**Efficacy of Synthetic insecticides against Sesame webworm (Antigastra catalaunalis Duponchel) in North West Amhara Region**

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**ABSTRACT**

*Antigastra catalaunalis is the most serious pest of sesame, which is causing heavy losses in lowland areas, in northwestern, Ethiopia. Therefore the field experiment was conducted at Metema both on the experimental site and on farm while in Mirab Armachiho only on experimental in West Gondar, Ethiopia during the main cropping seasons of 2022 and 2023 to identify effective and economical insecticides for the management of sesame webworms using Randomized Complete Block Design with three replications. The treatment consists nine synthetic insectocides and Control were evaluated against sesame webworm. variety Gonder 1 used at a seed rate of 4 kg ha-1 and plot size of 12 m2 was used. Data on larvae counts and yield and yield-related parameters were recorded. The combined analysis revealed that Plots sprayed with Profenofos 40%+ Cypermethrin 4%EC and Lambda-cyhalothrin had a low number of larvae and higher grain yield. Economic analysis showed that the maximum net benefit (ETB 71102.1 ha-1) was obtained on plots treated with Profenofos 40%+ Cypermethrin 4%EC followed by (66302.25 ETB ha-1) Lambda-cyhalothrin treated plots. Hence these insecticides are recommended for the management of sesame webworm in the study areas and similar agroecologies.*

**Keywords:** Sesame, Efficacy, Economic analysis, Insecticide,Webworm,larvae,yild.

**Introduction**

Sesame (*Sesamum indicum*) is a vital oil crop produced in the tropical and subtropical parts of the World. Ethiopia is one of the major producers of sesame in the World. The crop is named the white golden because of its foreign exchange capability. 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% occurs (Pathirana, 1994). Production of sesame in the country is very crucial in many aspects but there are many hurdles to its production and productivity, like insect pest infestation and disease occurrence, seasonal delay, low yielding, postharvest loss, poor storage facility, difference in capsule maturity, shattering, and so on (Yohannes et al*.,* 2021). Out of which *A. catalaunalis* is the most important insect that affects sesame during various growth stages starting from two weeks after emergence and causes 90% of yield losses (Suliman et al., 2013b) . It is a pest on sesame in the tropics, and it is present in all continents, except Antarctica. *A. catalaunalis* is an important and widespread insect that damages sesame at all stages of development in Ethiopia (Negash ,2015). Studies on identification of effective and economical insecticide for the control of A. catalaunalis is limited in the study areas. Hence minimizing resistance development and knowing the efficacy of insecticides belonging to different classes is important for the management of the pest.

**MATERIALS AND METHODS**

The experiment was conducted in Metema both on the station and on farm while in Mirab Armachiho only on the station during the main cropping season of 2022 and 2023. The experimental sites are geographically located at 120 95’ Latitude to 36 015’ and 130 21’ and 370 23’ for Metema and Mirab Armachiho resepectively (IPMS, 2005). The altitude of the Metema district ranges from 550 to 1608 meters while Mirab Armachiho is 650-850 above sea level. The location represents the major commercial sesame production area of the region and There are a hot spot environment for the *A. catalaunalis*. The insecticides were applied as per factory recommendation rate. The treatments applied were: T1 (Profenofos); T2 (Dimethoate 40%); T3 (Profenafos+ Lambda Cyhalothrin); T4 (Ethiozinon 60% EC); T5 (Profenafos + cypermethrin); T6 (Profenafos + cypermethrin); T7 (Alphacypermethrin); T8 (Lambda-cyhalothrin); T9 (Deltamethrin) and T10 (Untreated control).

Randomized Complete block design (RCBD) was used replicated three times. The crop was sown on 5 m by 2.4 m with spacing of 1 m between plots and 1.5 m between blocks Sesame variety Gonder 1 with plant and row spacing of 0.1m and 0.4m respectively was planted. Fertilizer at the rate of 121 Kgha-1 NPS (all at planting) and UREA 100 ha-1 (half at planting, and half at tillering) were applied. All the insecticides had been sprayed with manual knapsack sprayer in their factory recommendation. The first spray was made economic threshold of (one larva/plant) and the second spray was at 10 days after. All other agronomic practices were implemented as per the general recommendations for sesame production and the second spray was at 10 days after. Webbed plant percentage (WPP) was recorded before and after treatment application on a plot basis by counting the total number of plants and infested plants (plants whose shoots were rolled by webworm) from the central rows of a plot. Data on plant height (PH), number of pods per plant (NPP), number of seeds per pod (NSPP), thousand seed weight (TSW), and grain yield (GY) data were collected at appropriate stages and times pertinent for each parameter. The collected data (both insect and crop) were statically analyzed using SAS software version 9.00 (SAS Institute, 2004) and means separated using Turkeys’ test (p=0.05). Partial budget analysis was done using CIMMYIT partial budget methodology. The effectiveness of each insecticide against the target insect pest, in comparison to untreated control was calculated using Abbott’s formula (Abbot, 1925)

**RESULTS AND DISCUSSION**

*Efficacy of insecticides on A. catalaunalis larvae counts;*The experiment was executed at one trial site in 2022 at Metema and two sites in 2023 at Metema and Mirab Armachiho. The result showed that in 2022 treatments didn’t show significant differences in *A. catalaunalis* intensity and other agronomic parameters before insecticide application. However, the webbed percentage after the first treatment applications has a significant difference among treatments at Metema for the 2022 season(Table 1). The lower webbed percentage was recorded in insecticide-treated plots as compared to untreated control(Table 1). About the effect of insecticide application, there was a minimum webbed percentage (33.3%)recorded on the profenfos sprayed plots followed by Lambda-cyhalothrin(36.7%) sprayed plots even if they were statistically insignificant. While the highest webbed percentage (50%) was recorded on the control plot after treatment application(Table 3). A similar study revealed that leaf and capsule damage were significantly lower on the lambda-cyhalothrin sprayed plot, whereas there were higher in the unsprayed plots (Akinyemi A, et al., 2015).

The combined analysis over the location in 2023 showed that there was no significant difference among treatments on larval counts before insecticide spray (Table 2). The larval population has not statically differed (P < 0.01) among the insecticide applications after the first spray, however, there were significant differences with unsprayed plots (Table 2). The lowest larval count (0.3 ) was obtained from T6 and T4 (Ethiozinon 60% and Profenafos +cypermethrin) on the count after spray. A similar result was reported by (Mintesnot Worku et al., 2024), who reported that a proven factory recommendation rate reduced the infestation level of *S. frugiperda* larvae(Lepidopetra family) on sorghum under field conditions.

The pooled data analysis also revealed that all the insecticides evaluated were found effective in controlling the insect. Hence, the number of mean larvae per plant was significantly lower in treated plots as compared with the untreated check. Similar findings on the efficacy of insecticides were reported by Ibekwe et al. (2014) who reported that lambda-cyhalothrin and deltamethrin were most effective against pod borer. This result is also in line with that of Geremew et al.(2012) who reported that *A. catalaunalis* can be controlled using Lambdacyhaolathrin 5% EC in infested fields.

*Efficacy of insecticides on A. catalaunalis;*The tested insecticides were significantly different in their effect on the larvae of sesame webworm. The result revealed that the highest efficacy (76.9%) and yield gain(78.9%) were recorded from plots sprayed with Profenofos 40%+Cypermethrin 4%EC and Profenofos insecticides (Figure 1). Insecticide efficacy increased and the number of larvae per plant significantly decreased from the first spray to the second spray for all insecticides. This might be due to the increment in the number of insects on unsprayed plots. Hence, 10 days after insecticide rate applications, the field efficacy and grain yield were highest in Profenofos 40%+Cypermethrin 4%EC followed profenofos, and lowest in Deltamethrin followed by untreated control, while others had intermediate values (Figure 1). Mintesnot and Yohannes (2020) reported that similar finding in a bioassay study of these insecticides on fall armyworms.

*Effect of insecticide application on grain yield and yield component of sesame;*The grain yield and number of seeds per pod were highly affected by *A. catalaunalis* infestation. All the treatments were significantly superior over control (untreated) regarding grain yield and number of seeds per pod. The maximum grain yield (850.9kgha-1) and (830.5 kgha-1) were recorded from plots receiving treatment of Profenofos 40%+Cypermethrin and profenfos, respectively while the lowest (475.5kgha-1) was from untreated plots (Table 2). The highest number of seeds per pod (67.9 and 67.3, correspondingly) was recorded on the Profenofos 40%+Cypermethrin sprayed (T6) and Dimethoate 40%(T2) sprayed plots while the lowest (56.1) was recorded on the control plot Zenawi et al., 2016 reported similar results. The result also revealed that there was a significant negative association and a linear relationship between the population of larvae and grain yield of sesame (y = -396.63x + 993.7, R² = 0.8111) (Figure 2). The 81.1% variability within grain yield can be attributed to the increasing larva density of webworm. From this regration result we confirmed the lowest population level of the insect (1-1.4) per plant can cause a reasonable yield loss on sesame. Wazier et al. (2016) on his study stated that the economic injury level of the sesame webworm is 0.25 larva per meter square.

*Economic analysis ;*Besides, the effectiveness of treatments on the protection of the grain yield of sesame was also evaluated through economic analysis comparing the marginal rate of return of each treatment by considering the overall mean grain yield (Table 3). Results of the partial budget analysis indicated that insecticide application of proven 44% EC(Profenafos + cypermethrin) 71102.1 ETB ha-1 ) with acceptable MRR(1066.6%) followed by karate 5 SC (Lambdacyhaolathrin 5% EC) (66302.25 ETB ha-1) with MRR (2137.5%) is better for controlling sesame webworm(Table 6). Hence, the use of Profenafos + cypermethrin and/or Lambdacyhaolathrin 5% EC is economically profitable and relatively low risk to non-target organisms and the environment. This result is in line with the result obtained by (Igyuve et al., 2018); who reported that lambda-cyhalothrin and cypermethrin are effective to manage *S.frugiperda(*Lepidoptrea family).

In conclusion**;** all insecticides evaluated were found effective in controlling the insect. The number of mean larvae per plant was significantly lower in treated plots as compared with the untreated check. The efficacy of the insecticides rate was varied. The highest efficacy (76.9%) and yield gain(78.9%) were recorded from plots sprayed with Profenafos + cypermethrin and Profenafos insecticides in factory recommendation. The highest grain yield (850.5kg ha-1) was obtained from sesame sprayed with Profenafos + cypermethrin followed by Profenafos treated plots (830.9kg ha-1) while the lowest (475.5kg ha-1) was reordered from untreated plots. The partial budget analysis revealed that, the application of (**Proven 44 %**) Profenafos + cypermethrin 44% EC 71102.1 ETB ha-1) with acceptable MRR (1066.6%) followed by (Karate 5% EC) Lambda-cyhalothrin 5 SC (66302.25 ETB ha-1) with MRR (2137.5%) is better for controlling sesame webworm. Hence the application of Profenafos + cypermethrin 44% EC (1 L ha-1) and Lambda-cyhalothrin (0.4 L ha-1) two times with 10 days intervals can be advised for the management of sesame webworm in the study areas and similar agroecology.

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**AUTHOR CONTRIBUTION STATEMENT**

As a first author, YK generated the researchable idea, wrote the proposal with detailed background, objectives, literature, experimental design,analyzing the data and acts as a corresponding author of this manuscript by rewriting the draft to fit into the requirements of this publication. MW involved in shaping, commenting, and reviewing the draft proposal. BF , MG, GA and SK also conducted the data collection, and provide inputs for this particular work. All authors read and approved the final manuscript.

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**COMPETING INTERESTS**

Authors have declared that no competing interests exist

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Table 1. ANOVA table for the effect of sesame webworm on WPP and agronomic traits of sesame - Metema research station 2022.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Treatments | PH | TSW | GY | WPB1 | WPA1 | WPA2 |
| Profenofos | 151.7 | 1.9 | **672.5** | 71.7 | **33.3** | 22.13 |
| Dimethoate 40% | 150.2 | 2.1 | 429.9 | 81.7 | 36.7 | 33.8 |
| Profenafos+ L. Cyhalothrin | 143.8 | 2.1 | 430.3 | 73.3 | 38.3 | 33.3 |
| Ethiozinon 60% EC | 150.2 | 1.8 | 451.6 | 80 | 43.3 | 33.6 |
| Neem oil | 148.1 | 2.1 | **574.6** | 76.7 | 45 | 34.4 |
| Profenafos cypermethrin | 150 | 1.9 | **516.5** | 76.7 | 45 | 31.3 |
| Alphacypermethrin | 143.4 | 1.8 | 295.7 | 76.7 | 43.3 | 29.3 |
| Lambda-cyhalothrin | 146.6 | 1.6 | 367.7 | 66.7 | **36.7** | 30.7 |
| Deltamethrin | 157.4 | 1.9 | 488.8 | 65 | 40b | 33.7 |
| Control | 151.1 | 1.8 | **360.2** | 70 | **50** | 30.7 |
| GM | 149.2 | 1.8 | 458.7 | 73.8 | 41.2 | 19.8 |
| CV(%) | 4.3 | 24.8 | 19.8 | 11.8 | 10.4 | 33.2 |
| LSD(5%) | 11 | 0.8 | 155.7 | 15.1 | 7.3 | 11.3 |
| Pr>F | NS | NS | \*\* | NS | \*\* | NS |

PH=Plant height, TSW=thousand seed weight, GY=grain yield kgha-1, WPBA1=wepped perecentage before first spray,WPA1=webbed percentage after first spray,WPA2=webbed percentage after second spray LSD=east significance difference, CV = coefficient of variation

Table 2 . Effects of selected insecticides on a larval population of *A. catalaunalis* Duponchel and yields of Sesame – 2023/2024 overall combined

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Treatments | PH | NPP | NSPP | GY | TSW | LBS | NLAS | ML |
| Profenofos | 152.9 | 33.3 | 65.6 | 830.5 | 2.7 | 0.8 | 0.4 | 0.6 |
| Dimethoate | 156.3 | 31.6 | 67.3 | 770.4 | 2.8 | 0.7 | 0.4 | 0.51 |
| P+ L. Cyhalothrin | 152.2 | 31.2 | 65.5 | 718.6 | 2.7 | 1.0 | 0.5 | 0.7 |
| Ethiozinon | 157.3 | 37.6 | 65.3 | 739.1 | 2.8 | 0.8 | 0.3 | 0.55 |
| Neem oil | 160.1 | 32.0 | 62.3 | 773.1 | 2.8 | 1.1 | 0.5 | 0.8 |
| P+ cypermethrin | 158.8 | 33.5 | 67.9 | 850.9 | 2.7 | 0.7 | 0.3 | 0.5 |
| Alphacypermethrin | 154.8 | 34.0 | 60.6 | 709.7 | 2.8 | 0.8 | 0.4 | 0.6 |
| Lambda-cyhalothrin | 155.3 | 33.0 | 63.6 | 789.5 | 2.6 | 0.8 | 0.5 | 0.5 |
| Deltamethrin | 155.1 | 31.8 | 58.9 | 662.8 | 2.8 | 1.0 | 0.6 | 0.8 |
| control | 154.5 | 30.0 | 56.1 | 475.5 | 2.7 | 1.2 | 1.3 | 1.3 |
| GM | 155.7 | 32.8 | 63.8 | 732.1 | 2.7 | 0.8 | 0.5 | 0.6 |
| T\*Loc | NS | NS | NS | \* | NS | \* | \* | \*\* |
| CV(%) | 5.2 | 25.1 | 5.9 | 18.3 | 8.6 | 58.3 | 62.4 | 56.6 |
| LSD(5%) | 7.5 | 7.7 | 3.5 | 126.6 | 0.2 | 0.4 | 0.3 | 0.3 |
| Pr>F | NS | NS | \*\* | \* | NS | NS | \*\* | \*\* |

PH=plant height, NPP number of pod per plant , NSPP=number of seed per pod, GY=Grain yield in kg per hectare , TSW=thousand seed weight ,NBS=number of larvae before spray, NLAS=Number of larvae after spray , ML=mean number of larvae, GM=grand mean, LSD=east significance difference, CV = coefficient of variation T=treatment,L=location

Table 3 Partial budget analysis of insecticide sprays for sesame webworm management in the study areas

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Treatment | **Variables** | | | | | | | |
| Adj.yield kg/ha(Y\*0.9) | Price of Sesame (Birr kg) | Sale revenue (1\*2) | Cost of insecticide (ETB ha-1) | Cost of labor for spray (ETB ha-1) | Total variable cost (ETB ha-1) | Net benefit (ETB ha-1) | MRR |
| control | 427.95 | 95 | 40655.25 | 0 | 0 | 0 | 40655.25 | - |
| L.cyhalothrin | 710.55 | 95 | 67502.25 | 600 | 600 | 1200 | 66302.25 | **2137.5** |
| Alphacypermethrin | 638.73 | 95 | 60679.35 | 630 | 600 | 1230 | 59449.35 | D |
| Dimethoate 40% | 693.36 | 95 | 65869.2 | 1000 | 600 | 1600 | 64269.2 | D |
| P + cypermethrin | **765.81** | **95** | **72751.95** | **1050** | **600** | **1650** | **71101.95** | **1066.6** |
| P+ Lambda Cyhalothrin | 646.74 | 95 | 61440.3 | 1100 | 600 | 1700 | 59740.3 | D |
| Profenofos | 747.45 | 95 | 71007.75 | 1200 | 600 | 1800 | **69207.7**5 | D |
| Deltamethrin | 596.52 | 95 | 56669.4 | 1200 | 600 | 1800 | 54869.4 | D |
| Neem oil | 695.79 | 95 | 66100.05 | 2200 | 600 | 2800 | 63300.05 | D |
| Ethiozinon | 665.19 | 95 | 63193.05 | 2400 | 600 | 3000 | 60193.05 | D |

Adj yield = yield adjusted to the farmers’ yield

Figure 1. Efficacy and yield gain of tested insecticides

Figure 2. Linear regression of grain yield and Mean larvae