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**Fazal Maula**
Principal Research Officer ARI Swat) (Agriculture, Livestock and Cooperative Department, Government of Khyber Pakhtunkhwa, Pakistan

**Aftab Ahmad Khan**
Research Officer, ARI Swat) (Agriculture, Livestock and Cooperative Department, Government of Khyber Pakhtunkhwa, Pakistan

**Arshad Ali**
Research Officer, ARI Swat) (Agriculture, Livestock and Cooperative Department, Government of Khyber Pakhtunkhwa, Pakistan

**Inamullah**
Research Fellow, ARI Swat) (Agriculture, Livestock and Cooperative Department, Government of Khyber Pakhtunkhwa, Pakistan

**Mohammad Younus**
Senior Research Officer ARI, Peshawar) (Agriculture, Livestock and Cooperative Department, Government of Khyber Pakhtunkhwa, Pakistan

**Mohammad Israr**
Secretory Agriculture, Livestock and Cooperative Department, Government of Khyber Pakhtunkhwa, Pakistan

**Mohammad Abdul Rauf**
DG, Agriculture Research) (Agriculture, Livestock and Cooperative Department, Government of Khyber Pakhtunkhwa, Pakistan

**Irshad Ahmad Khan**
Zhengzhou Fruit Research Institute, Chinese Academy of Agricultural Sciences, Zhengzhou, China

**Corresponding Author:**
**Aftab Ahmad Khan**
Research Officer, ARI Swat) (Agriculture, Livestock and Cooperative Department, Government of Khyber Pakhtunkhwa, Pakistan

# Evaluation of different traps and lures combinations for monitoring and eco-friendly management of fruit fly (*Bactrocera* Spp) in peach orchards

**Fazal Maula, Aftab Ahmad Khan, Arshad Ali, Inamullah, Mohammad Younus, Mohammad Israr, Mohammad Abdul Rauf and Irshad Ahmad Khan**

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**Abstract**
Chemical insecticides have hazardous effects on human health and the ecosystem hence there is a dire need of the hour to use nonchemical eco-friendly tactics for the management of major insect pests. While the use of traps and other attract-and-kill devices in pest management strategies to reduce fruit fly (Tephritidae) populations has proved to be efficient, therefore the current study was designed to evaluate different fruit fly traps and lure combinations for monitoring and eco-friendly management of fruit fly (*Bactrocera* spp) in the peach orchard at Agriculture Research Institute Swat. Among the tested traps, cylindrical bottle traps trapped the highest number of fruit flies/trap (155 fruit flies/trap/week), followed by Fruition NOVA® trap (34 fruit flies/trap/week) and Yellow sticky trap (12 fruit flies/trap/week). Similarly, for different lures the sequence is Methyl eugenol (134 fruit flies/trap/week)> Methyl eugenol + Cue lure (95 fruit flies/trap/week)> Fruition lure (26 fruit flies/trap/lure)> Cue lure (14 fruit flies/trap/week), while among different traps and lures combination Cylindrical bottle trap impregnated with Methyl eugenol trapped the highest number of fruit flies (321 fruit flies/trap/week) while the lowest number of fruit flies was trapped by Yellow sticky traps impregnated with Cue lure (10 fruit flies/trap/week). Moreover, among different species trapped in the peach orchard during 18 weeks *B. zonata* was found to be the most abundant (80 fruit flies/trap/week), followed by *B. invadense* (45 fruit flies/trap/week), *B. dorsalis* (7 fruit flies/trap/week), *B. cucurbitae* (1 fruit fly/trap/week) and *B. tau* (1 fruit fly/trap/week) while trapping population remained highest in mid-season (July, 2021) and it remained lowest at onset (June, 2021) and end of the season (September, 2021).

**Keywords:** *Bactrocera* spp, pheromone traps, fruit fly lure, Tephritidae

## Introduction
Fruit flies (Diptera: Tephritidae) are found in tropical and sub-tropical regions throughout the world and cause huge economic losses while infesting major fruit and vegetable crops and not only do they cause direct damage to horticultural crops but also retard agricultural development and trade in many countries due to strict quarantines for agricultural trade [1] As the demand for the quality of fruits and vegetables is increasing day by day, many exporting and importing countries give special attention to the management of fruit flies at pre-harvest and post-harvest stages [2]. The fruit fly genus *Bactrocera* Macquart (Diptera: Tephritidae) contains more than 500 invasive, polyphagous species [3] that infest fruits and vegetables throughout the globe and causes severe economic damage, while sometimes *Bactrocera spp* can cause 100% losses to produce [4]. Therefore, many countries conduct surveillance programs to detect and monitor these pests. To control the populationthe of fruit flies and to minimize infestation of fruit and vegetables different control strategies are applied including traditional ways and applicthe ation of chemical insecticides. In traditional methods fruits and vegetables are prevented from infestation by wrapping them with different materials like newspapers, plastic bags and coconut leaves [5]. While most of the farmers rely on apthe plication of synthetic insecticides, as these chemicals result in quick control of pests and can also be appliedon a large scalee [6] however, regular use of these synthetic chemicals disturb and pollute ecosystem, annihilate natural enemies population and results in the development of resistance and resurgence of the target pest [5].

Thus eco-friendly management tactics such the s installation of attractive and sticky traps is necessary to minimize hthe azardous effects of synthetic chemical insecticides on human health, edible produce an ecosystem [7].

Male of some *Bactrocera* species are strongly attracted to different lures like methyl eugenol, raspberry ketone and cu-lure [8] and these volatile substances can attract male fruit flies at a distance of about 3 km (Kardinan, 2003) [7] ; Therefore, farmers use these attractive traps for control of fruit flies infestation in their fields [9]. Different stimuli including visual stimuli, color and shape affect adult fruit flies behavior especially, while finding their host [5], Thus for effective control of fruit flies (*Bactrocera spp*) by using different traps material, shape and other modifications need special attention [10]. As various types of fruit flies traps have been developed for monitoring and control purposes and the efficacy of these traps depends upothe n attractant used, shape, environmental conditions, pest populathe tion, height of the web and direction of the trap installed [11]. There are significant differences record the ed in the efficacy of different traps [12], hence for effective management of the fruit flies population appropriate selection of surprises is indispensable [13]. Eco-friendly pest management tactics are increasingly focused throughout the world to protect ecosystem balance and the use of pheromones involving traps for management of fruit flies infestation, which is responsible for degrading crop quality and yield are proved to be useful [14]. As bait stations are established to be very effective for the management of fruit flies infestation and protection of fruits [13], Therefore, the current study was conducted with the intent to determine the most effective trap and lure combination for monitoring and eco-friendly management of *Bactrocera (spp)* in peach orchards.

## Materials and Methods

3 different fruit fly attractive traps (Yellow Fruition NOVA® trap, Cylindrical Bottle trap and yellow sticky trap) impregnother other fruit fly lures (Methyl eugenol, Methyl eugenol + Cue lure, Cue lure and Fruition lure) were installed in the peach orchard of 3 acre area at Agricultural Research Institute Mingora Swat. Recommended numbers (15/acre) of traps containing different lures were installed randomly at a height of 5 feet from the ground on trees within the peach orchard for a period of 18 weeks from the 1st week of June 2021 up to the last week of September, 2021. Each treatment was replicated three times and trapped fruit flies were collected, counted and identified up to species level on a weekly basis in the Entomology laboratory of ARI Swat. The lures were renewed after an interval of two weeks and the obtained data were analyzed through Statistix 8.1 for analysis of variance and the LSD test was applied to determine difference among the treatments while keeping a 5% significance level. The following four lures combinations including two female sex pheromones and a Fruition lure based on natural fruits aroma were used in each trap for attracting adult fruit flies dthe uring experiment.

1. 5cc methyl eugenol
2. 5cc cue lure
3. 2.55cc methyl eugenol + 2.55 cc cue lure
4. Fruition lure (12.5g)

### Pheromone traps

Different Pheromone traps used in the current study were:

1. Cylindrical bottle traps (L: 18cm, W: 10cm, Dia. 30cm) having six holes on each side of the trap at equal distance in the opposite direction, impregnated with a cotton piece; soaked in a prepared solution of lure were installed in the peach orchard at the recommended rate of 15 traps/acre. The methyl eugenol and cure lure were used to attract male fruit flies, while fruition lure was used to attract both male and female fruit flies. Malathion was used as a poison to kill the fruit flies inside the trap. Solution of sugar for sweetness and water was added to remove the chances of life of fruit flies which entered the traps.
2. Yellow Sticky Traps locally made for fruit fly trapping having 25cm length and 20 cm width were installed at the recommended rate. Cotton piece soaked in a 5cc solution of lure or recommended weight of lure was attached to traps with the help of a wire.
3. Double plated Yellow-colored Fruition NOVA® Traps having 30 cm circumference were installed at a recommended rate of 15 trA cottonre. A cotton piece soaked in a 5cc solution or recommended weight of lure was attached to the trap with the help of a wire.

## Results and Discussion

The current study was designed to determine the most effective trap and lure combination for monitoring and eco-friendly management of fruit fly (*Bactrocera* spp) in the peach orchard at ARI Mingora Swat.

Among the tested traps for management of fruit fly *(Bactrocera spp)* in peach orchard Cylindrical bottle traps trapped the highest number of fruit flies (155/trap/week), followed by Fruition NOVA® traps (34 fruit flies/trap/week) and Yellow Sticky traps (12 fruit flies/trap/week) (Table 1). Similar findings have been reported by Lasa *et al*., (2015) [15] and have concluded bottle trap impregnated with fruit fly lure as the most effective and economic tool for managing the fruit fly population in orchards. Navarro *et al.,* (2008) [12] noted that there are significant differences among different types of fruit fly traps and the best trap can trap 3 times more fruit flies as compared to others. Khan *et al*., (2015) [16] also reported the use of cylindrical bottle traps impregnated with a lure for control of peach fruit flies.

**Table 1:** Mean number of fruit flies trapped/trap/ week in different traps during June-Sep 2021

| Trap Model | Mean number of fruit flies trapped |
|---|---|
| Cylindrical Bottle Trap | 155 A |
| Fruition NOVA® Trap | 34 B |
| Yellow Sticky Trap | 12 C |
| LSD at 5% | 1.67 |
| **Note:** Means followed by different letters are significantly different from each other based on LSD 5% significance level. | |

Similarly among different fruit fly lures used, methyl eugenol attracted and trapped the highest number of fruit flies (134/trap/week), followed by methyl eugenol + cue lure (95 fruit flies/trap/week) and Fruition lure (26 fruit

flies/trap/week), while the lowest number of fruit flies was trapped in traps impregnated with Cue-lure (14/trap/week) (Table 2). Similar findings have been reported by Anjum *et al*., (2000) [17] that methyl eugenol impregnated traps were the best for controlling the fruit flies population. Khan *et al*., (2015) [16] has also reported that methyl eugenol impregnated traps trapped the highest number of fruit flies compared to cue lure and protein hydro lysate impregnated traps. Farmanullah *et al*., (2015) [18] also reported that Methyl eugenol impregnated traps attracted the highest population of fruit flies in peach orchard. Similar findings have been reported by El-Gendy (2012) [19], Dominiak *et al*., (2011) [20] and Math *et al*., (2018) [21].

The analyzed data regarding the trap and lure combination given in table 3 revealed the hat highest number of adult fruit flies was trapped in Cylindrical Bottle trap impregnated with Methyl eugenol (321 fruit flies/tra,p/week) which is significantly higher than all other traps and lures combinations, followed by Cylindrical Bottle trap impregnated with Methyl eugenol + Cue lure (229 fruit flies/trap/week), Fruition NOVA® trap impregnated with Methyl eugenol (65 fruit flies/trap/week), Cylindrical Bottle trap impregnated with Fruition lure (49 fruit flies/trap/week), Fruition NOVA® trap impregnated with Methyl eugenol + Cue lure (44 fruit flies/trap/week) and

**Table 2:** Mean number of fruit flies trapped/trap/ week in different Lures during June-Sep 2021.

| Lure | Mean number of fruit flies trapped |
|---|---|
| Methyl eugenol | 134 A |
| Methyl eugenol + Cue-Lure | 95 B |
| Fruition Nova Lure | 26 C |
| Cue-Lure | 14 D |
| LSD at 5% | 1.93 |
| **Note:** Means followed by different letters are significantly different from each other based on LSD 5% significance level. | |

Fruition NOVA® trap impregnated with Fruition lure (44 fruit flies /trap/week). Similarly the lowest number of adult fruit flies trapped per trap per week (10) was trapped in a Yellow sticky trap impregnated with Cue lure, which is on par with a Yellow sticky trap impregnated with Fruition lure (11 fruit flies/trap/week), Yellow Sticky trap impregnated with Methyl eugenol + Cue lure (11 fruit flies /trap/week)) and Yellow sticky trap impregnated with Methyl eugenol (15 fruit flies/trap/week). Khan *et al*., (2010) [22] has also reported that fruit fly traps impregnated with lure can efficiently and economically control the fruit fly population. El-Gendy (2012) [19] has also recorded similar results that methyl eugenol impregnated pheromone traps effectively controls the peach fruit fly population. Dominiak *et al*., (2011) [20] has also tested the combination of methyl eugenol and cue lure for control
of fruit flies and suggested that methyl eugenol alone trapped more fruit flies ompared to a combination. Our findings are also similar to that of Bajaj and Singh (2018) [23] that a Cylindrical box trap impregnated with methyl eugenol efficiently controlled fruit fly infestation. Math *et al.,* (2018) [21] have also reported that cylindrical bottle trap impregnated with methyl eugenol attracted the highest number of fruit flies compared to other traps. Susanto *et al*., (2020) [5] has also reported that bottle trap impregnated with methyl eugenol trapped the highest number of fruit flies. Similar findings have also been reported by Khan *et al*., (2015) [16], Fazlullah *et al* (2015) [1] and Kakar *et al*., (2014) [24].

**Table 3 shows the mean** number of fruit flies trapped/trap/week in different traps and lures combinations during June-Sep 2021.

| Lure | Traps | | |
|---|---|---|---|
| | **Cylindrical Bottle Trap** | **Fruition Nova® Trap** | **Yellow Sticky Trap** |
| Methyl eugenol | 321 A | 65 C | 15 GH |
| Methyl eugenol+Cue Lure | 229 B | 44 E | 11 I |
| Fruition Lure | 49 D | 17 FG | 11 I |
| Cue Lure | 20 F | 12 HI | 10 I |
| LSD at 5% | | | 3.35 |
| **Note:** Means followed by different letters are significantly different from each other based on LSD 5% significance level. | | | |

Table 4 revealed analyzed data regarding different species of fruit fly (*Bactrocera*) trapped in different traps impregnated with different lures from June to September 2021. Among different species of fruit fly *B. zonata* was found to be the most abundant species with the highest number of fruit flies trapped in all traps, followed by *B. invadense, B. dorsalis, B. cucurbitae* and *B. tau* (Table 4). Qureshi *et al*., (1992) [25] has also noted that Methyl eugenol impregnated traps attracted the highest number of *Bactrocera zonata*. Quraishi and Hussain (1993) [26] have also reported that *Bactrocera zonata* is a severe pest of orchards and can be effectively controlled through methyl eugenol impregnated traps. Khan *et al*., (2015) [16] have also reported *B. zonata* as a significant economic pest of peach and its control through methyl eugenol impregnated traps. Khan *et al*., (2020) [27] has also recorded the highest trapping of *B. zonata* in methyl impregnated traps. Similar results have also been reported by Fazlullah *et al*., (2015) [1].

Figures 1, 2 and 3 show analyzed data regarding week-wise trapping of fruit flies adults in the peach orchard by using different traps and lures combinations for a period of 18 weeks from June to September 2021. The data revealed that in all lures and traps combinations lowest number of fruit flies was trapped at the onset of the season (1st week of June 2021), which tended to increase and reached to the highest number in mid-season (July 2021) and then tended to decrease again towards the end of the season (September 2021). Similarly in Cylindrical bottle traps the lowest number of fruit flies was trapped at the onset of the season (16/trap/week), the highest number (652 fruit flies/trap/week) in mid-season i.e. 2nd week of July 2021 while 20 fruit flies/trap/week were trapped in the last week of September 2021. Similarly in Fruition Nova®

trap a lowest number of fruit flies was recorded at the onset and end of the season i.e. 1st week and last week (2 fruit flies/trap/week) while trapping density remained high in mid of the season from July to August 2021 with the highest population trapped in mid of July 2021 (118 fruit flies/trap/week). In Yellow Sticky traps the lowest number of fruit flies was trapped (3 fruit flies/trap/week) at the end of the se,ason while the highest number in mid of July 2021 i.e. week 8th (24 fruit flies/trap/week) and 5 fruit flies/trap/week was trapped in 1st week of June 2021. Kakar *et al*., (2014) [24] has also reported that the fruit fly population was highest in mid of the season and then started to decline from mid of September. Similarly Fazlullah *et al*., (2015) [1] also noted the lowest population of fruit flies at the beginning and end of the season while the highest population at mid of the season. Khan *et al*., (2020) [27] also reported the highest population of fruit flies in mid-season the and lowest at the end of the season.

**Table 4:** Number of different fruit fly species trapped/trap/week in different in traps included different lures from June 2021 to September 2021.

| Lure | *B. Zonata* | *B. invadense* | *B. dorsalis* | *B. cucurbitae* | *B. tau* |
|---|---|---|---|---|---|
| Methyl eugenol | 80 A | 45 C | 7 FG | 1 J | 1 J |
| Methyl eugenol + Cue Lure | 67 B | 19 D | 5 GH | 2 IJ | 1 J |
| Fruition Lure | 11 E | 10 EF | 3 HIJ | 1 J | 1 J |
| Cue Lure | 6 GH | 2 IJ | 1 J | 4 GHI | 1 J |
| LSD@ 5% | | | | | 3.18 |

**Note:** Means followed by different letters are significantly different from each other based on LSD at a 5% significance level.

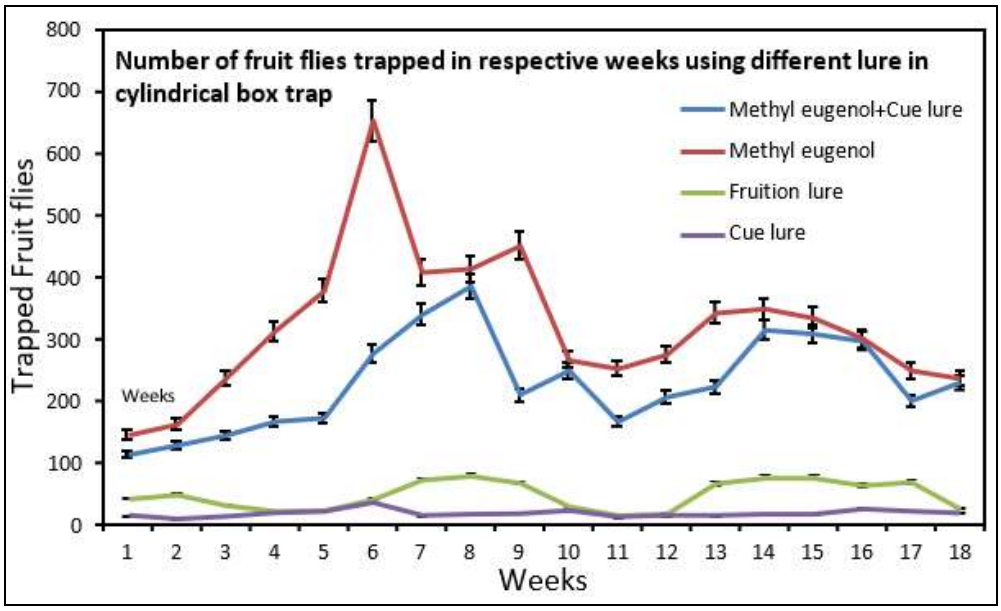


**Fig 1:** Week-wise data regarding the number of fruit flies trapped in Cylindrical Box trap with different lures combinations for 18 weeks (June-Sep2021).

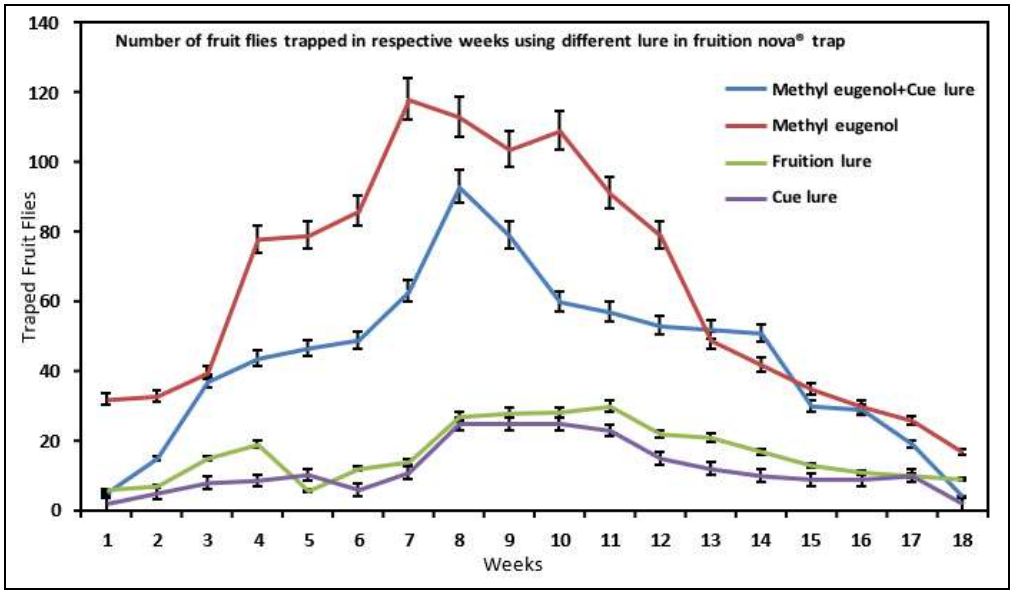


**Fig 2:** Week wise data regarding the number of fruit flies trapped in Fruition Nova® trap with different lures combinations for a period of 18 weeks (June-Sep 2021)

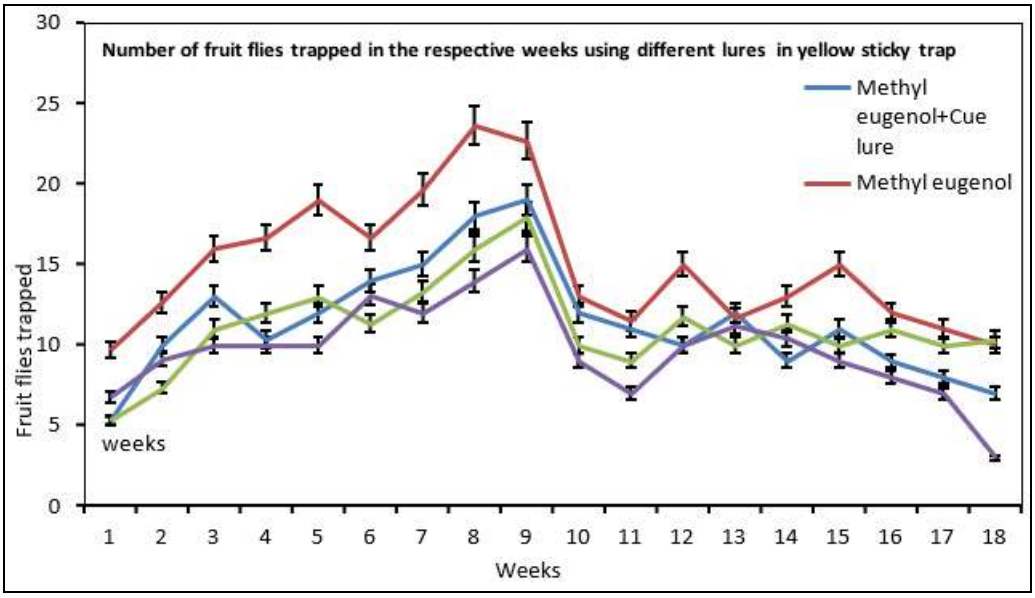


**Fig 3:** Week-wise data regarding the number of fruit flies trapped in Yellow Sticky trap with different lures combinations for 18 weeks (June-Sep 2021).

## Conclusions

From the obtained results, it is concluded that cylindrical bottle traps impregnated with Methyl eugenol can efficiently and eco-friendly control the fruit fly (*Bactrocera* spp) population in peach orchards and should be installed at recommended number and time for management of fruit flies (*Bactrocera spp*).

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