farmers who reported an increase in production mentioned the following as reasons for the increase: use of mechanized systems (tractors), good handling of their farm lands such as before sowing they plow it at least once following the first rainfall, and increasing sesame hectarage, which was the result of availability of good market. On the other hand, the majority of the respondents who said that there was a decrease in productivity mentioned different limiting factors related to rain and wind problems, an increment of pest prevalence, fertility problems and unavailability of improved seeds.

Farmers' perception of sesame pest (seedbug) as a threat to sesame yield

From a total of 188 who provided usable data among the 207 farmer respondents 156 (83%) replied that pests caused damage on their sesame crops. Many of these mentioned sesame seedbug to be the most important crop pest. They also listed other insect pests and diseases such as leaf webbers (sesame webworm), capsule borers, termites, ants, locust, and bacterial blight (bacterial leaf spot) attacking sesame at its different growth stages. On the other hand, 32 farmers (17.1%) reported no pest damage on their yield.

With respect to the degree of damage caused by the bug alone 203 farmers provided usable responses, Thus among these respondents 63.6% believed the damage was high and 17.7% said it was low, while the rest reported they faced medium threat (Table 1). The Chi-square test ($\chi 2$ =83.42, df=2, N= 203, P<0.05) reveals a statistically significant difference in the level of farmers perception of the threat of the bug. The standardized residuals (R for high = 61.3, R for medium = - 29.7, R for low= -31.7) indicate that most of the respondents perceived that the threat caused by the bug is high (Table 1).

When the farmers were asked to rank the most important factor(s) which most affect sesame production from the total respondents that provided usable data (N =187) about 117 (62.6%) and 63 (33.7%) respectively indicated that climate (rainfall and wind) and pest were the major problems (Figure 2) while seed quality and farm size were not their problems. This was slightly different from what was reported by the Ethiopian National Urban Planning Institute (ENUPI) (2002) on development plan of Humera town that included lack of improved seeds in the list of factors limiting Sesame productivity in the study area. In Kafta-Humera, unequal distribution of rainfall which could result in both water logging and moisture stress to sesame plays a major role in the reduction of both production and quality of the crop. Even though occasional snowstorms during the growing stage of the seasame occurrence of high rainfall (water logging), late on-set and early off-set of rain and severe winds at harvesting time were common problems in all Sesame growing parts of Kafta-Humera, the farmers considered them as "God's Decision" and had no complaint about them. In contrast, the farmers were very sensitive to the damage caused by insect pests, especially the sesame seedbug.

Farmers' awareness on yield loss caused by sesame seedbug

Among the 207 farmers 195 provided usable information about the minimum and maximum yield they get during infestation. These farmers said that the minimum and maximum yield they get respectively are 1.0 and 7.1 quintals per tractor hour (two hectares) if the crop is infested, and 4.3 and 12.9 quintals per tractor hour if no infestation occurs (Table 2). The trend of the response given by the agricultural government employees (N = 22) was similar (Table 2). This shows the sesame yield

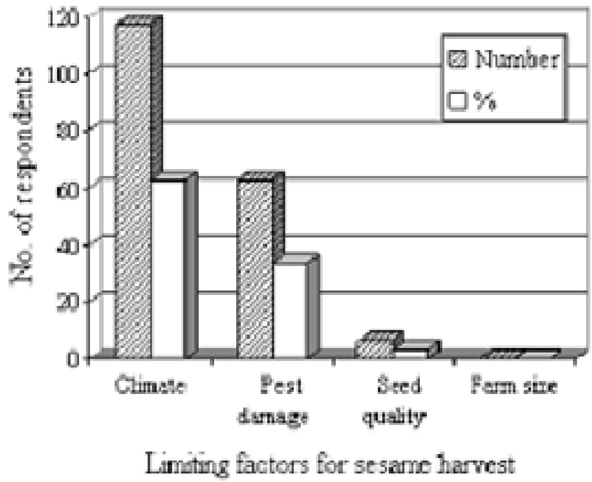

Figure 2. Farmers perception on limiting factors for Sesame harvest at Kafta- Humera area

Table 2. Estimated sesame yield during high sesame seedbug infestation and non - infestation periods as perceived by farmers and agricultural experts*.*

Groups of respondents	Average estimated sesame yield, quintals per one tractor hour per year				Average estimated weight of one Quintal (kg)			
	During infestation		No infestation		During infestation		No infestation	
	Min	Max	Min	Max	Min	Max	Min	Max
Farmers (n=195)	0.98	7.07	4.30	12.85	7.01	62.75	89.67	101.68
t- value	*16.234				*25.210			
Agricultural Experts (n =22)	3	6.55	4	9.73	70	81.44	90	90.2
t- value	*3.728				1.068			

*p < 0.05, min and max stand for minimum and maximum yields respectively.Among the 207 farmer respondents only 195 of them responded to the item pertaining to yield.

obtained during the non-infestation period was nearly as high as twice that in the infestation period in a given unit area. This was proved by the work of Muez et al. (2008) where there was significant loss when the harvest loss was very high not only during infestation but also during storage. The result of the analysis, paired t-test, showed that there is statistically significant difference between the average maximum yields obtained during the non infestation and infestation periods from the farmers responses (t = 16.234, α= 0.05, df = 193), and (t = 3.728, α= 0.05, df = 20) from the agricultural experts responses (Table 2).

The data obtained from the sample farmers and agricultural experts (extension workers), indicated that the seedbug does not only cause a yield loss but also a weight loss on the already harvested sesame seeds. According to farmers the average maximum weight (kg) of one sack sesame seed if not affected by the pest is 101.7 kg which ranged from 80 to 110 kg while that of the affected seeds is 62.8 kg. The experts indicated that the average weight was 81.4 kg during infestation and 90.0 kg when there is no infestation (Table 2). Results of the paired t-test for the farmers' estimated value indicated that there was a statistically significant mean difference (t = 25.210, α= 0.05, df = 193) between the maximum weight of one sack harvested during high infestation and that during non-infestation (Table 2).

According to the information obtained from the sesame producing farmers, the seriousness of this damage goes to the extent that little or no sesame seeds are obtained. During 100% infestation, farmers find it difficult to control these swarms of pests using the commonly suggested chemical, Malathion 50% EC, as a result of which the expected loss would be 100% in both quality and quantity. Regarding the decisions taken by some farmers in this case, one respondent wrote the following:

It was in 2012 that when I tried to thresh the harvested Sesame which was collected from four hectares, I found the capsules empty while dislodging. And the seedbug

Table 3. Distribution of farmers' response in relation to the type and application of control methods at Kafta-Humera.

Respondents	Farmers response									
	Use of controlling measures			Type of controlling measures used				Type of chemicals used as control measures		
	Yes	No	Total	chemical	Cultural	Both	Total	Malathion	Others	Total
No.	180	6	186	156	10	10	176	113	40	156
%	96.77	3.23	100	88.64	5.68	5.68	100	72.44	27.56	100

Among the 207 farmer respondents only 186 of them responded to the item on use of controlling methods. And among the 186 respondents 156 of them mentioned the type of controlling methods they used.

was still seen actively feeding on the Sesame seeds. During this time, I became nervous and hopeless. Thus, I burnt all Hillas (bunch of stocks). Finally, seeing the sesame seedbugs being burned, I returned home carrying my empty sacks with no sesame yield.

For this person burning the Sesame stalks was equated with burning the pest which was considered as a revenge for the loss it caused.

Application of control methods to sesame seedbug damage by the local farmers

Farmers of Kafta Humera use pesticides for minimizing the damage caused by sesame seedbug. Results in Table 3 show that 96.8% of the respondents used control methods. About 88% of those using control methods used chemicals and 5.7% used cultural methods. The rest used both chemical and cultural methods that are recommended in most cases. The use of chemical methods is the least preferred due to its side effects. However, it was the first choice for the farmers. Hence, the right chemical should be used at the right time for the right crop. The application method also matters. The cultural methods which could involve field sanitation or crop hygiene, crop rotation, plowing, irrigation and breeding resistant crop varieties are good control methods because if carefully done they are eco-friendly. From the total farmers that reported to have used chemicals 72.4% (Table 3) replied that they have used Malathion.

Cost of sesame seedbug control

Results obtained from the farmers showed that the amount of Malathion used by each farmer in one growing season ranges from 1-2000 L with an average of 44.7 L, depending on the size of their land. One liter of Malathion costs the farmers an average of 85.80 Ethiopian Birr, which means that 1-1200 L Malathion will cost about 85.80 to 171,600 Ethiopian Birr (4.29-.8580USD). Therefore, the incidence of sesame seedbugs exposes farmers to extra costs. Furthermore, the effect of Malathion 50% EC is short. After 1-2 days following the first application at the suggested rate, the pests survive and attack the Sesame harvest again.

Farmers knowledge about the origin, identity, biology, ecophysiology and controlling mechanisms of sesame seedbug

Assessment was done on knowledge of farmers about the origin, identity, biology, ecophisiology, and controlling methods of sesame seedbug, which was very important issue. With regard to the question pertaining to where the pests come from during the harvesting time 164 of the 207 farmer respondents provided usable data. From these people about 87.8% believed that the pest was spontaneously emerging from the cloud that rains down and from the mud in the ground while 9.8% farmers replied that they know nothing about the source of the pests. Only one respondent said the pests come from neighboring countries. Three respondents (1.8%) gave the most possible option. They said that the insects are coming from the eggs deposited in the grasses, weeds as well as the soil cracks found in their fields.

According to the researchers experience, once the farmers threshed their sesame harvest, they do not care about the pest until the next harvesting time. Most farmers consider the pests would die due to food shortage some days after the last threshing process is completed. Contrary to the farmers' perception, seedbugs at all the developmental stages survive throughout the year (Muez, 2007; Muez et al., 2008). Therefore, this knowledge gap possibly plays a great role in the loss of Sesame production in Kafta-Humera.

With respect to the farmers knowledge of identity, biology, ecophysiology and controlling methods of sesame seedbug, the sums of scores obtained from 198 of the total 207 respondents who provided usable answers were grouped into intervals of scores and the frequency distribution was sketched as shown in Table 4. To determine the general knowledge of farmers concerning the variables listed, the methods used by Hinkle et al. (1994) and Yalew (2006) were adopted. The

Table 4. Frequency distribution of sum of scores of 198 farmers, including the cumulative frequency and cumulative percentage.

Sum of scores	f	%f
20 - 22	1	0.51
17 - 19	8	4.04
14 - 16	44	22.22
11 - 13	97	48.99
8 - 10	34	17.17
5 - 7	14	7.07

f = frequency distribution,Among the 207 farmer respondents of the study only 198 of them responded to the items pertaining to knowledge of the pest.

Table 5. Analysis of farmers' general perception on the ecology, physiology, and biology of Sesame Seedbug at Kafta-Humera.

	N	Mean	Std. Deviation	Test Value	Mean Difference	df	t –value
Scores	198	12.03	2.79	15	-2.97	197	-14.996*

*p< 0.05**.** Among the 207 farmer respondents of the study only 198 of them responded to the items pertaining to knowledge of the pest.

Table 6. Analysis of farmers' perception of identity, biology, control method and ecophysiology of Sesame seed.

Issues	Test Value = 3,				
	N	Mean	Std. Deviation	t-test	df
Identity	198	3.6919	1.19688	8.135*	197
Biology	198	1.8131	0.78723	-21.215*	197
Control method	198	3.1364	0.98547	1.947	197
Ecophysiology	198	1.6944	0.66746	-27.523*	197

*p<0.05. Among the 207 farmer respondents of the study only 198 of them responded to the items pertaining to knowledge of the pest.

mean score ($\bar{x}$) of farmers obtained from five 5-scale items used was compared and against the expected or hypothesized mean (μ) by employing the single sample t-test method.

The result in Table 5 showed that the knowledge mean score of the sampled farmers was 12.03. The result of the single sample t-test indicated the presence of statistically significant mean difference between the obtained mean score and the hypothesized value, the expected mean (μ = 15) suggesting knowledge gap among farmers at least in one of the issues of identity, biology, control methods and ecophysiology of the sesame seedbug. To determine in which of the considered characteristics as well as control methods of seasame seedbug there is knowledge gap, a series of single sample t-tests were conducted (Table 6). Results showed that the knowledge gap was on the biology and ecophysiology of the pest. Although farmers believe they are aware of some possible control methods (Table 6), they could not prevent the impact of the pest (Muez et al., 2008).

Management of the pests could be more effective if they were applied at the lowest infestation level. By interfering in their life cycle when they are weak, it is possible to minimize their outbreak in the next seasons. It was observed that the threshed stack was a good breeding site for this pest, so clearing or burning the stack could probably be effective for interrupting the reproduction process. The pests were observed to be very sensitive to temperature and light. They were seen hiding inside the threshed stock (Jewjaw) and soil cracks during the day time (Figure 3). Hence, with no shelter and

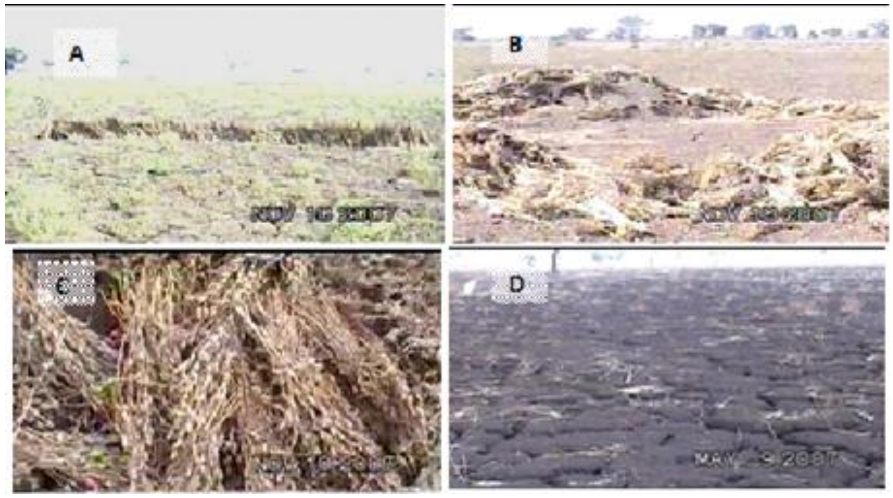

Figure 3. The unharvested Sesame (Hilla) (A), left over Sesame (Jewjaw) after threshing (B), bunches of Sesame (C) and cracked soils (D) serve as safe heavens for the Seedbugs during the unfavorable seasons of the year

Table 7. Alternate host plants of sesame seedbug in Kafta-Humera Sesame fields.

Numbers	Local name	Scientific name
1	*Humeray	*Corchorus triloc*
2	*Shico sar	*Helitropium cinerascens*
3	*Driya/ Hareg	*Ipomia triloba*
4	Mashila	*Sorghum bicolor*
5	*Hiletay	*Rottboellia cochinchinensis*
7	*Chomer	*Osimum spp*
8	*Wariat	*Digitaria abyssinica*
9	Adar	*Sorghum* sp.
10	*Teneg	*Hibiscus* sp.
14	Full	*Arachis hypogeae*
15	**Mekie	*Balanites aegyptiaca*
16	**Geba	*Zizyphus spina-christa*
17	**Ktrit	*Accacia mellifera*
18	**Semok	*Acacia Senegal*
19	**Nyme	*Azadirachta indica*
20	**Papaya	*Papaya carica*

*common Sesame weeds; **Perennial plants; Identification of host plants was done using Schmutterer (1969), Tadele (2004) and MoARD (2007).

hiding place, it would be very difficult for the pests to pass the hot climate especially from January to the beginning of July, if the threshed stock is burnt.

Another difficulty with the possible management of the pest is the presence of alternative host plants for the pest (Table 7). The Bugs were seen feeding on the young leaves of different plant leaves and twigs (Figure 4). This entails the necessity of educating farmers about these alternative host plants and handling the case.

Agriculture development workers' (extension workers') knowledge of Sesame Seedbug at Kafta - Humera

The Agricultural extension agents working at Humera came from different corners of the country including places where no Sesame crop was ever cultivated. Unless they get proper information formally or informally, it would be difficult for them to know about this pest.

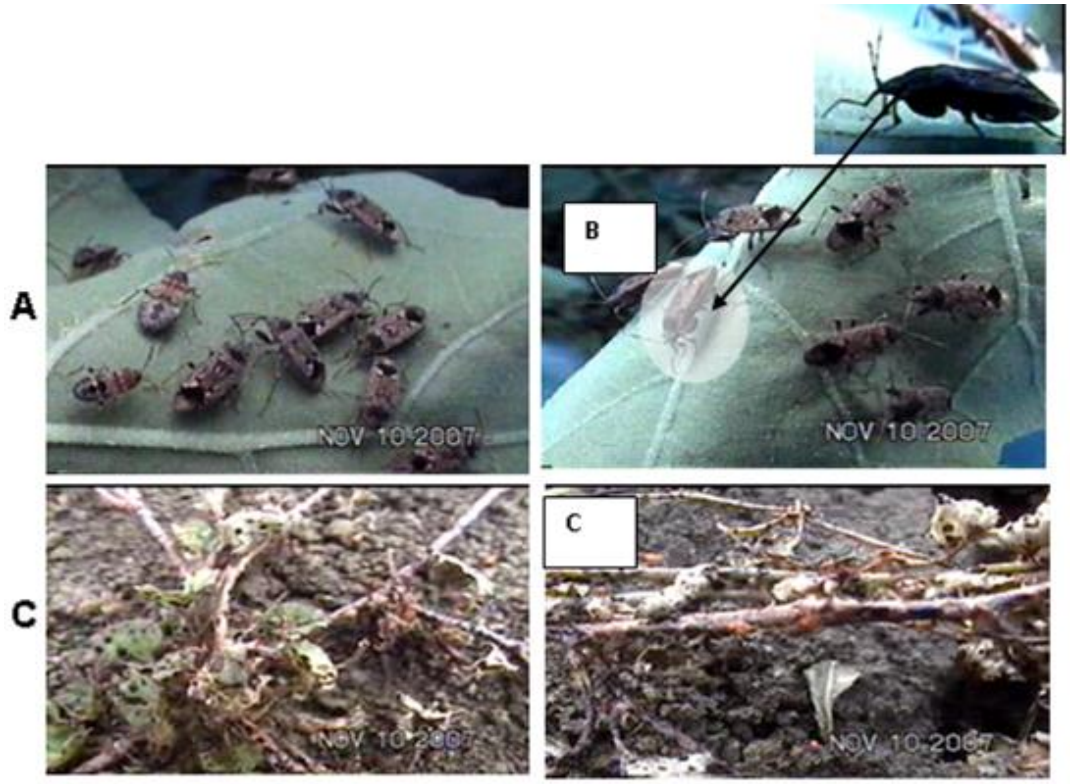

Figure 4. Sesame Seedbugs feeding on young alternate host plant leaves

Table 8. Analysis of agricultural experts' general perception on the biology and ecophysiology of sesame seedbug at Kafta-Humera.

Obtained mean ($\bar{X}$)	Expected mean (μ)	Mean difference	Df	t - value
17.16	21	3.84	18	-4.006 *

Among the 22 extension worker respondents all of whose educational qualifications is diploma and 18 said that they knew the presence of sesame seedbug previously, but the rest four respondents knew nothing about it. Even though most of the respondents knew the existence of the pest, the prevalence of sesame seedbug was high for a long time at Kafta-Humera. Why did this happen? To get possible answers, there was a need to assess knowledge of agricultural development workers with respect to biology, ecophysiology and control methods of sesame seedbug. This is because these experts are expected to serve as a bridge for transferring and spreading information from researchers to farmers and feedback from farmers to researchers which could contribute for the improvement of different seed varieties, minimizing pest incidence, introduction of new methods, etc. To determine the general knowledge of agricultural development workers concerning the bug, the method used above for the farmers was applied (Table 8).

Table 8 indicates that there was statistically significant mean difference ($t = -4.006$, $df = 18$, $P<0.05$) between the mean score of agricultural experts' general perception on the biology and ecophysiology of sesame seedbug ($\bar{X}$ = 17.16) and the expected mean (μ = 21). This shows the experts have lower level of knowledge regarding the biology and ecophysiology of sesame seedbug. In Kafta-Humera, the agricultural office and agricultural research center are the only two most responsible governmental organizations for the crops grown in that area. The agricultural office monitors the performance of crops and the agricultural development agents assist the farmers in different aspects including disseminating new information, methods and technologies such as utilization of improved seeds agricultural development workers are expected to be the main agents for the overall development of the agricultural sector. They are considered to be knowledgeable in increasing production and controlling outbreaks of crop pests. They are expected to know the how, where and when the common insects in a given locality reproduce and breakout, how they attack /damage the crop, which stage is damaging, and other related things in order to educate or train farmers in that area. But as results from Table 8 suggest they could not transfer knowledge about sesame seedbug to farmers.

To conclude, though all the respondent experts graduated from different colleges and universities as far as their training was concerned, they did not have the required knowledge which could enable them to train the farmers. From this, it is logical to say that the formal education they obtained at the institutions (colleges or universities) was not enough to contribute to knowledge about the bugs. Therefore, short term training about the bug is absolutely essential.

Possible controlling measures of sesame seedbug at Kafta - Humera

Farmers in the study area in addition to the use of chemicals such as Malathion could use the following cultural methods to protect their crop.

(i) Field sanitation and alternate host control: Sesame seedbugs live and reproduce in the threshed stacks, old grasses, weeds and other accumulated debris by feeding on the seed residues (Muez, 2007). Therefore, clearing or removing the grasses, debris, weeds and the residual seeds and burning the threshed stacks could be the best option for reducing the survival of sesame seedbugs from one season to the next season.
(ii) Block sowing: In Kafta Humera, depending on the onset of rain and other factors, the farmers sow the Sesame crops at different times. One farmer sows his land in 1 to 2 weeks gap. This gap in sowing results in maturity difference, which means a sustainable food for the bug. Therefore, to minimize the time needed for the pest to develop, all sesame crops in a given area could be sown at the same time. If sesame planting is spread out, the pest will have an opportunity to rapidly increase and move from one stand to another. To avoid this, simultaneous planting could be important.
(iii) Crop rotation: could minimize bug outbreak by reducing host plants.
(iv) Plow the field soon after threshing: This is an indirect pest control measure that exposes pests, especially the eggs to the hot sun and natural enemies or other unfavorable environmental conditions.
(v) Planting resistant crops: Wiemers and Longham (2002) indicated that seed loss due to the dehiscence of the capsules was solved by developing shattering resistant sesame cultivars. These non-shattering varieties do not only solve the seed loss during the drying time but also minimize the presence of residual seed which serves as a food source for pests. This is practiced in other countries such as the USA (Wiemers and Longham, 2002), to avoid stacking sesame crops in the field which creates favorable conditions for the insect and during which the greatest damage occurs. The shattering resistant variety could be adopted and used for plantation.
(vi) Storage methods: The bugs continue attacking sesame seeds even during storage (Muez et al., 2008). Thus, control can be achieved by using lined bagging materials (Muez et al., 2008) or by dusting/fumigating seeds with an appropriate powdered insecticide as they are bagged (USAID, 2006). The sesame seedbug has great difficulty penetrating woven polythene sacks. If these can be used instead of jute sacks, storage infestations of clean sesame seed can be significantly reduced.

In addition, stores and surrounding areas should always be kept clean of pests and loose seeds, which should be swept up and burned on a regular basis.

Devising ways of communication with farmers

Different concerned governmental and non-governmental organizations should seek to give the agricultural community at Kafta - Humera as much assistance as possible to enable them handle the pests and improve the efficiency of their Sesame production. The production unit in agriculture is the farmer.

Thus, their skill, knowledge and industry play great role for achieving the intended production in particular and the Ethiopian agricultural development in general. The great handicap in increasing crop production is lack of education of the farmers. Thus, considerable emphases should be put on education and extension services which could be done through different mechanisms including the following:

(i) Practical education of adult and prospective farmers: This can be for short or long term and can be conducted in framers' training centers. Such training was done in Asian countries for one to four weeks (Mancebo, 1984). The topics that could be offered in such short training periods include identifying important sesame pests, current infestation level in that locality, complete life cycle of sesame seedbug, ecophysiology of sesame seedbug, and possible controlling measures of the pest. The instructional methods that could be important are demonstrations, discussions, and farm visits or field trips. It is advisable that such trainings involve farmers from all sesame growing ecological zones of Ethiopia where sesame seedbugs are prevalent. The introduction of agricultural technologies at school level could also provide students with different work experiences, which could encourage them to engage in different activities to meet the needs of their family and the community.

(ii) Training Zonal Agricultural Development Workers at Kafta- Humera: The most important tool for accelerating national agricultural development in a country with a large agricultural sector is the establishment of an effective and strong linkage between researchers and extension systems. Such a strong linkage will promote the evaluation and transfer of new agricultural knowledge, skill, and technology that could satisfy the needs of farmers, increasing production.

(iii) Research results of different agricultural activities should reach farmers to increase their production and productivity. The extension system is most important for transferring research results to the target farmers; it can act as a bridge between research findings and farmers. Therefore, it is very important to train the agricultural development workers about the biology of the pests in general and of sesame seedbug in particular. Such a program has been implemented by the Research and Extension department of Holetta research center, Ethiopia for five years and the training program had created a better relationship and understanding between researchers and extension workers (Metaferia, 1990).

Conclusions

Findings showed that sesame production was continuously decreasing in the years 2003- 2007, in which climate and pest problem were the major causative factors. It was also revealed that there was a knowledge gap about sesame seedbug among farmers as well as the agricultural development workers (agriculture personnel). As agrarian country, this gap should be abridged and emphasis should be given even to primary and secondary education students in rural areas, where dropout rate is considerable and most of the dropouts join the farming sector. Creating strong linkage between research and extension systems is absolutely essential as well so that the evaluation and transfer of a new agricultural technology that satisfies the need of the farmers could be promoted.

Competing Interests

The authors declare that they have no competing interests.

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