Research Article Open Access

Changes in Height of Pheromone Traps Affect the Capture of Male Fruit fly, *Bactrocera* spp. (Diptera: Tephritidae)

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Received
November 22, 2016

Accepted
March 10, 2017

Published Online
March 31, 2017

Abstract: This study was conducted to evaluate the fruit fly capture in traps at different heights by using methyl eugenol. The field experiment was performed in mango orchards of Mango Research Institute (MRI), Multan, Pakistan. Handmade pheromone traps prepared from soda plastic bottles were used as traps, which were placed at different heights from the ground levels viz. 0 (Ground level), 1, 2, 3, 4, 5, 6 and 7 feet. The results showed that the maximum average male fruit flies (515) were caught at the height of 5 feet, whereas, the minimum (315) were caught at the ground level. These results suggest that for the monitoring of fruit flies, the methyl eugenol traps should be hanged at the height of 5 feet from ground level to get the maximum counts of fruit flies.

Keywords: Fruit fly, Handmade traps, Methyl eugenol, Mango orchard.

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Cite this article as: Hasnain, M., T.K. Babar, H. Karar, M.K. Nadeem, S. Nadeem, S.F. Ahmad and M. Ishfaq. 2017. **Changes in height of pheromone traps affect the capture of male fruit fly, *Bactrocera* spp. (Diptera: Tephritidae).** Journal of Environmental and Agricultural Sciences. 10: 33-39.

1 Introduction

In Pakistan, there is a great demand for fruits. Protecting the available fruit production from the devastation of insect pests can contribute significantly to meet this demand. Among various insect pests attacking the mango fruits, fruit flies (Diptera: Tephritidae) globally have been regarded as the most important pests due to heavy losses they cause. Currently fruit flies are recognized as one of the major pest of the horticultural crops (Vayssiéres et al., 2008). Fruit flies of genus *Bactrocera* are commonly associated to mango, citrus and guava orchards (Irshad et al., 2003). They over winter at adult stage and impose damage by infesting fruits. Female flies lay eggs in soft and tender fruit tissues and subsequently maggots nourish inside the host fruit (Dhilllon et al., 2005).

Fruit flies damage the horticultural production and inflict financial losses by deteriorating quality and quantity of harvested products (Rouse et al., 2005; Copeland et al., 2006; Nadeem et al., 2012; Nadeem et al., 2014). This pest has become the key pest of mango orchards globally (Pena et al., 1998; Vargas et al., 2005). In Pakistan 11 species of genus *Bactrocera*, out of total 43 species, have been marked out from Pakistan (Dhillon et al., 2005). Among these are *Bactrocera zonata*, *B. cucurbitae* and *B. dorsalis* are the most prominent (Abdullah et al., 2001; Abdullah et al., 2002; Stonehouse et al., 2002) infesting apple (*Malus domestic),* bitter gourd, (*Momordica charantia*), guava (*Psidium guajava*), ber (*Ziziphus mauritiana*), mango (*Mangifera indica*)**,** muskmelon (*Cucumis melo*) and snake gourd (*Trichosanthes cucumerina*) (Khan et al., 1999; Sultan et al., 2000; Khan et al., 2005). Sometimes fruit damage can reach

even up to 100% (White et al., 1992; Soesilohadi 2002; Anonymous 2002; Revis et al., 2004; Robacker et al., 2005). In Pakistan, the infestation of fruit flies in guava orchards may reach up to 50-55% (Syed, 1970), while in mango and guava, it may reach up to 74.66% and 46.62% , respectively (Khan et at., 2005). In addition to direct losses caused by fruit flies in terms of yield and marketability of plant products, they also impose a significant threat to quarantine security and consequently to international trade of fruits and vegetables (Joomaye et al., 2000; Dhillon et al., 2005; Qin et al., 2015). Fruit fly attack can significantly be reduced by proper management of infected fruits e.g., collecting and destroying infested fruits, or by chemical control using contact-insecticides (Narayanan and Batra, 1960) and by destroying the pupae through cultural or physical means.

Fruit flies are hard to control as their eggs and larvae are concealed in fruits while they pupate in soil (Stephens et al., 2007). Various ways and strategies have been used in order to control of fruit flies such as mechanical (Broumas and Haniotakis, 1994; Bashir et al., 2014), cultural (Deguine et al., 2015), biological and chemical control (Broumas et al., 2002). Integrated pest management found to be more suitable to reduce the pest attack (Epsky et al., 1998; Manrakhan et al., 1999; Bueno et al., 2002; Gopaul et al., 2002; Rouse et al., 2005). Attractant technique is one of the most important tools of monitoring pest populations and simultaneously applicable to discourage the population of *Bactrocera* spp. (Bueno et al., 2002; Michaud, 2003).

Recently pheromone traps have gained popularity and become a vital tool for pest monitoring in a wide range of agricultural crops. These traps are equipped with a sex pheromone (species-specific), which attract and capture males from field populations and therefore fertile egg production by female flies is reduced (Dhillon et al., 2005). Design of pheromone trap, its placement and ratio of the chemical components are the factors influencing the number of insect capture (Herman et al., 1994).

Methyl eugenol are widely used in pheromone traps to capture fruit flies, which can attract male adults of fruit flies from a distance of 800 m as combined action of phagostimulatory as well as olfactory action (Roomi et al., 1993; Adzim et al., 2016). Methyl eugenol pheromone baited traps have been regarded as one of the cheapest and important measure to monitor the presence and population level. In present study, efforts were made towards determining the optimal height for the placement of methyl eugenol traps in terms of their ability to capture the maximum number of male of *Bactrocera* spp.

2. Materials and Methods

The experiment was performed in orchards of Mango Research Institute (MRI), Multan, Pakistan. The study aimed to determine a suitable height for the placement of handmade pheromone traps in terms of the maximum fruit flies collected. The trap was made by using a clean, empty two liter plastic soda bottle. The upper one third portion of the bottle was removed by cutting along its circumference.

Fig.1. Average number of fruit flies caught in pheromone traps placed at different heights.

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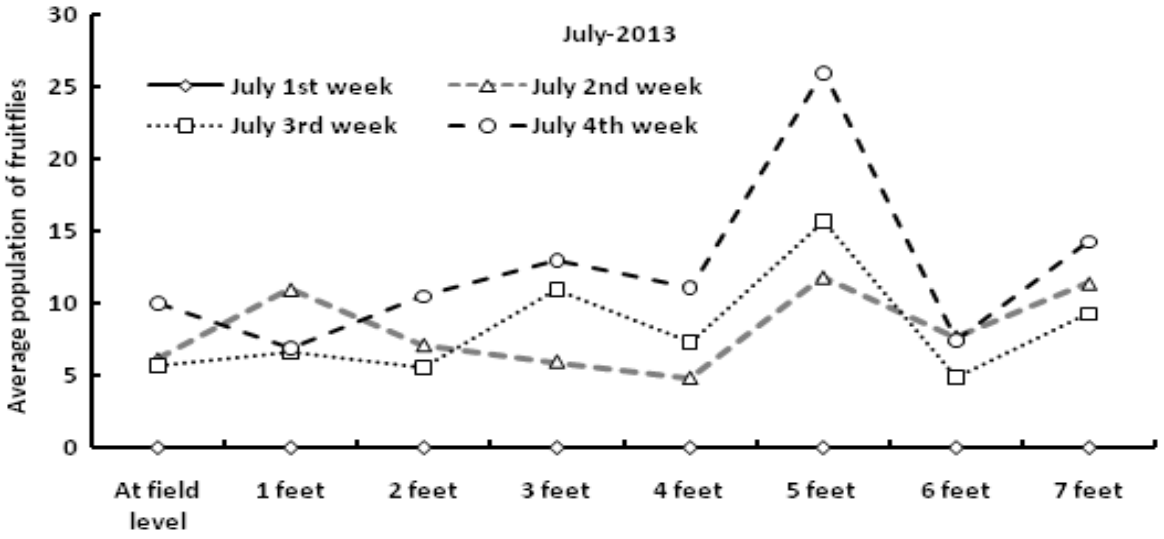

Fig.2. Weekly average population of fruit flies at different heights during July 2013.

Methyl eugenol was prepared by dipping cotton wicks (5cm long and 1cm diameter) in methyl eugenol (20% with > 96% purity, Jiulin Hutai, China) and placing in the bottom of cup shaped lower portion of soda bottle.Then, its upper cut part was turned down and inserted it into the lower cup shaped bottom part; sealed the joint at the top of the bottle with duct tape.

A ten feet iron pipe was installed in mango orchard in between trees, on which eight pheromone traps were hanged at heights from ground level i.e. 0 (or ground level), 1, 2, 3, 4, 5, 6 and 7 feet, during peak fruit fly activity months of July, August and September, 2013. The experiment was laid in randomized complete block design (RCBD) and replicated five times. The captured fruit flies were counted to record the daily variations in the fruit fly population from each trap at all the tested heights. Fortnightly methyl eugenol pheromone made lures were changed in each trap. Compiled data was subjected to analysis of variance (ANOVA) using Statistix 8.1 statistical package. The treatment means were compared using Tukey HSD Test at p= 0.05 probability level.

3. Results and Discussion

3.1 Height of trap

Data shown in bar diagrams (Fig. 1) indicate that the highest population (515 per trap) of fruit flies was observed in the traps placed at 5 feet height followed by 7 feet (439 per trap).

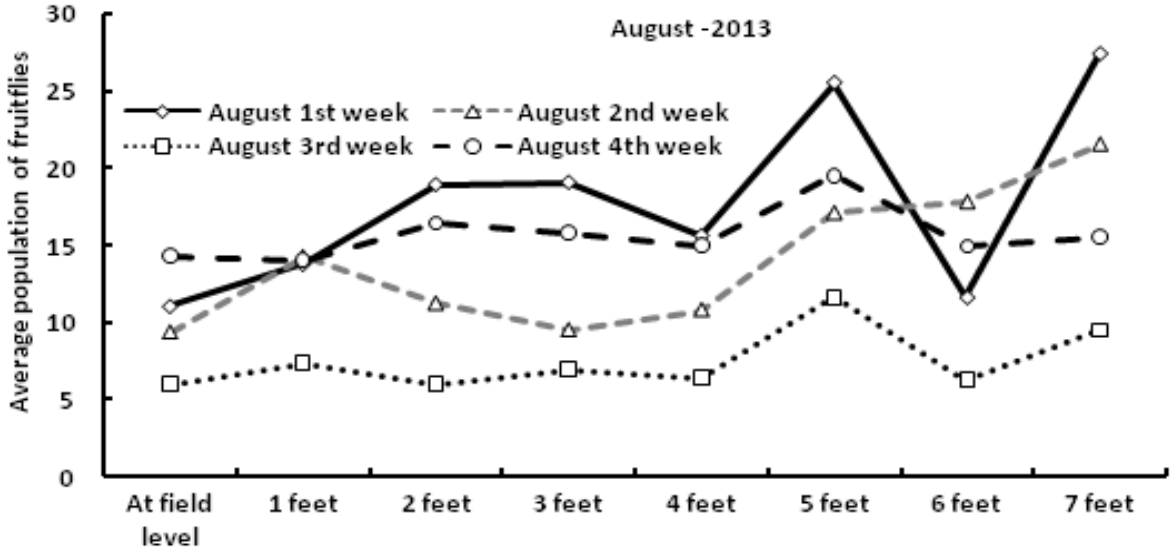

Fig. 3. Weekly average population of fruit flies at different heights during August 2013.

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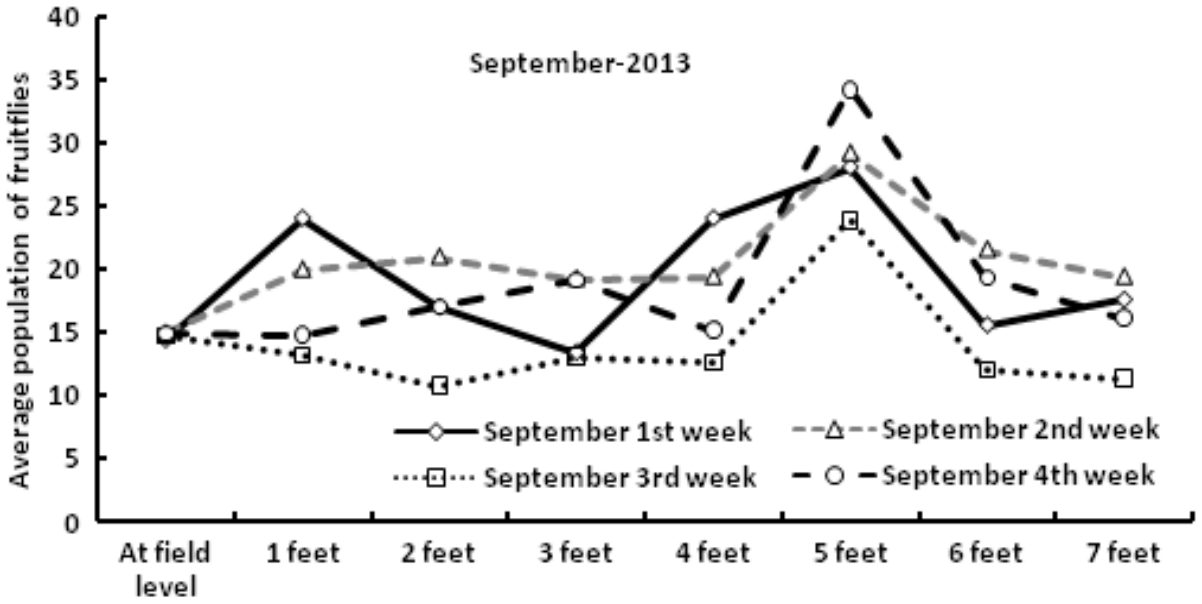

Fig. 4. Weekly average population of fruit flies at different heights during September 2013.

All the treatments in which traps were placed at the height of 1, 2, 3 and 4 feet (368, 365, 384 & 363 per trap respectively) were remained statistically non-significant. Among the tested pheromone heights lowest fruit fly population (315 per trap) was captured in the pheromone traps placed at the ground level. These results coincide to the work done by El-Gendy, 2012, who reported that suitable height for hanging pheromone traps in mango orchards is 1.5 meter to capturing maximum male fruit flies.

3.2 Average fruit fly population

During the month of July, the highest fruit fly population was caught in the traps placed at 5 feet height (4th week of July) followed by the pheromone traps placed at height of 7 and 3 ft, as shown in Fig. 2. Similarly, the lowest population of fruit fly was observed at ground level (GL), 1, 2, 4 and 6 feet, respectively. During the 2nd and 3rd week of July, population of fruit flies remained almost same while, the population captured at 5 feet height remained as the highest. Results obtained in this study supports findings of Marwat et al. 1992, they also found higher number of fruit flies caught in the pheromone traps at 5 feet above the ground.

Fruit flies captured during the month of August are presented in the Fig. 3, indicating similar trend, as observed during the month of July. Maximum number of fruit flies were captured in the traps located at 5 feet height (1st week of August) followed by the trap installed at 7 and 3 feet height. The lowest population of fruit fly was observed in the traps placed at GL followed by traps installed at 1, 2, 4 and 6 feet height, respectively. Except first week of August, population of fruit flies captured in the traps was observed in close range, with higher capture of fruit flies at 5 feet height. Gencsoylu et al. (2006), recommended installing at 1.5-2m above the ground level while EL-Messoussi et al. (2007), recommended at 1-2 m to get the maximum fruit flies capture which strengthen the results of this study.

The results in Fig. 4 describe population of fruit flies captured during the month of September. Maximum number of fruit flies was caught in the traps fixed at 5-feet height (1st week of September) followed by the traps placed at heights of 7 feet and 3 feet height. Like earlier months minimum population of fruit flies were recorded from traps placed at GL followed by traps placed at heights of 1, 2, 4 and 6 feet, respectively. Whereas, during 2nd, 3rd and 4th week of September, the population of fruit fly remained almost the same from GL to 4 feet height while the highest counts recorded at 5 feet height. Qureshi et al., (1992) mentioned that pheromone traps caught the maximum number of male fruit flies when installed at 2 feet above the ground level. On the other hand Siddiqui et al. (2003) observed that the maximum number of peach fruit flies was captured at 10 feet followed by 8, 6, 2 and 4 feet height from ground level. Furthermore, a significantly high capture of *Rhagoletis cingulated* (Loew) was achieved in un-baited pheromone traps hung at 15 feet within cherry trees (Pelz-Stelinski et al., 2006).

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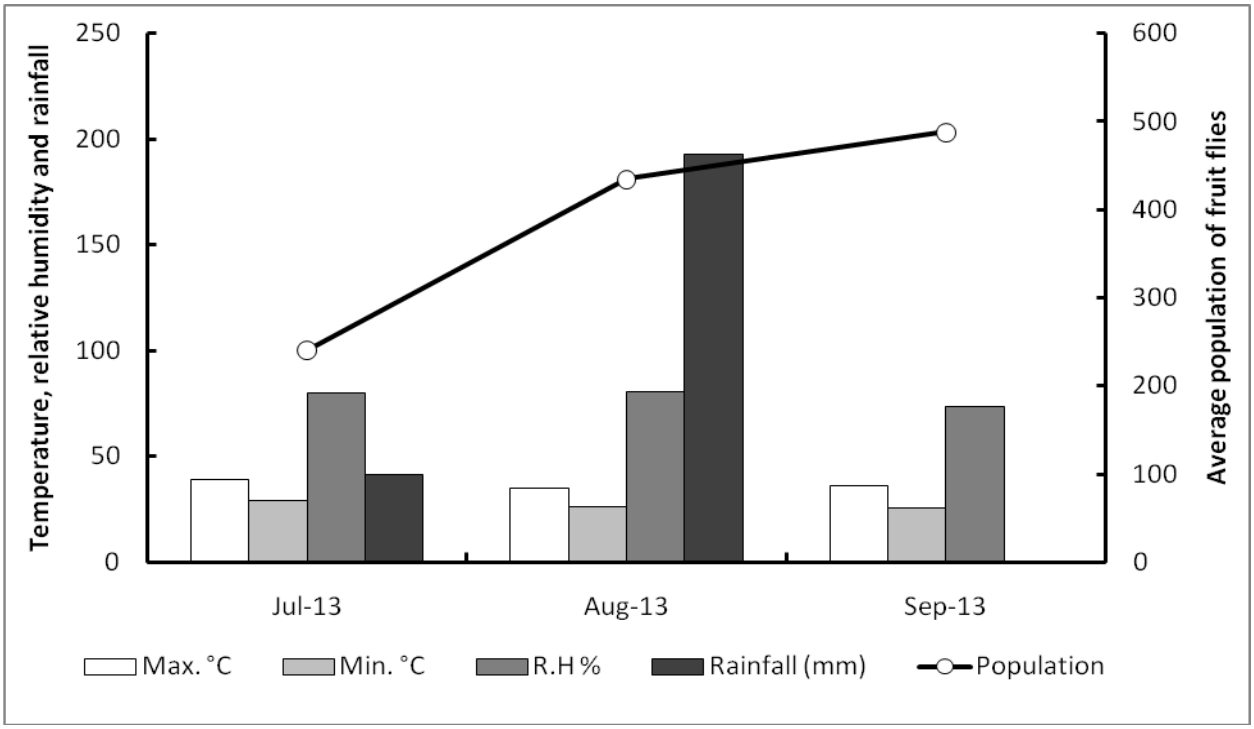

Fig. 5. Trend of population of fruit flies, average temperature (maximum and minimum), relative humidity and rainfall.

3.3 Average fruit fly population in relation to temperature and relative humidity

The flies remained active throughout the year in different fruit orchards and vegetables. In mango orchards, the population build up was started in July. However, it got a peak during 4th weeks of August and September, followed by another relatively smaller peak at 4th week of September.

Analysis of fruit fly population captured in pheromone traps in relation to temperature and relative humidity showed that the maximum fruit flies were trapped during the month of September characterized with the temperature range of 25.8 to 36.1^{o}C and relative humidity was 61.3% (Fig. 5). Bagle and Prasad (1983) reported a positive relationship of weekly trap catches of *B. dorsalis* with average temperature and a negative relationship with relative humidity, rainfall and wind velocity. Their findings are in agreement with our results. Agarwal et al. (1995) also noted a significant positive correlation between pheromone trap catches of *B. dorsalis* and maximum and minimum temperature. So, monitoring helps to identify fruit fly pests, follow variations in their population levels and ultimately help in decision making about its control measures.

4. Conclusion

The comparison among different heights of pheromones traps suggested that they should be hanged at the height of 5 feet in mango orchards from the ground to get maximum counts of *Bactrocera* spp.

Acknowledgements: The authors highly acknowledge the cooperation provided by Directorate of Mango Research Institute, Multan, Pakistan for allowing us to conduct this research work in their mango orchards.

Competing Interest: The authors declare that there is no potential conflict of interest.

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