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# Response of male fruit fly (Diptera: Tephritidae) to various food essences in Methyl Eugenol and Cue-Lure baited traps

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**Abstract**
The role of food essences to enhance the efficacy of baited fruit fly traps were studied at Malakandair Research Farm, The University of Agriculture, Peshawar, Pakistan against the major fruit fly species of fruits and vegetables. In two experiments, the desire food essences were added to Methyl Eugenol (ME) baited and Cue Lure (CL) baited traps. Mean population for treatments showed that Mango essence added ME- traps attracted significantly highest population of *B. zonatus* (23.5 flies) followed by Pine apple essence traps (23.0). Least number of *B. zonatus* (16.5) was killed in the control-traps. Significantly higher number (9.47) of *B. dorsalis* was captured in Pineapple and Mango essence added traps as compared to a lower number of 6.49 by Raspberry essence added traps. In the CL baited traps, highest numbers of 18.33 and 13.93 *B. cucurbitae* were killed by Raspberry and Pine apple essence added traps respectively as compared to the control-traps (7.67). Population trends of the three species are also reported.

**Keywords:** Food essence, Fruit flies, *Bactrocera spp*, Methyl eugenol, Cue lure, fruit fly trap

## 1. Introduction
Tephritid fruit flies are serious pests of many fruits and vegetables (Khattak *et al*., 1997) [1]. Over 250 different kinds of fruits and vegetables are attacked by the fruit flies (Chen, 2002) [2]. Their attack not only reduces the fruit yield but also affects the quality, as a result commercial value of the crop is reduced (Carrolle *et al.* 2002) [3]. Fruit flies increases cost of production and restricts free trade and movement of produce to "fruit fly free zones" (Kapoor, 2006) [4]. Though fruit and vegetable growers mostly rely on scheduled spray (Irshad *et al*. 2003) [5], however, Methyl eugenol baited traps are in use in most orchards. Methyl eugenol (ME) is male attractive lures for *B. dorsalis* while cue-lure (C-L) attracts male flies of *B. cucurbitae* (Khan *et al*. 2003) [6]. Mixture of Methyl eugenol, Sugar and an insecticide applied on wicks in baited traps form the basis of male annihilation technique. This technique has been successfully used for the control of several *Bactrocera* species (Ullah *et al*. 2012; Chuang and Hou. 2008) [7, 8]. Methyl eugenol ether and cue lure are the two potent sex-lures used against the *Bactrocera spp*. (Khattak *et al.* 2005) [9].
In nature fruit flies find proper host by their odor (Nigg *et al*., 1994) [10]. Traps height were studied, different insecticides were tested and various food stuffs have been tried for enhancing fruit fly catch efficiency (Jang *et al*., 1997) [11]. Ammonia, Urine, Chicken feces, Birds dropping, Putracine, food items as jaggery, molasses, etc. have been tested with various degree of success (Jaime *et al.*, 2003) [12], however not much attention has been paid to the food essence. The present study was conducted to investigate any possible role of some of the common food essence in the fruit fly attraction in the ME and CL baited traps.

## 2. Materials and methods
**Experiential materials: Traps-** Trap was a modified cone-shaped plastic bottle with four holes at equal distance of 5.4 cm along the bottle circumference for the entry of flies. Diameter of each hole was 2.3 cm and the length of the trap was 11.00 cm. The trap had a lid with a flexible copper wire across its middle. The outer portion of the wire (20 cm long) was to hook in tree where as the inner portion (6 cm long) was meant to hook cotton swab application of the desire treatment.

Para-pheromones, Methyl Eugenol and Cue Lure (in 85:10: 5 ratio of the attractant, sugar and insecticide) were used to attract male fruit flies. Dipterex (Trichlorophon) was used as an insecticide to kill insects attracted to traps (Khattak *et al*., 2004) [13]. 5 ml of the above mixture was applied to one side of the cotton wick while 1ml of the food essence was applied to the other side of the cotton wick avoiding mixing of food essence with the para-pheromone mixture. Banana, Raspberry, Mango and Pine Apple essences were purchased from the local market.

**Trials**

In first experiment the traps were installed from 7th April and monitored till 1st August 2010. There were five treatments i.e. $T_1$ (pine apple essence), $T_2$ (mango essence), $T_3$ (banana essence), $T_4$ (raspberry essence) and $T_5$ (control with ME or CL only) in RCBD design. Each treatment was replicated three times in orchard of mixed trees i.e. peach, citrus and non-fruit bearing trees. In second experiment the traps were installed on 1st June and monitored for fruit flies till 15th August 2010. Cue lure was used as a food lure. The rest of the procedure was the same as mentioned for the first experiment. Observations were made regarding the number of flies trapped per week. The recorded data was analyzed for ANOVA using MSTATC package and LSD test was applied for mean separation.

## 3. Results

### First Experiment

**Effect of various food essences added to sex attractant traps on *B. zonatus* and *B. dorsalis* trapping/killing at different time intervals**

The results indicated that the number of *Bactrocera zonatus* and *Bactrocera dorsalis* killed in various treatments showed significant effect ($P<0.05$) due to treatments and time intervals. However, interaction effect for *B. zonatus* was non significant where as for *B. dorsalis* it was significant.

The results of main factor treatments for both species are shown in Fig 1. The mean values for treatments showed that maximum number (23.5) of *B. zonatus* were killed in Mango essence added traps followed by Pine apple essence traps but were non-significantly different from each other. Traps without any essence were the least effective treatment where 16.5 numbers of *B. zonatus* were killed. Maximum number of *B. dorsalis* (9.47) was killed in Pine apple and Mango essence added traps followed by Banana essence added traps. However the differences in the fly catch of these three treatments were non-significant. Least number of *B. dorsalis* (6.49) was trapped by Raspberry essence followed by the Control traps but these two results were non-significant to each other. The results of main factors time intervals for both species are shown in Fig 2. The mean values for time interval showed that population of *B. zonatus* was at increase from 7th April (7.87) and reached to its peak on 25th May (39.60) from where onward it declined and reached to minimum level on 2nd June (6.0). Afterward it started increasing again and reached to its second peak on 6th July (31.33) and then again declined. The *B. dorsalis* population was at increase from 7th April (4.27) and reached to its peak on 17th May (9.73) from where onward it declined. From 2nd June to 27th June it fluctuated between 2.80 and 6.40 from where onward it started increasing until it reached to its peak (17.93) on 1st August. The population of *B. zonatus* was consistently quite higher than *B. dorsalis* during the course of study. The interaction effect of treatments x time intervals (weeks) for *B. zonatus* was non-significant, however it is shown in Table- I. On 7th April maximum population (12.67) was recorded on Pine apple essence traps and minimum (4.0) on Banana essence traps. On 15th April maximum population (19.33) was recorded on Mango essence traps and minimum (12.0) on Raspberry essence traps. On 23rd April maximum population (26.67) was recorded on Mango essence traps and minimum (14.0) on Raspberry essence traps. On 1st May maximum population (23.0) was recorded on Mango essence traps and minimum (12.0) in treatment without essence (control). On 9th May maximum population (34.0) was recorded on Banana essence and minimum (15.4) in treatment without essence (control). On 17th May maximum population (38.7) was recorded on Mango essence traps and minimum (22.0) was recorded on treatment without essence (control). On 25th May maximum population (49.33) was recorded on Mango essence traps and minimum (27.33) was recorded on treatment without essence (control). On 2nd June maximum population (11.33) was recorded on Pine apple essence traps and minimum (4.0) on Raspberry essence. On 10th June maximum population (14.0) was recorded on Pine apple essence traps and minimum (10.0) was on treatment without essence (control). On 18th June maximum population (13.4) was recorded on Pine apple essence traps and minimum (6.0) was recorded on Raspberry essence traps. On 27th June maximum population (14.0) was recorded on Pine apple essence traps and minimum (6.7) was recorded on Raspberry essence traps. On 6th July maximum population (40.0) was recorded on treatment without essence (control) and minimum (22.7) on Banana essence traps. On 15th July maximum population (25.4) was recorded on Pine apple essence traps and minimum (15.4) on Raspberry essence traps. On 23rd July maximum population (25.4) was recorded on Mango essence traps and minimum (18.0) on Raspberry essence traps. On 1st August maximum population (30.7) was recorded on Mango essence traps and minimum (16.4) on treatment without essence (control).

Interaction effect of treatments x time intervals (weeks) on *B. dorsalis* was significant (Table- II). On 7th April all the treatments were statistically non-significant; however maximum population (6.0) was recorded on Mango essence traps and minimum (3.4) on Pine apple essence trap. Similarly on 15th April treatments effect was non-significant; however maximum population (6.7) was recorded on Mango essence traps and minimum (4.0) on Raspberry essence treatment. On 23rd April treatments effect was again non-significant wherein maximum population (6.7) was recorded on Pine apple essence traps and minimum (4.0) on treatment without essence (control). On 1st May all the treatments showed significant effect as compared to control but were non-significant among each other. Maximum population (11.4) was recorded on Mango essence treatment traps as compared to minimum (3.4) treatment without essence (control). On 9th May Mango essence trapped significantly maximum population (12.7) as compared to minimum (4.67) by Pine apple trap. On 17th May Mango essence again trapped significantly maximum population (14.0) followed by banana essence non-significantly. Minimum population (6.0) was trapped by Raspberry traps. On 25th May consistency of Mango essence was maintained where maximum population (12.7) was recorded as compared to minimum (2.0) on treatment without essence. On 2nd June all the treatment including control were statistically non significant; however maximum population (5.3) was recorded on Pine apple essence and minimum (0.7) on Mango essence traps. From 10th to 27th June all treatment including control were statistically non-significant wherein maximum population (8.0) was recorded on 10th June in Pine apple traps as compared to minimum (2.7) on 18th June in Banana essence traps. On 6th July Pine apple essence traps

killed significantly maximum (16.0) population as compared to minimum (8.7) on Banana essence traps. On 15th July treatment effect was non-significant, maximum population (11.4) was recorded on Pine apple essence traps as compared to minimum (8.7) on Banana and Mango essence treatments. On 23rd July the treatments effect was again non-significant; however maximum population (16.7) was recorded on Banana essence traps compared to minimum (11.4) on Raspberry essence traps. On 1st August significantly maximum population (26.7) was recorded on Pine apple essence traps as compared to all other treatments. Minimum (12.0) population was recorded on Raspberry essence traps.

**Second Experiment**

**Effect of various food essences added to Cue Lure baited traps on *B. cucurbitae* trapping/killing at different time intervals**

The number of *B. cucurbitae* trapped/killed in various treatments showed significant effect (P<0.05) due to treatments, time intervals and interaction (P-value < 0.05). The mean values for treatments (Fig 3) showed that maximum number of *B. cucurbitae* was trapped in Raspberry essence added traps (18.33) followed by non-significant lower number of (13.93) in Pine apple essence added traps. In the control traps only 7.67 of *B. cucurbitae* were killed. It was followed by Mango essence traps with non-significant difference. The mean values for the effect of time intervals (Fig 4) showed that population significantly increased from 2nd June (0.0) to 18th June (5.87) from where onward till 20th July it fluctuated non-significantly between 3.87 and 6.87. On 28th July the population increased significantly and maximum numbers of *B. cucurbitae* were trapped on 28th July, 6th and 15th August that fluctuated between 29.6 and 31.3 non-significantly.

The interaction effect between time intervals and treatments for mean population of *B. cucurbitae* trapped/killed was significant as shown in Table- III. It is evident from the table that numbers of *B. cucurbitae* killed at different time intervals in various treatments showed varied trend i.e. no single treatment consistently trapped highest population throughout the course of study. The peak population (62.0) was trapped by Raspberry essence traps on 15th August followed by same treatment on 28th July. The lowest population was recorded as zero in all treatments on 2nd June. Weekly results could be interpreted as that on 2nd June no *B. cucurbitae* was found in any of the treatments. On 10th June treatment effect was non-significant wherein maximum population (3.3) was recorded on Pine apple essence treatment and minimum (0) on Raspberry essence treatment. On 18th June treatments effect was again non-significant wherein maximum population (12.7) was recorded on traps without essence as compared to minimum (3.3) on Raspberry essence treatment traps. On 26th June the treatments effect remained non-significant wherein the maximum population (6.0) was recorded on Pine apple essence treatment and minimum (2.0) on Banana essence treatment. On 4th July the treatments effect remained non-significant; however maximum population (9.0) was recorded on Pine apple essence traps as compared to minimum (3.4) on Mango essence traps. On 12th July maximum population (10.0) was recorded on Raspberry essence traps and minimum (3.4) on Banana essence traps. On 20th July maximum population (8.7) was recorded on Pine apple essence treatment and minimum (4.0) on control. In short from 2nd June till 20th July the treatments effect was non-significant. On 28th July significantly high population (53.4) was recorded on Raspberry essence treatment as compared to minimum on treatment without essence i.e. control. On 6th August significantly high population (39.4) was recorded on Pine apple essence treatment as compared to minimum (16.0) on control. On 15th August significantly high population (62.0) was recorded on Raspberry essence treatment as compared to minimum (16.0) on control.

## 4. Discussion

Model selection and parameter estimates indicated that the data were consistent with the hypotheses that addition of food essence may enhance the effectiveness of methyl eugenol and cue lure traps having insecticides and sugar as bait ingredients (John *et al.,* 2001) [14]. However, methyl eugenol and cue lure traps without food essence (control treatments) also attracted sufficient numbers of fruit flies i.e. *Bactrocera zonatus*, *B. dorsalis* and *B. cucurbitae* (Casana, 2003) [15]. Mango essence traps, Pine apple essence traps and Banana essence traps significantly proved better and killed/attracted more *B. dorsalis* and *B. zonatus* as compared to other essences including traps without essence i.e. control (Victor *et al.,* 2004) [16]. *B. cucurbitae* was more attracted to Raspberry and Pine apple essence as compared to others and control (Fabre *et al.,* 2003; Duyck *et al.,* 2004) [17, 18].

Slight activity of *B. zonatus* and *B. dorsalis* noted from the start of experiment proved that activity started before the 7th April (Chen and Ye 2007) [19]. The population consistently increased till 25th May (Chen *et al*., 2006) [20]. In June the activity slowed down may be due to rainfall or temperature but again increased in July till end of the experiment i.e. 1st August (Mahmood and Mishkatullah 2007) [21]. As such it may be concluded that the population may sustain or increase further in coming months (Chen and Ye 2007) [19]. *B. dorsalis* population was quite smaller than *B. zonatus* through the study. However, it was at slight increase form 7th April till mid May from where onward it decreased slowly till end June. In July it increased sharply till 1st August (Ye and Liu 2007) [22]. The population of *B. cucurbitae* was at slight increase from June till 20th July and then onward it abruptly increased till experiment end i.e. 15th August (Vargas *et al.,* 2008) [23]. This one year/season study is not sufficient to draw out substantial conclusions for the quality potential of the essences studied, a wise scale research is yet to be needed to further study these essence in different localities as well in fruits and vegetables however the results achieved so far if followed and applied properly as per recommendations made in this study it is hoped that fruit flies attack on fruits could be controlled successfully without polluting the environment and avoiding extra expenses on labor and risk to human lives.

All the tested food essence enhanced the efficacy of pheromone traps to attract/kill maximum population of fruit flies (*B. zonatus, B. dorsalis and B. cucurbitae*) as compared to traps without food essence. Pine apple and Mango essence were the effective for attracting the *B. zonatus and B. dorsalis* while *B. cucurbitae* was most attractive to Raspberry and Pine apple essence. Population of *B. zonatus* was quite higher than *B. dorsalis* and *B. cucurbitae* throughout the study period. The peak population of *B. zonatus* was noted on 25th May and 6th July whereas as *B. dorsalis* population was at its peak on 15th August i.e. at termination of the study. Maximum population of *B. cucurbitae* was recorded from 28th July to 15th August.

Based on our present finding, Pine apple and Mango essence could be used to enhance the effectiveness of the Methyl Eugenol baited traps against *B. zonatus* and *B. dorsalis* while Raspberry essence could be used in Cue Lure baited traps against *B. cucurbitae.*

**Table 1:** Mean number of *B. zonatus* per trap per week (Interaction effect of treatments X time intervals) in Essence added Methyl Eugenol (ME) Baited Traps.

| Treatments (Essence added ME Traps) | | | | | |
|---|---|---|---|---|---|
| **Time Intervals** | **Pine apple** | **Mango** | **Banana** | **Raspberry** | **Control (ME)** |
| 7th April | 12.67 | 9.33 | 4.00 | 5.33 | 8.00 |
| 15th April | 15.33 | 19.33 | 17.33 | 12.00 | 18.00 |
| 23rd April | 15.33 | 26.67 | 24.67 | 14.00 | 16.67 |
| 1st May | 23.33 | 32.00 | 29.33 | 29.33 | 12.00 |
| 9th May | 28.67 | 31.33 | 34.00 | 27.33 | 15.33 |
| 17th May | 37.33 | 38.67 | 34.67 | 36.67 | 22.00 |
| 25th May | 45.33 | 49.33 | 42.00 | 34.00 | 27.33 |
| 2nd June | 11.33 | 4.67 | 5.33 | 4.00 | 4.67 |
| 10th June | 14.00 | 13.33 | 10.67 | 10.00 | 10.00 |
| 18th June | 13.33 | 11.33 | 7.33 | 6.00 | 8.67 |
| 27th June | 14.00 | 11.33 | 9.33 | 6.67 | 8.67 |
| 6th July | 39.33 | 28.00 | 22.67 | 26.67 | 40.00 |
| 15th July | 25.33 | 21.33 | 18.00 | 15.33 | 18.00 |
| 23rd July | 24.67 | 25.33 | 20.00 | 18.00 | 22.67 |
| 1st August | 25.33 | 30.67 | 22.67 | 20.00 | 16.67 |
| Mean± SD | 23.02a ±10.95 | 23.51a ±12.23 | 20.13b ±11.53 | 17.69bc ±10.85 | 16.60c ±9.03 |

**Table II:** Mean number *B. dorsalis* per week (Interaction effect of treatments x time intervals) in Essence added Methyl Eugenol (ME) baited traps

| Treatments (Essence added ME Traps) | | | | | |
|---|---|---|---|---|---|
| **Time Intervals** | **Pine apple** | **Mango** | **Banana** | **Raspberry** | **Control** |
| 7th April | 3.33 n-r | 6.00 j-r | 4.00 m-r | 4.00 m-r | 4.00 m-r |
| 15th April | 5.33 k-r | 6.67 i-q | 5.33 k-r | 4.00 m-r | 6.67 i-q |
| 23rd April | 6.67 i-q | 6.00 j-r | 6.00 j-r | 5.33 k-r | 4.00 m-r |
| 1st May | 8.67 g-m | 11.33 c-j | 10.00 e-l | 6.67 i-q | 3.33 n-r |
| 9th May | 4.67 l-r | 12.67 c-h | 10.67 d-k | 8.67 g-m | 5.33 k-r |
| 17th May | 8.67 g-m | 14.00 c-g | 12.00 c-i | 6.00 j-r | 8.00 h-o |
| 25th May | 9.33 f-m | 12.67 c-h | 8.67 g-n | 3.33 n-r | 2.00 p-r |
| 2nd June | 5.33 k-r | 0.67 r | 1.33 qr | 2.67 o-r | 4.00 m-r |
| 10th June | 8.00 h-o | 7.33 h-p | 6.00 j-r | 4.67 l-r | 6.00 j-r |
| 18th June | 6.00 j-r | 4.67 l-r | 2.67 o-r | 4.00 m-r | 3.33 n-r |
| 27th June | 6.00 j-r | 6.67 i-q | 4.67 l-r | 4.00 m-r | 4.00 m-r |
| 6th July | 16.00 b-d | 10.33 e-k | 8.67 g-m | 10.00 e-l | 14.33 b-f |
| 15th July | 11.33 c-j | 8.67 g-m | 8.67 g-m | 10.67 d-k | 10.00 e-l |
| 23rd July | 16.00 b-d | 14.67 b-f | 16.67 bc | 11.33 c-j | 14.67 b-f |
| 1st August | 26.67 a | 19.67 b | 15.33 b-e | 12.00 c-i | 16.00 b-d |
| Mean ±SD | 9.47 ±6.06 | 9.47 ±4.79 | 24.14 ±4.41 | 6.48 ±3.19 | 21.13 ±4.59 |

LSD value at 5% for interaction = 5.661

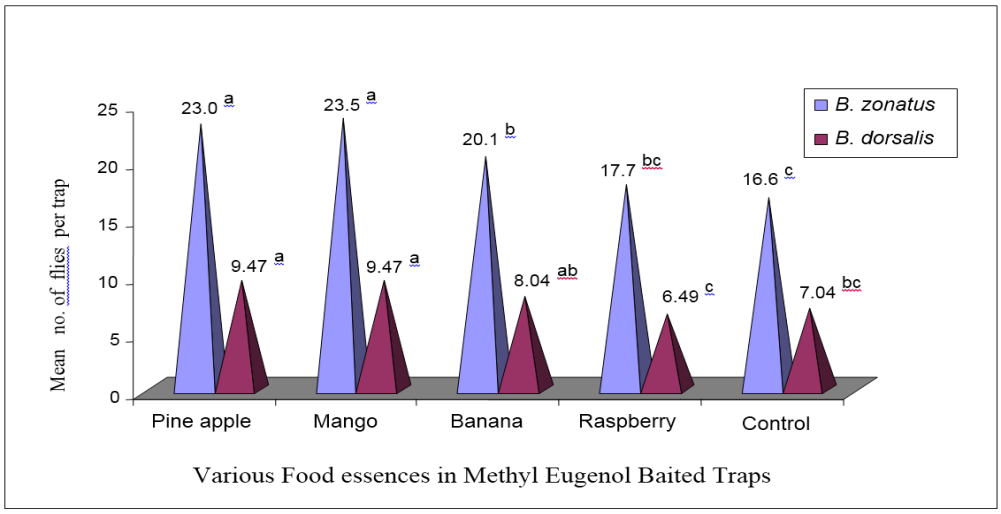
Means followed by same letter are non-significantly different at 0.05% level of significance.

**Table III.** Mean number *B. cucurbitae* trapped/killed per week (Interaction effect of treatments x time intervals) in essences added cue lure (CL) baited traps.

| Treatments (Essence added CL Traps) | | | | | |
|---|---|---|---|---|---|
| Time Intervals | Pine apple | Mango | Banana | Raspberry | Control |
| 2nd June | 0.00 k | 0.00 k | 0.00 k | 0.00 k | 0.00 k |
| 10th June | 3.33 jk | 2.00 jk | 0.67 k | 0.00 k | 1.33 k |
| 18th June | 4.00 jk | 5.33 jk | 4.00 jk | 3.33 jk | 12.67 g-k |
| 26th June | 6.00 i-k | 3.33 jk | 2.00 jk | 4.67 jk | 3.33 jk |
| 4th July | 9.00 h-k | 3.33 jk | 3.33 jk | 6.67 i-k | 5.33 jk |
| 12th July | 9.67 h-k | 4.67 jk | 3.33 jk | 10.00 h-k | 6.67 i-k |
| 20th July | 8.67 h-k | 6.00 i-k | 6.67 i-k | 7.33 i-k | 4.00 jk |
| 28th July | 34.00 c-f | 12.00 g-k | 43.33 bc | 53.33 ab | 11.33 g-k |
| 6th August | 39.33 b-d | 22.67 e-h | 34.00 c-f | 36.00 c-e | 16.00 g-j |
| 15th August | 25.33 d-g | 20.00 f-i | 33.33 c-f | 62.00 a | 16.00 g-j |
| Mean ± SD | 13.93 ±13.81 | 7.97 ±7.75 | 13.07 ±16.74 | 18.33 ±23.22 | 7.67 ±5.92 |

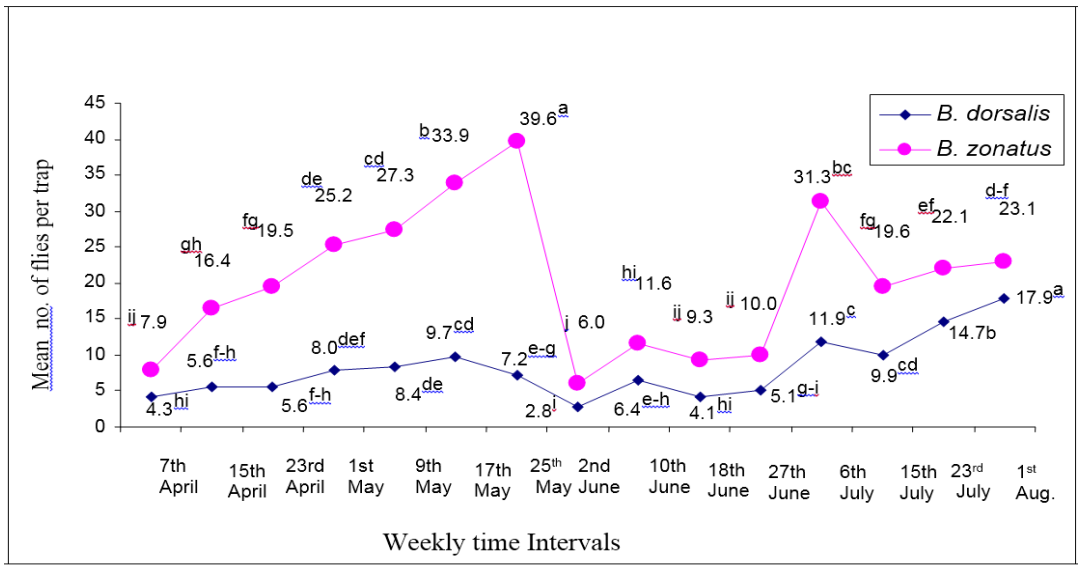
LSD value at 5% for interaction = 14.02

Means followed by same letter are non-significantly different at 0.05% level of significance.



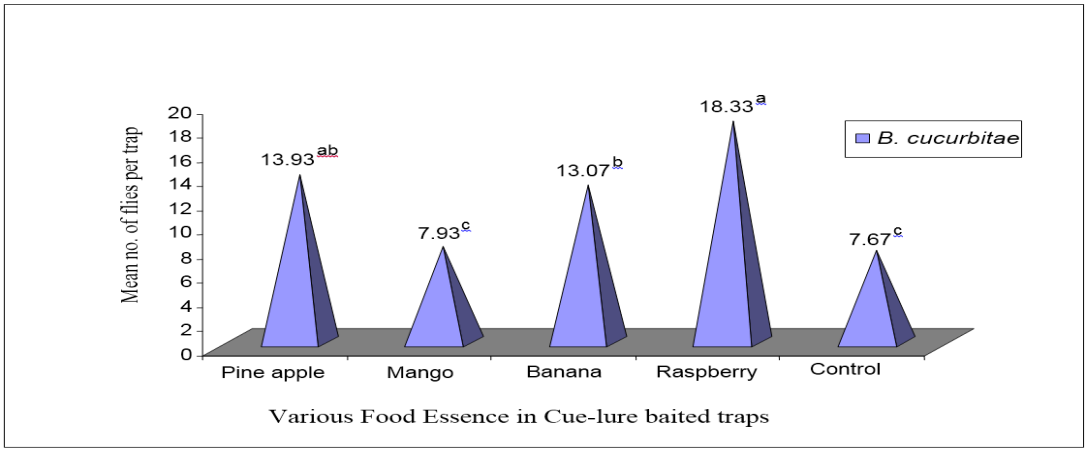

LSD value for treatments effect on *B. zonatus* and *B. dorsalis*= 2.889 & 1.462 respectively
Means followed by same letter are non-significantly different at 0.05% level of significance

**Fig 1:** Mean Number of *Bactrocera zonatus* and *B. dorsalis* trapped in various essence in Methyl Eugenol baited traps (averaged over time intervals).



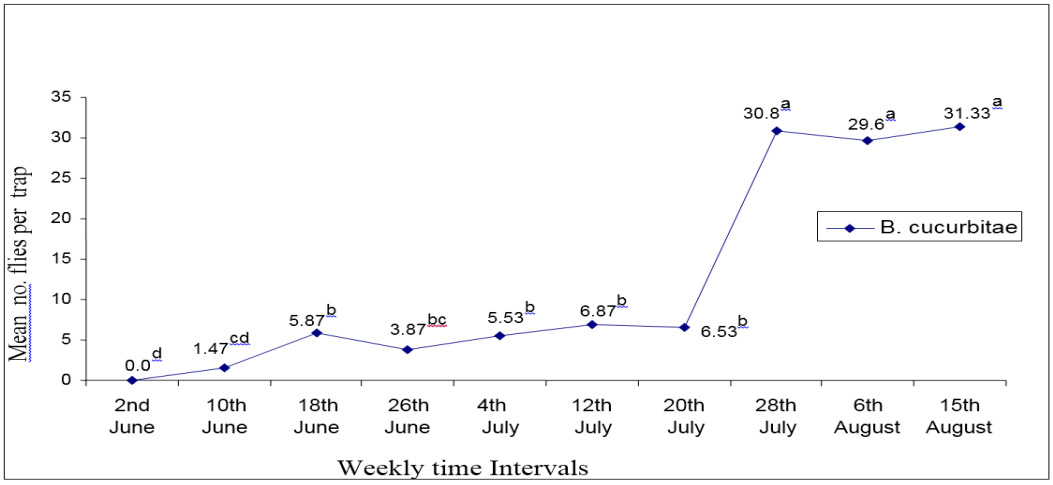

LSD value for time intervals (weeks) effect on *B. zonatus* and *B. dorsalis* = 5.003 & 2.532 respectively
Means followed by same letter are non-significantly different at 0.05% level of significance

**Fig 2:** Population trend of *Bactrocera zonatus and B. dorsalis* in Methyl Eugenol baited traps (averaged over treatments).




LSD value for treatments effect on *B. cucurbitae* = 4.34
Means followed by same letter are non-significantly different at 0.05% level of significance

**Fig 3:** Mean number of *B. cucurbitae* trapped in various treatments in Cue-Lure baited traps (averaged over time).




LSD value for time intervals (weeks) effect on *B. cucurbitae* = 3.435
Means followed by same letter are non-significantly different at 0.05% level of significance.

**Fig 4:** Population trend of *Bactrocera cucurbitae* in Cue-Lure baited traps (averaged over treatments).

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