THE SEASONAL ABUNDANCE OF FRUIT FLY SPECIES IN SRI LANKA AND THE MALE ANNIHILATION TECHNIQUE AS A CONTROL MEASURE FOR FRUIT FLIES; TWO CASE STUDIES

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ABSTRACT

Methyl Eugenol (ME) is a male lure used for monitoring and mass trapping (male annihilation) of fruit flies. A dynamic pattern of fruit fly population fluctuations was observed with peak abundance from July to September in two locations; Guruwela and Gannoruwa, in Sri Lanka. *Bactrocera correcta* was the predominant species during the peak period, followed by *B. kandiensis* and *B. dorsalis*. The effect of male annihilation on fruit fly populations was evaluated in both locations using an effective pheromone:insecticide combination and a suitable absorbance material selected from preliminary trials with cotton wool/wood dunk baits soaked in ME + Spinosad 25 g/L SC and ME + Abamectin 18 g/L EC and two readymade commercial traps. Cotton wool soaked in 1 ml ME + 0.15 ml Abamectin 18 g/L EC was selected as the most effective insecticide: pheromone combination last for two months. For mass trapping, fifteen to twenty traps were deployed in Guruwela and Gannoruwa from 2017 to 2018. A significant decline of average number of fruit flies/trap/day was revealed at Guruwela from 159 to 5 (χ2 108.80; P<.0001) and 243 to 104 (χ252.7; P<.0001) at low and high abundance periods, respectively. In Gannoruwa, the baseline fruit fly number significantly reduced from 188 to 68 FF/trap/day (χ2 51.70; P<.0001) after one year.

Key words: Bactrocera spp., Fruit fly, Male annihilation, Methyl eugenol

INTRODUCTION

Fruit fly (Diptera: Tephritidae) is a devastating pest, which is distributed worldwide. A survey has estimated that Sri Lanka harbours more than 35 fruit fly species (Tsuruta *et al*., 1998). Females of most of the fruit fly species lay eggs beneath the skin of the fruit and the larvae develop inside the fruit consuming the inner soft parts. The presence of larvae in fruits and secondary microbial infestations initiated at pierced positions cause losses in fruit quality and quantity. The fruit flies are invasive species and are carried out to far distances with imported commodities or by wind currents (Allwood, 2002; Vargas *et al*., 2010). Considering its economic importance, most of the countries have designed appropriate Area-Wide Integrated Pest Management (AW-IPM) programmes, which is an integration of two or more methods applied on an area-wide basis, as an effective and sustainable approach for pest management (Hendrichs *et al*., 2007). The common approaches of crop sanitation by removal and destruction of damaged fruits, wrapping, bagging or netting of fruits, protein bait sprays and early harvesting are integrated in AW-IPM programmes for fruit fly control. In addition, Male Annihilation Technique (MAT) or use of fruit fly sex lure Methyl Eugenol (ME) with a toxicant to attract, trap and kill fruit flies has begun more than six decades ago (Steiner, 1952) and continued thereon (Steiner *et al*., 1965; Koyama *et al*., 1984; Vargas *et al*., 2010; Vargas *et al*., 2014). However, the history of use of ME for attracting fruit fly dates far back to 1912 where citronella was used in India while in 1946, Ceylon citronella oil was used in Hawaii (Steiner, 1952). Advancements of ME applications such as modeling with mass reared sterile fruit flies of different species are in place (Barclay *et al*., 2014; Haq *et al*., 2018; Kamiji *et al*., 2018).

The MAT is a chemical control method designed to deplete the males by mass trapping with male lures and a recommended toxicant (Dominiak and Nicol, 2012). The absence or reduction of males in a population breaks or reduce the reproduction cycle resulting in a population decline. Methyl eugenol is a highly effective male lure (para pheromone) that can attract fruit flies from a long distance of about one kilometer (Steiner, 1952). It is used in MAT programmes to attract oriental fruit fly, *Bactrocera dorsalis* and several other fruit fly species (HAW-FLYPM, Undated; Koyama *et al*., 1984; Vargas *et al*., 2010; Kamiji *et al*., 2018; Khosravi *et al*., 2018). Isolated islands and the countries

that abide by strict quarantine regulations incorporate MAT alone or followed by Sterile Insect Technique (SIT) to control or eradicate the fruit fly populations (Steiner *et al*., 1965; Koyama *et al*., 1984; Vargas *et al*., 2010). The initial MAT programmes used lure bait stations composed of ME and Parathion (Steiner, 1952). Subsequent programmes used the organophosphate insecticides such as Naled (Steiner *et al*., 1970; Koyama *et al*., 1984), Fipronil (Allwood *et al*., 2002), Dimethyl Dichloro Vinyl Phosphate (DDVP) (Vargas *et al*., 2010) and Malathion (Vargas *et al*., 2003). Naled has rated first with its high effectiveness even at the 20th week of field deployment. Recent trials have replaced Naled with Spinosad, which is a less hazardous insecticide compared to originally used organophosphates and therefore, included in AW-IPM programmes (Vargas *et al*., 2003). As absorbent materials, wooden fiberboard squares, pieces of cotton ropes and cane-fiber squares have been used (Steiner *et al*., 1965; Koyama *et al*., 1984). The trap density varied according to the background information and used as approximately 12-25/ha (HAW-FLYPM, Undated; Allwood *et al*., 2002), 0.32 km apart (Steiner *et al*., 1965), and 60-1700 impregnated blocks per 2 km (Allwood *et al*., 2002). They can be deployed at weekly intervals or more depending on the area and the objective of the programme (Steiner *et al*., 1965; Steiner *et al*., 1970; Koyama *et al*., 1984; Allwood *et al*., 2002).

In Sri Lanka, ME lures are used for monitoring purposes (Galanihe *et al*., 2017) and hence, are useful to identify the peak periods of outbreaks and population dynamics of species for correct timing of AW-IPM applications. The present study focused on identifying the peak periods of outbreaks of fruit flies, the dynamic pattern of population fluctuations and the effect of continuous mass trapping and annihilation of fruit fly male population.

MATERIALS AND METHODS

Identification of fruit flies

Fruit fly species were identified using a pictorial key (Tsuruta *et al.*, 1998; 1999). Accordingly, the wing characteristics, colour patterns and markings on thorax, abdomen, legs, shape of the ovipositor and setae were studied to distinguish the species.

Identification of suitable pheromone: insecticides combination and absorbance material for male annihilation

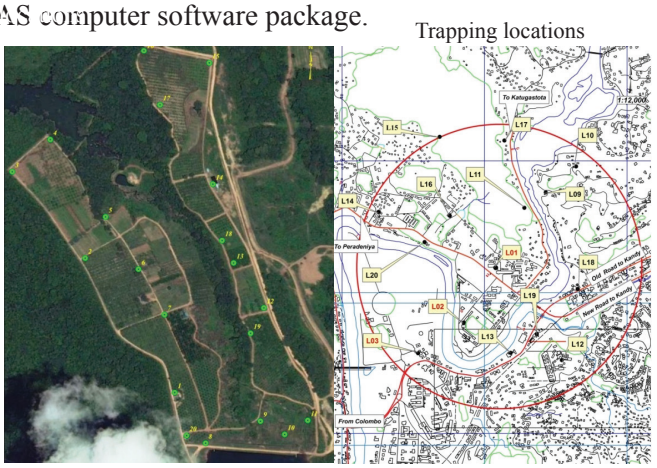
Four laboratory-prepared fruit fly para-pheromone Methyl Eugenol (ME) and insecticide combinations together with two ready-to-use commercial ME baits were evaluated at field level for their efficacy in catching fruit flies over a two month period. Methyl eugenol alone as a bait was not included, as it does not effectively kill or retain the fruit flies in the trap. The commercial traps were known to contain ME combined with an insecticide. Accordingly, swab of cotton wool soaked in 1 ml 98% Methyl eugenol + 0.15 ml Spinosad 25 g/L SC (T1), 4 cm x 4 cm wood dunk soaked in 1 ml 98% Methyl eugenol + 0.15 ml Spinosad 25 g/L SC (T2), swab of cotton wool soaked in 1 ml 98% Methyl eugenol + 0.15 ml Abamectin 18 g/L EC (T3), 4 cm x 4 cm wood dunk soaked in 1 ml of 98% Methyl eugenol + 0.15 ml Abamectin 18 g/L EC (T4), locally purchased ME commercial bait, Baska® (T5) and imported ME commercial bait received for local field evaluation (unnamed, T6) were used. The baits were hanged in manually prepared bottle traps with the help of a wire. The trap is a traditionally used bottle with two holes one at the bottom and the other on the lid making an entrance inward to fruit flies by passing through a piece of plastic tube of 6 cm long and 1 cm diameter, at each side. The imported commercial bait was placed in its original container serving the same purpose as for the previously described trapping device. The study was designed as a Randomized Complete Block Design (RCBD) with six treatments and three replicates. A preliminary study was carried out in December 2016 at three locations at Gannoruwa in the Kandy district to observe the effectiveness of the traps. Thereafter, the traps were deployed in three locations in a RCBD at the Guruwela Mahaweli fruit farm in the Matale district for over two months. The fruit fly trap count data were taken after 1, 2, 5 and 8 weeks of trap placement in test locations. The trapped species were counted using digital counters and identified with the help of fruit fly identification keys (Tsuruta *et al*., 1998). Fruit fly trap count data obtained at each week were analyzed using Chi Square test using CATMOD procedure in SAS computer software package. Mean separation was done using maximum likelihood predicted values. Z values were used to find the significance.

Trap setting for fruit fly male annihilation at selected locations

Guruwela Mahaweli farm (7° 33’ 40.03’’ N, 80° 51’ 17.92’’ E) located in the

Matale district in Sri Lanka was selected as the initial study area for mass trapping, considering its favourable environment for fruit flies such as abundance of fruit crops, nearby natural forest and minimum disturbances from urbanization. The extent of the farm land is about 20 ha (0.2 km^2). From February 2017, twelve traps (at the rate of 60 traps/km^2) of the selected combination from the trap screening study, were placed 100 to 300 m apart from each other. Due to biotic and abiotic disturbances occurred to several traps during the study, the trap number increased up to 20 (at the rate of 100 traps/ km^2) in November 2017 (Figure 1A).

Trapping continued until August 2018. The trap bottles were hanged horizontally in a twig of a tree branch about 2-3 m above ground, with the help of a hook attached. Inside the bottle, the cotton swab was attached to a piece of wire hanged to the other end of the hook (Figure 2). Trapped dead flies were collected, approximately at four weekly intervals at every possible occasion and the traps were replenished at the time of collection. The trapped fruit flies were counted at the entomology division of Horticultural Crops Research and Development Institute (HORDI), Gannoruwa, Sri Lanka. Species were identified at the time of counting using published keys (Tsuruta *et al*., 1998; Tsuruta *et al*., 1999). For statistical comparisons, average fruit fly counts (the number of fruit flies per trap per day) were used. The average fruit fly counts of comparable months/weeks of two study years were statistically compared using Chi Square test using CATMOD procedure in SAS computer software package.



A B

Figure 1. Fruit fly trapping locations. A - Guruwela Mahaweli farm and B – Gannoruwa

A similar study was conducted in Gannoruwa in the Kandy district from July 2017 to June 2018. A baseline data set was obtained in February 2017. The Gannoruwa location was selected owing to the high abundance of fruit trees and convenience of trap collection. A forest is located in the centre of the area and some parts of the area are semi-urbanized. Also, sales outlets with fruits which supply additional breeding sources for fruit flies are common in Gannoruwa. Fifteen traps were deployed (at the rate of 5 traps/ km^2) within a circular area of a 1 km radius (3.14 km^2) from HORDI (7° 16' 30.57''N, 80° 36' 4.90''E), at 300 to 500 m apart from each other (Figure 1B). Trapped dead flies were collected approximately at 4-week intervals at every possible occasion. However, several data collections were made 2 to 7 weeks from the date of trap placement due to unavoidable circumstances such as rainy periods, difficulty in acquiring transportation, etc. The dead fruit flies were identified, counted and analyzed as previously described.

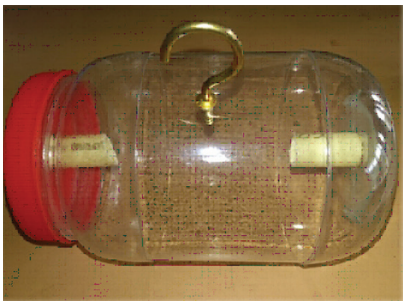


Figure 2. Trap bottles used for ME:toxicant mixtures

RESULTS AND DISCUSSION

Identification of suitable pheromone: insecticides combination and absorbance materials

At the end of 1st week of trapping at Guruwela, wood dunk impregnated with ME and Abamectin (T4) gave the significantly highest fruit fly catch. Trap count with cotton wool swab impregnated with ME and Spinosad (T1) was non-significant with the highest caught trap T1 and also with wood dunk impregnated with ME and Spinosad (T2), cotton wool impregnated with ME and abamectin (T3) and the imported commercial trap (T6). The least trap catch which was significant from all other traps was observed with the local commercial trap (T5l Table 1). At the end of 2nd week of trap placement, results highly

similar as of the end of 1st week were observed. Thus, all lure: toxicant combinations (treatments-T1, T2, T3, T4 and T6) except local commercial trap, Baska® (T5), gave significantly higher fruit fly catches. At the third collection of trapped fruit flies carried out after the 5th week of trapping, imported commercial trap (T6) gave the highest catch. The catch with cotton wool soaked in ME and Spinosad (T1) was non-significant with the highest catch and also with cottonwool: ME:Abamectin combination (T3). Even after the 8th week of trapping a higher efficacy was observed with cotton wool soaked in ME:Abamectin (T3) over the other tested traps (Figure 3). Therefore, considering the higher fruit fly catching ability for a longer period of time over two months treatment T3 was chosen for mass trapping studies in Guruwela and Gannoruwa sites.

Table 1. The effect of different combinations of para-pheromone: insecticides on average fruit fly catches with respect to exposure period

Treatment No and Type of trap	*Average number of fruit flies (FF No/Trap/Day)			
	After 1st week	After 2nd week	After 5th week	After 8th week
T1-Cotton wool in ME (1 ml) + Spinosad 25 g/L SC (0.15 ml) per trap	158^{ab}	83^{abc}	117^{ab}	20^{c}
T2-Wood dunk in ME (1 ml) + Spinosad 25 g/L SC (0.15 ml) per trap	126^{b}	60^{c}	0d	9^{cd}
T3-Cotton wool in ME (1 ml) + Abamectin 18 g/L EC (0.15 ml) per trap	124^{b}	91^{ab}	89^{b}	179^{a}
T4-Wood dunk in ME (1 ml) + Abamectin 18 g/L EC (0.15 ml) per trap	169^{a}	65^{bc}	45^{c}	3de
T5-Local commercial trap (Baska)	10^{c}	9^{d}	1^{d}	0^{e}
T6-Imported commercial trap (Unnamed)	125^{b}	103^{a}	123^{a}	123^{b}
ChiSq Pr<.0001	82.3	58.7	59.1	194.0

**Maximum likelihood predicted values were used for mean separation; Means with same letters in superscript indicate the significance at (0.0001); . Z values were used to find the significance.*

Figure 3. Fruit flies caught in ME:Abamectin traps

The use of ME:insecticide combinations evaluated in this study can be recommended in the future fruit fly control programmes. Further studies are necessary to develop a user-friendly and cost-effective absorbance material with slow releasing properties to use without a trapping device.

Mass trapping effect on fruit flies at Guruwela and Gannoruwa locations

The initial data obtained in February 2017 were observed with comparable population levels in both locations (χ2 2.5, P>0.1; Tables 2 and 3). After one calendar year from initial trapping (9th - 12th week of 2017; Table 2), there was a significant reduction of male fruit fly catches per trap per day in Guruwela from 159 to 5 (χ^2 108.80, P<0.0001; Table 2; Figure 4). A prominent peak was identified from the 26th to 41st week (June to September) in 2017. In comparison of the results of two-years, a significant reduction of the peak was observed from 243 Fruit Fly/trap/day during the trapping period from the 26th to 29th week (July) 2017 to 104 Fruit Fly/trap/day observed from 27th to 31st week (July) in 2018 (χ^2 52.7, P<0.0001; Table 2; Figure 4). As a whole, a significant reduction (χ^2 115.0, P<0.0001) of the average fruit fly density was evident in the early half of 2018 (8th to 31st week) compared to the comparable period (9th-29th week) in 2017.

The total rainfall data in Guruwela area during the study period has been plotted against fruit fly trap counts. In 2017, the latter half of the year had a higher rainfall which has continued throughout first half of 2018. However, long term studies on rainfall and its effect on fruit fly life stages, food habits, etc are required to trace a relationship in between the rainfall pattern and dynamics of fruit fly populations.

Table 2. Parameters assessed during the trapping period at Guruwela location

Week No	Respective Year	FF No. per Trap per Day	Trapping period (Days)	No of Rainy Days
09-12	2017	159†	23	10
13-15		31†	20	3
16-18		41†	23	0
19-22		53†	27	5
23-25		55†	22	0
26-29		243#†	28	0
30-33		250	28	4
34-37		147	28	7
38-41		141	28	0
42-45		54	28	7
46-49		27	28	14
50-01	2017/18	12	28	11
02-07	2018	9	45	10
8-14		4.8†	43	12
15-18		8†	30	8
19-22		21†	29	18
23-26		125†	25	2
27-31		104#†	38	0

 # (χ^2 52.7, P<0.0001); †(χ^2 115.0, P<0.0001)

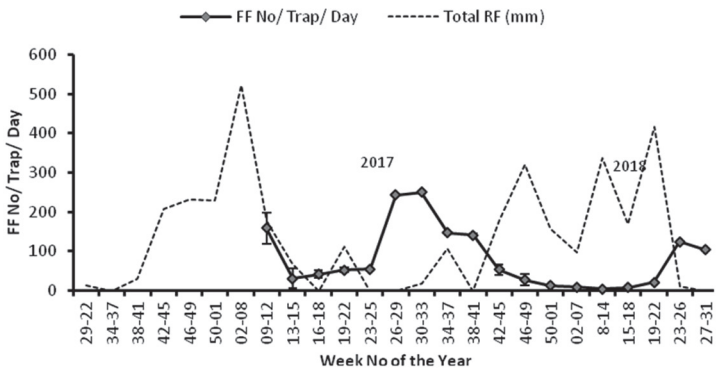


Figure 4. Dynamics of the average male fruit fly population caught per trap per day at Guruwela location and the total rainfall during the study period 2017-2018

In Gannoruwa, the initial data collection was carried out in the 9th week (February) in 2017, recording 188 Fruit Fly/trap/day. During the study commenced from the 29th week (July) in 2017 to 23rd week (June) in 2018, a significant reduction of average fruit fly catch was observed from the initial trapping, from 188 to 68 Fruit Fly/trap/day (χ^2 51.70; P<.0001; Table 3; Figure 5). A peak trapping period similar to the Guruwela fruit fly population was observed from the 29th to 36th week (July to September) from 1st of January 2017. During the peak observation period in Gannoruwa, the data could not be compared with that of the previous year due to the shortness of the collection period. The rainfall has shown an average distribution throughout the study except for a higher fluctuation in a short period in 2018. The fruit fly fluctuation compared to rainfall pattern was difficult to be traced.

Table 3. Parameters assessed during the trapping period at Gannoruwa location

Week no	Respective year	FF No. per trap per day	Trapping period (Days)	No of rainy days
09	2017	188†	4	0
10-15		*	*	24
16-20		*	*	9
21-24		*	*	17
25-28		*	*	16
29-32		1123	14	9
33-36		381	23	17
37-38		235	15	10
38-42		84	20	16
43-46		24	26	20
47-50		29	28	16
51-02	2017/18	27	28	6
03-06	2018	26	28	3
07-12		68†	45	14
13-19		94	49	19
20-23		51.2	29	*

*†(χ^2 51.70; P<.0001);; * Data not available*

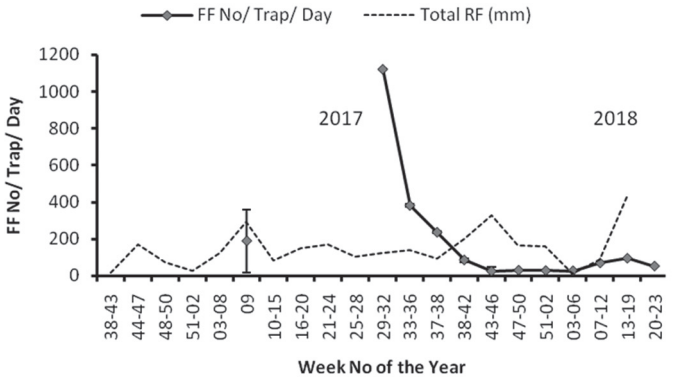


Figure 5. Dynamics of the average male fruit fly population caught per trap per day at the Gannoruwa location and the total rainfall during the study period 2017-2018

Identification of fruit flies

B. correcta, B. kandiensis and *B. dorsalis* were the commonly caught species in both locations during the study. The fruit flies in several traps could not be identified due to deterioration from rain water. In the traps with identifiable specimens, *B. correcta* was the dominant species of which the populations peaked from 22nd (June) to 50th (December) week in 2017 (Table 4). In parallel, populations of *B. kandiensis* also increased however, the population was below the levels of *B. correcta* during the identified peak period. From 10th to 19th week (March to May) *B. dorsalis* was the dominant species at Guruwela location.

Table 4. Fruit fly species distribution obtained during the study period in Guruwela location

Week no	Respective year	Fruit fly no/ Trap/ Day			Number of traps	Number of trapping days
		Bactrocera dorsalis	*Bactrocera kandiensis*	*Bactrocera correcta*		
10-12	2017	93	11	56	15	23
13-15		26	3	2	12	20
16-18		31	1	5	8	23
19-22		24	3	25	11	27
23-25		14	10	30	9	22
26-29		13	10	65	11	28
30-33		5	23	275	8	28
34-37		6	37	104	8	28
38-41		5	19	92	8	28

Table 4(continued). Fruit fly species distribution obtained during the study period in Guruwela location

Week no	Respective year	Fruit fly no/ Trap/ Day			Number of traps	Number of trapping days
		Bactrocera dorsalis	*Bactrocera kandiensis*	*Bactrocera correcta*		
42-45		12	9	49	7	28
46-49		10	5	38	4	28
50-01	2017/18	4	1	8	19	28
02-07	2018	5	0	4	20	45
8-14		2	0	2	18	43
15-18		1	0	7	20	30

In the Gannoruwa location, *Bactrocera dorsalis* was the dominant species in the 9th week (February) in 2017. From 29th to 50th week (July to December) *B. correcta* peaked up showing a dynamic pattern similar to the Guruwela population (Table 5).

Table 5. Fruit fly species distribution obtained during the study period in Gannoruwa location

Week no	Respective year	Fruit fly no/ Trap/ Day			No of traps	No of trapping days
		B. dorsalis	*B. kandiensis*	*B.correcta*		
09-10	2017	111	47	24	12	4
13-16		*	*	*	*	*
17-20		*	*	*	*	*
21-24		*	*	*	*	*
25-28		*	*	*	*	*
29-32		62	97	700	3	28
33-36		39	70	283	14	27
37-38		25	39	288	3	10
38-42		13	28	38	11	30
43-46		4	4	19	14	26
47-50		9	7	13	3	28
51-02	2017/18	6	15	5	13	28
03-06	2018	7	14	5	12	28
07-12		23	29	15	14	45

** Data not obtained*

After 1 year of the study at Guruwela, the average no of *B. dorsalis* (χ^2 30.65; P<.0001) and *B. correcta* (χ^2 22.75; P<.0001) were reduced significantly while in Gannoruwa, only *B. dorsalis* showed a significant reduction in population (χ^2 46.40; P<.0001; Table 6).

Table 6. Fruit fly species abundance before and after one year of the study in Guruwela and Gannoruwa locations

Fruit fly species	Guruwela FF No. per Trap per Day**		Gannoruwa FF No. per Trap per Day**	
	2017 10th -12th Week #	2018 8th-14th Week	2017 9th -10th Week	2018 7th-12th Week
B. dorsalis	93†	2†	111*	23*
B. kandiensis	11	0	47	29
B. correcta	56††	2††	24	15

*†(χ2 30.65; P<.0001); ††(χ2 22.75; P<.0001); *(χ2 46.40; P<.0001); #Trapping period represented weeks from February to April.;** The trapped flies during the trapping period were averaged per trap per day.*

In addition to the three prominent species, two other species; *B. nigrofemoralis* and *B. apicofuscans* were identified from the traps. The identification was confirmed by fruit fly taxonomist Dr. K. Tsuruta (2018 – personal communication).

A total of more than 500,000 male fruit flies were caught during the study period, 300,000 at Guruwela and 200,000 at Gannoruwa. The results revealed a significant reduction of fruit fly populations in 2018 compared to 2017 after the study. Thus, continuous mass trapping can be considered to have a significant impact on reduction of male fruit fly populations. The overall results showed a characteristic dynamic pattern of male fruit fly populations throughout the year at both locations. It is assumed that the peak abundance is correlated with the fruiting season from July to September of a given year. It was noted that among the several host plants of the collected fruit fly species (Tsuruta *et al*., 1997), mango was observed to be a major fruit crop in both locations.

Male annihilation is a proven technology for its effectiveness in application in fruit fly control programmes across the world (HAW-FLYPM, Undated; Koyama *et al*., 1984). However, the net effect of the technique can be masked by numerous variables such as environmental parameters, food availability, and natural enemy abundance. For instance, the distribution and number of rainy days during the study period may also have a synergistic effect on the decline in fruit fly population. However, long term observation or specific modeling studies are required to find the interaction of associated factors. Due to the interaction of many other factors and as replication or maintaining a 'çontrol' is

not feasible, these type of studies are extremely difficult to conduct. Therefore, to draw a conclusion based on the results of the analysis of data, other supportive data from elsewhere should also to be considered.

There were two main constrains encountered during the study. The first set of difficulties in collecting trap catches at regular intervals due to rainy periods. In such occasions, the traps were collected at 7-8 week intervals and it was assumed that the baits were significantly effective over the period supported by the fact that was experienced with the initial experiment carried out to find a suitable bait mixture.

The other obstacle faced was the unexpected external disturbances occurred to traps from monkeys, ants, rain, etc. In such cases, only the undisturbed traps were considered as effective for the analysis. Accordingly, the usable traps in Guruwela ranged at the rate between 40 to 100 traps/km^2. At Gannoruwa, the trapping rate deployed was far below than at Guruwela with 1 to 5 traps/km^2. However, at both locations, continuity of trapping even with lesser number may have resulted in significant control of male fruit fly population owing to their nature of long distance attraction to sex pheromones (Froerer *et al*., 2010).

Even though the initial trap catches were comparable at both locations, the differences in the rate of trapping/unit area, period of trapping, fruit fly density in the area, new introductions with fruit commodities, environmental factors, etc., may have resulted in the variations of final trap catches. For example at Gannoruwa, the trap counts never reached close to zero. Among many other variables at the Gannoruwa location, re-introduction of fruit fly by fruit stalls could be a major factor for high population densities in this site.

Overall, the study covered almost two comparable peak periods and reduced fruit fly density periods from 2017 to 2018 in the Guruwela site. The large number of fruit fly caught during the study period may have reduced the male fruit fly density in the area. Far better results may have been obtained with the extension of the study period. The results of the study can be used in future AW-IPM programmes by intensifying lure trapping especially near the peak period from June to October. Further, the efficacy of insecticides combined with ME require regular assessing as escaped fruit flies can easily develop

resistance against the commonly used products such as Spinosad and Abamectin (Pan *et al*., 2005; Hsu and Feng, 2006; Zhang *et al*., 2007).

CONCLUSION

Bactrocera correcta followed by *B. kandiensis* and *B. dorsalis* were the dominant fruit fly species attracted to ME traps in Gannoruwa and Guruwela. A peak abundance period of fruit fly population was identified from June to October. Continuous usage of a large number of fruit fly lure: toxicant bait traps contributed to a significant reduction of the fruit fly populations. A higher effectiveness was observed with trap deployment at a rate of 60 to 100 traps/km^2. The male annihilation technique can be incorporated in AW-IPM programmes for efficient control of fruit flies. Thus, a handmade trap baited with a swab of cotton wool impregnated in 1 ml absolute (98%) ME:0.15 ml Abamectin 18 g/L EC can be recommended for effective usage over period of two months. The local bait Baska showed a poor performance.

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