

Research Article

Population Dynamics of Coffee Thrips (*Diarthrothrips coffeae*) (Thysanoptera: Thripidae) Using Sticky Traps with Different Essential Oils

Banchiamlak Nigussie Tefera* 

Ethiopian Institute of Agriculture Research, Plant Protection Department, Wondo Genet Agricultural Research Center, Wondo Genet, Ethiopia

Abstract

Coffee (*Coffea arabica* L.) is one of the most traded commodities worldwide, and it is grown in about 80 coffee producing countries. Ethiopia is the origin of *coffea arabica* L which is grown in different production systems. Insect pests are one of the biotic factors that contribute to low yield and quality. Thrips are key insect pests in several coffee-producing regions in Southern Ethiopia. This study evaluated blue sticky traps treated with different essential oils to monitor the population dynamics of coffee thrips over three years. The experiment was conducted at the Awada sub center research site on established coffee plots, with six treatments and three replications. The results showed a significantly different in the number of coffee thrips populations per week, month and year. In the 2021 cropping season, the highest number of coffee thrips was caught on sage oil-treated sticky traps in the second week of trap installation (WK2=77.50). In the 2022 cropping season, the highest number of coffee thrips was caught on lavender oil-treated sticky traps in the third week of trap installation (WK3=1,100.33). In the 2023 cropping season, the highest number of coffee thrips was caught on lavender oil-treated sticky traps in the third week of trap installation (WK3=2,320.00). Thus, the blue sticky trap treated with lavender oil attracted a higher thrips population in 2022 and 2023 year. Therefore, lavender oil is a promising essential oil along with the blue sticky trap for monitoring coffee thrips populations.

Keywords

Coffee Thrips, Blue Sticky Trap, Medicinal Plants, Essential Oils, Attractants, Population Dynamics

1. Introduction

Coffee is one of the most valuable crops in Ethiopia and worldwide. Ethiopia is the origin of *Coffea arabica* L., which is grown in different production systems, namely forest, semi-forest, garden, and plantation coffee production systems [1]. Coffee production accounts for 55% of the total export earnings, 10% of the government revenue, 25% of the domestic labor force, and about 20% of the population depends

on coffee for their livelihood [2, 3].

Coffee thrips (*Diarthrothrips coffeae*) are potentially important insect pests in Ethiopia [4, 5]. In coffee farming, *D. coffeae* is the most damaging species of thrips especially in East Africa [6]. It occurs on coffee in very small numbers, but can increase to populations likely to cause severe damage. This pest is a serious threat under hot dry weather conditions

*Corresponding author: titigonidae@yahoo.com (Banchiamlak Nigussie Tefera)

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and especially where the soil is dry and lacking in humus [7].

Insect traps are used to monitor or directly reduce the populations of insects or other arthropods. Traps warned of pest presence, hotspots, and migration. They also provide a relative measure of insect density by comparing the number of adults caught indicated that yellow, blue, and white sticky traps attract a range of flying pests, including, thrips, whiteflies, moths, aphids, fruit flies and leaf miners [8-10]. Thrips are minute insects that live hidden in plant parts, and their presence in crops is easily missed. Therefore, monitoring by setting colored sticky traps is an important tool in thrips pest management. Most economically relevant species are visually attracted to white, yellow and blue traps [11, 12]. Trap efficiency can be enhanced by combining an attractive color cue with an attractive odor cue, particularly for the early detection of thrips infestation in a crop, [13, 14], and for thrips trapping in low-wind environments, such as greenhouses [15].

Demirel N. [16] studied the attraction of coloured traps for thrips and concluded that neon yellow traps possessed the highest attraction for *Frankliniella occidentalis* and *Thrips tabaci* and that the blue and white coloured traps owned no attraction for Thrips species. Teulon D. A. J [17] studied the colour preference by the thrips of New Zealand. Trdan S. et al. [18] reported low efficiency for blue coloured sticky traps in their study on the onion thrips control and mentioned that this colour is suitable only for monitoring this pest but not for its control. Moreover, Ranamukhaarachchi S. [19] studied the advantages of coloured sticky traps in the management of *Ceratothripoides claratris* on tomato crop, and reported more attractiveness for white and blue coloured traps, which may refer to different reaction of the different species to the specific coloured traps.

Macintyre Allen J. K. [20] in their study on onion thrips population in two commercial onion fields using white sticky traps concluded that the highest number of the thrips was captured between 0.7 and 0.95 m above the ground. Similar results were reported by Andjus L. [21] in that the maximum capture recorded for predatory thrips *Aeolothrips intermedius* was at 70 cm and the minimum for the traps at the ground level.

Therefore, Coffee Thrips are tiny, slender insects with fringed wings and are severe in coffee growing areas of Southern Ethiopia, which is a potentially serious threat to coffee production at the Awada Agricultural Research Sub-center. Thus, the aims of this study were to discover easily affordable coffee thrips control methods and provide solutions to the coffee producing farmers.

Research Objectives

- 1) To evaluate the effectiveness of different essential oils on sticky trap for coffee thrips management;
- 2) To record and document the population dynamics of coffee thrips and other pests;
- 3) To develop cost effective, safe for humans and ecologically sustainable pest management methods for coffee thrips.

2. Material and Methods

2.1. Study Site Description

The experiment was conducted at the Awada agricultural research sub center experimental site. The Awada research sub-center is located at 6°3'N latitude, 38°3'E, longitudes and at an altitude of 1740 masl. The mean annual rainfall of the sub center was 1335 mm. The mean maximum temperature is 28 °C while the mean minimum annual temperature is 11 °C.

2.2. Treatment and Design

The experiment was laid out in a randomized complete block design (RCBD) with six treatments and three replications. An established coffee plot was used in the field trial. The treatment consisted of blue sticky traps, four essential oils (mint, lavender, sage and rosemary), a mixed oil, and no oil (control) (Table 1).

Table 1. Treatment setup and description.

No.	Treatment description	Code
1	Blue sticky trap with mint essential oil	BSMEO
2	Blue sticky trap with lavender essential oil	BSLEO
3	Blue sticky trap with sage essential oil	BSSEO
4	Blue sticky trap with rosemary essential oil	BSREO
5	Blue sticky trap with cocktail essential oil	BSCEO
6	Blue sticky trap with no oil (control)	BSNEO

2.3. Experimental Procedures

Blue sticky traps were prepared from transparent A4 size paper by cutting in half (22 cm × 17.5 cm) and painting blue sticky glue using a paintbrush. Blue sticky traps were installed in the fields of established coffee plot and the sticky traps were replaced with new traps weekly. The sticky trap with the caught pest were brought to the laboratory for more inspection, counting and insect identification.

Upon hanging the sticky trap, different essential oils were sprayed on the lower part of the trap using a sanitizer sprayer. All the essential oils were applied in the amount of 0.1 ml per one sticky trap. For the control, blue sticky traps were used without the addition of aromatic substances. Two sticky traps were suspended per coffee plot at the top of the coffee plant.

The suspension of the traps was changed in each coffee plot every 7 to 15 days interval in order to eliminate the effect of the suspension place on the number of caught insects. Seven to fifteen days after suspension, the traps were removed and the number of trap insect pests was counted.

2.4. Thrips Counting Method

The number of each pest type caught per sticky trap was counted. During the high insect catch on the trap, we counted the insects in a vertical column that was 1 inch (2.5cm) on the front sides of the trap to obtain the result for the entire trap [22].

2.5. Data Collection and Analysis

The number of insect pests caught per trap was recorded accordingly and the collected data were statistically analyzed using SAS software.

3. Results

3.1. Coffee Thrips Population During 2021 Year

The analysis of variance indicated that all the treated blue sticky traps showed a significant difference ($P < 0.01$) in the number of thrips caught across the sampling weeks (Table 2).

The highest number of coffee thrips populations was recorded in the blue sticky trap treated without oil in the first week (WK1=72.50). The blue sticky traps treated with sage oil revealed a higher coffee thrips population in the second and third weeks of trap installation (WK2=77.50, WK3=17.66). The lavender oil treated blue sticky trap showed a higher number of coffee thrips in the fourth week of trap installation (WK4=38.33).

Table 2. Mean population of coffee thrips during 2021 year.

Treatment	No. of coffee thrips per sticky trap (WAI)			
	WK 1	WK2	WK 3	WK4
Mint oil	46.66	67.50	19.33	37.83
Lavender oil	61.66	61.16	13.83	38.33
Sage oil	46.66	77.50	17.66	28.33
Rosemary	60.83	41.66	12.16	35.33

Treatment	No. of coffee thrips per sticky trap (WAI)			
	WK 1	WK2	WK 3	WK4
Control	72.50	50.00	12.66	28.66
CV	48.34	42.22	55.88	29.00
LSD	52.49	47.36	15.92	18.40

Note: WK=week, WAI=weeks after installation

The lowest coffee thrips population was recorded in blue sticky traps treated with sage oil (WK1=46.66, WK4=28.33) in the first and fourth weeks. The lowest number of coffee thrips was recorded in the blue sticky trap treated with rosemary oil in the second and third weeks of trap installation (WK2=41.66, WK3=12.16).

In the 2021 cropping season, the highest number of coffee thrips was caught on sage oil treated sticky trap in the second week of traps installation (WK2=77.50). The lowest coffee thrips population was recorded on rosemary oil sprayed sticky traps during the third week of installation (WK3=12.16).

3.2. Coffee Thrips Population During 2022 Year

The presence and population densities of thrips and other insect pests were monitored using sticky traps. The analysis of variance indicated that all the treated blue sticky traps showed a significant difference ($P < 0.01$) in the number of thrips caught across the sampling weeks (Table 3). The highest number of coffee thrips populations was recorded in the lavender treated plot in the first, second, and third weeks of sticky trap installation (WK1=101.67, WK2=426.67, WK3=1100.33). In the 4th week, the blue sticky traps treated with no oil had a higher number of thrips (WK4=62.23). In the 5th week, the blue sticky trap treated with rosemary oil obtained a higher number of thrips (WK5=38.66).

The lowest coffee thrips populations were recorded in plots treated with sage oil (WK1=37.00), rosemary oil (WK2=80.00), sage oil (WK3=134.00), mixed oil (WK4=19.66), mint oil (WK5=15.66), and mixed oil (WK6=5.66).

Table 3. Population dynamics of coffee thrips during 2022 year.

Treatment	No. of coffee thrips per sticky trap (WAI)					
	WK1	WK2	WK3	WK4	WK5	WK6
Mint oil	88.33	105.67	199.33	20.00	15.66	11.33
Lavender oil	101.67	426.67	1100.33	25.00	30.33	11.66
Sage oil	37.00	86.33	134.00	21.00	22.33	11.66
Rosemary	42.00	80.00	182.33	29.66	38.66	6.66

Treatment	No. of coffee thrips per sticky trap (WAI)					
	WK1	WK2	WK3	WK4	WK5	WK6
Mixed oil	74.33	153.33	227.33	19.66	31.00	5.66
Control	77.33	155.00	956.33	62.33	29.66	11.66
CV	54.01	127.20	151.64	37.33	36.55	39.50
LSD	68.891	388.39	1287.3	20.11	18.582	7.0277

In the 2014 cropping season, the highest number of coffee thrips was caught on lavender oil treated sticky trap in the third week of trap installation (WK3=1100.33). The lowest coffee thrips population was recorded on the mixed oil sprayed sticky traps during the sixth week of installation (WK6=5.66).

3.3. Coffee Thrips Population During 2023 Year

The analysis of variance indicated that all the treated blue sticky traps showed a significant difference ($P<0.01$) in the number of thrips caught across the sampling weeks (Table 4).

The highest number of coffee thrips populations was recorded in mint treated sticky trap in the first week (WK1=16.00). Blue sticky traps treated with no oil revealed

higher coffee thrips populations in the second, fourth, and fifth weeks of trap installation (WK2=133.33, WK4=543.33, WK5=21.66). The lavender oil treated blue sticky traps showed a higher number of coffee thrips in the third and sixth weeks of trap installation (WK3=2320.00, WK6=24.66).

The lowest coffee thrips population was recorded in blue sticky traps treated with no oil (WK1=6.00) in the first week. The lowest number of coffee thrips was recorded on the blue sticky trap treated with sage oil in the second, fifth and sixth weeks of trap installation (WK2=22.33, WK5=10.33, WK6=12.66). The lowest number of coffee thrips was recorded on the blue sticky trap treated with mint oil in the third and fourth weeks of trap installation (WK3=905.33), (WK4=29.66).

Table 4. Population dynamics of coffee thrips during 2023 year.

Treatment	No. of coffee thrips per sticky trap (WAI)					
	WK1	WK2	WK3	WK4	WK5	WK6
Mint oil	16.00	85.00	905.33	29.66	16.33	15.00
Lavender oil	11.33	57.66	2320.00	60.00	19.33	24.66
Sage oil	31.66	22.33	480.00	37.66	10.33	12.66
Rosemary	7.00	84.00	1402.67	78.33	18.66	21.66
Mixed oil	8.33	127.00	2232.00	234.00	14.33	17.66
Control	6.00	133.33	2048.00	543.33	21.66	23.33
CV	76.45	87.9	87.7	209.75	48.36	37.00
LSD	18.623	135.86	2498.6	625.19	14.76	12.94

In the 2023 cropping season, the highest number of coffee thrips was caught in lavender oil treated sticky trap in the third week of trap installation (WK3=2320.00) (Figure 1). The lowest coffee thrips populations was recorded in no oil sprayed sticky trap in the first week of installation (WK1=6.00).

The graph showed that the number of coffee thrips caught

per sticky trap was higher during mid-March to end of March in the none treated oil followed by rosemary oil (Figure 2).

The graph showed the number of coffee thrips caught per sticky trap were higher during mid-March to end of March on lavender oil treated followed by non treated blue sticky trap (Figure 3).

The number of coffee thrips caught per sticky trap were higher during mid-March to end of March on non treated oil followed by rosemary oil.

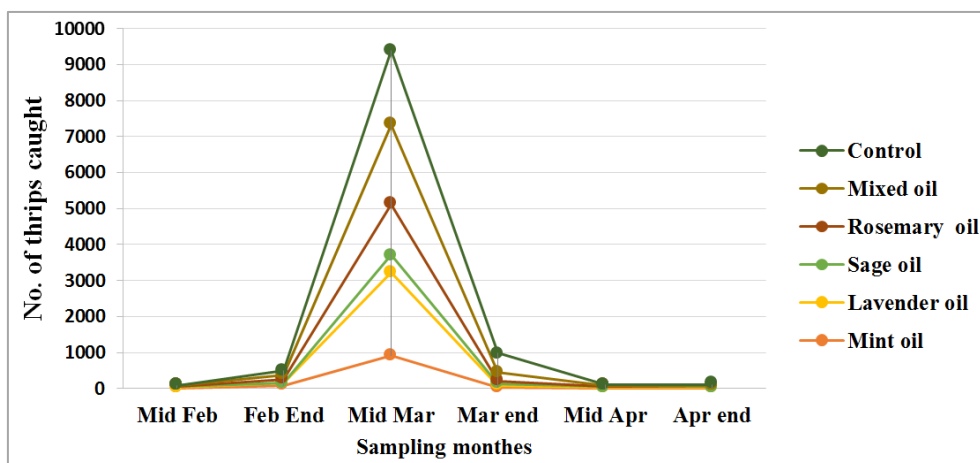


Figure 1. Population dynamics of coffee thrips per sticky trap in 2023 year.

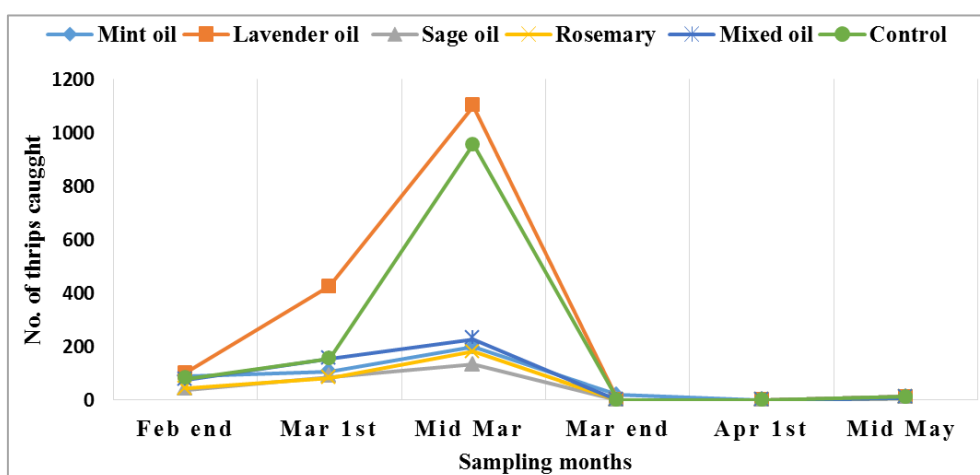


Figure 2. Population dynamics of coffee thrips per sticky trap in 2022 year.

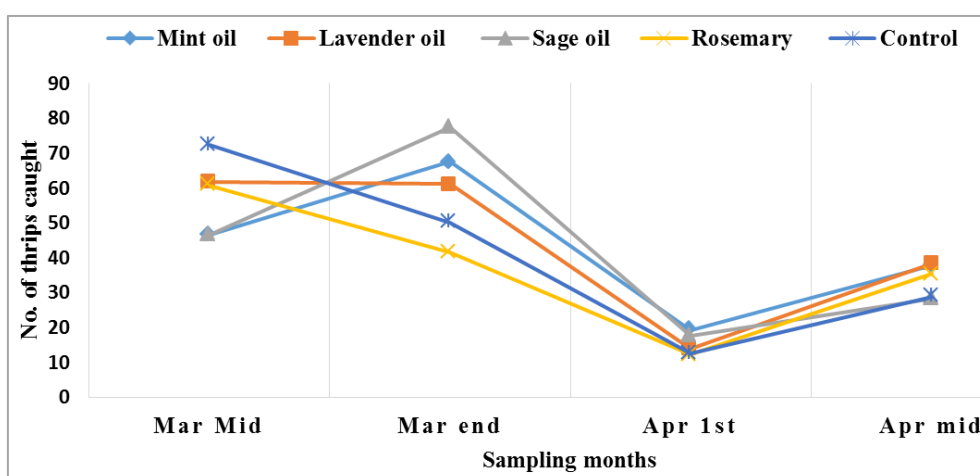


Figure 3. Population dynamics of coffee thrips per sticky trap in 2021 year.

The graph showed the number of coffee thrips caught per sticky trap over three years. The thrips population during 2023 period followed by 2022 year. The coffee thrips population were lower during 2021 year. (Figure 4).

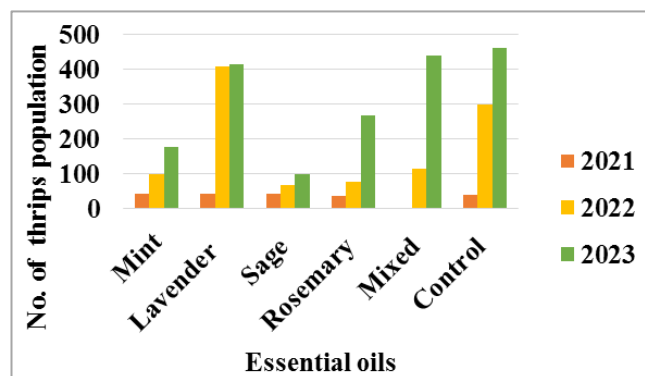


Figure 4. Population of coffee thrips during 2021-2023 years.

3.4. Coffee Beetles Population During 2022 Year

The analysis of variance indicated that all the treated blue sticky traps showed a significant difference ($P < 0.01$) for the number of caught beetles on the third and fourth weeks of sampling (Table 5). Highest number of coffee beetles population were recorded on lavender treated blue sticky trap on the third week of the sticky trap installation (WK3=72.33). The lowest number of coffee beetles was recorded on mint oil treated blue sticky trap on the fourth week of trap installation (WK4=3.333).

Table 5. Population dynamics of coffee beetles during 2022.

Treatment	No. of Beetles per sticky trap (WAI)	
	WK3	WK4
Mint oil	20.00	3.333
Lavender oil	72.33	7.333
Sage oil	67.00	4.333
Rosemary	37.00	5.666

Table 6. Mean population of coffee beetles during 2023.

Treatment	No. of coffee Beetles per sticky trap (WAI)					
	WK 1	WK2	WK3	WK4	WK5	WK6
Mint oil	4.666	31.00	10.00	0.00	2.000	0.000
Lavender oil	2.666	46.66	23.66	2.00	1.333	0.666

Treatment	No. of Beetles per sticky trap (WAI)	
	WK3	WK4
Mixed oil	23.00	4.333
Control	39.66	5.000
CV	71.72	56.33
LSD	56.33	5.124

Note: WK=week, WAI=weeks after installation

3.5. Coffee Beetles Population During 2023 Year

The analysis of variance indicated that all the treated blue sticky traps showed a significant difference ($P < 0.01$) for the number of caught beetles on the sampling weeks (Table 6).

Highest number of coffee beetles population were recorded on mint oil on the first and fifth week of sticky trap installation (WK1=4.666, WK5=2.000). Highest number of coffee beetles population were recorded on mixed oil on the second and sixth week of sticky trap installation (WK2=58.66, WK6=1.000). Lavender oil on the third week recorded higher beetles population than the other treatments (WK3=23.66). Sage oil treated blue sticky trap on the fourth week of the sticky trap installation showed higher beetles population (WK4=4.66) compared to the other treatments.

However, the lowest number of coffee beetles was recorded on mint oil treated blue sticky trap on the third, and nil on the fourth and sixth weeks of trap installation (WK3=10.00, WK4=0.00, WK6=0.00). The blue sticky trap with mint oil treatment, however, caught the fewest coffee beetles throughout the third, fourth, and sixth weeks after trap installation (WK3=10.00, WK4=0.00, WK6=0.00).

In the blue sticky trap treated with no oil, the number of beetles was nil in the first and third week of trap installation. Sage oil treated sticky trap on the second week was very low (WK2=23.66) compared to the other treatments. On the fifth week of trap installation, very low beetles population was recorded on lavender, sage, rosemary and mixed oil treated sticky trap (WK5=1.333).

Treatment	No. of coffee Beetles per sticky trap (WAI)					
	WK 1	WK2	WK3	WK4	WK5	WK6
Sage oil	5.333	23.66	17.33	4.66	1.333	0.333
Rosemary	0.666	36.00	16.00	3.00	1.333	0.333
Mixed oil	0.333	58.66	19.33	4.33	1.333	1.000
Control	0.000	43.33	13.33	2.00	1.666	0.000
CV	130.15	52.45	59.75	62.74	124.72	111.75
LSD	5.3934	38.06	18.058	3.0442	3.4035	0.7907

Note: WK=week, WAI=weeks after installation

The population of coffee beetles was also examined using blue sticky trap in coffee tree. The number of coffee beetles captured on blue sticky trap varied at different essential oil treatments. More beetles were captured on lavender and sage oils. In 2022, blue sticky trap treated with lavender essential oils were showed higher number of beetles population followed by sage oil. In 2023, blue sticky trap treated with mixed essential oils were showed higher number of beetles population followed by lavender oil.

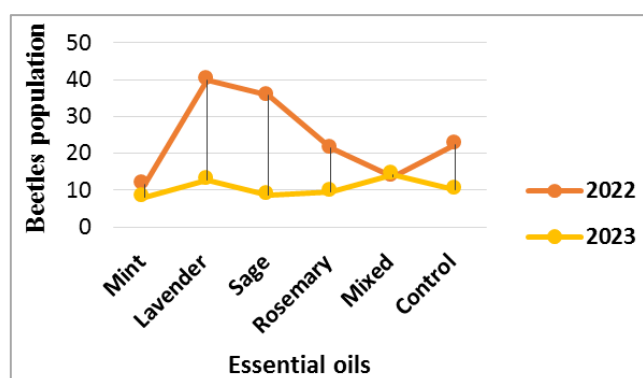


Figure 5. Population of coffee beetles per sticky trap and years.

3.6. Other Coffee Insect Population During 2023 Year

The analysis of variance indicated that all the treated blue sticky traps showed a significant difference ($P < 0.01$) in the number of caught insects other than coffee thrips and beetles on the sampling weeks (Table 7).

Highest number of insects other than coffee thrips and beetles population were recorded on sage oil treated blue sticky trap on the first week of the sticky trap installation (WK1=8.00). Highest number of insects other than coffee thrips and beetles population were recorded on lavender oil treated blue sticky trap on the second and fourth week of the

sticky trap installation (WK2=39.00, WK4=20.33). Highest number of insects other than coffee thrips and beetles population were recorded on mint oil treated blue sticky trap on the fifth and sixth week of the sticky trap installation (WK5=37.33, WK6=44.66).

The lowest number of insects other than coffee thrips and beetles was recorded on mixed oil treated blue sticky trap on the first weeks of trap installation (WK1=1.00). The lowest number of insects other than coffee thrips and beetles was recorded on the blue sticky trap treated with no oil on the second and third weeks of trap installation (WK2=14.00, WK3=49.00). The lowest number of insects other than coffee thrips and beetles was recorded on the blue sticky trap treated with sage oil on the fourth and fifth weeks of trap installation (WK4=9.66, WK5=9.00). The lowest number of insects other than coffee thrips and beetles was recorded on the blue sticky trap treated with lavender oil on the sixth weeks of trap installation (WK6=24.00).

3.7. Population of Coffee Thrips, Beetles and Other Insect Pests

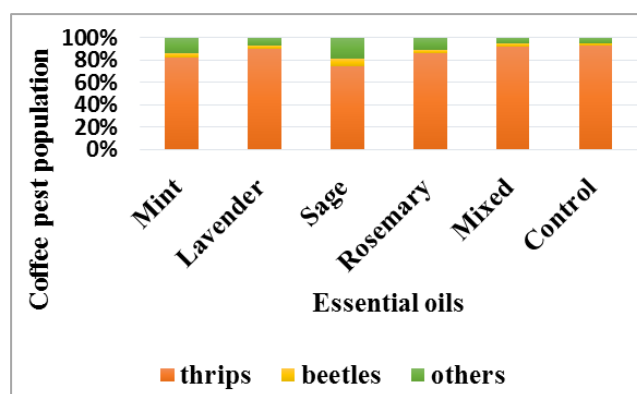


Figure 6. Population of Coffee thrips, beetles and other insect pests in 2023 year.

The population dynamics of coffee pests during 2023 period was presented in graph below. The graph indicated that thrips population was higher than the beetles and other insect pests of coffee (Figure 6). Blue sticky trap treated with no oil attracted higher number of thrips population followed by mixed oil and lavender oil respectively. The lowest thrips population was recorded on the blue sticky trap treated with sage oil.

The graph indicated that thrips population was higher on the blue sticky trap treated with lavender oil followed by untreated blue sticky trap. Similarly, beetles population was higher on the blue sticky trap treated with lavender oil. Thus, lavender oil is good attractant plant for thrips population (Figure 7).

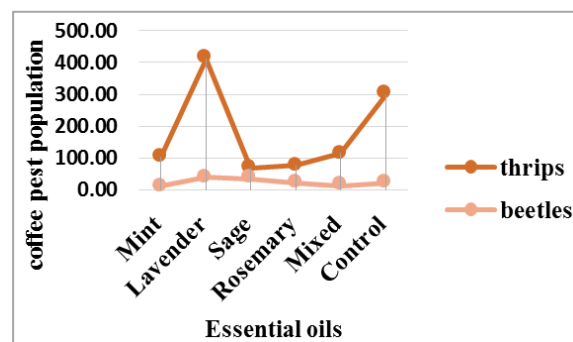


Figure 7. Population of coffee pests (thrips and beetles) per blue sticky trap in 2022 year.

Table 7. Mean population of other insects during 2023.

Treatment	No. of other insects per sticky trap (WAI)					
	WK1	WK2	WK3	WK4	WK5	WK6
Mint oil	4.333	32.00	51.66	10.00	37.33	44.66
Lavender oil	1.666	39.00	56.33	20.33	56.00	24.00
Sage oil	8.000	33.66	50.66	9.66	9.00	35.00
Rosemary	4.333	33.00	84.00	15.00	31.00	39.66
Mixed oil	1.000	18.66	58.00	13.33	16.33	27.66
Control	1.333	14.00	49.00	13.00	23.66	35.33
CV (%)	82.05	64.701	28.857	24.193	92.457	30.167
LSD (0.05)	5.1421	33.417	30.595	5.9664	48.593	18.873

Note: WK=week, WAI=weeks after installation

4. Discussion

Blue sticky traps were made from transparent paper, painted with blue sticky glue and used for the study. Traps were hang on branches of the coffee canopy at random height. Two traps per plot at each treatment were placed randomly throughout the experimental trial. The total number of thrips on each trap were recorded weekly. The number of thrips caught per traps was counted within 7 to 15 days interval.

In 2013 cropping season, The highest number of coffee thrips were caught on sage oil treated sticky trap on the second week of trap installation (WK2=77.50). Whereas the lowest coffee thrips population were recorded on rosemary oil sprayed sticky trap on the third week of installation (WK3=12.16). In 2014 cropping season, the highest number of coffee thrips were caught on lavender oil treated sticky trap on the third week of trap installation (WK3=1100.33). Whereas the lowest coffee

thrips population were recorded on mixed oil sprayed sticky trap on the sixth week of installation (WK6=5.66). In 2023 cropping season, the highest number of coffee thrips were caught on lavender oil treated sticky trap on the third week of trap installation (WK3=2320.00). Whereas the lowest coffee thrips population were recorded on no oil sprayed sticky trap on the first week of installation (WK1=6.00).

The present study indicated that a blue sticky trap treated with lavender oil and untreated sticky trap caught higher number of thrips population. Previous studies reported that blue sticky traps have been shown to be effective in attracting various thrips species [23, 24]. Blue, yellow, and white traps had been previously reported to attract various thrips species and orchard pests in various settings such as greenhouse and orchards [25-28].

The population of thrips was increased during 2023, 2022 and 2021 year of the study respectively. This is due to climate change and temperature fluctuation. Previous researches reported that there is an increase in number of insect pest pop-

ulation and out breaks of insects due to the climate change [29]. Jaramilo reported that some coffee insect pests benefited from the rise in temperature and increased in their generation per life cycle [30, 31]. A blue sticky trap treated with lavender essential oil attracted higher number of coffee thrips population at Awada. The none essential oil treated blue sticky trap is also the best in attracting coffee thrips population compared to the other treatments.

High infestation of coffee thrips was observed during mid to end March of the cropping season. Therefore, coffee farmers should give due attention in monitoring the thrips population using blue sticky trap. As the result indicates that, high coffee thrips population was recorded on lavender oil treated blue sticky trap at Awada research sub center. Thus, this essential oil has to be studied at different concentration and thrips infested location. Further research works on another thrips infested location has to be done.

5. Conclusion

Blue sticky traps were made from transparent paper, painted with blue sticky glue and used for the study. Traps were hang on branches of the coffee canopy at random height. Two traps per plot at each treatment were placed randomly throughout the experimental trial. The total number of thrips on each trap were recorded weekly. The number of thrips caught per traps was counted within 7 to 15 days interval.

The present study result revealed that the highest number of coffee thrips was caught on sage oil-treated sticky traps in the second week of trap installation (WK2=77.50) in 2013 cropping season. The highest number of coffee thrips was caught on lavender oil-treated sticky traps in the third week of trap installation (WK3=1100.33) in the 2014 cropping season. The highest number of coffee thrips was caught on lavender oil-treated sticky traps in the third week of trap installation (WK3=2320.00) in the 2023 cropping season. Thus, the blue sticky trap treated with lavender oil attracted a higher thrips population in 2022 and 2023. Therefore, lavender oil is a promising essential oil along with the blue sticky trap for monitoring coffee thrips populations.

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Author Contributions

Banchiamlak Nigussie Tefera is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no competing interests.

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