EFFECTS OF DIFFERENT CONTROL STRATEGIES FOR INSECT PEST MANAGEMENT OF MANGO

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Abstract

Mango is one of the most economically significant agricultural products in Myanmar, but its production is severely constrained by insect pests. The effective pest management is important for enhancing mango production. The present study aimed to evaluate methods for reducing mango damage by investigating the effectiveness of insect pest control strategies in a mango orchard located at the Vegetable and Fruit Research and Development Center (VFRDC), Ye Mon Village, Hlegu Township, Yangon Region. Insect pests were collected from February to September 2024 using the three trap methods: methyl eugenol traps, yellow sticky traps, and pineapple fruit juice traps. A total of 21 insect species, representing 16 genera across 15 families and six orders, were recorded. Among them, 5722 individuals from 17 pest species and four natural enemy species were observed. The mango infection prevalence at the VFRDC was 13.3%. Of the control strategies tested, yellow sticky traps captured the highest number of pests. Visual inspection of fruit damage was more significant in the control group, where fruit size was reduced. Larvae were not found in fruits associated with methyl eugenol or yellow sticky traps. Statistically significant differences in insect capture were observed between traps ($P < 0.05$). The study concludes that the strategic deployment of Yellow Sticky and Methyl Eugenol traps is a highly effective, low-cost, and sustainable component of an IPM strategy for enhancing mango quality and yield in Myanmar.

Keywords: mango, pests, management, control

Introduction

The cultivation of mangoes is growing throughout the world. Its origin is Southern Asia, originating from the border area of Northwest Myanmar and Eastern India. Mangoes are commercially cultivated in the central Mandalay region, Ayeyarwady region, the Southern regions, and Shan State in the east over a size of some 80,000 hectares (Hirano *et al*., 2008). Among the cultivated mango species in Myanmar, Sein Ta Lone, *Mangifera indica* L., belongs to the family Anacardiaceae and is the most popular mango verity in Myanmar. Mango is attacked by a variety of insect pests, these insect pests attack roots, stems, leaves, flowers, and fruits thereby, causing a decline in quantity or quality of potentially harvestable and unmarketable (Brower, 1997). Nearly 440 species of fruit flies are distributed primarily in tropical Asia, the South Pacific, and Australia (White and Elson-Harris, 1992).

Adult female fruit flies attacked the fruits including mango by oviposition and maggots polluted and destroyed the fruit by feeding on the pulp (White and Elson-Harris, 1992). The main hosts of *Bactrocera dorsalis* are guava, mango, citrus, banana, avocado, papaya, etc. It is a serious pest of all fleshy fruits and vegetables in the general Southeast Asia region, Hawaii (Hill, 1983). *Bactrocera dorsalis* is a serious pest of mangoes and other soft fruits in Myanmar and in several parts of the world (Jayanthi and Verghese, 2002).

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Infested fruits are unmarketable and sometimes they cause total losses if it is not controlled by suitable insecticide, or the fruits are not bagged. Therefore, the fruit fly plays an important role in fruit production for domestic consumption and export as well (Pedigo, 2002). Therefore, pesticides are widely used to protect crops against insect pests. Agricultural insect pest management is largely dependent on the use of chemical insecticides. However, sticky traps are used as one of the effective Integrated Pest Management (IPM) strategies for different insect pests in most parts of the world (Stern *et al*., 1959).

The yellow sticky traps can be utilized for controlling and monitoring the population of many pests that are more effective in capturing adult insects than the other color sticky traps. Yellow sticky traps can capture a great number of adult pests therefore reducing the adults on the host (Mi Zin Mar Khaing, 2023). Methyl eugenol can attract male fruit flies at a distance of 0.6 km (Steiner, 1952). Methyl eugenol is a very significant sex pheromone for the control of male fruit flies. If the male fruit flies are absent and only females remain in the field then the population of fruit flies is automatically reduced without causing any harm to the crops (Steiner *et al*., 1965). The fruit juice trap that comprises a solution attractive to the insect. These traps are broadly applied in commercial crops and are low-cost to make. The rate of insect populations may depend on several factors including food, predators, host plants, and competitors. The aim of the present study is to provide information on the damage caused by pests. Thus, the study was conducted with the following objectives:

- to identify the insect pests in mango trees at the Vegetable and Fruit Research and Development Center (VFRDC)
- to calculate the prevalence of infestation rate on mango trees in study area
- to compare the effects of different methods in insect pests control on mangoes

Materials and Methods

Study site and period

The investigation on the insect pests of mango, Mangifera indica Linnaeus (1753) was conducted at the Vegetable and Fruit Research and Development Center (VFRDC), Ye Mon Village (N 16∘49′36″, E 96∘7′50″), (56 km from Northeast of Yangon), Hlegu Township, Yangon Region (Fig. 1 and Plate 1). The study area comprised 180 mango plants across 0.74 acres. Data collection spanned from January to September 2024.

Experimental Design and Trapping Methods

The experiment was set up as a Randomized Complete Block Design (RCBD) with four treatments, (1) Plot with methyl eugenol traps (2) Plot with yellow sticky traps (3) Plot with pineapple fruit juice traps and (4) Plot without traps (control). Each treatment had four replications. Traps were placed between plots. Insect collection was performed twice a month (every two weeks) between 7:00 am and 11:00 am. Collected specimens from each trap were transferred to plastic containers to the laboratory to count the numbers, identification of species, and further investigation. **Insect Identification**

Specimens were identified using dissecting and stereo microscopes at the VFRDC. Identification keys and published literature were used to classify insects into pests and natural enemies (Hill, 1983; White Elson-Harris, 1992; Drew and Hancock, 1994; Nair, 1995 ; Morris and Waterhouse , 2001).

Fruit Quality and Damage Assessment

For each of the four treatments with four replications, ten mango fruits were randomly harvested for assessment. Each mango harvested from the field was weighed with a weight scale from the laboratory. Then, the width, length, and thickness of the mangoes were measured by using an vernier clipper. Then, the sweetness was measured using a refractometer. The number of oviposition marks, number of pest infestation marks, and presence of larvae on the mangoes were observed and counted. The number of oviposition marks, number of pest infestation marks, and presence of larvae in the pulp of mangoes were searched with hand lenses.

Data Analysis

Analysis of variance (ANOVA) test was used to analyze obtained data for comparison between the different trapping methods using the Statistical Package for Social Science (SPSS) software version. Mean and Standard deviation values were calculated by Microsoft Excel.
To calculate the prevalence of mango infestations, the following formula was used.

$$\text{Prevalence (\%)} = \frac{\text{Number of inspected trees}}{\text{Total number of mangoes}} \times 100$$

Where:

Number of inspected trees - the number of trapped trees in this study

Total number of mangoes - the total number of studied mango trees

(Source from Google Maps, 2024)

Figure. 1 Map of Myanmar showing study site, VFRDC in Hlegu Township, Yangon Region

A. Location of study site B. Mango trees in study site

Plate 1 Study area

Results

A total of 21 insect species belonging to 16 genera under 15 families and 6 orders were collected and identified in the study site of Ye Mon Village, Hlegu Township, Yangon Region. The percentage of species occurred according to the order (Fig. 2).

Descriptive account of insect pests

1. *Batocera rufomaculata* (De Geer, 1775) (Plate 2 A)

Its body is about 20 to 70 mm in length. The antennae are very long, and the adult beetles are grayish with two pink dots having a lateral spine. The spots are on the hardened forewings, having the bright red prothorax.

2. *Aulacophora foveicollis* (Lucas, 1849) (Plate 2 B)

The body is about 6 to 8 mm in length. It is reddish yellow, oval-shaped, and the antennae are about half of the body length. Its head is small, and the color is brown. It has dark-colored eyes.

3. *Aulacophora lewisii* (Baly, 1886) (Plate 2 C)

The body of adult beetles is 6 to 6.5 mm in length. Its body is slender, and it has black colored wings. Its head is golden yellow color, having black-colored eyes.

4. *Monolepta australis* (Jacoby, 1882) (Plate 2 D)

The body is about 6 to 12 mm in length. The color is yellow with a red spot on the base of each wing cover, having a red mark across the top of the shoulders.

5. *Odontotermes* sp. (Holmgren, 1912) (Plate 2 E)

The body is about 8.5 to 9.7 mm in length, including wings. The color of the body varies from light to dark brown. It has equal two large and translucent wings. The body shape is straight, having two straight antennae with a slight curve.

6. *Oecophylla smaragdina* (Fabricius, 1775) (Plate 2 F)

The body is about 6 to 10 mm in length. The adults are red-colored.

7. *Ricania* sp. (Germar, 1818) (Plate 2 G)

The body is about 10 to 14 mm in length. The color is dark brown with pale bands. A notch is included on each side of the forewings, and the rest of the margin appears with many bands.

8. *Leptocentrus taurus* (Fabricius, 1775) (Plate 2 H)

The body is about 9 to 13 mm in length. The color of the dorsal surface on the conical body is black, having white spots on the sides of the body.

9. *Dictyophara* sp. (Germar, 1830) (Plate 2 I)

The body is about 12 to 14 mm in length. The color of the body is light green at the end of the rostrum, and it is rounded in shape. It has slender legs, and the wing is membranous, the large, extending behind the abdomen.

10. *Idioscopus clypealis* (Lethierry, 1889) (Plate 2 J)

The body is about 8 to 9 mm in length. The color is light brown with dark spots on the vertex, having two spots on the scutellum.

11. *Idioscopus nitidulus* (Walker, 1870) (Plate 2 K)

The body is about 4 to 5mm in length. The color is dark brown, and it is wedge-shaped with wavy lines on the wings and three spots on the scutellum.

12. *Bemisia tabaci* (Gennadius, 1889) (Plate 2 L)

The body is about 1 mm in length, and has two pairs of white wings. The color of the body is light yellow.

13. *Drosophila melanogaster* (Meigen, 1830) (Plate 2 M)

The body is only about 3 mm in length and yellow-brown color. It has a rounded head and the antennae are short. Black stripes appear on the dorsal surface of its abdomen. Larvae are minute white maggots.

14. *Bactrocera dorsalis* (Hendel, 1912) (Plate 2 N)

The body is about 5.2 mm in length. It has a yellowish abdomen and a black T-shaped mark. A brown band appears along the edge of its wings. It has a prominent dark thorax with two yellow stripes on top and yellow marks on each side.

15. *Bactrocera correcta* (Bezzi, 1916) (Plate 2 O)

The body is about 5.6 mm in length. The thorax is black colored with yellow patches, while the color of the abdomen is also yellow-orange with a dark T-shaped mark, having black spots at the tip of the wings.

16. *Bactrocera zonata* (Saunders, 1841) (Plate 2 P)

The body is about 6.7 mm in length. The color is orange to brownish. It has a yellow dorsal shield having a dark spot on the tip of the wing.

17. *Bactrocera cucurbitae* (Coquillet, 1849) (Plate 2 Q)

The body is about 6.5 mm in length. The color of the body is light brown. It has bright yellow marks on the thorax and a black 'T' pattern appears at the base of the abdomen. The wings are clear having "a melon seed" shaped spot at the tip with a dark coastal vein.

Descriptive account of natural enemies

18. *Cheilomenes sexmaculatus* (Fabricius, 1781) (Plate 2 R)

The body is 3 to 6 mm in length. The shape is oval, and the color is shiny, light red. Six black spots appear on the wing covers including two zigzag lines, having a rear black spot.

19. *Chrysoperla* sp. (Steinmann, 1964) (Plate 2 S)

The body is about 12 to 20 mm in length. It is pale green with long antennae, having bright, and golden eyes. It has large, transparent and pale green wings and the body is delicate.

20. *Condylostylus* sp. (Bigot, 1859) (Plate 2 T)

The body is about 5 to 6 mm in length and slender. The colors of the head, eyes, thorax, and abdomen are shiny and metallic green. It has short black antennae. It has three segments, and the wings have two smoky-brown bands on the outer half, connected along the leading edge.

21. *Lucilia sericata* (Robineau-Desvoidu, 1830) (Plate 2 U)

The body is about 8 to 10 mm in length. The color varies from metallic green to copper green color. It has a hairy back and the wings are clear with light brown veins, and the colors of the legs and antennae are black.

Species composition and variation of insects during the study period

Among them, 5722 individuals from 17 pest species and four natural enemy species were observed. The highest population (1808 individuals) occurred in May, while the lowest (1260 individuals) was recorded in March 2024. *Bactrocera dorsalis* was the most abundant species (1365 individuals), followed by *Idioscopus nitidulus* (1139 individuals), while *Ricania* sp. and *Dictyophara* sp. were the least abundant (2 individuals each) (Fig. 2 and Table 1, 2).

Prevalence of insect pest infestations on mango trees

A total of (24) out of (180) plants were found to be infected, resulting in a prevalence rate of 13.3% (Table 3).

Insect population observed on different traps

The yellow sticky treatment is the highest capturing pests among other treatments. The methyl eugenol treatment is higher than the pineapple fruit juice treatment and lower than yellow sticky treatment in catching pests. Yellow sticky traps were found most attractive for insects ($371.25^{b}\pm46.90$). Pineapple fruit juice traps were less attractive than recorded traps ($22.88^{a}\pm2.48$). Statistically significant differences were found in the number of recorded insects captured on different traps at $P < 0.05$ (Table 4).

In methyl eugenol traps, a total of (2342) individuals with four species of pests were caught in mango orchards during the study period (Fig. 3). In yellow sticker traps, the total population of pests was (2895) individuals, and the population of natural enemies was (302) individuals. Totally (15) species of pests and four species of natural enemies were collected (Fig. 4 and 5). In the pineapple fruit juice trap, a total of (183) individuals with seven species of the pest were collected (Fig. 6).

Effectiveness of fruit quality and damage status of infestations caused by pests

The mangoes without treatment and with treatment were found significant to the insect pests. The lowest number of pest infestation marks and the highest number of fruit length and fruit width were in ME traps. The fruit weight and thickness in the FJ trap were the highest. The lowest average number of oviposition marks was recorded in YS traps (Table 5).

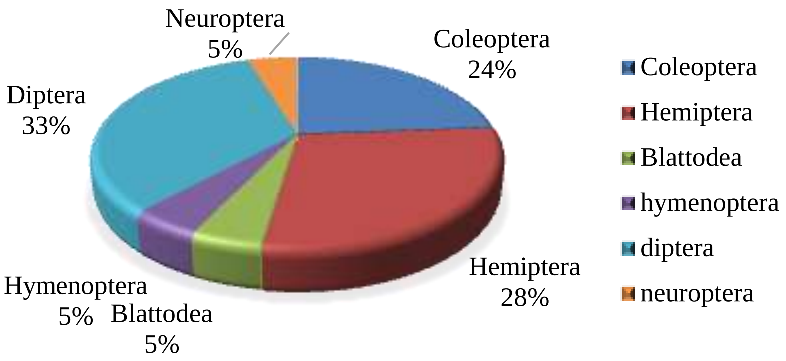
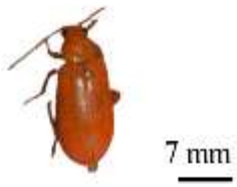
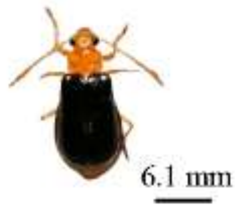


Figure. 2 Species composition of recorded insects according to order





(A) *Batocera rufomaculata* (B) *Aulacophora foveicollis* (C) *Aulacophora lewisii*

(D) *Monolepta australis* (E) *Odontotermes* sp. (F) *Oecophylla smaragdina*

(G) *Ricania* sp. (H) *Leptocentrus taurus* (I) *Dictyophara* sp.

(J) *Idioscopus clypealis* (K) *Idioscopus nitidulus* (L) *Bemisia tabaci*

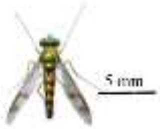
(M) *Drosophila melanogaster* (N) *Bactrocera dorsalis* (O) *Bactrocera correcta*

(P) *Bactrocera zonata*

(Q) *Bactrocera cucurbitae*

(R) *Cheilomenes sexmaculatus*

(S) *Chrysoperla* sp.



(T) *Condylostylus* sp.

(U) *Lucilia sericata*

Plate 2 Pests and Natural enemies of Order Coleoptera, Hemiptera, Blattodea, Hymenoptera, Diptera and Neuroptera on Mango

Table 1 The recorded insect pests and natural enemies of mango

Sr. No.	Order	Family	Scientific Name	Common Name
1.	Coleoptera	Cerambycidae	*Batocera rufomaculata*	Mango stem borer
2.		chrysomelidae	*Aulacophora foveicollis*	Red pumpkin beetle
3.			*Aulacophora lewisii*	Pumpkin beetle
4.			*Monolepta australis*	Red-shouldered leaf beetle
5.	Hemiptera	Ricaniidae	*Ricania* sp.	Ricaniid planthopper
6.		Membracidae	*Leptocentrus taurus*	Treehopper
7.		Dictyopharidae	*Dictyophara* sp.	Planthopper
8.		Cicadeliidae	*Idioscopus clypealis*	Mango leafhopper
9.			*Idioscopus nitidulus*	Mango flower jassid
10.		Aleyrodidae	*Bemisia tabaci*	Silverleaf white fly
11.	Blattodea	Termitidae	*Odontotermes*	Flying termite
12.	Hymenoptera	Formicidae	*Oecophylla smaragdina*	Red ant
13.	Diptera	Drosophilidae	*Drosophila melanogaster*	Fruit fly
14.		Tephritidae	*Bactrocera dorsalis*	Oriental fruit fly
15.			*Bactrocera correcta*	Guava fruit fly
16.			*Bactrocera zonata*	Peach fruit fly
17.			*Bactrocera cucurbitae*	Melon fruit fly
18.	Coleoptera	Coccinellidae	*Chilomenes sexmaculatus*	Ladybird beetle
19.	Neuroptera	Chrysopidae	*Chrysoplera* sp.	Green lacewing
20.	Diptera	Dolichopodidae	*Condylostylus* sp.	Long-legged fly
21.		Calliphoridae	*Lucilia sericata*	Blowfly

Table 2 Species composition and variation of insects at different mango fruit development stages in the study period

Sr. No.	Species	Numbers of collecting insect time per observation												Total No. of individuals
		February			March			April			May			
		1st week	2nd week	Sub total	3rd week	4th week	Sub total	5th week	6th week	Sub total	7th week	8th week	Sub total	
1.	*Batocera rufomaculata*	1	0	1	1	0	1	0	0	0	0	0	0	2
2.	*Aulacophora foveicollis*	5	12	17	6	7	13	9	6	15	2	1	3	48
3.	*Aulacophora lewisii*	1	5	6	1	0	1	0	0	0	0	0	0	7
4.	*Monolepta australis*	0	0	0	0	0	0	0	1	1	2	0	2	3
5.	*Ricania* sp.	1	1	2	0	0	0	0	0	0	0	0	0	2
6.	*Leptocentrus taurus*	2	1	3	0	0	0	3	0	3	3	0	3	9
7.	*Dictyophara* sp.	0	0	0	1	0	1	1	0	1	0	0	0	2
8.	*Idioscopus nitidulus*	202	233	435	102	156	258	75	87	162	139	145	284	1139
9.	*Idioscopus clypealis*	126	200	326	107	153	260	122	44	166	154	98	252	1004
10.	*Bemisia tabaci*	7	5	12	10	6	16	4	3	7	5	2	7	42
11.	*Odontotermes*	1	2	3	1	17	18	43	15	58	8	32	40	119
12.	*Oecophylla smaragdina*	1	3	4	5	2	7	2	4	6	8	1	9	26
13.	*Drosophila melanogaster*	21	7	28	8	16	24	11	10	21	14	11	25	98
14.	*Bactrocera dorsalis*	74	82	156	136	141	177	240	157	397	282	253	535	*1365
15.	*Bactrocera correcta*	70	67	137	149	113	162	175	115	290	217	221	438	1127
16.	*Bactrocera zonata*	18	29	47	36	47	83	111	39	150	58	62	120	400
17.	*Bactrocera cucurbitae*	0	0	0	0	0	0	0	0	0	9	18	27	27
18.	*Cheilomenes sexmaculatus*	1	5	6	1	0	1	0	0	0	0	0	0	7
19.	*Chrysoperla* sp.	11	12	23	4	0	4	2	1	3	0	0	0	30
20.	*Condylostylus* sp.	16	5	21	5	26	31	34	16	50	23	23	46	148
21.	*Lucilia sericata*	43	50	93	1	2	3	4	0	4	4	13	17	117
Total number of individuals		601	719	1310	574	686	1260	836	498	1334	928*	880	1808	5722

* maximum individuals

Table 3 Prevalence of mango infection caused by insect pests

Location	Number of inspected trees	Total number of mangoes	Prevalence (%)
VFRDC, Hlegu Township, Yangon Region	24	180	13.3

Table 4 Mean number (±SEM) of trapped insects on different traps

	Treatments			P-value
	ME	FJ	YS	
$\overline{X}$±SEM	$292.75^{b} \pm 45.12$	$22.88^{a} \pm 2.48$	$371.25^{b} \pm 46.90$	0.00

ME - Methyl Eugenol, FJ - Fruit Juice, YS - Yellow Sticky

$^{a, b}$ superscripts on the same column indicate significant differences ($P < 0.05$)

a – The minimum value, b – The maximum value

Table 5 Quality index of fruits and damage status of pest infestations

Treatment (Total)	No. of oviposition marks	No. of pest infestation marks	Presence of larva (cut)	Fruit weight (g)	Fruit length (cm)	Fruit width (cm)	Thickness (cm)	Sweetness (%)
ME	0.83	0.13	0	406	14.4*	7.9*	7	14.2
FJ	2.67	0.67	1.3	408*	13.8	7.8	7.1*	16.2
YS	0.54	0.63	0	378	14	7.6	6.8	14
Control (No Trap)	7.93*	1.53*	7.3*	299	13	7.4	6.5	16.4*

* Maximum quality index

ME - Methyl Eugenol

FJ - Fruit Juice

YS - Yellow Sticky

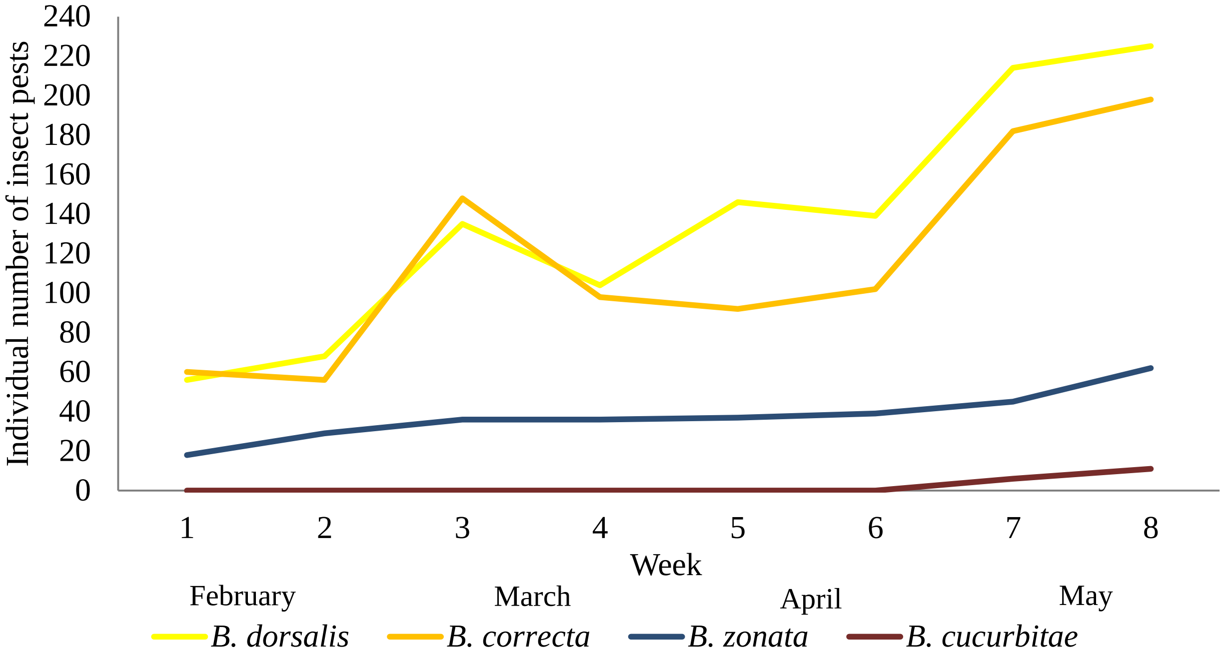


Figure. 3 Number of trapped insect pests on methyl eugenol trap

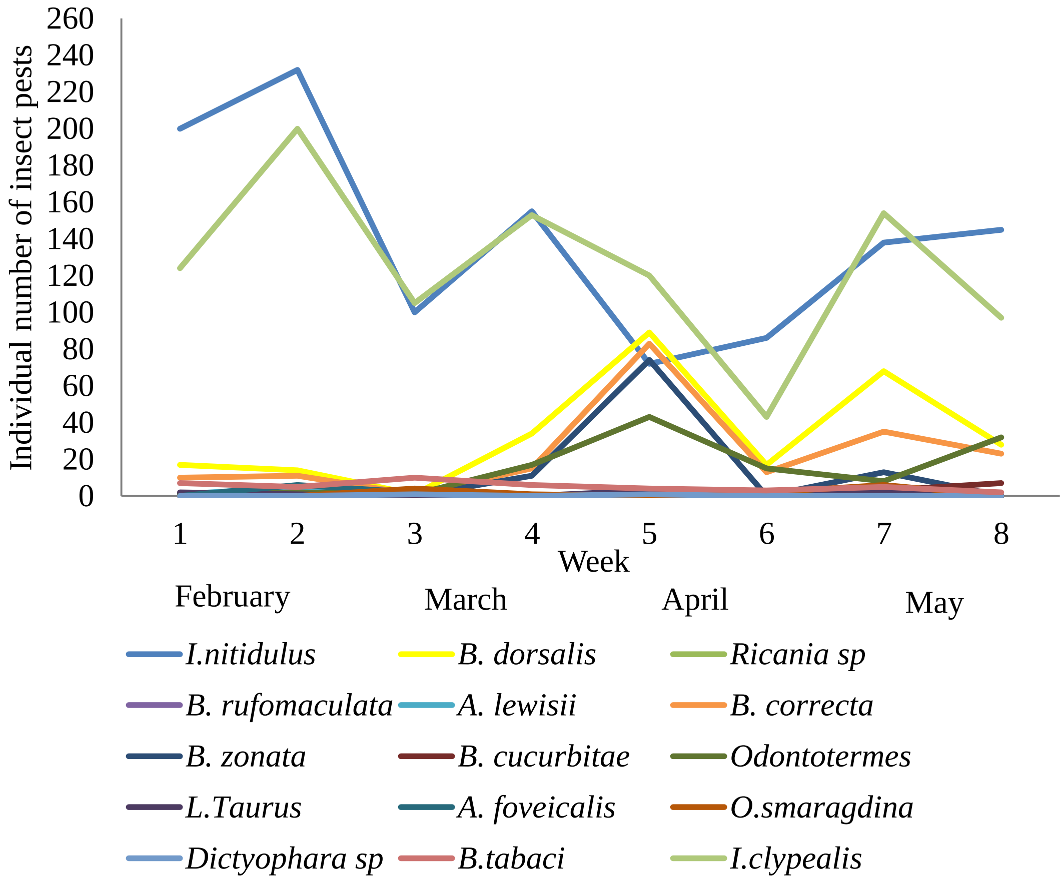


Figure. 4 Number of trapped insect pests on the yellow sticky trap

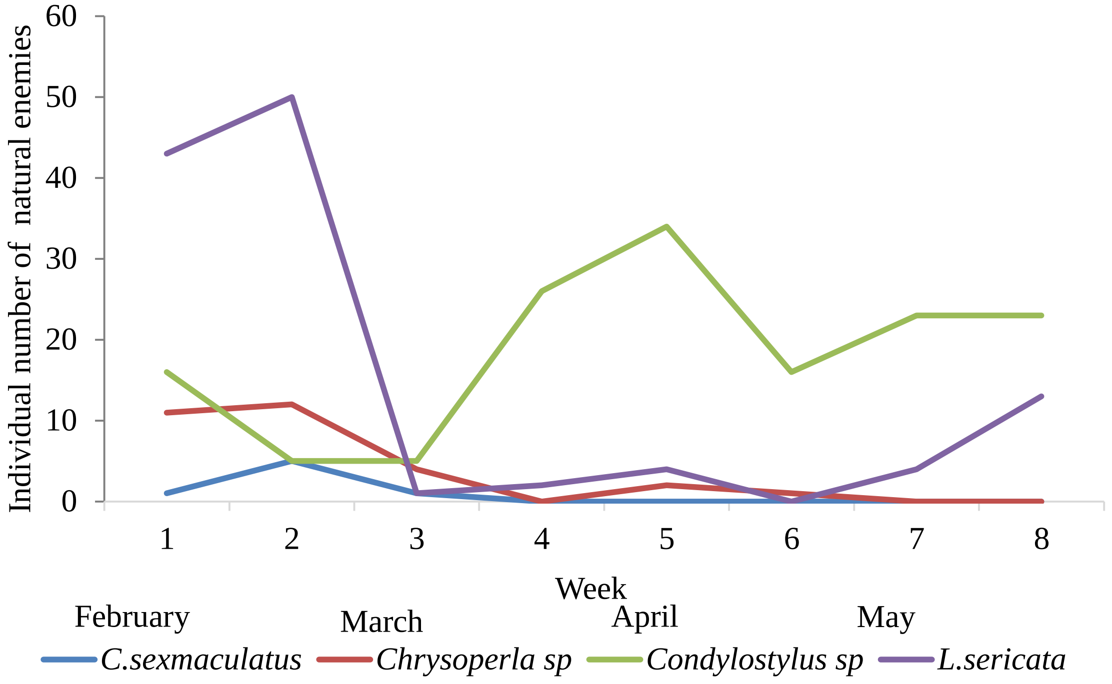


Figure. 5 Number of trapped natural enemies on the yellow sticky trap

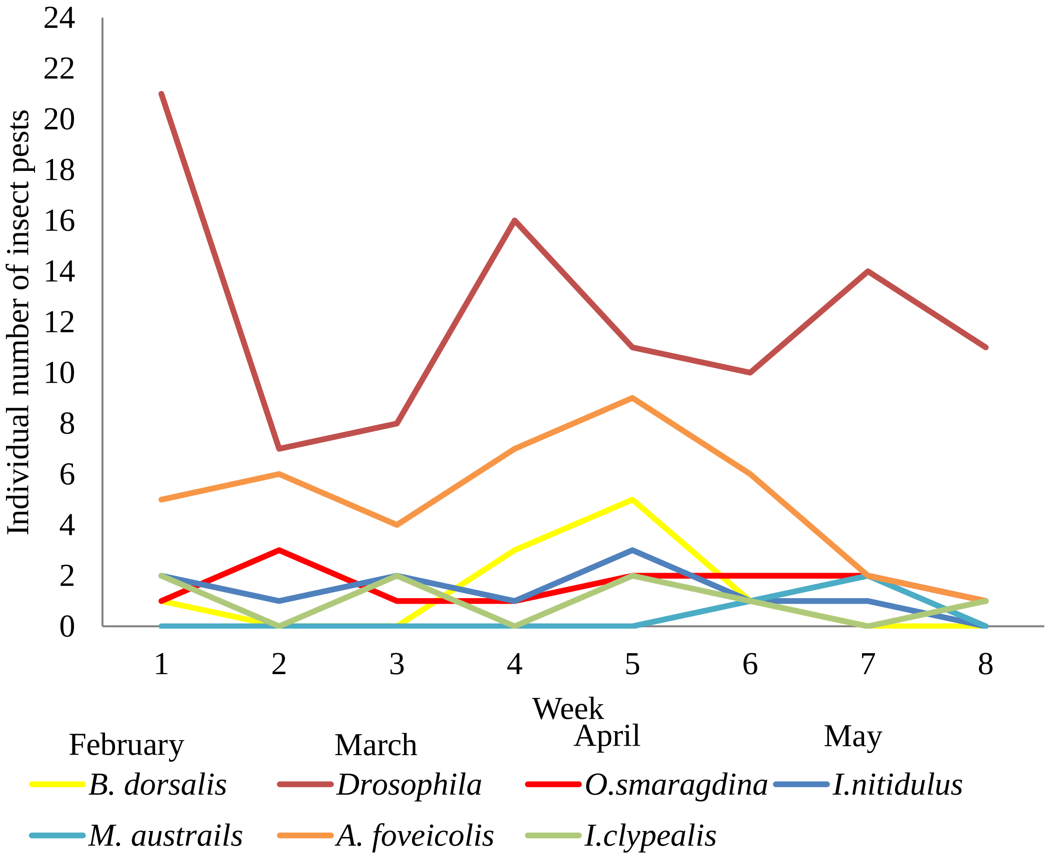


Figure. 6 Number of trapped insect pests on fruit juice trap

Discussion

The present study was done to assess the status of the pest infestations and their damage level on economically important mango cultivated at VFRDC, Ye Mon village, Hlegu Township of Yangon Region.

A total of 21 insect species representing 16 genera across 15 families and 6 orders were observed in this study site. In the present study, *Idioscopus clypealis*, *Idioscopus nitidulus*, *Bactrocera correcta*, and *Bactrocera dorsalis* occurred all through the study period. The minimum occurrence of insect pests was *Monolepta australis*, *Ricania* sp., *Dictyophara* sp. and *Batocera rufomaculata* in the present study. *Idioscopus* and *Bactrocera* species are dominant at study site in the present study. They occurred mostly during the harvesting period.

Nan Zarchi Win *et al*. (2014) assessed that *B. dorsalis* and *B. correcta* were most abundant from different fruit samples in Yezin, Myanmar.

According to the results, *Bactrocera dorsalis* and *Bactrocera correcta* were found to be the most dominant at mango in the study site. Therefore, the finding of the present study agrees with Nan Zarchi Win *et al*. (2014). Drew and Roming (1996) reported that the species *Bactrocera dorsalis* plays an important role in fruit production for domestic consumption and export as well.

Bana *et al*. (2018) studied that *Idioscopus clypealis* and *I. nitidulus* were the dominating species during the full bloom period.

In the present study, mango hopper *I. clypealis* and *I. nitidulus* were found in flowering and fruiting stages were considered as serious pests. Therefore, the finding of the present study is the same as Bana *et al*. (2018).

Among the natural enemies, 10 species of coccinellids and two species of chrysopids were observed in the mango ecosystem (Gundappa, *et al*., 2019). In the present study, *Condylostylus* sp., *Lucilia sericata* and *Chrysoperla* sp. can help reduce pest insect populations including aphids, thrips, white flies, spider mites, caterpillars and insect eggs.

A total of 24 out of 180 plants were found to be infected, resulting in a prevalence rate of 13.3%. Statistically significant differences were found in the number of recorded insects captured on different traps at $P < 0.05$.

In control, the visual inspection of fruit damage was more significant than the other three traps and also the sizes of fruit in control decreased in this study site. The lowest infestation occurred in ME and YS traps in the present study.

The yellow sticky traps were more effective than any other traps. These traps were effective not only to control the pest but also to improve the quality and yield of mango trees. The number of damaged fruits was the lowest in yellow trap. But the outcomes of plants without traps showed the lowest marketable fruits, the low quality of fruit size, the highest number of damaged fruits and the suffered stress in mangoes caused by the pests. Therefore, physical control is mostly controlled using pesticides, which harm on human health and beneficial insects.

The result of this study suggests important information on effective monitoring, and management of major pests in mango plants for farmers who should use a reduction to pesticides which further leads to less cost, less workers' exposure to pesticides, and ultimately less pesticides-induced phyto-toxicity and less expenses. Therefore, most effective control methods should be used for local and exports markets.

Conclusion

This study found that Diptera was the dominant pest in *Mangifera indica* plantation at VFRDC, Hlegu, Yangon. Among the recorded species, *Bactrocera dorsalis* and *Idioscopus nitidulus* were major pests that whose populations exploded as the mango fruits near the harvest stage. Among control methods, methyl eugenol and yellow sticky traps were most effective in reducing infestations. However, in untreated control, visual inspection revealed greater fruit damage and smaller, less healthy fruits. The study suggests that the utilization of yellow sticky and methyl eugenol traps were cost-effective methods to control the pests with reduced labor requirements for sustainable mango production and quality maintenance. The economic importance of mangoes is essential to maintain quality and yield in both export and local markets.

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