Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Studies on the Use of Sugarcane By-Product (Molasses) for the Management of the Fall Armyworm, Spodoptera frugiperda (J.E. Smith) (Lepidoptera: Noctuidae), on Maize and Sorghum

Ahmed Ibrahim

ibrahimyuya03@gmail.com

Ethiopian Institute of Agricultural Research

Mulatua Wondimu

Ethiopian Institute of Agricultural Research

Workshet Taye

Ethiopian Institute of Agricultural Research

Tola Demiyo

Ethiopian Institute of Agricultural Research

Mogos Mekonine

Ethiopian Institute of Agricultural Research

Research Article

Keywords: /phrases: Molasses, Maize, Pheromone lure, Sorghum and Tracer

Posted Date: November 19th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10758234/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Studies on the Use of Sugarcane By-Product (Molasses) for the Management of the Fall Armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae), on Maize and Sorghum.

Ahmed Ibrahim[1], Mulatua Wondimu[1], Workshet Taye[2], Tola Demiyo[2] and Mogos Mekonine[2]
[12]Ethiopian Institute of Agricultural Research, Melkassa Agricultural Research Centre, P.O.Box-436, Adama, Ethiopia.
Corresponding Author's E-mail: ibrahimyuya02@gmail.com/ibrahimyuya03@gmail.com.

Abstract

Two field experiments evaluated sugarcane molasses as an attractant, monitoring tool, and management component against the fall armyworm (*Spodoptera frugiperda*) in maize and sorghum at the Melkassa Research Centre and the Miesso Research Sub-Station. The first experiment compared molasses (1 kg/ha), a commercial sex-pheromone lure, and an untreated check. Traps were installed 1.5 m above ground, spaced 100 m apart, and deployed from 10–15 days after crop emergence until flowering. Molasses and pheromone traps were replaced every 15 and 30 days, respectively. Pheromone traps captured the highest number of moths, while molasses traps ranked second, confirming their potential for adult monitoring, early detection, and assessment of pest population dynamics and migration. Following these promising results, the second experiment evaluated molasses alone (1 kg/ha), molasses at half rate plus chemical at half rate, the standard chemical treatment (Tracer), and an untreated check. The standard chemical and molasses–chemical combination achieved the greatest suppression of *S. frugiperda*, followed by molasses alone. These results indicate that molasses can complement chemical control by attracting adults and potentially increasing their exposure to management interventions. Overall, molasses demonstrated value as a food-based attractant and tool for monitoring fall armyworm activity under field conditions. Molasses-based trapping can therefore support integrated pest management (IPM) programs by providing early warning, improving understanding of pest population dynamics, and complementing chemical control. Its use may be particularly valuable in maize production, where timely detection and effective management of fall armyworm are essential for reducing crop damage and improving the effectiveness of integrated pest management strategies.

Keywords/phrases: Molasses, Maize, Pheromone lure, Sorghum and Tracer

1. Introduction

Fall armyworm (FAW), *Spodoptera frugiperda*, is an insect native to the tropical and subtropical regions of the Americas. The pest first arrived in Africa in 2016 and was intercepted in late February 2017 in a few hectares of irrigated maize fields in southern Ethiopia. Since then, it has spread to nearly all parts of Ethiopia. In the Americas, *Spodoptera frugiperda* is a migratory pest that can cause severe damage to maize during warm and humid conditions (FAO, 2017).

In Ethiopia, cereal crops, especially maize grown in the belg and meher seasons under consistently warm and moist weather, provide favourable conditions for the insect to multiply rapidly and expand into new areas. The larval stage feeds on more than 80 plant species and produces multiple generations each year. Adult moths can fly up to 100 km in a single night. *Spodoptera frugiperda* was first detected in Central and Western Africa in early 2016, and has since been reported and confirmed across all mainland Southern African countries (except Lesotho), as well as in Madagascar and the Seychelles (island state). To date, *Spodoptera frugiperda* has been detected in almost all Sub-Saharan African countries, including Ethiopia (FAO, 2018).

After *Spodoptera frugiperda* appeared in Ethiopia, farmers were advised to regularly monitor their fields and manually remove larvae that avoid pesticide treatments. Recent reports indicate that more than 80,000 hectares of maize and sorghum have been attacked by *Spodoptera frugiperda* (Abraham *et al.,* 2017). Kumela *et al.* (2019) further reported that the infestation has reached almost all parts of the country. Out of 1.8 million hectares planted with maize and sorghum, about 190,000 hectares had been affected so far. According to FAO (2019), without effective control measures, the pest could cause extensive crop losses, particularly in maize and sorghum, estimated at USD 3.6–6.2 billion per year across 12 major African cereal-producing countries, including Ethiopia. FAO (2019) also notes that, if not properly managed, *Spodoptera frugiperda* an cause 70–100% yield losses of maize and sorghum in Ethiopia.

To address these problems, various management practices have been applied in different parts of Ethiopia, including wood ash, sand, plant-based repellents, soap, salt, and chemical pesticides. However, chemical control accounts for the largest proportion of responses. FAO (2019) reported

that approximately USD 2 million was allocated to purchase 69,000 litres of pesticides, and that about 15,600 hectares were managed through handpicking. Despite these efforts, farmers require substantial support to sustainably manage *Spodoptera frugiperda* within their cropping systems through Integrated Pest Management (IPM). One potential IPM approach is the use of sugarcane byproduct molasses as a pest-control tool.

Somchai (2001) reported that, while observing a farmer's field, he noticed insects were attracted to the farmer's hands after the farmer worked with sugarcane molasses. He later found many dead insects in a container of waste molasses that had been unintentionally left near asparagus fields for two days. This observation led to the idea that sugarcane molasses could be used to control insect pests. Somchai (2001) also described work under a "Participatory Technology Development" (PTD) program in the Kalasin project area, where multiple designs of insect trap bottles with different molasses concentrations were tested in asparagus fields to attract insects. Andrade et al. (2000) reported that molasses traps can be useful for local monitoring of *Spodoptera frugiperda*, early warning, control, and for understanding migration patterns. They also noted that this approach had been used in Costa Rica for *Spodoptera frugiperda* management since 1992 in more than 2,000 hectares of melon fields, using four to five traps per hectare.

Similarly, Berhanu (2014) reported that, farmers in Ethiopia, particularly Northern Gonder (Metema), Gemu Gofa, and Afar, used molasses traps to control cotton bollworm and achieved a 72% reduction in yield loss due to the worms. Data from Zambia in the 2014 season showed that an average of 155 weekly moths were caught per trap, which suggested potential yield savings of 465 kg on a cotton farm (Kaut, 2016). In Uganda (Kampala), FAO (2017) reported that molasses traps were distributed to farmers, resulting in a reduction of pesticide applications by 50%. Therefore, molasses traps represent an emerging technology for managing *Spodoptera frugiperda*. However, they have not yet been used in the present study cases. Based on the information above, the current study has the following objectives:

1.1. Objective (s)

- To identify the species of insect pests trapped by molasses and pheromone traps
- To evaluate the trapping efficacy of molasses and pheromone traps on fall armyworm moths

- To evaluate the control efficacy of molasses traps against *Spodoptera frugiperda* on maize

2. Material and Methods

2.1. Trapping efficacy evaluation experiment

The first experiment was conducted on maize and sorghum in the Mlkassa and Miesso areas. To prepare one molasses trap, the following materials were used: 1 kg molasses, a 1 m string (rope), a 3-litre-capacity yellow jerry can, a 2.5 m peg for hanging, a knife for cutting the plastic, and clean water (to slightly dilute the molasses). Molasses (1 kg/ha), commercially available sex pheromone lures, and untreated plots (controls) were evaluated for trapping efficacy against insect pests, including *Spodoptera frugiperda* moths, in maize and sorghum fields. Yellow and white plastic jerry cans were purchased from the local market. Molasses was obtained as a sugarcane by-product from a sugar factory. Commercially released pheromone lures were obtained from ICIPE. Traps were installed at a height of 1.5 m above the ground using wooden stakes, with a spacing of 100 m between traps. The molasses was stirred every 5 days. Funnel traps were used to deploy the commercial pheromone lures. The molasses and pheromone components were replaced every 15 and 30 days, respectively. Traps were placed when the crops were 10–15 days old (after germination) and remained in place until the flowering stage. Trap catches were recorded every 7 days. During each assessment, the number of *fall armyworm* individuals and the species and numbers of other insect pests captured were recorded to evaluate trap performance. '**Clinical trial number: not applicable.**'

2.2. Field evaluation of molasses for the control of *Spodoptera frugiperda*

The second experiment was conducted at Melkassa Agricultural Research Centre in the maize field to evaluate the control efficacy of molasses against fall armyworm (*Spodoptera frugiperda*). Molasses trap preparation followed the same procedure as in the first experiment. Treatments used for evaluating molasses efficacy included: molasses at 1 kg/ha; molasses at 1/2 rate (0.5 kg/ha) combined with chemical at 1/2 rate; a standard check chemical treatment (Tracer, 300 ml/ha); and an untreated control. Yellow and white plastic jerry cans were purchased from the market, and molasses was obtained from a sugar factory. Commercially released pheromone lures were supplied by ICIPE and the Ministry of Agriculture. Traps were installed at a height of 1.5 m above

the ground using wooden stakes, with a spacing of 100 m between traps. The molasses was stirred every 5 days. Funnel traps were used to deploy the commercial pheromone lures. Molasses and pheromone components were replaced every 15 and 30 days, respectively. Traps were placed when maize plants were 10–15 days old after germination and remained in place until the flowering stage. Trap catches were recorded every 7 days. To assess field performance, multiple parameters were recorded, including: fall armyworm leaf damage rating at 15 days after emergence (DAE); number of plants after thinning; number of damaged plants at seedling stage; number of larvae per 30 sampled plants; number of cobs attacked by *S. frugiperda*; number of tassels attacked by FAW; number of egg mass colonies per 30 plants; and number of plants at harvest and yield-related parameters. We analysed the collected data using SAS version 13.2. **'Clinical trial number: not applicable.'**

3. Results and discussions

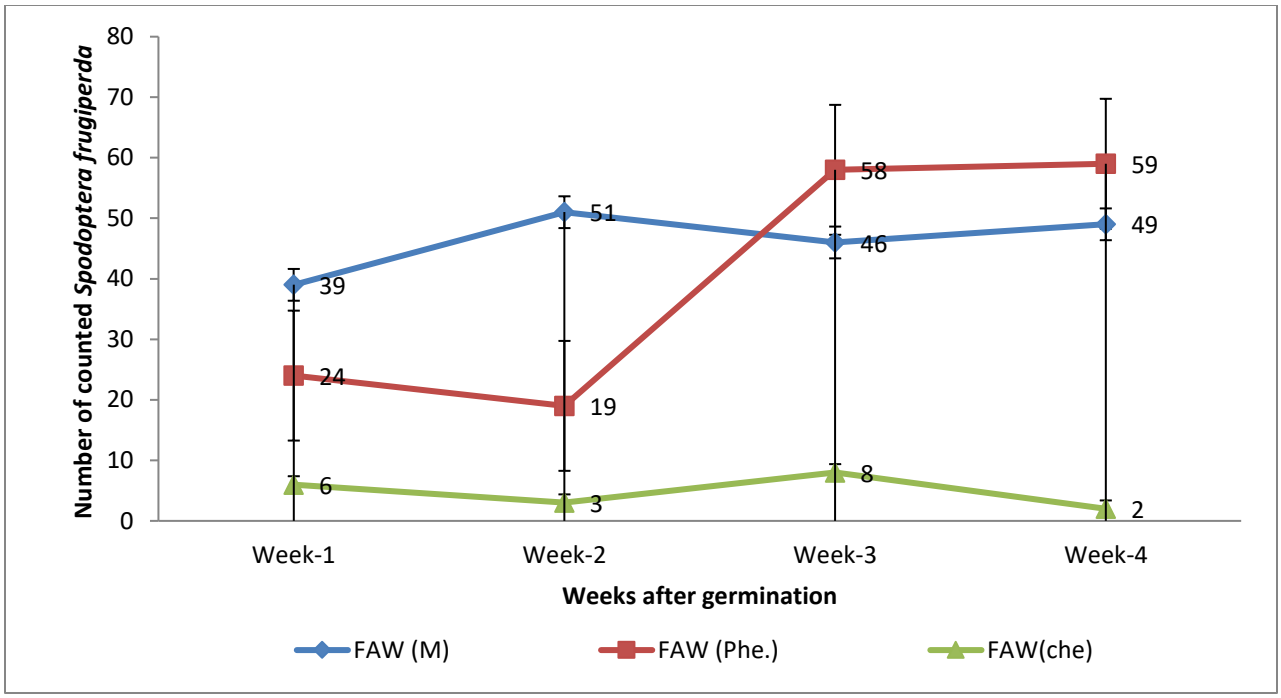
3.1. Molasses and pheromone trapping efficacy of *Spodoptera frugiperda* moths in maize fields at Melkassa Agricultural Research Centre, East Shoa, Ethiopia.

Molasses trap, pheromone trap, and check without lure were evaluated for *Spodoptera frugiperda* trapping efficacy in maize and sorghum crop fields. The maximum number of *Spodoptera frugiperda* moths was trapped in the molasses trap, followed by the pheromone trap from week-1 to week 2, and increasing trends were observed. However, the reverse and maximum numbers of fall armyworm moths were recorded in the pheromone trap from week-3 to week 4, followed by the molasses trap (Figure 1). Likewise, the maximum number of fall armyworm moths was recorded in the pheromone trap, followed by the molasses trap from week-5 to week 12, and decreasing trends were observed after week-12 (Figure 2, Figure 3, Figure 6 and Figure 7).

The maximum number of *Spodoptera frugiperda* moths was recorded in the pheromone trap (644), followed by the molasses trap (571) during the experimental season at Melkassa Agricultural Research Centre in the maize field (Figure 4). Likewise, the number of *Spodoptera frugiperda* moths trapped in the pheromone trap was significantly ($P<0.01$) higher (724), followed by the molasses trap (650) during the experimental season on Sorghum at Miesso (Figure 8). This is in accordance with Berhanu (2014), who reported that, 7011 moths were trapped in molasses traps on 428 farmers' fields. Berhanu (2014) also mentioned that more than 420 farmers used the trap and more than 7,000 moths were reported to be trapped in 2014, while 9,200 farmers set up traps

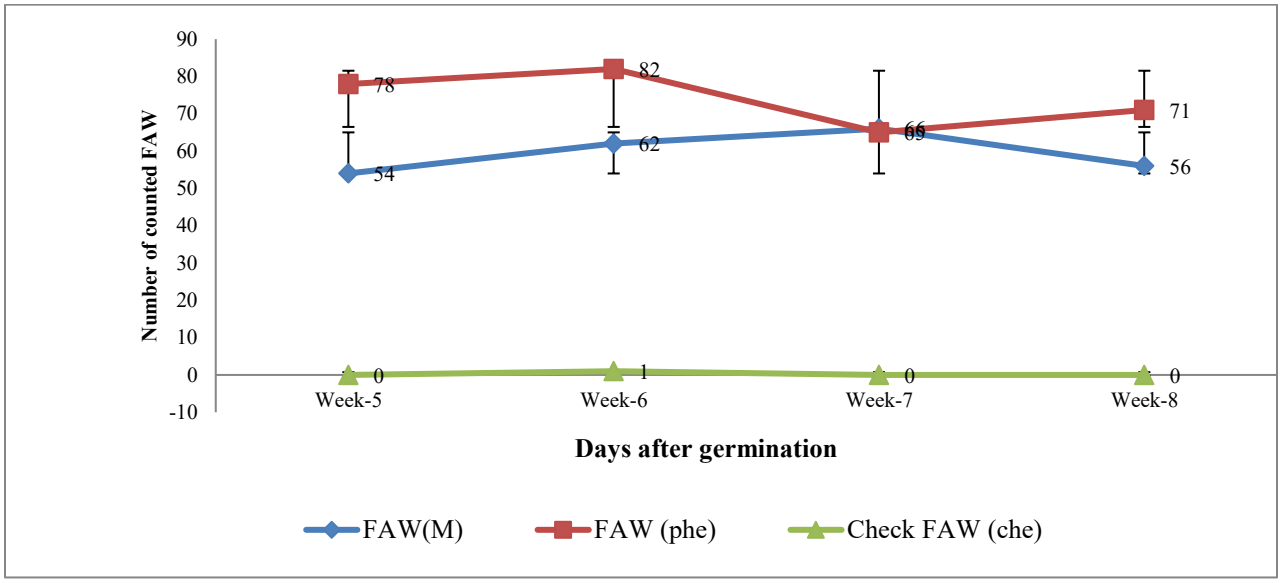
on 7,575 ha in 2015. Compared to the 2014 season, molasses trap use by farmers increased by 22-fold. This was due to farmers' awareness and an increased number of farmers growing cotton during the 2015 cropping season.

In pheromone traps, only *Spodoptera frugiperda* moths and very few other insects were trapped because of trapping specificity. But in molasses traps, insects from Diptera, other Lepidoptera, Coleoptera, and Hymenoptera were also trapped. On the other hand, the experiment at miesso (Sorghum) trapped the maximum number of *Spodoptera frugiperda* moths (724) compared to the MARC (maize) experiment (647). Even though the maximum number of *Spodoptera frugiperda* moths was trapped in a pheromone trap, almost an equivalent number of *Spodoptera frugiperda* moths was also recorded in a molasses trap, both in maize and sorghum fields. According to Somchai *et al.* (2004), 388 Lepidopteron insect pests such as cabbage looper, cabbage cutworm, and leaf-eating beetles were trapped in the molasses trap in the cabbage field. The number of fall armyworms trapped in the molasses trap increased from week1 to week 8, and decreasing trends were observed in the next weeks; similarly, the numbers of trapped Lepidopteron insect pests were alarmingly increasing from week1 to week8 in the cabbage field's experiments (Somachi *et al.*, 2004). The trapped *Spodoptera frugiperda* was reduced as the age of the plants increased from the early stage to the maturity stage. For the reasons that *Spodoptera frugiperda* prefers young and succulent leaves for its progeny over mature leaves. Dissimilarities of trapped insect pests were recorded between molasses and pheromone lure traps, and the majority of insect pests trapped in pheromone traps were fall armyworms, because the pheromone lure is specific to *Spodoptera frugiperda*. Even though the trapped *Spodoptera frugiperda* was very high in molasses traps, insect pests from Coleoptera, Diptera, and Hymenoptera were also trapped in molasses traps. According to (Hongayo *et al.*, 2014), five (5) insect taxa were identified in Songculan Lagoon, Thailand, namely: Hymenoptera, Lepidoptera, Diptera, Coleoptera, and Blattodea. These insects were trapped in molasses bait. On day 1, five (5) insect taxa were determined, which included Lepidoptera, Hymenoptera, Coleoptera, Diptera, and Blattodea, which had the highest number of individuals collected in the Songculan Lagoon area. For days two (2) and three (3), five (5) taxa were determined, namely Lepidoptera, Hymenoptera, Blattodea, and Diptera, with day three (3) having the least number of individuals collected in Songculan Lagoon, Thailand.



Key: M=molasses**, W**=week**, Phe**=pheromone lure, **FAW**= fall armyworm and **Che**= chemical

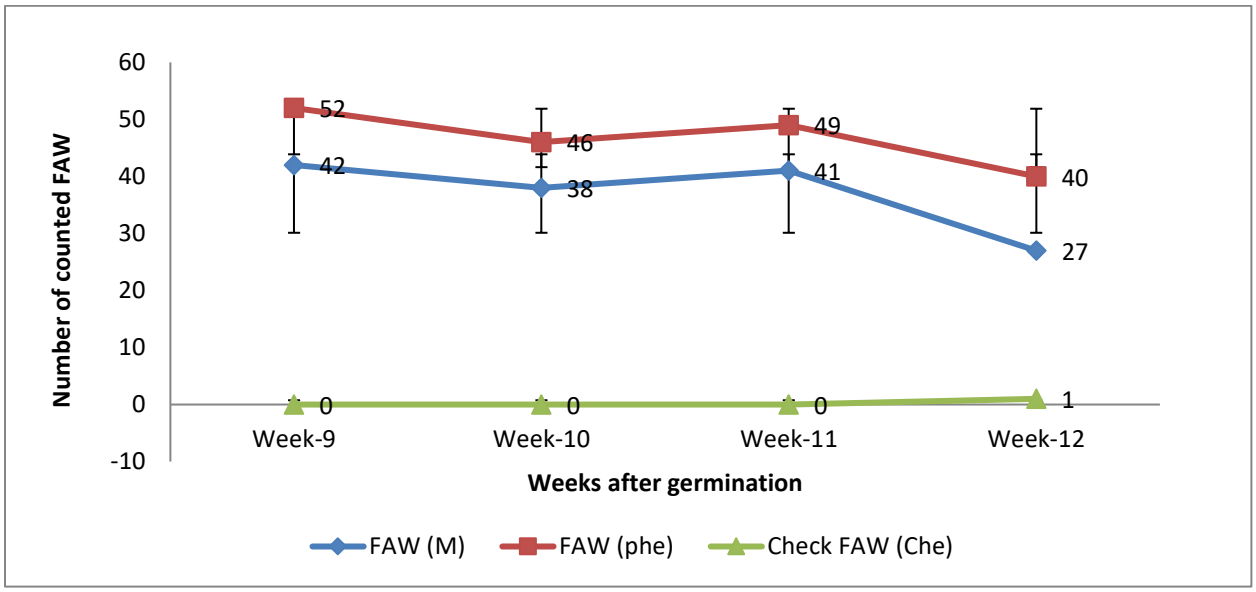
Figure 1: Trapping efficacy evaluation of molasses and pheromone traps for *Spodoptera frugiperda* at Melkassa Agricultural Research Centre (W1-W4) in a maize field.



Key: **FAW**=fall armyworm**, Phe**=pheromone lure**, and che**= chemical

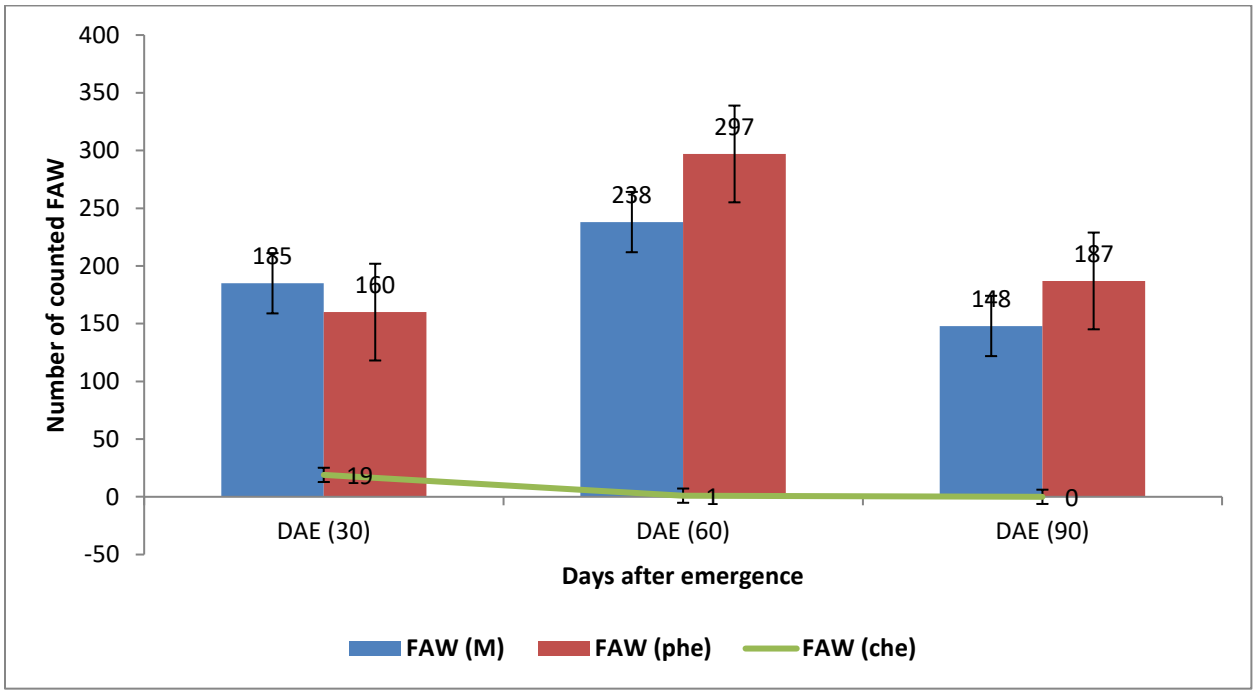
Figure 2: Trapping efficacy evaluation of molasses and pheromone traps on *Spodoptera frugiperda* at Melkas' Agricultural Research Centre from W 5-W 8 in a maize field.

ibrahimyuya03@gmail.com



Key: M=molasses**, W**= week**, Phe**=pheromone lure**,** and **Che**= chemical

Figure 3: Trapping efficacy evaluation of molasses and pheromone traps for *Spodoptera frugiperda* at Melkassa Agricultural Research Centre (W9-W12) in a maize field.



Key: M=molasses**, Phe**=pheromone lure**, DAE**= Days after emergency and **Che**= chemical

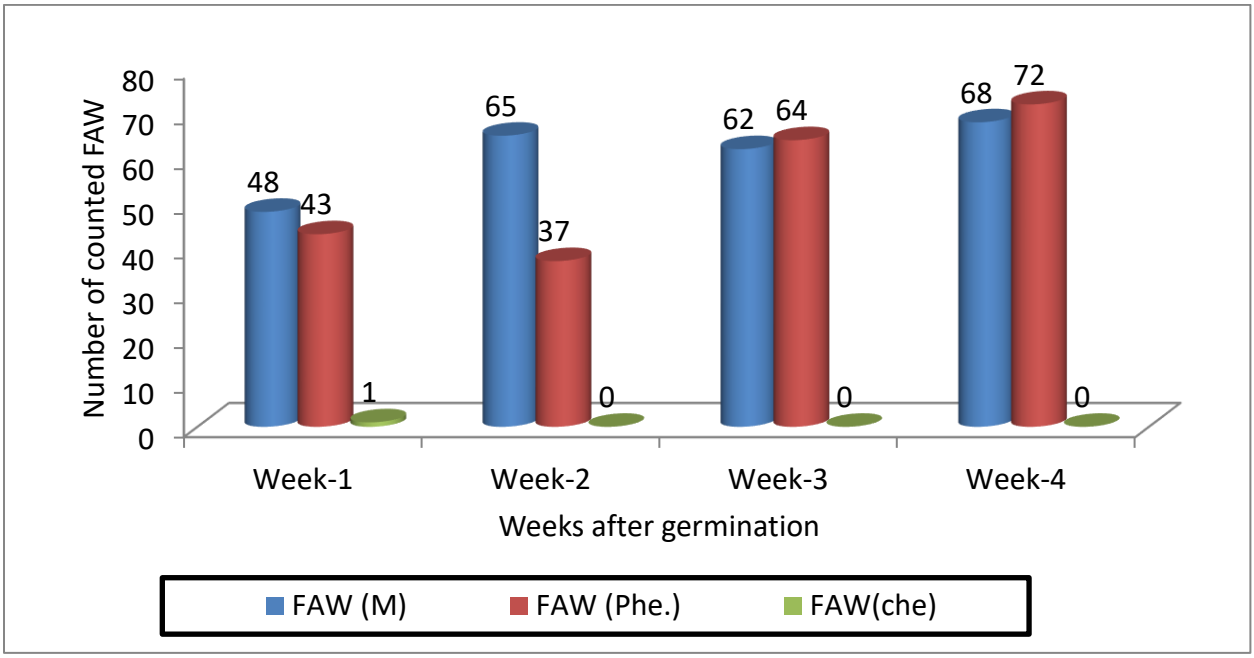
Figure 4: Trapping efficacy evaluation of molasses and pheromone traps for *Spodoptera frugiperda* in the maize field at Melkassa Agricultural Research Centre from DAE (30) to DAE (90).

ibrahimyuya03@gmail.com

Table 1: Total number of insect pests trapped during the experimental period in the maize field at Melkassa Agricultural Research Centre

Other insect pests trapped	Molasses	Pheromone	Check
Other Lepidoptera	373	37	2
Diptera	414	0	9
Hymenoptera	63	2	4
Colleoptera	75	2	0

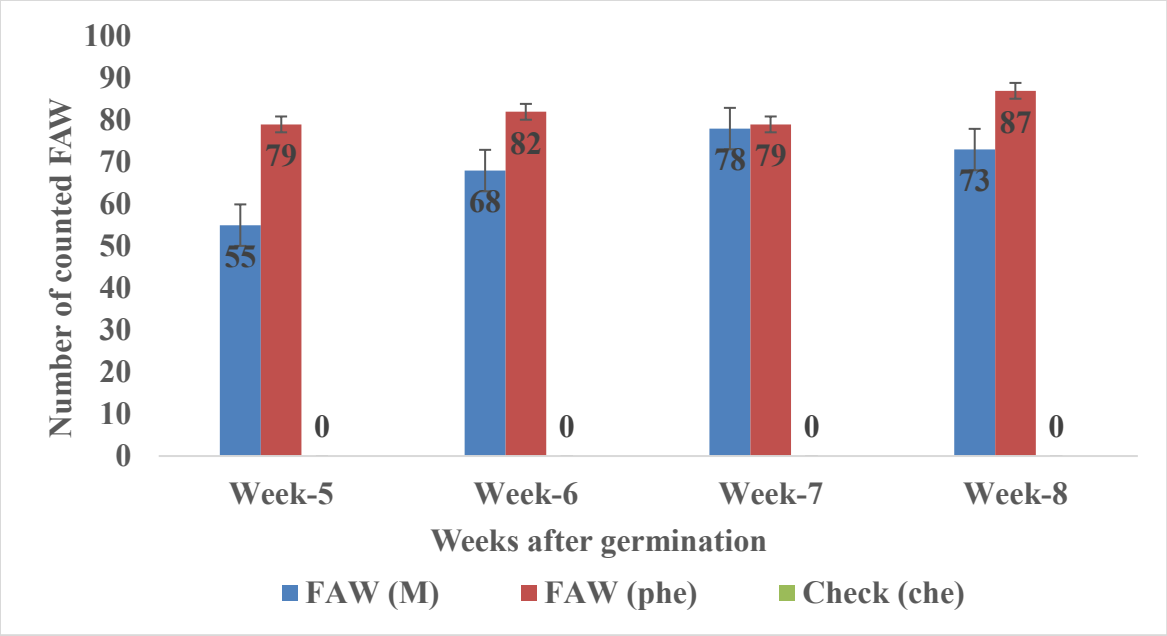
3.2. Evaluations of Molasses and pheromone trapping efficacy of *Spodoptera frugiperda* moths in sorghum fields at Miesso area, West Hararghe, Ethiopia.



Key: M=molasses**, W**=week, **Phe**=pheromone lure**, and Che**= chemical, **FAW**=fall armyworm

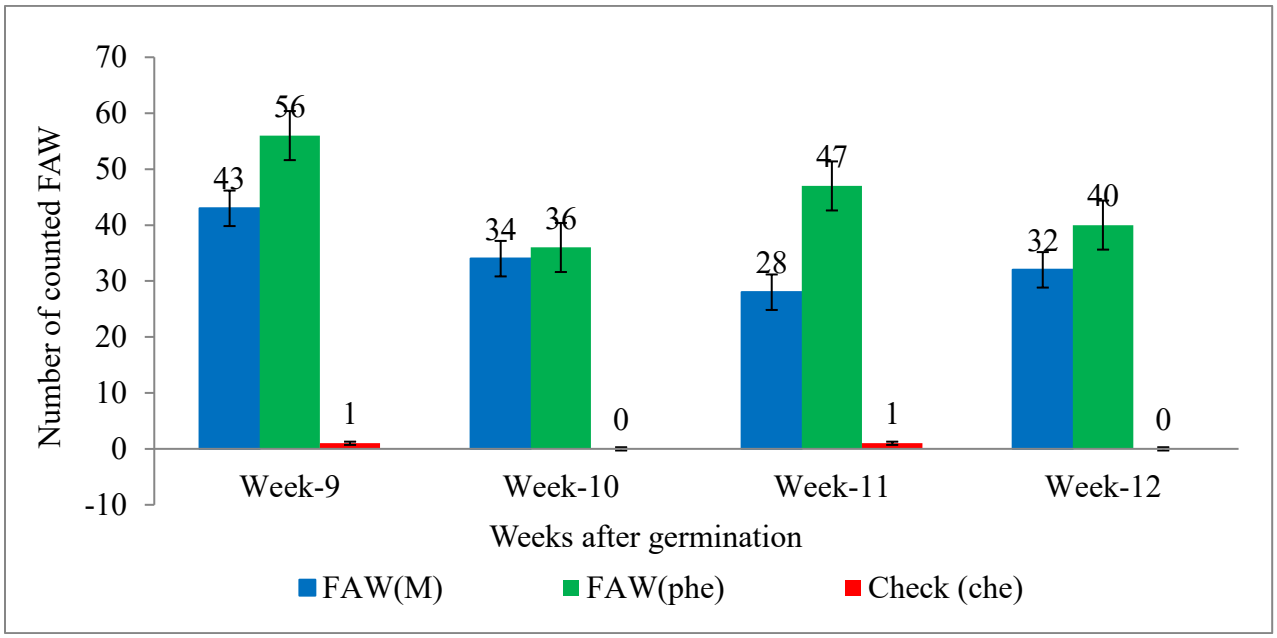
Figure 5: Tapping efficacy evaluation of molasses and pheromone traps for *Spodoptera frugiperda* moths at Miesso from Week 1 to Week 4 in a sorghum field at the Miesso area.

ibrahimyuya03@gmail.com



Key: W=week, FAW=fall armyworm, **M**=molasses**, phe**=pheromone lure**,** and **che**= chemical

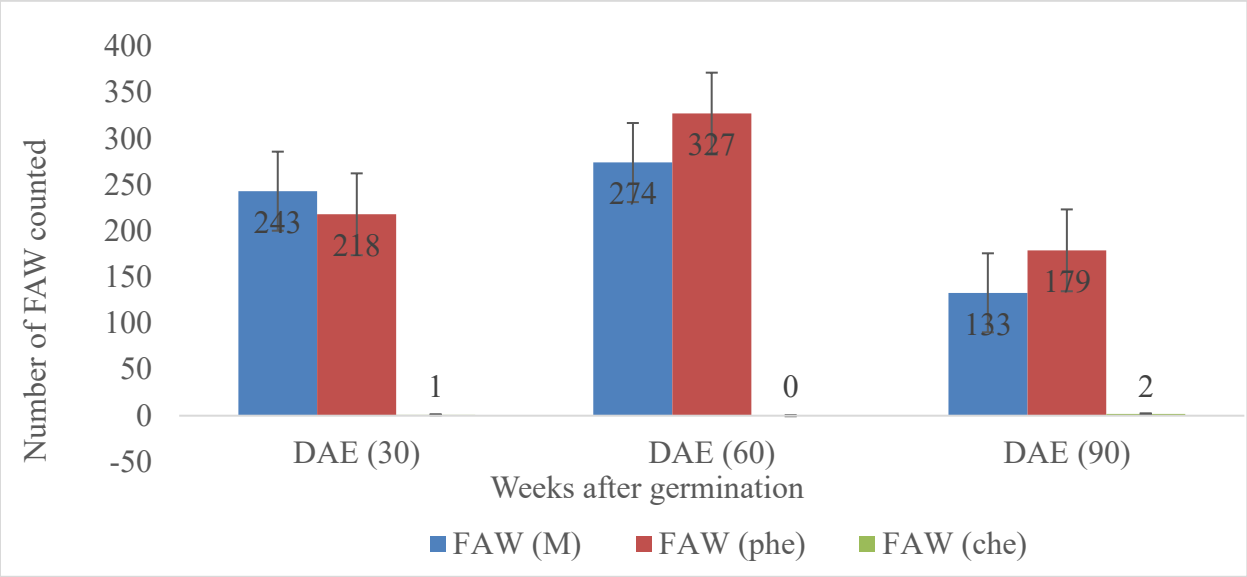
Figure 6: Tapping efficacy of molasses and pheromone traps for *Spodoptera frugiperda* moths at Miesso area from Weeks 5-8 in the sorghum field.



Key: M=molasses, phe=pheromone lure, and che= chemical

Figure 7: Tapping efficacy of molasses and pheromone traps for *Spodoptera ferugiperda* at Miesso area from Week 9 to Week 12 in sorghum.

ibrahimyuya03@gmail.com



Key: M=molasses, Phe=pheromone lure, DAE=Days after emergency and Che= chemical

Figure 8: Tapping efficacy of molasses and pheromone traps for *Spodoptera frugiperda* moths at Miesso area from DAE (30) – DAE (90) in sorghum field.

Table 2: Total number of insect pests trapped in molasses, pheromone and check traps during the experimental period in the sorghum field at Miesso area, West Hararghe.

Other insect pests trapped	Molasses	Pheromone	Check
Other Lepidopteron	421	23	2
Dipteran	387	2	7
Hymenoptera	40	11	1
Coleopteran	67	17	0

Significant differences were observed among the treatments in terms of *S. frugiperda damage* at the knee-height stage, the number of cobs and tassels damaged by *S. frugiperda*, the number of egg mass colonies, and grain yield (Table 3 and Table 4). In particular, the number of damaged plants at the seedling stage, average fall armyworm damage rating, number of ears (cobs) attacked, number of tassels attacked, egg mass colony counts, and larval abundance (larvae per 30 sampled plants) were significantly ($P < 0.01$) higher in the untreated check. Infestation levels were also higher in the molasses and pheromone trap treatments, indicating that these attract-and-capture approaches allow some pest pressure to persist compared with chemical protection.

In contrast, infestation and plant damage were significantly ($P < 0.01$) reduced in the standard check (chemical) and the integrated treatment combining half molasses with half chemical. This pattern suggests that combining a semi-targeted, behaviorally driven lure (molasses/pheromone) with a corrective, rapid-kill chemical component can better interrupt key pest population processes such as adult attraction, oviposition success, and larval survival, thereby limiting egg deposition and subsequent larval establishment on the crop. Consistent with this interpretation, yield (quintal/ha) was significantly ($P < 0.01$) higher in the standard check and in the half molasses + half chemical treatment, followed by the pheromone and molasses-only treatments (Table 3 and Table 4).

Overall, while the present results were not identical to those reported by other studies that evaluated molasses traps for *S. frugiperda* management, they align in a general direction: trap-based approaches produced substantially better outcomes than the untreated check, but chemical control remained more suppressive. Importantly, the trap-based treatments recorded higher performance (in terms of reduced damage and improved yield) than the untreated plots, but were not as effective as chemical treatments. From an applied IPM perspective, molasses-based trapping showed meaningful agronomic and economic advantages. For example, Somchai et al. (2004) reported that using molasses to grow cabbage increased farmers' net profit by 51% compared with conventional chemical insect control and the untreated check. They also found that farmers perceived the molasses IPM system as effective in reducing insect population and damage, and that insecticide costs were reduced by about 30–50% compared with untreated control conditions and conventional approaches.

Similarly, Berhanu (2014) emphasised that molasses trap-based IPM is an important component of sustainable production because it reduces reliance on hazardous insecticides. Berhanu (2014) also reported that, farmers in molasses-trap-based production systems relied on these traps to manage bollworm (cotton) during the production season. At the pest ecology level, molasses traps are also supported as practical tools for *S. frugiperda* monitoring and behavioural disruption. Andrade et al. (2000) described molasses traps as useful for local *S. frugiperda* monitoring, early warning, and understanding fall migration patterns. They further reported that the method had been used in Costa Rica since 1992, deploying about four to five traps per hectare across more than 2,000 hectares of melon fields for *S. frugiperda* management. Consistent with this, Berhanu (2014)

reported that, farmers using molasses traps in Northern Gondar (Metema), Gemu Gofa, and Afar reduced yield losses by about 72% compared with the untreated check due to reduced pest pressure.

Other evidence from regional field situations also supports the potential of molasses traps. Kaut (2016) reported that molasses trap data from Zambia showed an average of 155 weekly moths caught per trap during the 2014 season, suggesting possible yield savings of about 465 kg on cotton farms compared with untreated conditions. Additionally, FAO (2017) in Uganda (Kampala) reported that molasses traps were distributed to farmers and pesticide applications were reduced by 50%. Collectively, these findings support the conclusion that molasses-based trapping can contribute effectively to FAW/IPM programs, particularly when used to reduce pest populations and enhance early detection, and when integrated with other control measures where needed.

Table 3: Evaluation of molasses for reducing maize damage caused by *Spodoptera frugiperda*

Treatments	Number of plants after thinning	No of plants at harvest	No. of damaged plants at seedling stage	FAW damage rating scale before treatment	Average FAW damage rating (30dae-105dae)
Molasses trap(1kg/ha)	359.67a	354.33b	3.00b	3.22b	5.69b
Molasses (1/2rate/ha) + chemical tracer (1/2rate/ha)	359.67a	356.67ab	0.33c	3.42b	1.9c
Standard check (Tracer 500ml/ha)	360.00a	358.00a	0.33c	4.35a	1.24c
Commercial pheromone lure	359.67a	353.33b	4.67b	3.69ab	5.60b
Untreated check without chemical but with killer	359.66a	337.00c	10.67a	3.75ab	8.01a
CV%	0.15	0.52	30.95	10.56	8.54
Lsd	1.059	3.48	2.21	0.73	0.72
Critical value	2.30	2.30	2.30	2.30	2.31
Error mean square	0.32	3.43	1.38	0.15	0.14

Means followed by the same letter within a column are not significantly different from each other at the 1% level of probability (Student-Newman-Keuls Range Test).

ibrahimyuya03@gmail.com

Table 4: Evaluation of Molasses on the Number of Egg Masses, Larvae, and Maize Ears and Tassels Attacked by *Spodoptera frugiperda.*

Treatments	No of ears attacked by FAW/30plants	No. of tassels attacked by FAW/30plants	No of egg mass colony/30plants	No of larvae/ 30plants	Yield qt/ha
Molasses trap(1kg/ha)	14.33b	20.00ab	6.33b	13.00b	31.80c
Molasses (1/2rate/ha) + chemical tracer (1/2rate/ha)	2.67c	6.33c	0.66c	1.00c	38.70b
Standard check (Tracer 500ml/ha)	1.00c	4.33c	1.33c	1.33c	44.85a C
Commercial pheromone lure	13.00b	14.33b	6.67b	12.33b	30.87c
Untreated check without chemical but with killer	24.33a	26.33a	13.33a	22.67a	24.36d
CV%	14.38	27.65	20.88	14.51	8.03
Lsd	2.99	7.42	2.23	2.75	5.16
Critical value	2.31	2.31	2.31	2.31	2.31
Error mean square	2.53	15.57	1.4	2.13	7.51

4. Summary and conclusion

Molasses (1 kg/ha), a synthetic sex pheromone lure, and an untreated check were first evaluated to determine the trapping efficacy of different attractants against *S. frugiperda* (fall armyworm) moths. After the trapping performance of molasses was confirmed, subsequent field experiments were conducted to evaluate molasses for *S. frugiperda* control. In the field, treatments included molasses at 1 kg/ha; molasses at 1/2 rate (0.5 kg/ha) combined with chemical at 1/2 rate; a standard chemical check (Tracer, 500 ml/ha); and an untreated control. The field evaluation indicated that the highest level of *S. frugiperda* control was achieved in the standard chemical check and the half molasses + half chemical treatment, followed by the molasses-only treatment and the pheromone lure trap (Table/Results section). Although chemical treatments provided the strongest suppression, molasses and pheromone-based traps still produced better pest control outcomes than the untreated check. This demonstrates that lure-based strategies can reduce pest pressure and contribute to *S. frugiperda* management, even if they may not fully replace chemical protection.

From a behavioural and pest-ecology standpoint, molasses acts primarily as an attractant because it contains volatile compounds that can disperse into the surrounding air. These volatile chemicals

may be detected by insects that are receptive to the specific odour cues, enabling the insects—particularly adult moths to locate the trap from short to long distances. In addition, molasses-baited traps can support monitoring and early warning by increasing the likelihood of capturing the pest population at the adult stage, which is critical because adult moth abundance is closely linked to subsequent egg laying and larval infestation.

Similarly, synthetic pheromone lures target sex-specific communication signals, making them effective for attracting male moths to traps. When used together with molasses, these lure types can provide complementary information about adult presence and relative population dynamics. In this study, although different insect groups were attracted to the traps (including hymenopteran, coleopteran, and dipteran insects), *S. frugiperda* was the dominant species captured with molasses. This suggests that the chemical/volatile profile of molasses preferentially draws *S. frugiperda* moths, while non-target insects are attracted to the same general odour environment.

Overall, the results support the conclusion that molasses can be recommended as part of *S. frugiperda* integrated pest management (IPM). Specifically, molasses-based trapping is useful for (i) monitoring moth activity, (ii) providing early alert for impending infestation, (iii) supporting localized detection of pest presence and movement patterns (including fall migration flights), and (iv) contributing to control by reducing the adult population available for egg laying. When integrated with other IPM components such as cultural practices, scouting, and, where necessary, selective chemical use, molasses trapping can enhance the sustainability and effectiveness of *S. frugiperda* management while helping reduce reliance on hazardous insecticides.

5. Acknowledgement

I am very grateful for the field assistance and field supervision rendered by the Crop Protection Research Process of Melkassa Agricultural Research Centre and to the research staff there for their efforts in managing the field.

ibrahimyuya03@gmail.com

6. Funding Statement

This study received financial support from the Ethiopian Institute of Agricultural Research and the Korea-Africa Food and Agriculture Cooperation Initiative (KAFACI) through the FAW-IPM Project. The views expressed in this manuscript are those of the authors and do not necessarily represent the opinions or policies of the funding organizations.

7. Consent for publication

This manuscript does not contain any person's data in any form (including individual details, images, or videos), and therefore, consent for publication is not applicable.

8. Competing Interests

The authors declare that they have no competing interests.

9. Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

ibrahimyuya03@gmail.com

10. References

Abrahams P., Bateman M., Beale T., Clottey V., Cock M., Colmenarez Y., Corniani N., Day R., Early R., Godwin JL., Gomez J., Gonzalez-Moreno P., Murphy ST., Oppong-Mensah B., Phiri Pratt C., Richards G., Silvestri S., Witt A. (2017) Fall Armyworm: Impacts and implications for Africa (September 2017), CABI, UK.

Andrade R., Rodriguez C. and Oehlschlager, A. C. (2000) Optimisation of a pheromone lure for *Spodoptera frugiperda* (Smith) in Central America. J. Braz. Chem. Soc. 11: 609-613.

Berhanu Woldu and Asefa A. (2014) The challenges of large-scale cotton farms and the prospects of sustainable small-scale farmer cotton production in Ethiopia. In: the Proceedings of the 3rd ICTA held on May 02-03, 2014, Bahir Dar University, Ethiopia.

CSA (2012) Central Statistical Agency for Ethiopia 2012.

FAO and ICAC (2015) Measuring of Sustainability in cotton farming systems. Toward a guidance framework. Report prepared by the ICAC Expert Panel on Social, Environmental and Economic Performance of Cotton Production with the FAO Plant Production and Protection Division, Rome, pp 116-121.

FAO (2017c) Briefing note on FAO actions on fall armyworm in Africa, Oct. 1, 2017, http://www.fao.org/3/a-bt415e.pdf.

FAO (2017) Briefing note on FAO actions on fall armyworm in Africa, Oct. 1, 2017, http://www.fao.org/3/a-bt415e.pdf

FAO (2018) Integrated management of the fall armyworm on maize a guide for farmer field schools in Africa. Retrieved from http://www.fao.org/faostat/en/.

FAO (2019) Briefing note on FAO actions on fall armyworm. http://www.fao.org/3/BS183E/bs183e.pdf.

OAE **(**2006**).** Bangkok, Thailand: Centre for Agricultural Information, Office of Agricultural Economics, Ministry of Agriculture and Co-operatives. Pp 124-127.

Oerke E.C.C., Deline H.W., Schonbeck F. and Weber A. (1999). Crop production and crop protection: estimated crop losses in major food and cash crops. 9(24-54).

Kaut C. (2016). Cotton Crop Protection by Local Means, *33rd International Cotton Conference,* March 16-18, 2016*,* Bremen, Germany. 9(54-63).

Kumela T., Simiyu J., Sisay B., Likhayo P., Mendesil E., Gohole L. & Tefera, T. (2019) Farmers' knowledge, perceptions, and management practices of the new invasive pest, fall armyworm (*Spodoptera frugiperda*) in Ethiopia and Kenya. International Journal of Pest Management, 65(1), 1–9. doi:10.1080/ 09670874.2017.1423129

Somchai S., Chuachin W., Suhas P., Wani TJ., Rego and Prabhakar P. (2001) Simple and Effective Integrated Pest Management Technique for Vegetables in Northeast Thailand.15(3) (57-60).

ibrahimyuya03@gmail.com

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- DeclarationStatement.docx