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

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Abstract

Chemical insecticides have hazardous effects on human health and ecosystem hence there is a dire need of the hour to use non chemical eco-friendly tactics for 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 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/lure), while among different traps and lure 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 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 they cause direct damage to horticultural crops but also retard agricultural development and trade in many countries due to strict quarantines for agricultural trade. 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. The fruit fly genus Bactrocera Macquart (Diptera: Tephritidae) contains more than 500 invasive, polyphagous species that infest fruits and vegetables throughout the globe and causes severe economic damage while sometimes Bactrocera spp can cause 100% losses to produce. Therefore, many countries conduct surveillance programs for detection and monitoring of these pests. To control population of fruit flies and to minimize infestation of fruit and vegetables different control strategies are applied including traditional ways and application 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. While most of the farmers rely on application of synthetic insecticides, these chemicals result in quick control of pest and can also be applied on large scale 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.
Thus eco-friendly management tactics such as installation of attractive and sticky traps is necessary to minimize hazardous effects of synthetic chemical insecticides on human health, edible produce and ecosystem [7]. Male of some *Bactrocera* species are strongly attracted to different lures like methyl eugenol, raspberry ketone and cucurbitacin [8] and these volatile substances can attract male fruit flies at distance of about 3 km (Kardin, 2003) [9]. Therefore, farmers use these attractive traps for control of fruit flies infestation in their fields [10]. Different stimuli including visual stimuli, color and shape affect adult fruit flies behavior especially, while finding their host [11]. Thus for effective control of fruit flies (*Bactrocera spp*) by using different traps material, shape and other modifications need special attention [12]. As various types of fruit flies traps have been developed for monitoring and control purposes and the efficacy of these traps depends upon attractant used, shape, environmental conditions, pest population, height of the trap and direction of the trap installed [13], and there are significant differences recorded in efficacy of different traps [14], hence for effective management of fruit flies population appropriate selection of traps is indispensable [15]. 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 [16]. As bait stations are proved to be very effective for management of fruit flies infestation and protection of fruits [17]. Therefore, the current study was conducted with 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) impregnated with different fruit fly lures (Methyl eugenol, Methyl eugenol + Cue lure, Cue lure and Fruition lure) were installed in 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 height of 5 feet from ground on trees within the peach orchard for a period of 18 weeks from 1st week of June 2021 up to 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 was analyzed through Statistix 8.1 for analysis of variance and LSD test was applied for determining difference among the treatments while keeping 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 during 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: 18 cm, W: 10 cm, Dia. 30 cm) having six holes on each side of the trap at equal distance in opposite direction, impregnated with a cotton piece, soaked in a prepared solution of lure were installed in peach orchard at recommended rate of 15 traps/acre. The methyl eugenol and cue 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 25 cm length and 20 cm width were installed at 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 traps/acre. Cotton piece soaked in a 5cc solution or recommended weight of lure was attached to the trap with 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 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 has concluded bottle trap impregnated with fruit fly lure as the most effective and economic tool for management of 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 use of cylindrical bottle trap impregnated with lure for control of peach fruit flies.

| 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                               |

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

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: 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.

The analyzed data regarding trap and lure combination given in table 3 revealed that highest number of adult fruit flies was trapped in Cylindrical Bottle trap impregnated with Methyl eugenol (321 fruit flies/trap/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 combination of methyl eugenol and cue lure for control of fruit flies and suggested that methyl eugenol alone trapped more fruit flies as compared to combination. Our findings are also in similarity with that of Bajaj and Singh (2018) [23] that 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 highest number of fruit flies as 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: Mean number of fruit flies trapped/trap/week in different traps and lures combinations during June-Sep 2021.

| Lure                      | 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 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 highest number of Bactrocera zonata. Quraishi and Hussain (1993) [26] have also reported that Bactrocera zonata is a serious pest of orchards and can be effectively control through methyl eugenol impregnated traps. Khan et al., (2015) [16] have also reported B. zonata as a major 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 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 season (1st week of June 2021) which tended to increase and reached to highest number in mid-season (July 2021) and then tended to decrease again towards end of the season (September 2021). Similarly in Cylindrical bottle traps lowest number of fruit flies was trapped at the onset of 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 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 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 season 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 highest population at mid of the season. Khan et al., (2020) [27] also reported the highest population of fruit flies in mid-season 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. invadens | 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 J           | 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 5% significance level.

Fig 1: Week wise data regarding number of fruit flies trapped in Cylindrical Box trap with different lures combinations for a period of 18 weeks (June-Sep 2021).

Fig 2: Week wise data regarding number of fruit flies trapped in Fruition Nova® trap with different lures combinations for a period of 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 fruit fly (Bactrocera spp) population in peach orchards and should be installed at recommended number and time for management of fruit flies (Bactrocera spp).

References
1. Fazlullah, Muhammad S, Fazal M, Ahmad A, Atta U. Evaluation the efficiency of pheromone traps and monitoring of fruit fly population in peach orchards in Swat valley. Journal of Entomology and Zoology Studies. 2015;3(5):108-109.
2. Elekcioglu NZ. Fruit flies of economic importance in Turkey, with special reference to Mediterranean fruit fly, Ceratitis capitata (Wied.). Türk Bilimsel Derlemeler Dergisi 2013;6(2):33-37.
3. Nishida R, Tan KH. Search for new fruit fly attractants from plants: a review. In Proceedings, 9th International Symposium on Fruit Flies of Economic Importance. 2016.
4. Drew RA, Romig MC. Tropical fruit flies (Tephritidae daciinae) of South-East Asia: Indomalaya to North-West Australasia. CABI. 2013.
5. Suanto A, Sudarjat S, Yulia E, Permana AD, Gunawan A, Yudistira DH. Effectiveness of modified traps for protection against fruit flies on Mango. Jurnal Biodjati. 2020;5(1):99-106.
6. Kardinian A. Vegetable Pesticide Herbs and Applications. Independent Publisher Jakarta. 2000.
7. Kardinian IA. Fruit Fly Handler Crops. Agro Media. 2003.
8. Metcalf RL, Metcalf ER. Fruit flies of the family Tephritidae. Plant kairomones in insect ecology and control. 1992, 109-152.
9. Iwahashi O, Syamusdin-Subahar TS, Sastrodihardjo S. Attractiveness of methyl eugenol to the fruit fly Bactrocera carambolae (Diptera: Tephritidae) in Indonesia. Annals of the Entomological Society of America. 1996;89(5):653-660.
10. Eliopoulos PA. Evaluation of commercial traps of various designs for capturing the olive fruit fly Bactrocera oleae (Diptera: Tephritidae). Intl. J. of Pest Manage. 2007;53(3):245-252.
11. Rizki MMA, Abdel-Galil FA, Temerak SAH, Darwish DY. Factors affecting the efficacy of trapping system to the peach fruit fly (PFF) males, Bactrocera zonata (Saunders) (Diptera: Tephritidae). Archives of Phytopathology and Plant Protection. 2013;47(4):490-498.
12. Navarro-Llopis V, Alfaro F, Domínguez J, Sanchis J, Primo J. Evaluation of traps and lures for mass trapping of Mediterranean fruit fly in citrus groves. Journal of Economic Entomology. 2008;101(1):126-131.
13. Navarro-Llopis V, Primo J, Vacas S. Bait station devices can improve mass trapping performance for the control of the Mediterranean fruit fly. Pest management science. 2015;71(7):923-927.
14. Bhagat D, Samanta SK, Bhattacharya S. Efficient management of fruit pests by pheromone nanogels. Scientific reports. 2013;3(1):1-8.
15. Lasa R, Herrera F, Miranda E, Gómez E, Antonio S, Aluja M. Economic and highly effective trap–lure combination to monitor the Mexican fruit fly (Diptera: Tephritidae) at the orchard level. Journal of Economic Entomology. 2015;108(4):1637-1645.
16. Khan S, Hussain S, Maula F, Khan MA, Shinwari I. Efficacy of different lures in male annihilation technique of peach fruit fly, Bactrocera zonata (Diptera: Tephritidae). J. Entomol. Zool. Stud. 2015;3(4):164-168.
17. Anjum S, Razaq M, Yazadni MS. Studies on seasonal activity and control of fruit flies (Dacus spp.) on mango (Mangifera indica L.) at Faisalabad, Pakistan. Arab Journal of plant protection. 2000;18(2):121-123.
18. Ullah F, Wardak H, Badshah H, Ahmad A, Kakar MQ. Response of male fruit fly (Diptera: Tephritidae) to various food essences in Methyl Eugenol and Cue-Lure
baited traps. Journal of Entomology and Zoology Studies. 2015;3(5):239-245.
19. El-Gendy IR. Elevation of attraction efficiency of Jackson trap on peach fruit fly, Bactrocera zonata (Saunders). International Journal of Agricultural Research. 2012;7(4):223-230.
20. Dominik BC, Kerruish B, Barchia I, Pradhan U, Gilchrist AS, Nicol HI. The influence of mixtures of parapheromone lures on trapping of fruit fly in New South Wales, Australia. Plant Protection Quarterly. 2011; 26(4).
21. Math M. Development and standardization of fruit fly traps against Bactrocera dorsalis Hendel in Custard apple. Journal of Entomology and Zoology Studies. 2017;5(4):462-465.
22. Khan MA, Gogi DA, Khaliq A, Subhani MN, Ali A. Efficacy of methyl eugenol and cue-lure traps for monitoring melon fruit fly in relation to environmental conditions in bitter gourd. J. Agric. Res. 2010;48(4).
23. Bajaj K, Singh S. Response of fruit flies, Bactrocera spp. (Diptera: Tephritidae) to different shapes of methyl eugenol based traps in guava orchards of Punjab. Journal of entomology and zoology studies. 2018;6:2435-2438.
24. Kakar MQ, Ullah F, Saljoqi AUR, Ahmad S, Ali I. Determination of fruit flies (Diptera: Tephritidae) infestation in guava, peach and bitter gourd orchards in Khyber Pakhtunkhwa. Sarhad Journal of Agriculture. 2014;30:241-246.
25. Qureshi ZA, Siddiqui QH, Hussain T. Field evaluation of various dispensers for methyl eugenol, an attractant of Dacus zonatus (Saund.) (Dipt., Tephritidae) . Journal of applied entomology. 1992;113(1-5):365-367.
26. Qureshi ZA, Hussain T. Monitoring and control of fruit flies by pheromone traps in guava and mango orchards. In Fruit Flies. Springer, New York, NY. 1993.
27. Khan M, Memon SA, Solangi BK, Jillani G, Uddin A, Shah SJ et al. Monitoring and management of fruitfly (Bactrocera zonata) population on peach (Pronus persica) Quetta Balochistan-Pakistan. Pure and Applied Biology (PAB). 2020;9(4):2425-2434.